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Parallel Processing in Monte Carlo Integration

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***Abstract*:** Monte Carlo Integration (MCI) is an algorithm for numerical integration using random numbers. MCI methods are used for the approximate evaluation of definite integrals which are usually multidimensional integrals. In usual numerical integration algorithms, evaluation is done for the integrand on all points of a regular grid. However, the proposed method, Monte Carlo (MC) methods select the points in random basic to evaluate the integrand. Informally the MCI algorithm first picks a simple domain *u* whose area is easily calculated and which contains *v*, to estimate the area of a domain v. Now it picks a sequence of random points that fall within u. There are also some points of actions that fall within v. The area of *v* is then estimated as this fraction multiplied by the area of *u*. The main contributions of this paper are the MC algorithm for parallel implementation. Parallelization strategies namely Open Multi-Processing (OpenMP) and Message Passing Interface (MPI) have been developed and the performance of parallel programs analyzed.

***Keywords*:** Monte Carlo Integration, OpenMP, MPI, random numbers, simulation

I. Introduction

Monte Carlo (MC) is derived from the name of a European city referring the nature of people there who play games of chance, which involve randomness. Since its first use, the term "Monte Carlo method" is used to represent a wide range of problem solving techniques that use random numbers and the statistics of probability. In MC methods, simulating or calculating physical phenomena is done based on randomness. MC simulations typically are parallel. The evaluation of integrals is the most common application of MC simulation. This is also the basis of Monte Carlo Integrations (MCI). Parallel MC is effective rate of convergence independent of integrand's dimension [5,8]. When integrand has 6 or more dimensions, parallel MC method is superior.

Previous studies focus on studying the MCI with conventional processing power and older version of CPU and therefore a decision is made to extend the research to accelerating MC simulation by harvesting the power dormant in the modern CPU. The main objectives of this research paper are: to solve practical application problems using MC simulation and to provide a range of possible results in cases when it is impossible to arithmetically calculate just one solution. Judging the solution obtained upon parameters of accuracy and time taken for computation. If complex codes run sequentially on a single core machine, it leads to lesser accuracy and also more time taken for the application to run and give final results. Hence, when parallel MC simulation techniques is used, not only the power of parallelization is exploited, but also leads to a higher accuracy in the solutions

II. Monte Carlo Integration

According to the mean value theorem

$$I = \int_c^d f(x)dx = (d-c)\overline{f}. \tag{1}$$

In equation (1), $\overline{f}$ is the mean value of f (x) in the intervals [c; d].

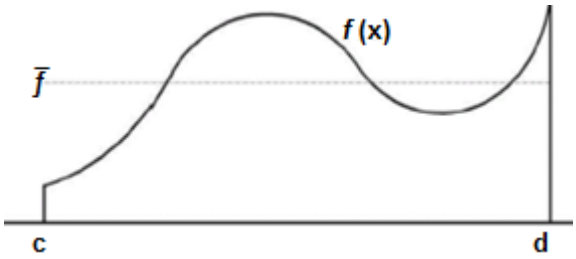

Figure 1. The Integral Diagram of the Function f(x)

The value of I is estimated with MC method by evaluating f (x_i) at n points selected from a uniform random distribution over [c; d] as shown in figure 1.

Expected value is

$$\frac{1}{n}\sum_{i=0}^{n-1} f(x_i) = \overline{f}. \tag{2}$$

According to equation (1) and equation (2), the value of integral (I) is estimated the following calculation:

$$I = \int_c^d f(x)dx$$

$$= (d-c)\overline{f}$$

$$\approx (d-c)\frac{1}{n}\sum_{i=0}^{n-1} f(x_i) \tag{3}$$

A. Hit or Miss Method

In this method, height h, width (d-c), and area A=h (d-c) are imagined to form a rectangle. The function *f* (x) is denoted within the boundaries of that rectangle [6]. Number Pairs of random numbers x_i, y_i are computed between $c \le x_i \le d$ and $0 \le y_i \le h$. The points fraction x_i, y_i that satisfy the condition $y_i \le f(x_i)$ is an estimate of the ratio of the integral of *f* (x) to the area of the rectangle as shown in figure 2. Therefore, the estimate F_n in the hit or miss method is given as

$$F_n = A\frac{n_s}{n_t} . \quad (4)$$

In equation (4), n_s are the number of points below the curve, and n_t is the total number of points.

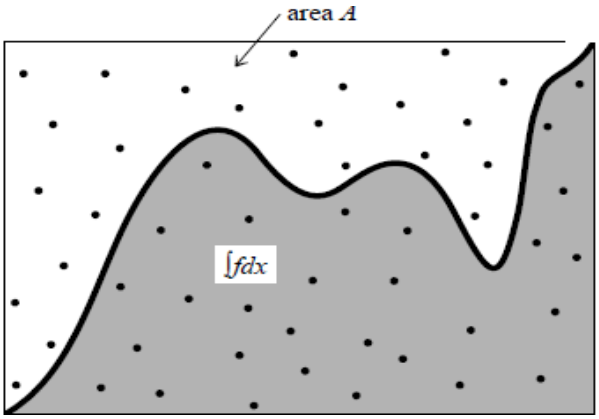

Figure 2. Hit or Miss Method of the Monte Carlo Integration

III. A Serial Implementation of the Monte Carlo Integration

MCI or MC method is the method of simulating stochastic variables in order to approximate entities. This is applied in applications where complicated integrals frequently arise and solutions are close to a rarity such as Mathematics. This method is often used for complex, nonlinear models, which involves more than just a couple uncertain parameters.

A. Algorithm for Serial Implementation

The MCI procedure for serial implementation is as follows:

1. The range of X and Y coordinates where the random number will be placed are identified.
2. The area of the rectangle using the X and Y range is computed.
3. The random process is done. All the random numbers (X,Y) will fall within the rectangle. Many points below the curve are counted.
4. The sum of points below the curve is divided by the number of iterations to get the proportion of points below the curve to the total number of points.
5. This proportion is multiplied by the area to get the probability.

B. Pseudo Code for Serial Implementation

Pseudo code for serial implementation is described with the following functions.

```
PROGRAM montecarlo_integration
  READ  input(…)
  DO iteration = 1,    number_of_ iterations
    GENERATE  random_number(…)
    CHECK  random _number (…)
  END DO
 COMPUTE  area(…)
END PROGRAM montecarlo_integration
```

IV. A Parallel Implementation of the Monte Carlo Integration

In MCI, parallel implementation needs the random sequences that are distributed to the different nodes. The random sequence is distributed either by communication or by a local generation of the sequence [3, 7].

A. Master-Workers Paradigms

The worker nodes are responsible for generating random numbers and computing the MC sub-sums. The derived sub-sums are passed to node 0 (Master) that finishes the sums. The MPI_Reduce( ) function is then used to expedite the global sums. Figure 3 shows a master workers parallel programming scheme: step a is that node 0 send the data points assigned for each worker and step b sends the computed integral at the assigned data points for the master.[1,2,4]

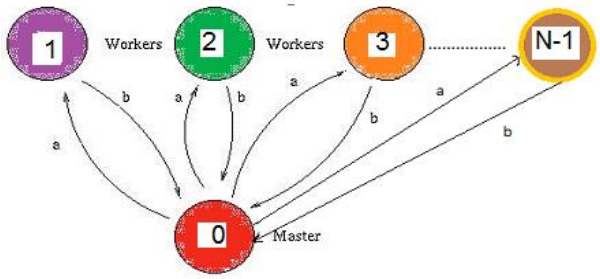

Figure 3. Master Workers Paradigms

B. Algorithm for Parallel Implementation

Steps in algorithm for parallel implementation are as follows.

1. Two random numbers (x,y) are generated between [c,d] for x, and between [0,h] for y in each worker node. This is done for a given specified number of times.
2. Whether the generated random pairs satisfy y < f(x) or not, each worker node checks i.e. if the pairs are below the curve of *f*(x). For each successful process, the counter is increases by one. This loop continues up to the given specified number of times.
3. Except node 0, each worker node sends its count to node 0.
4. All the counts received from other nodes are summed at node 0. And it calculates the area and prints out the result.

C. Pseudo Code for Parallel Implementation

Pseudo code for parallel implementation is shown in the following code.

```
PROGRAM montecarlo_integration
   [MPI startup]
  IF (node == 0) THEN
    READ data(…)
  END IF
DO iteration = 1, number_of_iterations
    GENERATE random_number(…)
    CHECK  random _number (…)
  END DO
  IF (node == 0) THEN
         [receive random _number]
  ELSE
         [send random _number]
  END IF
  SUM  global_sum_from_local_sub_sum(…)
  COMPUTE  area(…)
   [MPI stop]
END PROGRAM montecarlo_integration
```

Each worker node generates two random numbers with the following code segments.

```
for (int i = 0;i<n;i++)
  {
   double x = (double)2*rand()/
  (RAND_MAX + 1.0);
  double y = (double)8*rand()/
  (RAND_MAX + 1.0);
  }
```

Each worker node checks if the generated random pairs satisfy $y < f(x)$ with the following code segments.

```
            if (y < x*x*x)
             {
                count++;
             }
```

Node 0 sums all the counts received from other node with the following code.

```
if(node ==0)
   {
     totalcount = count;
     for(int i =1;i<numprocs;i++)
       { source = i;
         MPI_Recv(&count,1,MPI_DOUBLE,
         source,tag,MPI_COMM_WORLD, &status);
         totalcount+= count;
       }
     }
```

Except node 0, each worker node sends its count to node 0 with the following code.

```
MPI_Send(&count, 1, MPI_DOUBLE, dest,
tag,MPI_COMM_WORLD);
```

Node 0 calculates the function area with the following code.

```
if(node==0)
 {
  double resultarea =   (double)16*totalcount/
 ((double)(numprocs*m));
  std::cout<<"area = "<<resultarea<<"\n";
 }
```

D. Implementation of Parallel Monte Carlo Integration with Open Multi-Processing

The program uses OpenMP directives to allow parallel computation. The disadvantage of OpenMP is that overheads can become an issue when the size of the parallel loop is too small. The computation is fully parallel with the following code segments.

```
#pragma omp parallel
 tdata= omp_get_wtime();
{
   srand((int)time(NULL) ^ omp_get_thread_num());
   for(int i = 0;i<n;i++)
     {
      double x = (double)2*rand()/(RAND_MAX + 1.0);
      double y = (double)8*rand()/(RAND_MAX + 1.0);
       }
 }
```

V. Results and Discussion

The computational time of using the MC method is shown in Table 1.

Table 1. Results Obtained after Four Consecutive Trial Runs with Various Samples

Number of Samples	Serial Execution Time (seconds)	OpenMP Execution Time (seconds)	MPI Execution Time (seconds)
10,000,000	2.01	1.84	1.77
100,000,000	18.37	17.01	11.28
1,000,000,000	192.47	181.56	86.69
10,000,000,000	283.00	248.85	120.74

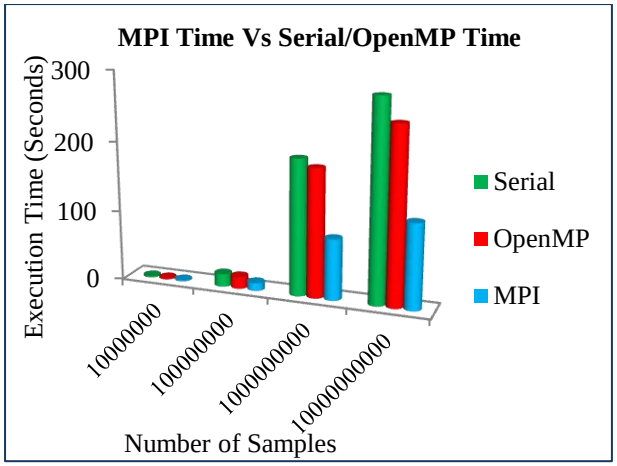

Figure 4. Variation of Execution Time with Number of Samples

The execution time for serial processing and the execution time for parallel processing are obtained while the program is executed with corei7 multiprocessor. Comparison on execution times of parallel version with the sequential version is shown in figure 4. MPI execution time and OpenMP execution time goes faster than serial execution time. MPI execution time goes faster than OpenMP execution time. So it can be observed that MPI execution time is fastest. From table 1 and figure 4, it can be observed that parallel computing is more suitable for enormous data.

Table 2 shows speedup for various sample using serial and parallel programming interfaces.

Table 2. Relation between the Number of Samples, and Speedup of Serial and Parallel Programming Interfaces

Number of Samples	Serial Speedup	OpenMP Speedup	MPI Speedup
10,000,000	1	1.09	1.13
100,000,000	1	1.08	1.63
1,000,000,000	1	1.06	2.22
10,000,000,000	1	1.14	2.34

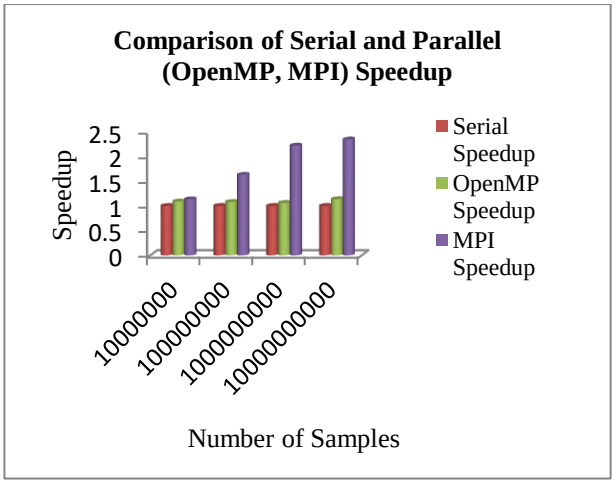

Figure 5. Comparison of Serial and Parallel (OpenMP and MPI)Speedup

Figure 5 demonstrates that the performance of parallel programming interfaces is superior to that of sequential for all the number of data sets tested here. The speedup depends on the efficiency of software, hardware and their application. The experimental results show that parallel algorithms using MPI achieve comparable accuracy over the traditional serial version and OpenMP version. MPI can be used on a wider range of problems than OpenMP.

VI. Conclusion

This research has investigated the feasibility of parallelizing MC methods for estimating integral. Because of the non-communicative nature of MC methods for estimating integrals, it was thought that they would parallelize well. Applying parallel MC technique can give good results and reduce significantly the computing time. The advantage of MC is tractable and adaptable with problems in higher dimension. It's important that each processor use different random numbers. Approach to computing integral using random positions, called samples, whose distribution is carefully chosen. MC fluctuates in time because of random events. System can be in various states. MC depicts movements between states. At present, the applications of the MC method find their utility in: cancer therapy, forecasts of all type, solving some traditional physics problems, such as the planets evolution and designing the nuclear reactors. Likewise, the MC method is used, in the processes of modeling the chemical materials and products, modeling the metallic alloys and the analysis of polymer structure.

As a future work Graphical Processing Units (GPUs) will be used for faster computations of MCI. GPU are attractive for scientific computation as they offer the potential speed-up of multi-processor devices with reasonably low cost. It also has additional advantage of low maintenance, efficient energy and dedicated local devices that are easy to program.

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Implementation of Ticket Reservation System by Timestamp Based Distributed Certificate Concurrency Control

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Abstract: Concurrency control in database systems is an important problem for the simultaneous execution of transaction over a shared database can create several data integrity and consistency problem. In order to transactions to operate concurrently on a shared database, a protocol must be adopted to coordinate their activities. Most distributed concurrency control algorithms fall into one of three basic classes: locking algorithms, timestamp algorithms, and optimistic or certification algorithms. Timestamp ordering associates timestamps with all recently accessed data items and requires that conflicting data accesses by transactions be performed in timestamp order. The distributed certification operates by exchanging certification information during the commit protocol. Distributed certificate restarts the conflict transaction to handle and give messages complete their work. This system presents concurrency control for Ticket reservation system which proves that distributed certification algorithm performs better than timestamp ordering. Distributed databases are implemented at the sales center and main office is the central database for all ticket sales.

Keywords: Concurrency Control, Distributed concurrency control, timestamp ordering, distributed certificate.

I. Introduction

From the previous years, Distributed Databases have taken consideration in the database research network. Information dispersion and replication offer open doors for improving execution through equal inquiry execution and burden adjusting just as expanding the accessibility of information. Truth be told, these open doors have assumed a significant job in propelling the plan of the current age of database machines.

A distributed database system (DDBS) is an assortment of a few intelligently related databases which are truly circulated in various PCs (in any case called locales) over a PC arrange. In database the board frameworks, simultaneousness control is a significant issue for the synchronous execution of exchange over a mutual database can make a few information trustworthiness and consistency issue. With the end goal for exchanges to work simultaneously on a mutual database, a simultaneousness control calculation must be embraced to arrange their exercises. In Optimistic Concurrency Control (OCC), exchanges are permitted to execute unhindered until they come to their submit point, at which time they are approved. OCC gives opportunity from gridlock. The execution of an exchange consists of three stages, read stage, approval stage, and compose stage [11].

A large portion of the dispersed simultaneousness control calculations come into one of three essential classes: locking calculations, Timestamp calculations, an idealistic (or confirmation) calculations. Many proposed calculations looked into and portray how extra calculations might be integrated by joining fundamental systems from the locking and timestamp classes.

In this paper, Section 1 is the introduction of the system, and Section 2 presents related work of the system. And then, Section 3 describes background theory, and system overview is described in section 4. Section5 is implementation of the personalization system and its results. Finally, *S*election6 is conclusion of the system.

II. Related Works

The capacity of simultaneously dealing with the undertakings put together by the various clients is one of the fundamental prerequisites forced on the database framework. Database simultaneousness control manages the issues emerging when the clients all the while procedure shared information. Simultaneousness implies that various clients approach the database simultaneously. The fundamental goal of simultaneousness control calculations is to locate a right and proficient synchronization of simultaneous procedures getting to the mutual database assets. In such a framework every client must be secured against others. We should maintain a strategic distance from the circumstance wherein one client is adjusting an article in the database, while another client is understanding it.

Critical depend on locking and identify struggle when they happen and resolve them utilizing

blocking. The synchronous gets to on shared information things are overseen by locks. At the point when an information thing is bolted by an exchange, different exchanges that need to get to this information thing will be suspended until the lock on it is discharged. In critical framework, activities can defer pointlessly and can get into stop circumstances because of unbounded holding up because of blocking, where a gathering of activities can't continue in light of the fact that each activity in the gathering is hanging tight for a lock held by some other activity in the gathering. This implies helpless throughput, if exchanges invest a great deal of energy holding up in a blocked state. [1]

The essential thought of a hopeful simultaneousness control instrument is that the execution of an exchange comprises of three stages: read, approval and compose stages. For all hopeful simultaneousness control (OCC) plans a contention is identified after the information object has been gotten to. In the OCC, strife location and goals are both done at the confirmation time when an exchange finishes its execution; it demands the simultaneousness control chief to approve all its got to information objects. In the event that it has not yet been set apart for prematurely end, it enters the submit stage where it composes every one of its updates to the database.

Idealistic simultaneousness control conventions [3,2] have the decent properties of being non-blocking and gridlock free. In light of, in a critical framework with locking, it is important to secure the fitting lock (by sending a lock demand) before getting to an item. In this way, a full circle arrange delay is required in any event, when perusing an article. This postponement is important to guarantee two things: the activity must peruse (or alter) an exceptional duplicate of the item and the locking rules must be kept up. Note that a system lock demand is nearly as exorbitant as a solicitation for a duplicate of the item, since the expense of a message is autonomous of message size, for objects of sensible size. In idealistic framework an activity can peruse objects without utilizing any system messages.

Hopeful framework can keep away from the postponement related with sending lock asks for and lessen the quantity of messages that must be prepared by the framework: as more messages are sent, message transmission times and message handling times both increment. In skeptical framework, must send one message for each lock demands, alongside certain messages at activity submit time. In any case, hopeful methodology, just send messages at submitted time. The hopeful submit time messages would bigger than the negative submit time messages, since they should incorporate some additional data utilized for approval. In any case, the quantity of messages is a higher priority than the size of each message. [6] Optimistic methodologies are superior to locking conventions, [8, 4].

III. Theory Background

A. Concurrency Control

Concurrency means that different users have access to the database at the same time. The task of a concurrency control mechanism is to ensure the consistency of the database while allowing a set of transactions to execute concurrently [10].

B. Concurrency Problems

Concurrency problems include-

- Lost or buried Updates
- Inconsistent Analysis (Non repeatable Read)
- Uncommitted Dependency (Dirty Read)
- Phantom Reads

1) Lost or Buried Updates

This problem occurs at the point when at least two exchanges are perused and update on similar information thing at the offer database. Every exchange is unconscious of different exchanges.

In the event that a subsequent exchange read a thing for update after the main exchange has understood it, yet before the principal exchange has submitted. Whichever of the exchange submit first, that update will be lost.

2) Inconsistent Analysis (Non repeatable Read)

An exchange, in the event that it peruses similar information thing more than once, should consistently peruse a similar worth.

Non repeatable read emerges when a subsequent exchange gets to similar information thing a few times and peruses various information each time in light of the fact that the another exchange has been refreshed this thing while the subsequent exchange is perusing. Conflicting examination includes numerous read (at least two) of a similar thing and each time the data is changed by another exchange; therefore, this term is non repeatable perused.

3) Uncommitted Dependency (Dirty Read)

A transaction, if it retrieve or update a data item that has been update by another transaction but not yet committed by that other transaction. Dirty read is like to inconsistent analysis, the item read by the one transaction was committed by the other transaction that made the change.

4) Phantom Reads

A transaction re-executes a query, finding a set of data not equal to a previous one-although the search condition is unchanged. Phantom reads may causes when inset or delete action is performed against a

row that belongs to the range of rows being by a transaction.

C. Types of Concurrency Control

The task of a concurrency control mechanism is to ensure the consistency of the database while allowing a set of transactions to execute concurrently. Basic two kinds of Concurrency Control

1. Pessimistic Concurrency Control (PCC) - avoid any concurrent execution of transactions as soon as conflicts that might result in future inconsistencies are detected. Pessimistic concurrency control mechanisms have been based on two-phase locking, multi-version timestamps and hybrids of these approaches.

2. Optimistic Concurrency Control (OCC) - allow such transactions to proceed at the risk of having to restart them in case these suspected inconsistencies materialize. Optimistic methods are based on validation.

3. Timestamp Concurrency Control

D. Timestamp Concurrency Control

Timestamp ordering algorithm employs transaction startup timestamps, but it uses them differently. Rather than using a locking approach, BTO associates timestamps with all recently accessed data items and requires that conflicting data accesses by transactions be performed in timestamp order [9].

Transactions that attempt to perform out-of-order accesses are restarted. When a read request is received for an item, it is permitted if the timestamp of the requester exceeds the item's write timestamp. When a write request is received, it is permitted if the requester's timestamp exceeds the read timestamp of the item; in the event that the timestamp of the requester is less than the write timestamp of the item, the update is simply ignored (by the Thomas write rule).

For replicated data, the "read any, write all" approach is used, so a read request may be sent to any copy while a write request must be sent to (and approved by) all copies. Integration of the algorithm with two-phase commit is accomplished as follows: Writers keep their updates in a private workspace until commit time.

Timestamp (TS): a number associated with each transaction
Can be assigned by a logical counter
Unique for each transaction
Should be assigned in an increasing order for each new transaction

Timestamp associated with each database item

- Read timestamp(RTS):the largest timestamp of the transactions that read
- the item so far
- Write timestamp(WTS): the largest timestamp of the transactions that write the item so far

In the timestamp ordering, when read request arrives, the validation is performed locally and if the validation is passed, read request is allowed. Otherwise, it is aborted and rejected.
When write request is arrives, this request is sent to other coordinators. Coordinates validates the write request locally and sent back to sender coordinator. If the validation passes, write request is committed in all coordinators.

- After each successful read/write of object O by transaction T the timestamp is updated

-RTS(O)=max(RTS(O),TS(T))
-WTS(O)=max(WTS(O),TS(T))

- Given a transaction T
- If T wants to read(X)
  - If TS(T) < WTS(X) then read is rejected, T has to abort
  - Else, read is accepted and RTS(X) updated.

Write-Read conflict

- If T wants to write(X)
  - If TS(T) < RTS(X) then write is rejected, T has to abort
  - If TS(T) < WTS(X) then write is rejected, T has to ignore
  - Else, allow the write, and update WTS(X) accordingly

E. Distributed Certificate

Distributed Certificate is the distributed, timestamp-based, optimistic concurrency control algorithm from, which operates by exchanging certification information during the commit protocol. For each data item, a read timestamp and a write timestamp are maintained. Transactions may read and update data items freely, storing any updates into a local workspace until commit time. For each read, the transaction must remember the version identifier (i.e., write timestamp) associated with the item when it was read. Then, when all of the transaction's cohorts have completed their work, and have reported back to the master, the transaction is assigned a globally unique timestamp. This timestamp is sent to every partner in the "plan to submit" message, and it is utilized to locally confirm the entirety of its peruses and composes as follows: A read demand is affirmed on the off chance that (i) the adaptation that was perused is as yet the current form of the thing, and (ii) no compose with a fresher timestamp has just been privately guaranteed. A compose demand is guaranteed in the event that (i) no later peruses have been confirmed and in this way

dedicated, and (ii) no later peruses have been privately ensured as of now.

IV. The Implementation of the System

This system is an implementation of proving concurrency control using Optimistic Concurrency Control (OCC) Algorithm. Distributed Certificate is used in OCC algorithm. It is a concurrency control schemes for client – server systems. There may be concurrent accesses to the same ticket and in such case, conflicts may occur.

Hence concurrency control is necessary to solve the concurrent conflicts.

In this system, distributed certification approach is used for controlling concurrent accesses. Distributed certification is based on timestamp ordering approaches, which restarts instead of aborting the transactions. Client fetch objects from server machine operate on them locally and send back any modifications to the server.

Our system used highway ticket sales system as a case study of Distributed Concurrency Control. Ticket Center will be implemented as the central database holding bus, trip plans and ticket information. There are three sales centers to generate the concurrent transactions. Concurrency control by distributed certificate is implemented in the Ticket Center to control the concurrent transactions. System architecture is explained in figure 1.

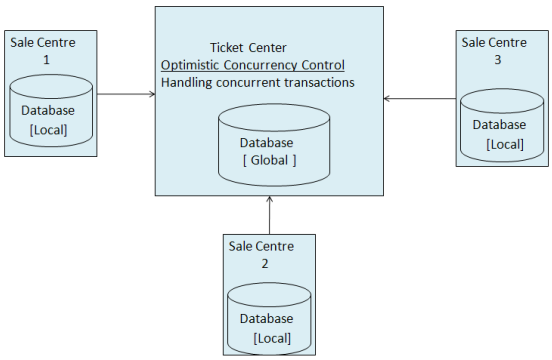

Figure 1. System Architecture

The system architecture consists of two layers. There are the Main layer (The Server of the system/ Main Sale Center) and the Client layer (The other Sale Center). The system always checks the server database contents and the client database contents for the data consistency.

Algorithm 1: ***Distributed Certificate Algorithm of the System***

```
Global Variables: ReadSet, WriteSet
Algorithm BuySeats
Input: SeatNum, Tripdate, DepetureTime, salescenter, customer
Local Variables: localRead, localWrite

Begin

   TWS =CreateWriteSetTransaction (SeatNum,Tripdate, DepeturTtime);

    if (ReadSet.TimeStamp > TWS.TimeStamp)

     {MessageBox.Show ("Your current selected
       Seat No… is held by Other Sales center(sale
          center name)@ month day, year (h:m:s)
           Check again in next 3 minutes!");
                        // at the late Write Set site

      MessageBox.Show ("Are you sure to buy for
       your selected item? Because other client
         also selected for this seat. If not confirm,
         please release it! ");}
                        // at the early Read Set site

      TWS.restart ();
       return;

     }
   Else{  salesid  GetNewSalesID;
          Tripid   GetTripPlanID(SeatNums,
          date, time);
      for each (seatnum in SeatNums)

INSERT Seats SET SeatStatus = "BOOK" WHERE SeatNumber = @seatnum AND TripID =  @tripID;

INSERT INTO transaction VALUES (@TripID, @SaleCenterID, @SeatNo, @Transaction Time);

DELETE tempSeat WHERE Trip= @TripID AND SalesCenter = @SalesCenterID AND SeatNo = @SeatNo;
 end for
 Certification();

    TWS.commitTransaction();
}
End
```

A. Process Flow of the System

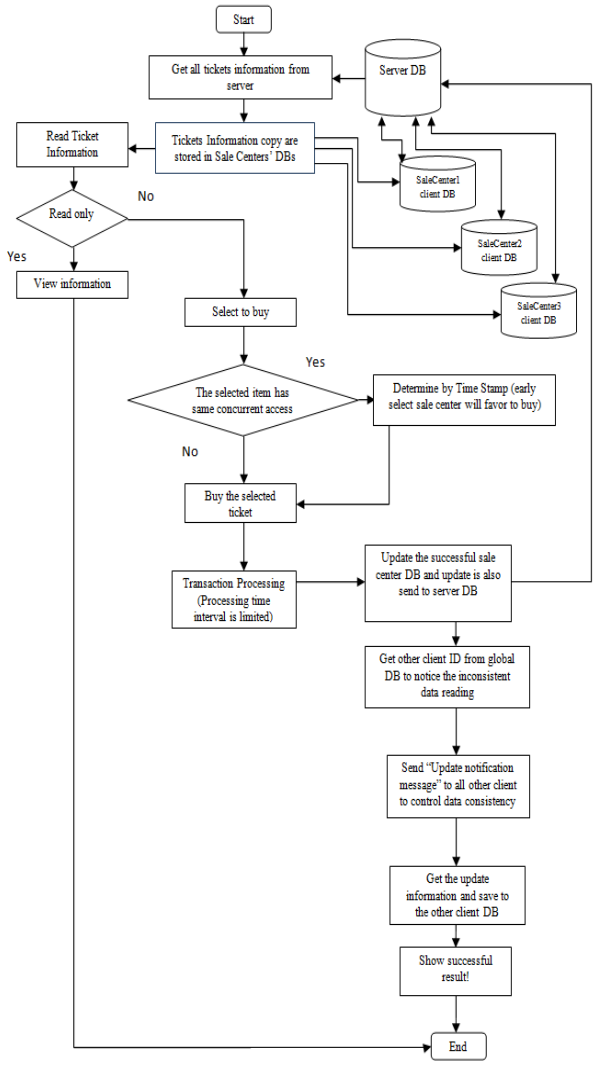

Figure 2. Process Flow of the Proposed System

In this system, there are two types of operations, customer query (READ operation) and buying tickets (WRITE operation).

Buying tickets will be included customer query operation.

Customer will buy tickets only after looking which seat is available and which seat is better. So he / she will select ticket for buying.

This system is implemented as distributed system and hence, there may be more than one sales center and conflicts may be occurred.

Conflicts are controlled by distributed certificate algorithm based on timestamp.

After transactions are committed or restarted, seat status is shown again.

B. Benefits of the system

The main advantage of the system (OPT using Distributed Certificate) is dead –lock free thus saving the expense that deadlock detection usually required in locking approach. Procedure can be simultaneously without influencing different procedures and without fizzling. Getting objects at the customer side and working there locally significantly decreased the handling time and system inactivity. Also, customer – server plan of ticket deal framework gives effective handling. Select concedes correspondence among accomplices and updaters until submit time, piggybacking its simultaneousness control data on the messages of the submit convention.

To deal with the reproduced information, the calculation expects updaters to take an interest in accreditation. Updaters essentially affirm the arrangement of composes that they get at submit time, and again the fundamental correspondence can be cultivated by passing data in the messages of the submit convention. Disappointment of affirmation test by any partner or updater is dealt with in OPT by having that procedure send a "can't submit" answer because of the "get ready to submit" message, making the exchange be restarted.

Circulated declaration restarts the contention exchange to deal with and give messages total their work. Along these lines, the framework has no disappointment exchange. This framework presents simultaneousness control for Ticket reservation framework which demonstrates that conveyed accreditation calculation is timestamp-based, hopeful simultaneousness control calculation approach. Dispersed databases are executed at the business place and fundamental office is the focal database for all ticket deals. The System consistently check the fundamental place database substance and the business communities database substance to have the framework information consistency. Along these lines, the ticket deal framework can maintain a strategic distance from the grimy read and the lost and covered update.

V. Conclusion

Optimistic Concurrency Control (OCC) protocols detect conflict at transactions commit time and resolve them using restarts. Ticket sales system will be implemented to show the ***distributed concurrency transactions.*** Timestamp ordering associates timestamps with all recently accessed data items and require that conflicting data accesses by transactions be performed in timestamp order. In Distributed Certificate operates by exchanging certification information during the commit protocol. OPT avoids the deadlocks by **restarting** transactions thus it also avoids failures. The system has the data consistency because of the main database and sales center database are always check and update its data contents.

The main advantage of OCC algorithm is deadlock free thus saving the expense that deadlock

detection usually required in locking approach. Fetching objects at the client side and working there locally greatly reduced the processing time and network latency. An action can read objects without using any network message. So, it can avoid the delay associated with sending lock requests and reduce the number of messages that have to be processed by the system: as more messages are sent, message transmission times and message processing times both increase. Moreover, client server scheme of ticket sales system provides efficient processing and more simple processes. But the transaction processing status messages are broadcasted and informed to all concurrent clients. So, this may lead to message overhead as a drawback but it is not major for drawback and acceptable.

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Natural Language Processing

Statistical Joint Segmentation and POS Tagging for Myanmar Language

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***Abstract*:** Word segmentation and part-of-speech (POS) tagging are fundamental steps for higher-level natural language processing (NLP) tasks. In traditional pipeline process modeling, given the raw contexts, segmentation is performed at the first step and then POS tagging is carried out on top afterwards. In morphologically rich and high ambiguous languages like Myanmar, the accuracy of word segmentation has a significant impact on POS tagging. In the same way, POS tags provide beneficial information for word segmentation. In this work, word segmentation and part-of-speech (POS) tagging are treated jointly as a single sequence learning problem and the advantage of statistical conditional random fields (CRF) model, which have been proven to deliver state-of-the-art results in many sequence labeling tasks, on this joint segmentation and POS tagging for Myanmar language is investigated. Experiments are performed on both syllable-level and Unicode character-level Myanmar contexts, respectively. The experiment results show that statistical CRF models can produce promising results for this joint segmentation and POS tagging for Myanmar language.

***Keywords*:** joint word segmentation and POS tagging, sequence learning, statistical model, CRF, Myanmar Language

I. Introduction

In written style of Myanmar language, there is no regular space between words or phrases. Myanmar scripts are written continuously as a sequence of characters forming a syllable without any delimiter between those syllables. Word segmentation for Myanmar language is the important step to Natural Language Processing (NLP) research work. It is more complicated while addressing word segmentation and part-of-speech POS tagging for Myanmar language than other languages; there are many issues. As one of the distinct characteristics of Myanmar language, its morphology is extremely rich and complex and even ambiguous. Further, its writing structure has no definite order and it also makes the segmentation a complicated process. Wrong segmentation can lead to wrong POS tagging and affect other NLP tasks. POS information is very useful for word segmentation. For this reason, in this effort, word segmentation and POS tagging are treated together as a single joint process rather than solving each task separately.

The reason of trying to solve this joint segmentation and POS tagging is to provide a statistical model to other NLP research and applications.

Numerous research efforts have been worked in word segmentation and POS tagging developed separately with various methods to get high accuracy and performance. The most applied approaches are ruled-based, statistical based and hybrid approaches. Deep learning approach has also got attention to be applied in solving for word segmentation and POS tagging problems. For Myanmar language, there are also efforts that only focus on word segmentation and POS tagging separately. In the study, joint segmentation and POS tagging model for Myanmar language is built by applying statistical Conditional Random Fields (CRFs). Additionally, well-prepared linguistic resources required for these research have not been available sufficiently now. As part of this work, manually segmented and POS tagged corpus for Myanmar language is created to address the resource limitation problem. In this work, it has been proved that statistical CRF works well on this joint segmentation and POS tagging task for Myanmar language. The best accuracy is achieved when the input token is syllable-level.

II. Related Works

Being the fundamental tasks and essential parts in NLP tasks, both word segmentation and POS tagging have got instant research attention over past years. In some languages, there have been a few research conducted on joint word segmentation and POS tagging by applying various approaches.

Myanmar word segmentation methods have been proposed based on syllables, rule-based maximum matching the longest string, statistical approaches and machine learning approaches. A two-step strategy of rule-based syllable segmentation and dictionary-based statistical syllable merging was proposed by the authors of [13]. A similar two-step principle was proposed by the authors in [5]. The authors in [11] also proposed a hybrid probability model. Pa et al. (2016) [12] examined the effectiveness of CRFs when using it to identify Myanmar word boundaries within a supervised framework. Experiments on various word segmentation approaches for the Myanmar language were conducted and discussed in the note written by Ding et al., 2016).[2]

POS tagging for Myanmar language using Hidden Markov Model (HMM) is presented in [14]. The authors in [10] proposed a Bigram POS tagger for Myanmar language. Back-propagation neural network approach to Myanmar part-of-speech tagging had been investigated by the paper [7].

Joint segmentation and POS tagging for Arabic Using CRF-based classifier was presented in [4]. A character-based model for joint segmentation and POS tagging for Chinese is proposed by using Bidirectional RNN-CRF neural architecture in [15]. The authors proved that their model is accurate and robust across datasets in different sizes, genres and annotation schemes. The authors in [18] proposed a single linear model for combined word segmentation and POS tagging for Chinese. They chose the generalized perceptron algorithm for joint training and bean search for efficient decoding.

As far as being aware and up to my knowledge, there is only recent research on joint segmentation and POS tagging for Myanmar language which applies HMM. Experiments were recently conducted by analyzing morphology to improve the accuracy [1, 3]. Firstly, the authors conducted experiments on word segmentation and POS tagging separately. And then when joint word segmentation and POS tagging was conducted by applying HMM, 84% of F-score was gained on their given data. When morphological rules are added in their experiments, the F-score reached up to 93%.

III. Statistical Joint Segmentation and POS Tagging Modeling

A statistical probabilistic model for structured prediction, CRF is applied in this modeling. Based on the conditional approach, CRF provides a probabilistic framework for segmenting and labeling sequential data. Conditional models are being used to label the observation sequence x_* by picking the label sequence y_* that maximizes the conditional probability $p(y_*|x_*)$. A conditional probability is computed as follow:

$$p(y|x,\lambda) = \frac{1}{Z(x)} \exp(\sum_j \lambda j F j(y,x)) \qquad (1)$$

where the feature function $F_j(y,x)$ is either a state function $s_j(y_{i-1},y_i,x,i)$ or transition function $t_j(y_{i-1},y_i,x,i)$ of the label at the position i and the observation sequence; λj is the weight of indicating the precision of feature f_j, Z(x) is a normalization factor.

A. Corpus Building

1) Data Collection

As Myanmar language is a low-resourced language, publicity available corpus for this work is not still available. With the aim of solving resource scattered problem and for this experiment, a manually segmented and POS tagged corpus was created. Raw sentences from online official Myanmar news websites within a range of year between 2017 and 2018 including various kinds of news genres were collected. These sentences are manually segmented and annotated with defined POS tags for training and testing. Currently there are 51,000 sentences in total. Those data were separated into two sets, 49,000 for training, and 2000 for testing. Table 1 lists the corpus statistics in syllable-level and Unicode character-level.

Table 1. Data Statistics

Data (#sent/#token)	Syllable-level (#overall syllable)	Character-level (#overall characters)
Train (49K/1.6M)	1.9 million	4.9million
Test (2K/38K)	60,004	226,583

2) Data Preprocessing

The quality of the data totally affects the performance. As data preprocessing, it is necessary to clean the collected data because of the noisy nature of raw data (there are spelling errors and typing error). Moreover, it is needed to be consistent in encoding scheme. Therefore, all the collected data are converted into standard Unicode encoding.

3) Defined POS Tags

To construct POS tagged corpus manually, 16 types of POS tags are applied. The description of the POS tags and their examples are shown in Table 2.

Table 2. POS Tags and Examples of Each Tag

No.	POS Tag	Description	Example
1.	N	Noun	ကျောင်း
2.	PRON	Pronoun	သူမ
3.	V	Verb	သင်ယူ
4.	ADJ	Adjective	လှ
5.	ADV	Adverb	လှပစွာ
6.	PART	Particle	ခဲ့
7.	PPM	Postpositional Marker	သည်၊က
8.	CONJ	Conjunction	၍၊ ထို့အပြင်
9.	INT	Interjection	အိုး၊ အလို
10.	PUN	Punctuation	၊ ။
11.	ABB	Abbreviation	အထက
12.	NUM	Number	၁၂
13.	TNUM	Text Number	တစ်နှစ်
14.	FW	Foreign Word	Technology
15.	TLW	Transliterated Word	စတော့
16.	NE	Named Entity	ရန်ကုန်

In the following Figure 1, data distribution for each POS tag in the training data is shown.

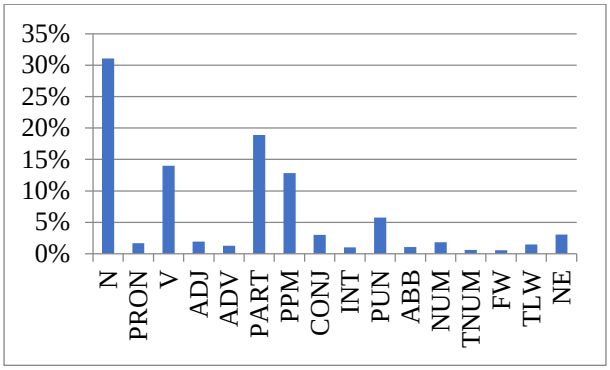

Figure 1. Distribution of POS Tags

4) Segmentation Scheme

For each language, the segmentation scheme will be different due to the characteristics of different languages. A Myanmar sentence is the combination of two or more phrases and two or more words come together to form a phrase. Myanmar words composed of single or multiple syllables are usually not separated by white space. In addition, there is no consistent rule for word segmentation even though space is sometimes used in Myanmar sentences to segment between phrases. It is necessary to define the segmentation rules to provide flexible segmentation for manual data preparation.

As Myanmar language is analytic, most of nouns, adjectives and verbs are usually suffixed or affixed with post-positional markers or particles. Normally we do not use lexical words (nouns, verbs and qualifiers) by themselves and they have to be joined by grammatical words (particles or post-positional markers) to form a phrase. Particles are subordinated to words to form qualifiers, adjectives and adverbs. Formation particle derives a new word by attaching particles to root morphemes or stems. It may also change the grammatical class of a word by adding affix (prefix or suffix). As an instance, singular nouns are followed by particles so that they become plurals.

Based on the facts that are mentioned above and to be consistent in the manual segmentation, we segmented sentences into word based on POS.

Sample segmented and POS tagged sentence is shown in Figure 2. Each segmented word is separated with the symbol '|' and annotated with respective POS tag.

ပြည်သူ/N | များ/PART | ဟာ/PPM | မျှော်လင့်ချက်/N | ပြည့်/V | သွား/PART | သည်/PPM | ။/PUN |

Figure 2. Sample Segmented and POS Tagged Sentence

B. Training Set up

The experiments were conducted as character-based and syllable-based sequence labeling, respectively, in which the CRFs were trained. In order to convert this joint segmentation and POS task into a sequence labeling task, a label is needed to assign for each input token (character or syllable) to indicate the word boundary and POS of each word in training and test data. For all the conducted experiments, *{B, I}* was used as tagging scheme where each token is assigned a label of *{B, I}* corresponding to the beginning or inside of a word, and beginning or inside of a particular POS tag, respectively.

For both character-based and syllable-based CRF trainings, a toolkit for linear chain CRF which is an open source [16] was used. Experiments were performed by tuning different parameters and also with various features. All the experiments were run on Intel(R) Core(TM) i5-6200U CPU @2.30GHz 2.40 GHz. Each training time differs depending on the different parameter settings and feature template. For example, it is obvious that the larger the features in feature template, the longer the training time.

1) Character-based Experiments

For the character-based modeling, only the input sequence and the neighbours around were considered as feature. Experiments were performed by increasing the window size from 3 to 7. However, the outcomes were not the satisfactory results. Therefore, for character-based experiments, types of character were added as features. For Myanmar script, it normally has a total of 75 characters and the characters can be further grouped into 12 types. For more details about this, check the paper [8]. Besides, there is another type of characters which is not written in Myanmar scripts. So in this work, there are 13 types of characters which are used as features. Firstly, the window size was set as 3 and then increased .When the window size was set as 5, the hyper-parameter c was 2.7 and cut-off threshold parameter was 3, the best F-score of 86.36% is obtained. With larger c value, CRF tends to overfit to the given training corpus. This parameter trades the balance between overfitting and underfitting. The results will significantly be influenced by this parameter. The cut-off parameter sets the cut-off threshold for the features [16]. Besides, a dictionary obtained from NLP lab, UCSY [9] was also added as additional features into the character-based experiments. With the additional dictionary feature plus character types feature, the F-score have increased around 1.3 % (88.74 %) compared to the F-score of 86.36 % (Table 3). From this, it can be said that CRF behaves the best when feature engineering is carefully prepared.

2) Syllable-based Experiments

Myanmar language is a syllabic language. A word is formed by combining syllables or a syllable can also be a word. Every syllable boundary can also be a potential of being a word boundary. Moreover, for a reason of a syllable is the smallest linguistic unit that can hold information about word, syllables were also considered as basic input tokens in this joint modeling.

It is quite definite and simple to implement a Myanmar syllable structure formation. Although the constituents can appear in different sequences, a Myanmar syllable was usually made up of an initial consonant followed by zero or more medials, zero or more vowels and optional dependent various signs. Some characters such as independent various signs, independent vowels, and digits can act as stand-alone syllables. Besides, only one consonant can even stand as a syllable. According to the Unicode standard, vowels are stored after the consonant. Detailed syllabification and syllable segmentation structure for Myanmar language were explained and discussed in [8] and [6].

For the syllable-level experiments, the Myanmar syllable segmentation algorithm of [17] was applied on unsegmented Myanmar sentences.

For the syllable-based experiment, the input syllable-level tokens and their neighbouring contents were only used as features. When the cut-off threshold parameter was 3, the window size was 6 and hyper-parameter c value was 2.8, it gives the highest F-score of 89.82% (See Table 3), which was almost the same as the character based system. With this same parameter setting, when the dictionary was added as external feature during training, the F-score had increased vividly up to 91.05%.

3) Evaluation Results

In Table 3, the best experimental results from different sequence modeling were listed. For the character-level experiments with no feature cannot provide satisfactory results. So the results are not listed in Table 3. By seeing the results in Table 3, it can be seen that features are vital in modeling with statistical CRFs.

As to the syllable based models, since syllables as inputs contain more information than individual characters as inputs, it is reasonable that it performs better than the character based models. On syllable level data, by using dictionary as additional information inputs, better results are produced compared to not using additional features (the best performance is highlighted in Table 3).

To evaluate the robustness of these sequence models, the models were tested on different test set which is totally different from sentences in training data. Another 1K sentences were used as open test. The sentences in open test set are not news sentences but from novels, school text book. The performance results of the models on open test data are listed in Table 4.

If compared the results in Table 4 with the results in Table 3, it can be seen that character-based models perform not so well as syllable-based models. By comparison, syllable based models can give better results on both close test and open test.

Due to time and data limit, the parameters used in the experiment and features applied may be not the best. This needs modeling experiences and also large amount of trial and error experiments to decide. Moreover it can't still solve named entities and out of vocabulary (OOV) words efficiently. Nevertheless, the experiment results have revealed that statistical CRFs can provide promising results for this joint segmentation and POS tagging for Myanmar language. Syllable-level input is more suitable than character-level.

Table 3. Comparison of Accuracies from Different Models on Close Test

Model	Close Test		
	Precision	**Recall**	**F-score**
Character-based (character type feature)	86.43	86.29	86.36
Character-based (character type + dictionary)	89.48	88.01	88.74
Syllable-level (no external feature)	89.84	89.79	89.82
Syllable-level (dictionary feature)	**91.14**	**90.97**	**91.05**

Table 4. Comparison of Accuracies from Different Models on Open Test

Model	Open Test		
	Precision	**Recall**	**F-score**
Character-based (character type feature)	85.08	82.49	83.74
Character-based (character type + dictionary)	86.43	86.29	86.36

Syllable-level (no external feature)	87.79	86.83	87.31
Syllable-level (dictionary feature)	**89.14**	**89.42**	**89.28**

IV. Conclusion

In this paper, word segmentation and POS tagging are worked as a single process and the effectiveness of statistical CRFs on joint Myanmar word segmentation and POS tagging have been explored. And a systematic comparison between character-level experiments and syllable-level experiments was conducted on the in-house manually segmented and POS tagged corpus. Experiment results revealed that the performance of statistical CRFs on joint word segmentation and POS tagging for Myanmar language is quite promising and it can facilitate this joint task.

Anyway, this exploration of using statistical conditional random fields (CRFs) for joint Myanmar word segmentation and POS tagging is the useful work to apply CRFs on Myanmar language. With more data and more experiments, better results will be reported in the future and we will keep exploring neural networks and deep learning on this joint segmentation and POS tagging for Myanmar language which is fundamental task in Myanmar NLP research.

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Geographic Information System

Evacuation Route Strategy for Emergency Vehicles by Using Improved Dijkstra's Algorithm

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***Abstract*:** The incident cases and emergency events may lead to damage the human lives and loss of properties and it is very important to evacuate the humans from the danger area to a safe area by emergency vehicles. The major reason of large amount of loss is that emergency vehicles are delay in the arrival of incident place in time because of complex structure road network. In the emergency evacuation, it is necessary to provide the evacuation route to the incident place without any delay. In some developing country like Myanmar, the metropolitan areas of road network structure are weak and complex. There are some narrow streets which are not wide enough to enter the vehicles and one-ended streets which are not passed through the other streets. If the emergency car drivers incorrectly select these streets, it will cause problems and interruptions. In order to solve these issues, web based optimal route finding system for emergency vehicles is developed by using the proposed route finding method which is improved with some modification on original Dijkstra's algorithm. The main idea of this paper is to implement the GIS base web application to provide the optimal evacuation route on complex road network by using the advanced route finding method. And, the better performance of improved method is verified by comparing with original method.

Keywords: Emergency events, Road network structure, Dijkstra's Algorithm, Improved Dijkstra's Algorithm

I. Introduction

The emergency events can happen everywhere and every time with numerous ways and will occur affect. Every emergency event always need rapid response and recovery actions. At the present time, road accident cases and fire events are the serious problem in the world particularly in unindustrialized countries. Evacuation route finding for emergency event is a vital request in everyday life and one of the concentrations in real world applications. According to the weak developing rate and technology, the road network structures are unstructured in many developing countries. To give effective response and recovery actions, the suitable road network structure is also important. If the optimal route is unidentified, it is relatively challenging to go and give the needed facilities to victim location. Moreover, to know the close emergency rescue teams which locate near the incident location is also important for evacuation process. To discuss and solve these above difficulties, the evacuation route strategy for emergency vehicles is implemented based on the former works [5-10].

In the recent years, the researchers are approved with many applications of existing studies for optimal route response system. Urban fire is a violent problem for both the developing and developed countries. For effective firefighting, GIS based effective route discovery system for fire event is developed by using Dijkstra's Algorithm and the system is implemented base on the landmarks of the tested region [5]. Most of the road networks in many developing countries are complex and unstructured. During the fire event, the vehicles faced many problems by closed, narrow and one ended roads. To solve these problems optimal route finding for weak infrastructure road network is proposed. In this paper, modified Dijkstra's algorithm is used to calculate the optimal route [7]. The GIS base transport system to reach hospitals within Allahabad city is proposed by N. Kumar, M. Kumar and S. Kumarsrivastva. The system supports fastest, shortest and safest route however it does not work on a real road network in a city tends to hold different levels of crowding during different time periods of a day [4]. GIS base route finding system from the accident place to healthcare service providers is proposed by using Dijkstra's Algorithm and the unit for the best route is calculated based on the distance [3]. Decision support system for route analysis is implemented with GIS technology and GIS web service and also discusses how to interact with each other. This proposed work finds the shortest path between one facility to another during disaster situation [1]. R.Fadlalla, A.Elhag, S.E.K.Sideeg, A.E.Mohammed, N.A.Gism and M.S.A.Allah, developed the digital route guide map producing system to improve the services in the case of emergency such fire, accident, etc. [2].

Today, all of the developing countries struggle and emphasize to provide the effective evacuation response for emergency events. In many developing countries, the emergency service teams face some problems to give rapid response to emergency event on complex road network. The evacuation route strategy is critical to reduce the large amount risk by emergency events. The problem of identifying the close emergency rescue teams and finding the optimal route on the road network is a main issue for emergency vehicles in daily life. In the case of any emergency event, it is important to give the quick response to the victim people and to move and

transport them to the close emergency services and to the safe places. In order to give the effective evacuation process, emergency rescue teams are needed to know the suitable route to go the incident location without delay on the way. Therefore, in order to develop the well-organized evacuation route response system, the route finding method is advanced based on the Dijkstra's Algorithm and the optimal evacuation route responding system for emergency vehicles is implemented in this paper.

II. Problem Statements

In some developing countries, it is difficult to find the accident site as the received emergency call information and to give the rapid response in time because of the lack of an evacuation route responding system. The road network structures of some metropolitan areas in Myanmar are complex and unstructured. Due to the structure of road network, hours of vehicle delay can increase to give emergency response services. This delay can cause because of the following two major reasons.

1. One-ended streets that are blocked or cannot pass through to other side.
2. Narrow streets that are not wide enough to enter and exit the vehicles.

If the emergency car drivers use these street, it will cause delay and takes longer time to reach desired location. Consequently, the appropriate road network structure is also important for emergency transportation services. And, the issue of optimal evacuation route calculation on a complex road network becomes important factor for the evacuation process. There are many approaches to solve route finding problem but these methods are still challenging to apply on the large and complex road network. The major issue of road conditions can be noted that, the road condition between two locations may be separated by the river or the wall and also the roads cannot wide enough or the roads can block to enter the vehicles. How to fix these issues in route finding approaches?

III. Background Theory

There are many approaches to solve the route finding problems based on the focused application area. In computer science and mathematics, graph theory is related to the graph properties and applied in route finding problems. In order to easily understand the most of definition and concepts in graph theory, the graphical representations are used. Graphs can be used as the exceptional demonstrating tool to model several objects and relationships for physical circumstances and issues of the real world. In general, a graph is organized with a set of objects that represented vertices (locations or nodes) or and connected by links which are defined as edges (road segments or streets). Particularly, a graph is a pair of G = (V, E) where the symbols V is the finite set of vertices and E is the finite set of edges in graph G. The distance between two vertices are represented as the weights that can represent by using these features such as the travel time, distance and cost and so on. The path is a series of vertices using the edges [9]. The weight of the path is the sum of the weight of the constituent edges on the path. In order to solve the route finding problem on the real road network, firstly need to make the road network into a simple form called a graph which is easier to work that draw the lines (edges) for each street in the tested region as shown in Fig. 1. and place the dots (vertices) where streets are intersected each other displays as Fig. 2. Fig. 3 is the structure of graph which is equivalent to the figure illustrated in Fig. 2.

Figure 1. Line Shaping in Part of Tested Region

Figure 2. Intersecting in Part of Tested Region

Figure 3. Graph Structure for Part of Tested Region

A. Distance Calculation

Computing the distance between point locations is an important factor to determine the optimal path

finding process. There are various formulations to calculate between two locations on the earth. One of the key challenges to calculate distances is accounting for the Earth curvature. If the Earth is flat, the distance calculation between two locations would be as simple as the straight line. Haversine formula gives the minimum distance between any two points on spherical shape and contains a constant r that denotes the Earth radius. In this formula, two geographic coordinates are needed to calculate the distance. Both of the points must have their predefined coordinates of geolocation. The point to point distance calculation formula is as follow:

$$d = 2r \arcsin\left(\sqrt{\sin\left(\frac{\phi_1-\phi_2}{2}\right)^2 + \cos(\phi_1)\cos(\phi_2)\sin\left(\frac{\lambda_1-\lambda_2}{2}\right)^2}\right) \quad (1)$$

In equation (1), d is the distance between two points with longitude λ_1, λ_2 and ϕ_1, ϕ_2 latitude respectively and the value 6378 km is assigned for r which is the radius of the earth.

B. Disadvantages of Dijkstra's Algorithm

Most of the researchers are used Dijkstra's algorithm to find the shortest route on the road network. But, the major disadvantage of this algorithm is that it processes as blind search. So, it consumes a lot of time and waste of memory resources for route calculation [9]. In original Dijkstra's Algorithm, the priority queue is applied by using array data structure and perform insert operation, extract min operation and decrease key operation. In this data structure, the original Dijkstra's Algorithm have the following frequency of calls on these operations.

i. $O(1)$ times for insert operation,
ii. $O(n)$ times for extract min operation and
iii. $O(n)$ times for decrease key operation

where n is the number of nodes. Therefore, the total complexity of Dijkstra's Algorithm is $O(n)$. And the second disadvantage is that it can give only the shortest path without considering the road condition discussed in problem statement section. Therefore, the original Dijkstra's algorithm cannot provide the optimal for complex road network and it takes large amount of time complexity when apply in large road network.

C. Proposed Route Finding Method

A priority queue can be applied by using various data structures like an array, a linked list, or a binary search tree. In order to make all of the procedures of proposed method very efficient, heap data structure is applied for the priority queue to store node name and its tentative distance. The heap is a type of tree that have the property to store the value of all node is less than or equal or equal to the value of its child nodes, which is in terms of heap order invariant. The tree of nodes is accessed by a distinguished pointer to the node with the smallest distance value. Nodes can be either visited or unvisited but root nodes are never visited. In the proposed route finding method, there are three fundamental operations such as insert operation, extract_min operation and delete_key operation.

The time complexity of three basic operations in the proposed methods are

i. O(log n) times for insert operation,
ii. O(1). times for extract min operation and
iii. O(log n) times for decrease key operation

Consequently, the worst case complexity of proposed method is O (log n).

In order to fix some issues in original method, the advanced Dijkstra's algorithm is proposed. By using proposed method, the number of nodes which are not visited from the source node will reduce and the route result will compute by using road condition. Due to the reducing the number of visited node, can decrease the processing time and can also improve the performance of the algorithm in route finding process. In the method modification, the variable u_state is used to control and avoid the street which are one-ended or narrow. The statement dist[u] == ∞ is used to eliminate the nodes which do not visit from source node. The pseudo code of the proposed modified Dijkstra's algorithm is described as follow:

```
function ProposedDijkstra(G,s)
        int u_state;
        dist[s] := 0 ;
        H_Queue:= the set of all nodes in Graph ;
    while H_Queue is not empty:
u:= vertex in H_Queue with smallest distance in
dist[];
      if u_ state = =1
        remove node from H_Queue ;
      else if dist[u] == ∞ || u_state == 0:
          break;
          end if
        end if
        for each neighbor v of u
          int temp_dist;
          temp_dist := dist[u] + dist_between(u, v) ;
           if temp_dist < d[v]:
              dist[v] := temp_dist ;
              previous[v] := u ;
              decrease-key v in H_Queue;
           end if
        end for
       end while
  return dist[target];
```

IV. System Design and Implementation

The proposed work is intended to develop the GIS based web application to provide the evacuation route for emergency vehicles travelling on complex road network. The overview of proposed work is shown in Fig. 4. By using a regular phone call or message, users can report the address information of victim location to

emergency service providers. After receiving this information, the system will match this address on spatial database with coordinate information to determine the exact place and show on Google Map. And then, the system will offer close emergency service teams to get a rapid response and effective services. Finally, the system calculates the evacuation route between the emergency service and the accident location by using the proposed route finding method and original method. By using the evacuation route result, the emergency vehicles can reach there in a short time without delay caused by road condition. Therefore, it can decrease the damage level, protect and save valuable lives and properties. The proposed system is mainly developed for Yangon Region which situated at latitude 16.80528 and longitude 96.15611 with 10,276.7 km^2. It is the large city organized with 33 Townships and constructed with the complicated unstructured road network. In this proposed work, the road network of Yangon Region is created with the number of edges 96780 and the number of nodes 32885. Fig. 5 shows the road network of the Yangon Region.

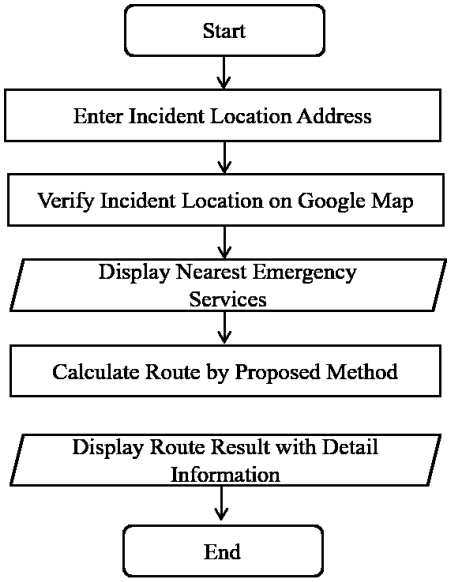

Figure 4. System Overview

Figure 5. Road Network of Yangon Region

In the proposed web application, the main page is illustrated with the location of emergency services points such as hospitals, fire stations and police stations in tested region as shown in Fig. 6. However, the emergency case which demonstrated and tested in this implementation is mainly focused on fire event.

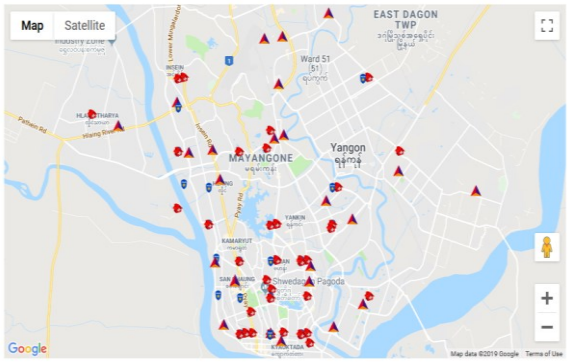

Figure 6. Emergency Services Location on Tested Region

There are three main processes in this proposed system such that incident location identification, close emergency services verification and optimal route calculation. In the location identification process, the system will take the residential address as incident location information. After receiving this information, the system verifies the location exactly with related latitude and longitude and then display this geo-location on the Google Map with location icon and Fig.7 shows the incident location verification process. After that, the system provides three close emergency services which locate near the incident location are also import to Google Map as shown in Fig.8. The green star is the closest emergency service among of three emergency service locations.

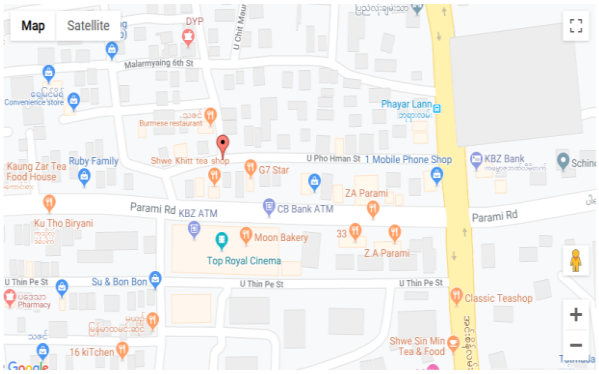

Figure 7. Incident Place Identification

After knowing the close emergency services, the desired emergency service can choose to calculation the optimal evacuation route and the system will calculate and display the route result on Google Map with detailed route direction with total distance and time which consume to reach the incident location as shown in Fig. 9. In the case of optimal route calculation, the system calculated the route by using conventional Dijkstra's Algorithm and advanced Dijkstra's Algorithm.

In this implementation, the source place is represented to fire station and destination place is denoted as fire incident place. The proposed system generates the evacuation route result by using original method and proposed methods to reach the incident location.

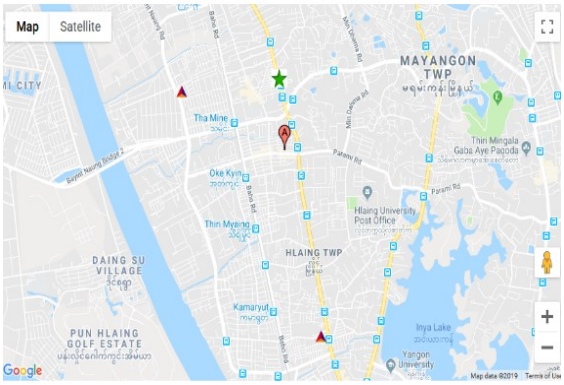

Figure 8. Nearest Emergency Services

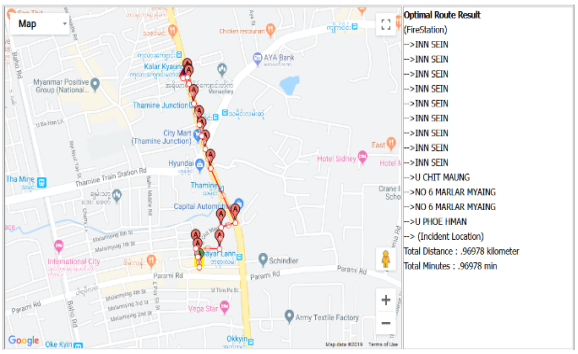

Figure 9. Detail Information of Route Result

In the following tested implementation, the emergency service (source) is Mayangone Fire Station and the fire incident location (destination) is Zayya Thu Kha Street, Mayangone Township.

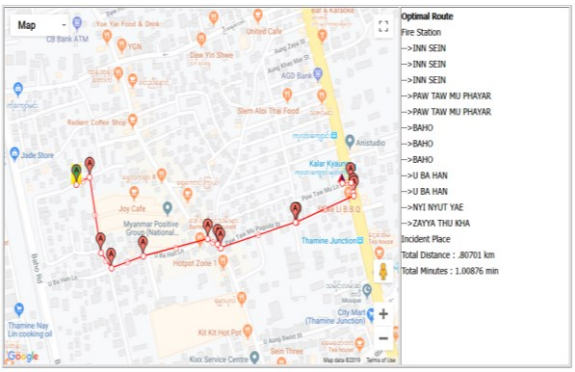

Figure 10. Evacuation Route by Original Method

The results between Mayangone Fire Station and Zayya Thu Kha Street by using two methods are described in Fig. 10 and Fig. 12. Fig. 11 show the issue in original method that give the route result without avoiding one-ended street. The emergency vehicle cannot pass in from Nyi Nyut Yae Street to Zayya Thu Kha Street because Nyi Nyut Yae Street is one-ended. Actually, one-ended street cannot not pass through the other side. In real world application, this is the main issue because it can cause delay for effective emergency response services. Fig. 12 shows the route result between Mayangone Fire Station and Zayya Thu Kha Street by using proposed method and Fig. 13 proves proposed method can overcome the issue that occurs in original method.

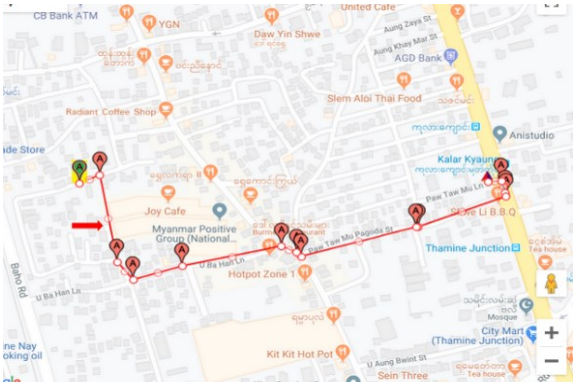

Figure 11. Issue of Original Method

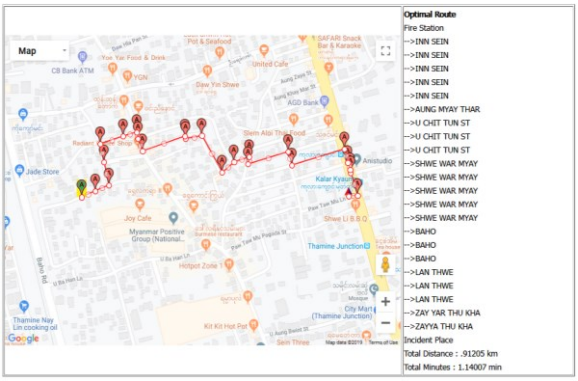

Figure 12. Evacuation Route by Using Proposed Method

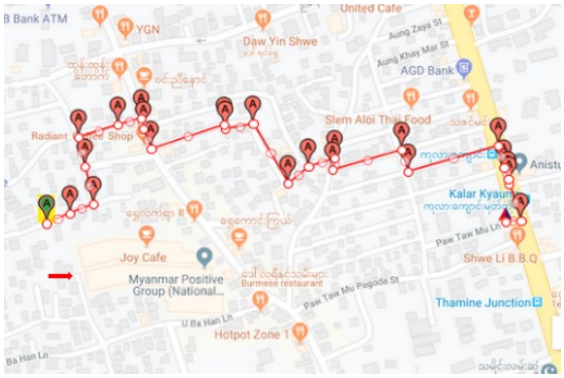

Figure 13. Avoiding One_ended Street by Using Proposed Method

According to the route results mentioned above, we can compare the evacuation route result by using two methods. The main purpose of proposed method is to avoid the streets which are not wide enough to enter fire trucks, one-ended or narrow. Therefore, it calculates the route for emergency vehicles by avoiding these conditions. That is why the proposed work can support

the optimal route result. According to the real data of road condition, one-ended street cannot pass to other side. If the driver enters this street it will consume time to get to the right street and it can cause delay on the way and the rapid rescue processes. The route result of the proposed method may be shortest but it can provide the accurate evacuation route and reduce the delay caused by wrong street choice along the way.

V. Performance Evaluation

In the performance testing, two methods are applied on Yangon Region road network. To prove the usefulness of improved Dijkstra's algorithm, the original Dijkstra's algorithm is used to compare. Fig.14 shows the comparison of processing time based on the number of nodes in route calculation process by using two methods. In this testing, the processing time of the original method is significantly increase than the proposed method when the number of nodes is large.

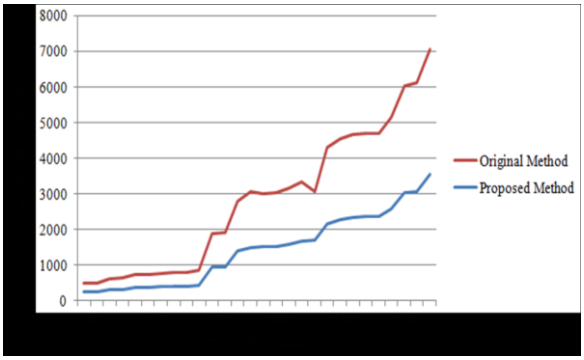

Figure 14. Execution Time Comparisons of Two Methods

VI. Conclusion

In any civilization, decreasing the harm rate, loss of lives and damage of properties are the key factors for the growth of many cities. In the advanced technology era, GIS and computer technology has been used to enhance efficiency in emergency response services. This paper discuss some issues encountered by the emergency vehicles which traveling on the complex road network and point out some disadvantages of original Dijkstra's algorithm in route finding process. In order to solve these concerns, the advanced version of Dijkstra's algorithm is developed by adding new algorithmic ingredients as road status variable and then tested on the real road network. The tested results of proposed method prove that it is more superior than the original method. The proposed method is more suitable to compute the evacuation route in the complex structured road network and it can provide the accurate route result. And also it can reduce the processing time than the original method in optimal route calculation.

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Prim's Minimum Spanning Tree Algorithm for Airline Network in Myanmar

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Abstract: This paper presents an application of Prim's algorithm to local access network with some airline areas in Myanmar. Nodes in airlines network are 30 airports in Myanmar and the arcs are the proposed major distances that link the two airports. The distances between airports are computed using in kilometer from two places with latitude and longitude converter software which make use of the latitude and longitude of each airport in Myanmar. By using Prim's algorithm, it was concluded that the best paths found from the analysis will save the less distance in transportation, minimize time and minimum cost of fuel for the plane. To determine the minimum spanning tree, Yangon International Airport was chosen as the starting point . Prim's algorithm found the minimum spanning tree of length 4813.3km.This is the reduction over the original 9609.51km from Yangon International airport to 29 different airports in Myanmar.

Keywords: Prim's algorithm, minimum spanning tree, vertex, edges, Latitude and longitude, undirected graph

I. Introduction

Some research has been done on efficient network architecture for delivery, communication, machine scheduling, power and pipeline purposes. The minimum spanning tree is the total commonly used for optimal design of such networks. A minimum spanning tree problem with many theoretical and practical applications is one of the most important and intensively studied problems in network optimization. (Ahuja, et al, 1993), (Taha, 2006), (Winston, 2004), (Dippon, 1999), (Seth, 2002), (Nahla,2011), (Mares,2008), (Rothfard, 1970) used minimum spanning tree to design optimal offshore natural gas piprline systems. [2]Prim's algorithm was developed in 1930 by Czech Vojtech Jarnik and later recovered and republished by computer scientists Robert C.Prim in 1957. A study on the optimal design of oil pipeline network for the South Gabon oil field having 33 nodes and 129 possible arcs reduces the total distance of 188.2 miles to 156.2 miles using Prim's algorithm(**Brimberg et al, 2003).**[7] **(Donkor et al, 2011)** used Prim's algorithm to determine the minimum spanning tree of length 712km of the West African gas pipeline from Nigeria through Benin and Togo to Ghana.[1]

In this paper, constructing a minimum spanning tree covering 30 airports, namely: Yangon International Airport, Pathein Airport, Thandwe Airport, Taungoo Air Base, Mawlamyaing Airport, Dawei Airport, Myeik Airport, Nay Pyi Taw International Airport, Magwe Airport, Kyaukpyu Airport, Loikaw Airport, Heho Airport, Naung U Airport, Pakokku Airport, Monywa Airport, Sittwe Airport, Kyauktu Airport, Kalaymyo Airport, Mandalay International Airport, Mong Hsat Airport, Kengtung Airport, Tachilek Airport, Lasho Airport, Bhamo Airport, Homalin Airport, Myitkyina Airport (Nampong Air Base), Khamti Airport, Putao Airport, Bokpyin Airport and Kawthaung Airport .

II. Methodology

Graph are discrete structures consisting of vertices and edges that connect these vertices.

Tree is a connected undirected graph with no simple circuits. A connected graph that contains no simple circuits is called a tree.[8]

Undirected graph is graph, i.e, a set of objects (called vertices or nodes) that are connected together, where all the edges are bidirectional. An undirected graph is sometimes called an undirected network. An undirected graph is a tree if and only if there is a unique simple path between any two of its vertices.

When drawing an undirected graph, the edges are typically drawn as lines between pairs of nodes, as illustrated in the following figure.[3]

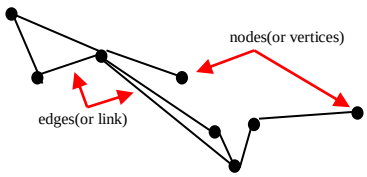

Figure 1. Small Undirected Network with Labeled Nodes and Edges

In graph theory, **the shortest path problem** is the problem of finding a path between two vertices (or nodes) in a graph such that the sum of the weights of its constituent edges is minimized. The problem of finding the shortest path between two intersections on a airline map may be modeled as a special case of the shortest path problem in graphs, where the vertices correspond to intersections and the edges correspond to airline segments, each weighted by the distance of the segment.

A **minimum spanning tree(MST)** or minimum weight spanning tree is a subset of the edges of a connected, edge-weighted undirected graph that connects all the vertices together, without any cycles and with the minimum possible total edge weight.[5]

In graph theory, there are many algorithms that find a shortest path between two vertices in a weighted graph. In this paper, calculate the minimum spanning tree or the shortest path from Yangon International Airport to any of the other airport on the networks found by using Prim's Algorithm.

In Computer science, **Prim's**(also known as Jarnik's**) algorithm** is a **greedy algorithm** that finds a minimum spanning tree for a weighted ***undirected graph***. This means it finds a subset of the edges that forms a tree that includes every vertex, where the total weight of all the edges in the tree is minimized.

Prim's Algorithm is a minimum spanning tree algorithm that takes a graph as input and finds the subset of the edges of that graph which

*form a tree that includes every vertex

*has the minimum sum of weights among all the trees that can be formed from the graph.

Start from one vertex and keep adding edges with the lowest weight until goal is reached.

The steps for implementing Prim's algorithm are as follows:

1.Initialize the minimum spanning tree with a vertex chosen at random.

2.Find all the edges that connect the tree to new vertices, find the minimum and add it to the tree.

3.Keeping repeating step 2, until a minimum spanning tree is got.[6]

III. Method of Data Collection

The data used for this paper is created using latitude and longitude converter software which makes use list of airports in Myanmar to determine the airport distance. Table 1 shows latitude and longitude of each airport, while Table 2 shows airport to airport distances in km.

Table 1. Latitude and Longitude of Airports in Myanmar

Vertex	Airport name	Latitude(N)	Longitude(E)
1	Yangon International Airport	016° 54′ 26″	096° 07′ 59″
2	Pathein Airport	016° 48′ 54″	094° 46′ 47″
3	Thandwe Airport	018° 27′ 38″	094° 18′ 00″
4	Taungoo Airport	019° 01′ 48″	096° 25′ 00″
5	Mawlamyaing Airport	016° 26′ 41″	097° 39′ 38″
6	Dawei Airport	014° 06′ 13″	098° 12′ 13″
7	Myeik Airport	012° 26′ 23″	098° 37′ 17″
8	Naypyitaw Airport	019° 37′ 24″	096° 12′ 03″
9	Magwe Airport	020° 09′ 56″	094° 56′ 28″
10	Kyaukpyu Airport	019° 25′ 35″	093° 32′ 05″
11	Loikaw Airport	019° 41′ 29″	097° 12′ 53″
12	Heho Airport	020° 44′ 49″	096° 47′ 31″
13	Naung U Airport	021° 10′ 43″	094° 55′ 48″
14	Pakokku Airport	021° 24′ 00″	095° 06′ 00″
15	Monywa Airport	022° 14′ 00″	095° 07′ 00″
16	Sittwe Airport	020° 07′ 57″	092° 52′ 21″
17	Kyauktu Airport	021° 24′ 45″	094° 08′ 31″
18	Kalamyo Airport	023° 11′ 19″	094° 03′ 03″
19	Mandalay International Airport	021° 42′ 07″	095° 58′ 40″
20	Mong Hsat Airport	020° 31′ 00″	099° 15′ 24″
21	Kengtung Airport	021° 18′ 05″	099° 38′ 09″
22	Tachilek Airport	020° 29′ 01″	099° 56′ 07″
23	Lasho Airport	022° 58′ 40″	097° 45′ 07″
24	Bhamo Airport	024° 16′ 15″	097° 14′ 49″
25	Homalin Airport	024° 53′ 58″	094° 54′ 50″
26	Myitkyina Airport	025° 23′ 01″	097° 21′ 06″
27	Khamti Airport	025° 59′ 18″	095° 40′ 28″
28	Putao Airport	027° 19′ 47″	097° 25′ 34″
29	Bokyin Airport	011° 16′ 00″	098° 46′ 00″
30	Kawthaung Airport	010° 02′ 57″	098° 32′ 16″

[4]

The Prim's algorithm can be explained and understood by using one airport to another airline map application.

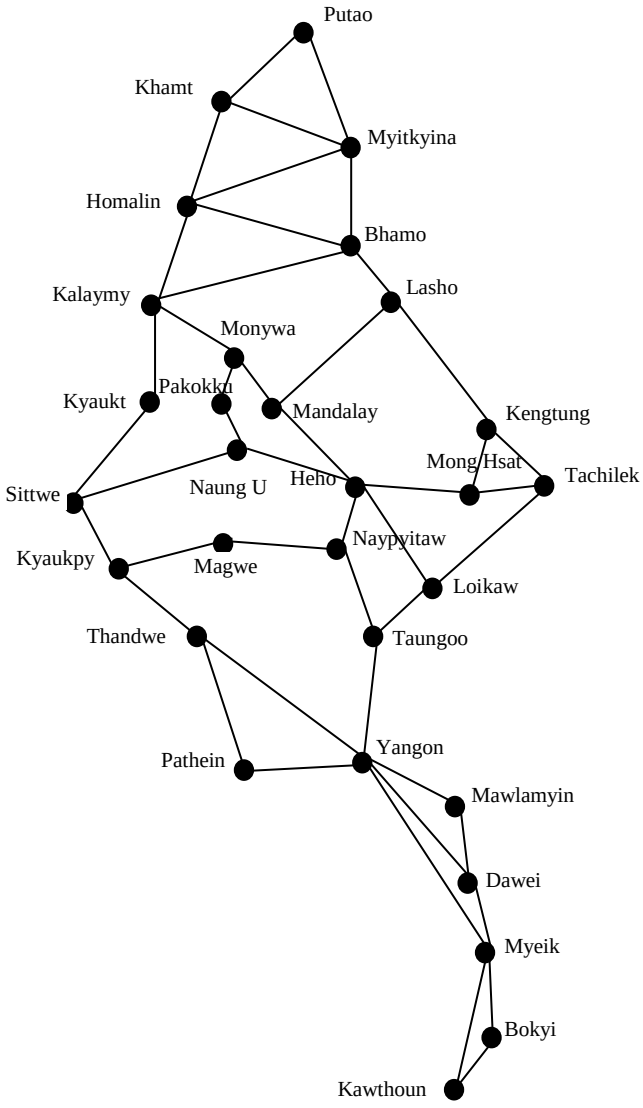

Figure 2. Airport to Airport Graph Modeling Airline System

Table 2. Distance in Km from One Airport to Another Airport

Vertex	Airport name	1.Yangon	2.Pathein	3.Thandwe	4.Taungoo	5.Mawlamyaing	6.Dawei	7.Myeik	8.Naypyiaw	9.Magwe	10.Kyaukpyu	11.Loikaw	12.Heho	13.Naung U	14.Pakokku	15.Monywa
1	Yangon		144.4	259.9	237.9	170.6	382.6	564.2								
2	Pathein	144.4		189.9												
3	Thandwe	259.9	189.9								134.2					
4	Taungoo	237.9							69.75			111.4				
5	Mawlamyaing	170.6					266.8									
6	Dawei	382.6				266.8		190.5								
7	Myeik	564.2					190.5									
8	Naypyitaw				69.75					144.9			139.3			
9	Magwe								144.9		168.5					
10	Kyaukpyu			134.2						168.5						
11	Loikaw				111.4								125.4			
12	Heho								139.3			125.4		199.2		
13	Naung U												199.2		30.27	
14	Pakokku													30.27		92.68
15	Monywa														92.68	
16	Sittwe										104.7			243.6		
17	Kyauktu															
18	Kalamyo															152.4
19	Mandalay												135.9			106.7
20	Mong Hsat												257.8			
21	Kengtung															
22	Tachilek											297.4				
23	Lasho															
24	Bhamo															
25	Homalin															
26	Myitkyina															
27	Khamti															
28	Putao															
29	Bokyin							586.3								
30	Kawthaung							266								

Vertex	Airport name	16.Sittwe	17.Kyauktu	18.Kalamyo	19.Mandalay	20.Mong Hsat	21.Kengtung	22.Tachilek	23.Lasho	24.Bhamo	25.Homalin	26.Myitkyina	27.Khamti	28.Putao	29.Bokyin	30.Kawthaung
1	Yangon															
2	Pathein															
3	Thandwe															
4	Taungoo															
5	Mawlamyaing															
6	Dawei															
7	Myeik														586.3	266
8	Naypyidaw															
9	Magwe															
10	Kyaukpyu	104.7														
11	Loikaw							297.4								
12	Heho				135.9	257.8										
13	Naung U	243.6														
14	Pakokku															
15	Monywa			152.4	106.7											
16	Sittwe		194.1													
17	Kyauktu	194.1		197.7												
18	Kalamyo		197.7							346.9	209.5					
19	Mandalay								231.1							
20	Mong Hsat						95.73	70.77								
21	Kengtung					95.73		96.11	269.1							
22	Tachilek					70.77	96.11									
23	Lasho				231.1		269.1			152.7						
24	Bhamo			346.9					152.7		246	124.2				
25	Homalin			209.5						246		251.2	143.1			
26	Myitkyina									124.2	251.2		181	216.5		
27	Khamti										143.1	181		229.2		
28	Putao											216.5	229.2			
29	Bokyin															580.9
30	Kawthaung														580.9	

IV. Analysis of Application

Relabeling 0,

Step 1. Start with a weight graph modeling airline system reference with figure 2.

Step 2. Vertex 1 is choosen as a starting point.

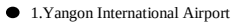

Figure 3. Starting Point as Yangon (V_1)

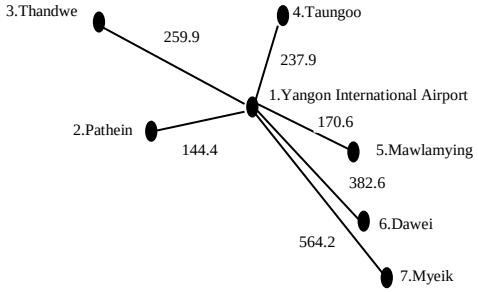

Figure 4. Tree that Represents the Paths from V_1

Step 3. The shortest edge is from V_1 to V_2 .

Figure 5. Right Shortest Path of Two Vertices

Relabeling 1, Again

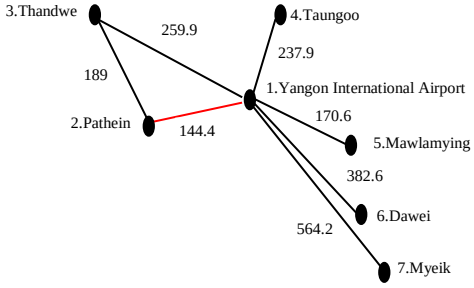

Figure 6. Tree that Represents the Paths from V_1 and V_2

Step 2. The shortest path is in vertex 1. Vertex 1 is chosen as starting point.

Step 3. The shortest edge is from V_1 to V_5 and add in figure 5.

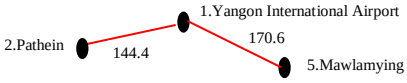

Figure 7. Right Shortest Path of Three Vertices

Relabling 2, Again

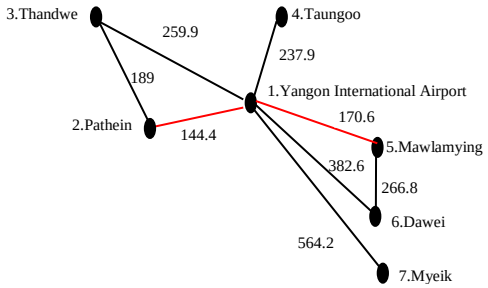

Figure 8. Tree that Represents the Paths from V_1, V_2 and V_5

Step 2.The shortest path is in vertex 2. Vertex 2 is chosen as starting point.

Step 3. The shortest edge is from V_2 to V_3 and add in figure 7.

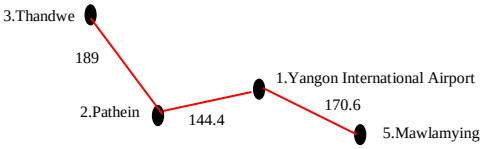

Figure 9. Right Shortest Path of Four Vertices

Relabeling 3, Again

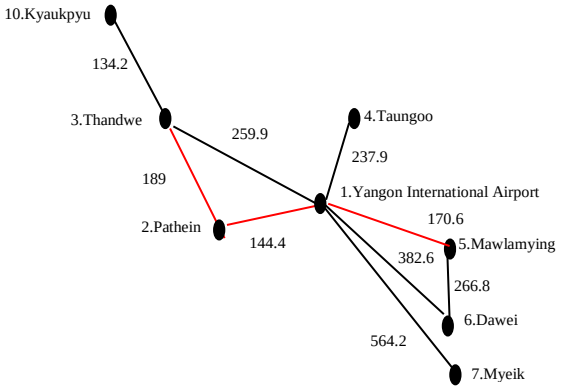

Figure 10. Tree that Represents the Paths from V_1 ,V_3 and V_5

Step 2.The shortest path is in vertex 3. Vertex 3 is chosen as starting point.

Step 3. The shortest edge is from V_3 to V_{10} and add in figure 9.

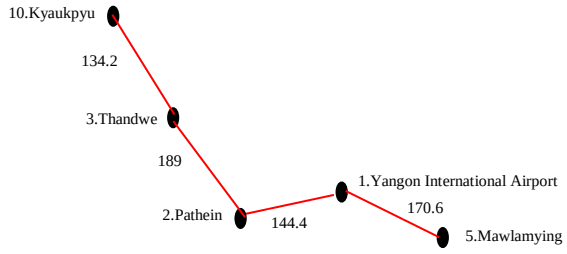

Figure 11. Right Shortest Path of Five Vertices

Relabling 4, Again

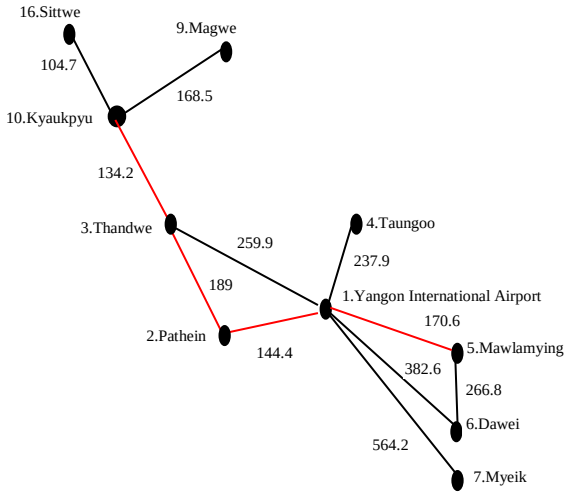

Figure 12. Tree that Represents the Paths from V_1 , V_5 and V_{10}

Step 2.The shortest path is in vertex 10. Vertex 10 is chosen as starting point.

Step 3. The shortest edge is from V_{10} to V_{16} and add in figure 11.

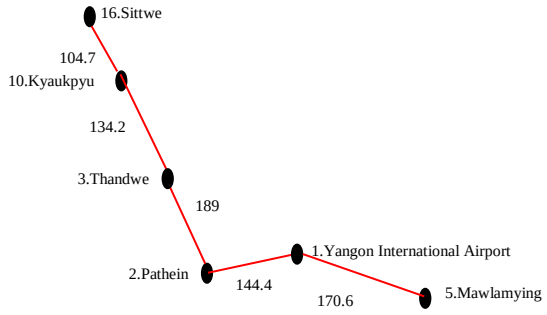

Figure 13. Right Shortest Path of Six Vertices

Relabling 5, Again

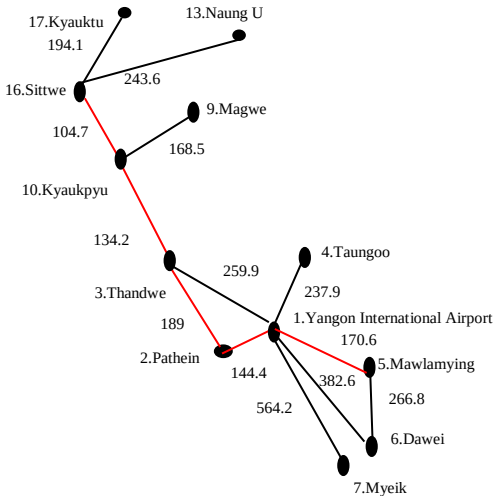

Figure 14. Tree that Represents the Paths from V_1 , V_5 , V_{10} and V_{16}

Step 2.The shortest path is in vertex 10. Vertex 10 is chosen as starting point.

Step 3. The shortest edge is from V_{10} to V_9 and add in figure 13.

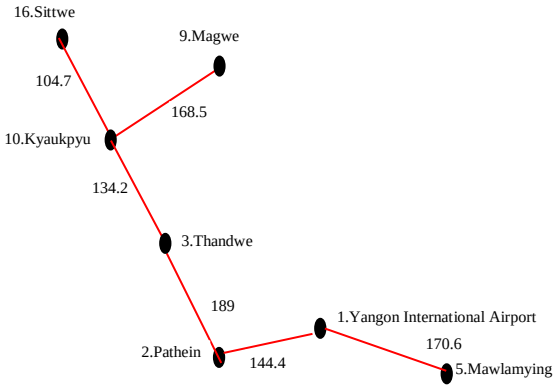

Figure 15. Right Shortest Path of Seven Vertices

Choose the nearest edge not yet in the solution, if there are multiple choices. Repeat until all vertices has been reached. Again relabling 5, 6, 7, 8,..., 28 are calculated by using Prim's algorithm. The result has been reached . Table 3 shows the right shortest path for Yangon International Airport and another 29 airports in Myanmer.

Table 3. Shortest Path Distance from One Airport to Another Airport

Vertex	Path	Distance(km)
2	L_{1-2}	144.4
3	L_{2-3}	189.9
4	L_{8-4}	69.75
5	L_{1-5}	170.6
6	L_{5-6}	266.8
7	L_{6-7}	190.5
8	L_{9-8}	144.9
9	L_{10-9}	168.5
10	L_{3-10}	134.2
11	L_{4-11}	111.4
12	L_{11-12}	125.4
13	L_{14-13}	30.27
14	L_{15-14}	92.68
15	L_{19-15}	106.7
16	L_{10-16}	104.7
17	L_{16-17}	194.1
18	L_{15-18}	152.4
19	L_{12-19}	135.9
20	L_{12-20}	257.8
21	L_{20-21}	95.73
22	L_{20-22}	70.77
23	L_{24-23}	152.7
24	L_{26-24}	124.2
25	L_{18-25}	209.5
26	L_{27-26}	181
27	L_{25-27}	143.1
28	L_{26-28}	216.5
29	L_{30-29}	580.9
30	L_{7-30}	266

V. Result

Final minimum spanning tree get.

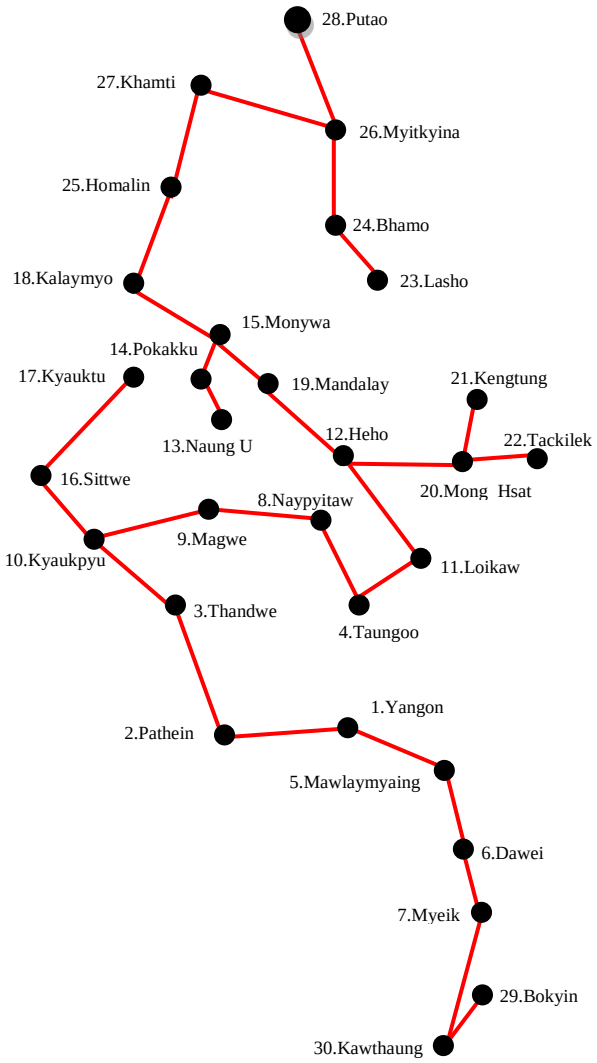

Figure 16. Minimum Spanning Tree Network of Yangon International Airport to Another 29 Different Airports in Myanmar

The result of applying the Prim's algorithm to the network in figure 2 is as shown in figure 16. From minimum spanning tree in figure 16 produces a total distance of 4831.3km from Yangon International Airport to another 29 different airports by using Prim's Algorithm.

VI. Conclusion

In this paper, Prim's algorithm was useful to find the shortest path in many paths to go from a starting place to another place with undirected graph. Yangon International Airport to another 29 airports have 30 vertices and 46 possible edges reduces the total distance of 9609.51 km to 4831.3km by using Prim's algorithm. Therefore, it was discovered that Prim's algorithm is very useful in providing shortest distance between set of airports. Prim's algorithm is reduced the cost of money and time for transportation of passengers from one place to another and is reduced the cost of fuel for plane.

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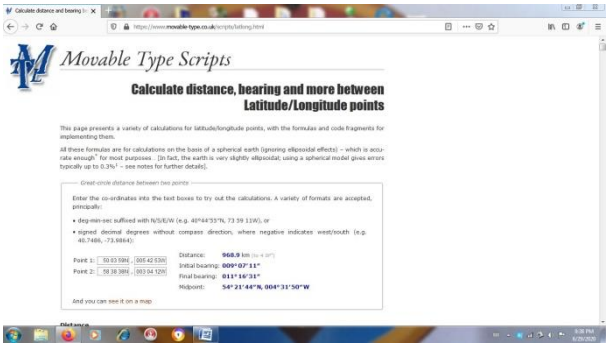
Appendix A



Calculate The Distance between Two Airport

Appendix B

Myanmar Airport Map

Database and Data Mining

Clustering of Marine Species in Myeik Fish Auction Market Using Divisive Hierarchical Approach

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Abstract: Clustering is a major task in data analysis and data mining applications. It is used for making group or cluster from the given data set depending upon similarity between data objects. Hierarchical clustering can be classified into two categories according to their clustering process: agglomerative and divisive. This paper uses divisive hierarchical clustering method to implement workflow model, clustered data table, dendrograms, statistics view and display the distance between each cluster with the aid of a data mining tool called KNIME. The divisive hierarchical clustering approach used for data samples of the list of marine species in Myeik Fish Auction market to obtain the clusters. The result shows the price of the marine species which are Fish, Prawn and Squid in the market for the customers by using SPSS statistical barchart.

Keywords: Hierarchical Clustering, agglomerative, divisive, dendrograms, KNIME, SPSS.

I. Introduction

The main goal of clustering technique in data mining is a division of data into groups of similar objects. A cluster is a group of data objects that are similar to one another within the same cluster or group and are not similar to data objects within another cluster or group [1]. There are several algorithms to perform clustering, and the criteria of deciding a particular algorithm mainly depends on three factors which are the size of the data sets, data dimensionality and the time complexity [2]. Clustering methods are mainly divided into two groups: hierarchical and partitioning methods [3].

The hierarchical clustering method is used to organize data into a set of groups placed at different levels in order to create a hierarchy. It uses a binary tree or a dendrogram to illustrate the different clusters. There are two types of hierarchical clustering methods agglomerative approach and divisive approach [4]. This paper focuses on the divisive hierarchical clustering method with dendrogram. In divisive approach, all data points are considered as a single cluster and they are splited into number of clusters based on certain criteria. Some of the hierarchical clustering methods are: DIANA, AGNES, LEGCLUT, CHAMELEON, BIRCH, CURE, and ROCK.

II. Background Theory

A. *Hierarchical Clustering*

The hierarchical clustering creates a cluster or data objects are grouped into hierarchy i.e. tree of clusters, also known as a dendrogram [5]. Any desired number of clusters can be obtained by cutting the dendrogram at the proper level. Hierarchical clustering does not require pre-specifying the number of clusters, but needs a way to compute distance between the clusters [6]. Hierarchical clustering methods are classified into divisive (DIANA) and agglomerative (AGNES). The agglomerative clustering approach is also known as bottom-up approach, initiates with each object forming individual cluster or group. It recursively merges two or more groups close to one another, until all the groups are merged into single separate group. The divisive clustering approach is also known as top-down approach, initiates with all the objects in the one cluster or group. It recursively splits the single cluster into smaller cluster or groups, until each object is in one cluster. The merging/splitting decisions are critical in AGNES and DIANA approaches. The process of agglomerative and divisive clustering are exhibited in figure 1.

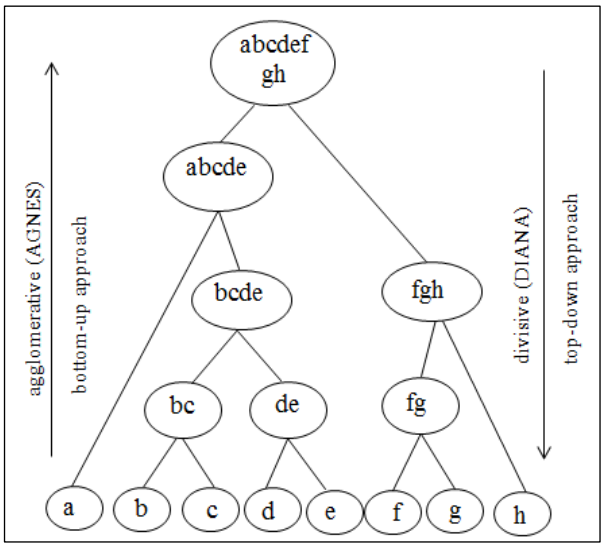


Figure 1. Hierarchical Clustering Process

B. Dendrogram

A dendrogram is a diagram that shows the hierarchical relationship between objects. It is most commonly created as an output from hierarchical clustering. The main use of a dendrogram is to work out the best way to allocate objects to clusters. The following dendrogram shows the hierarchical clustering process in figure 1.

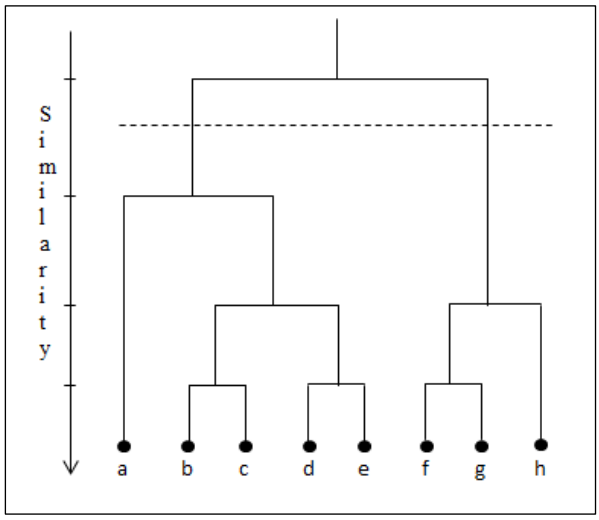


Figure 2. Dendrogram Showing the Hierarchical Clustering Process

III. Related Works

Chris ding and Xiaofeng He [7] introduced the merging and splitting process in hierarchical clustering method. The author performs extensive clustering experiments to test eight selection methods, and found that the average similarity is the best method in divisive clustering and the Min-Max linkage is the best in agglomerative clustering. They also introduced the concept of objective function saturation and clustering target distance to effectively assess the quality of clustering.

Vera M.B [8] explained the notion of clustering and used the agglomerative hierarchical algorithm as data mining tool in the capital market to analyse the trade on the Bulgarian Stock exchange with the aim of identifying similar temporal behavior of the traded stock.

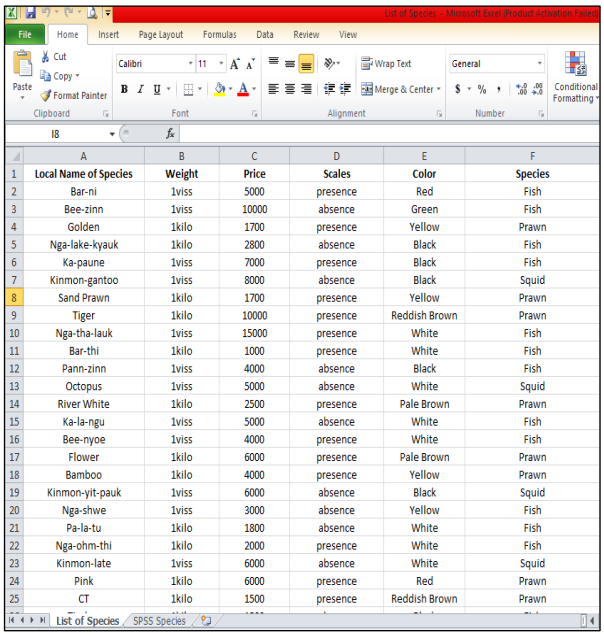
Odilie Yim and Kylee.T.Ramdeen [9] gives an overview of the hierarchical clustering analysis using the SPSS statistical software to analyze. They also focused on this statistical technique where group are sequentially created by the systematic merging of similar clusters together, as dictated by the linkage measures and the distance. He also comparison these linkage measures (single linkage, complete linkage and average linkage) and applied to psychological data to obtain results.

Tian Zhang et al. [10] proposed an agglomerative hierarchical clustering method named BIRCH (Balanced Iterative Reducing and Clustering using Hierarchies), and verified that it was especially suitable for large databases. BIRCH was also the first clustering algorithm proposed in the database area that can handle noise effectively. The author also evaluate BIRCH's time and space efficiency, data input order sensitivity, and cluster quality through several experiments.

Studipto Guha et al. [11] proposed a new hierarchical clustering algorithm called CURE that is stronger to outliers, and identifies clusters having non-spherical shapes and wide variances in size. CURE process represented each cluster by a certain fixed number of points that are generated by selecting well scattered points from the cluster and then shrinking them toward the center of the cluster by a specified fraction. To handle large databases, CURE employs a combination of random sampling and partitioning.

IV. Implementation and Experiment

In the Myeik Fish Auction Market, there are nearly fifteen marine species that are selling for the customers. As sample data sets with only three sets of marine species which are **Fish**, **Prawn** and **Squid** are used. The input data named "List of Marine Species" was imported to the KNIME tool for the analysis and also for ease in the building of workflow diagram. The following figure 3 shows the **.csv** file in Microsoft Excel format.



	A	B	C	D	E	F
1	Local Name of Species	Weight	Price	Scales	Color	Species
2	Bar-ni	1viss	5000	presence	Red	Fish
3	Bee-zinn	1viss	10000	absence	Green	Fish
4	Golden	1kilo	1700	presence	Yellow	Prawn
5	Nga-lake-kyauk	1kilo	2800	absence	Black	Fish
6	Ka-paune	1viss	7000	presence	Black	Fish
7	Kinmon-gantoo	1viss	8000	absence	Black	Squid
8	Sand Prawn	1kilo	1700	presence	Yellow	Prawn
9	Tiger	1kilo	10000	presence	Reddish Brown	Prawn
10	Nga-tha-lauk	1viss	15000	presence	White	Fish
11	Bar-thi	1kilo	1000	presence	White	Fish
12	Pann-zinn	1viss	4000	absence	Black	Fish
13	Octopus	1viss	5000	absence	White	Squid
14	River White	1kilo	2500	presence	Pale Brown	Prawn
15	Ka-la-ngu	1viss	5000	absence	White	Fish
16	Bee-nyoe	1viss	4000	presence	White	Fish
17	Flower	1kilo	6000	presence	Pale Brown	Prawn
18	Bamboo	1kilo	4000	presence	Yellow	Prawn
19	Kinmon-yit-pauk	1viss	6000	absence	Black	Squid
20	Nga-shwe	1viss	3000	absence	Yellow	Fish
21	Pa-la-tu	1kilo	1800	absence	White	Fish
22	Nga-ohm-thi	1kilo	2000	presence	White	Fish
23	Kinmon-late	1viss	6000	absence	White	Squid
24	Pink	1kilo	6000	presence	Red	Prawn
25	CT	1kilo	1500	presence	Reddish Brown	Prawn

Figure 3. CSV File of the Input Data

A. Data Collection and Implementation of Workflow Model

The marine species dataset samples are taken from the Myeik Fish Auction Market. This sample dataset contains three categories of marine species which are Fish, Prawn and Squid. It includes the number of attributes are 6 and the number of instances are 350. It can be saved Microsoft Excel format. Although many

other features are existed, the experiment of divisive hierarchical clustering process is based on the attributes such as Local Name of Species, Weight, Price, Scale, Color, and Species. These sample data sets are loaded on the workflow model.

Table 1. Description of Attributes of the Marine Species

Attributes	Types
Local Name of Species	nominal
Weight	numeric
Price	numeric
Scale	nominal
Color	nominal
Species	nominal

The experiment was conducted by using ten nodes repository which includes three row splitter nodes, three hierarchical clustering nodes, three statistics nodes and all of these nodes are used for the species of Fish, Prawn and Squid respectively; and one file reader node. In the workflow model, the file reader node which directly reads the CSV file imported to the KNIME platform for the analysis, the row splitter node removes one or more data rows from the input data table according to some filtering criteria, the hierarchical clustering node starts with all data points in one huge cluster and the most dissimilar data points are divided into sub-cluster until each cluster consists of exactly one data point and the statistics node calculates the statistical values of the clusters. With the KNIME platform, the building of workflow model is shown in figure 4.

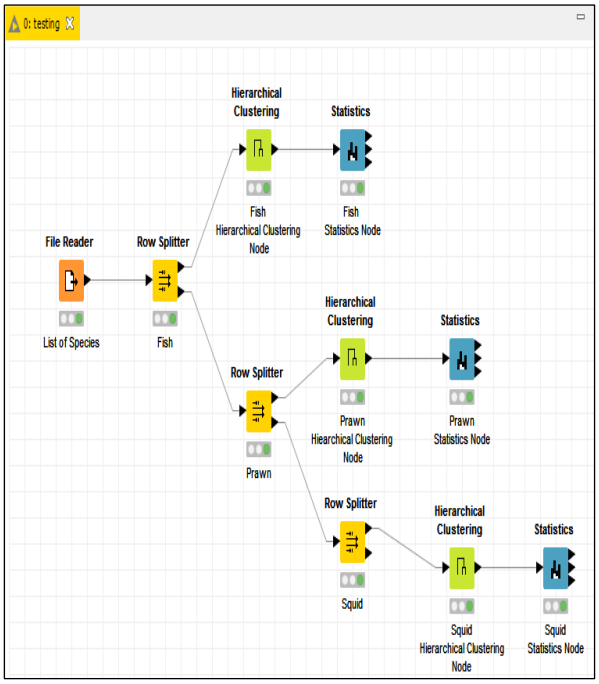


Figure 4. Hierarchical Clustering Workflow Model

B. Clustered Data Table

The divisive hierarchical clustering starts with all data points in one huge cluster and the most dissimilar data points are divided into sub clusters until each cluster consists of exactly one data point. The clustered data table for Fish is obtained from the hierarchical clustering node depending on the attribute values of Fish species. The numbers of five clusters of Fish are collected in the clustered data tables that are generated shown in figure 5.

Clustered data - 3:5 - Hierarchical Clustering (Fish)

File Hilite Navigation View

Table "default" - Rows: 13 | Spec - Columns: 7 | Properties | Flow Variables

Row ID	Local N...	Weight	Price	Scales	Color	Species	Cluster
Row1	Bee-zinn	1viss	10000	absence	Green	Fish	cluster_0
Row4	Ka-paune	1viss	7000	presence	Black	Fish	cluster_1
Row8	Nga-tha-lauk	1viss	15000	presence	White	Fish	cluster_2
Row3	Nga-lake-ky...	1kilo	2800	absence	Black	Fish	cluster_3
Row18	Nga-shwe	1viss	3000	absence	Yellow	Fish	cluster_3
Row9	Bar-thi	1kilo	1000	presence	White	Fish	cluster_3
Row24	Tin-hay	1kilo	1500	absence	Black	Fish	cluster_3
Row19	Pa-la-tu	1kilo	1800	absence	White	Fish	cluster_3
Row20	Nga-ohm-thi	1kilo	2000	presence	White	Fish	cluster_3
Row0	Bar-ni	1viss	5000	presence	Red	Fish	cluster_4
Row13	Ka-la-ngu	1viss	5000	absence	White	Fish	cluster_4
Row10	Pann-zinn	1viss	4000	absence	Black	Fish	cluster_4
Row14	Bee-nyoe	1viss	4000	presence	White	Fish	cluster_4

Figure 5. Clustered Data Table for Fish

The clustered data table for Prawn is obtained from the hierarchical clustering node depending on the attribute values of Prawn species. The numbers of four clusters of Prawn are collected in the clustered data tables that are generated shown in figure 6.

Clustered data - 3:6 - Hierarchical Clustering (Prawn)

File Hilite Navigation View

Table "default" - Rows: 8 | Spec - Columns: 7 | Properties | Flow Variables

Row ID	Local N...	Weight	Price	Scales	Color	Species	Cluster
Row7	Tiger	1kilo	10000	presence	Reddish Brown	Prawn	cluster_0
Row16	Bamboo	1kilo	4000	presence	Yellow	Prawn	cluster_1
Row15	Flower	1kilo	6000	presence	Pale Brown	Prawn	cluster_2
Row22	Pink	1kilo	6000	presence	Red	Prawn	cluster_2
Row12	River White	1kilo	2500	presence	Pale Brown	Prawn	cluster_3
Row23	CT	1kilo	1500	presence	Reddish Brown	Prawn	cluster_3
Row2	Golden	1kilo	1700	presence	Yellow	Prawn	cluster_3
Row6	Sand Prawn	1kilo	1700	presence	Yellow	Prawn	cluster_3

Figure 6. Clustered Data Table for Prawn

The clustered data table for Squid is obtained from the hierarchical clustering node depending on the attribute values of Squid species. The numbers of three clusters of Squid are collected in the clustered data tables that are generated shown in figure 7.

Clustered data - 0:7 - Hierarchical Clustering (Squid)

File Hilite Navigation View

Table "default" - Rows: 4 | Spec - Columns: 7 | Properties | Flow Variables

Row ID	Local Na...	Weight	Price	Scales	Color	Species	Cluster
Row5	Kinmon-gantoo	1viss	8000	absence	Black	Squid	cluster_0
Row11	Octopus	1viss	5000	absence	White	Squid	cluster_1
Row17	Kinmon-yit-p...	1viss	6000	absence	Black	Squid	cluster_2
Row21	Kinmon-late	1viss	6000	absence	White	Squid	cluster_2

Figure 7. Clustered Data Table for Squid

The experimental test was conducted on the number of sample data set of the Myeik Fish Auction Market for the hierarchical clustering. The summary of the used datasets is presented in Table 2.

Table 2. Description of Datasets of the Marine Species

Datasets	No. of Data Instances	No. of Clusters
Fish	200	5
Prawn	100	4
Squid	50	3

C. Dendrogram of the Clusters

A dendrogram which displays the whole cluster hierarchy. At the bottom of the dendrogram are all data points and the closet data points are connected, where the height of the connection shows the distance between them. The dendrogram of Fish Species shows the relationships between similar sets of clustered data according to price. It is obtained from the clusters data table for the Fish species after analyzing the clusters with the row ID for Fish species are shown in figure 8.

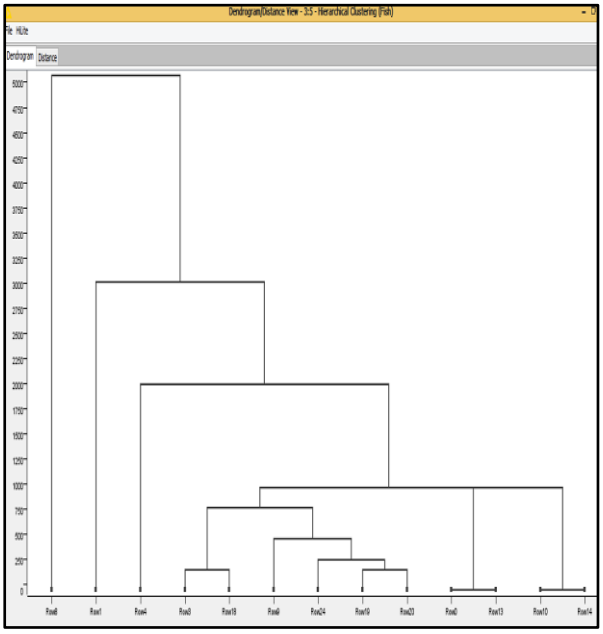


Figure 8. Dendrogram of Clusters for Fish

The dendrogram of Prawn Species shows the relationships between similar sets of clustered data according to price. It is obtained from the clusters data table for the Prawn species after analyzing the clusters with the row ID for Prawn species are shown in figure 9.

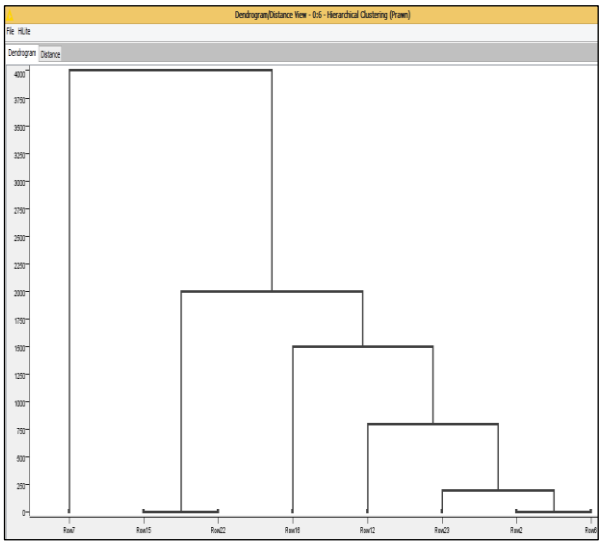


Figure 9. Dendrogram of Clusters for Prawn

The dendrogram of Squid Species shows the relationships between similar sets of clustered data according to price. It is obtained from the clusters data table for the Squid species after analyzing the clusters with the row ID for Squid species are shown in figure 10.

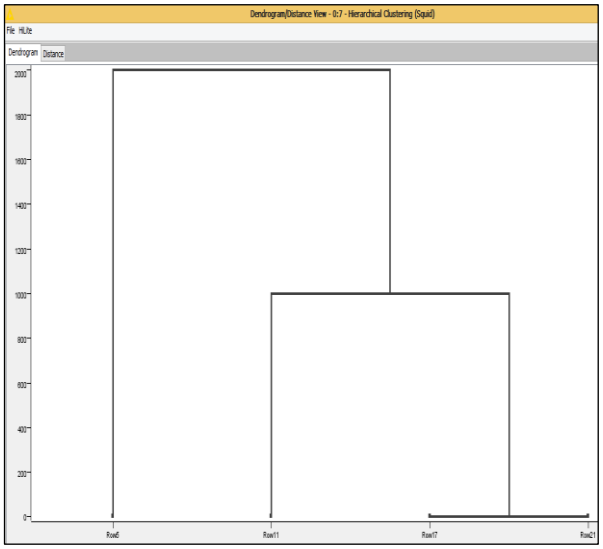


Figure 10. Dendrogram of Clusters for Squid

D. Distance of the Clusters

In the hierarchical clustering problem, calculating the distance between two clusters is important to merge or divide the clusters. In this paper, the single-linkage approach is applied to calculate the distance of two clusters C1 and C2 which is equal to the minimum of the distance between point Pi and Pj such that Pi belong

to C1 and Pj belongs to C2. Mathematically this can be formulated as,

$$d(C1,C2) = Min\ d(Pi,Pj),\ Pi \in C1\ and\ Pj \in C2 \quad (1)$$

where *d(C1,C2)* is the distance between clusters C1 and C2, Pi is the object in cluster C1, Pj is a object in cluster C2, and then *d(Pi,Pj)* denotes the distance between objects belonging to these clusters.

The distance plot displays distances between the clusters for each number of clusters. The distance plots for Fish species are obtained from the clusters splitting according to dendrogram of Fish. The distances between the clusters of Fish species are shown in figure 11.

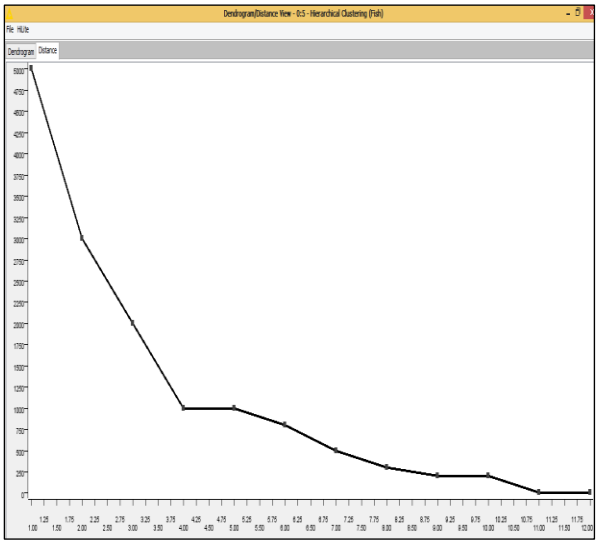


Figure 11. Distance between the Clusters for Fish

The distance plots for Prawn species are obtained from the clusters splitting according to dendrogram of Prawn. The distances between the clusters of Prawn species are shown in figure 12.

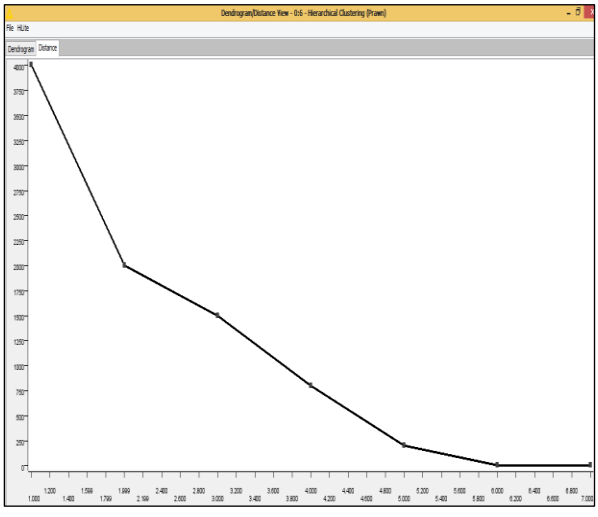


Figure 12. Distance between the Clusters for Prawn

The distance plots for Squid species are obtained from the clusters splitting according to dendrogram of Squid. The distances between the clusters of Squid species are shown in figure 13.

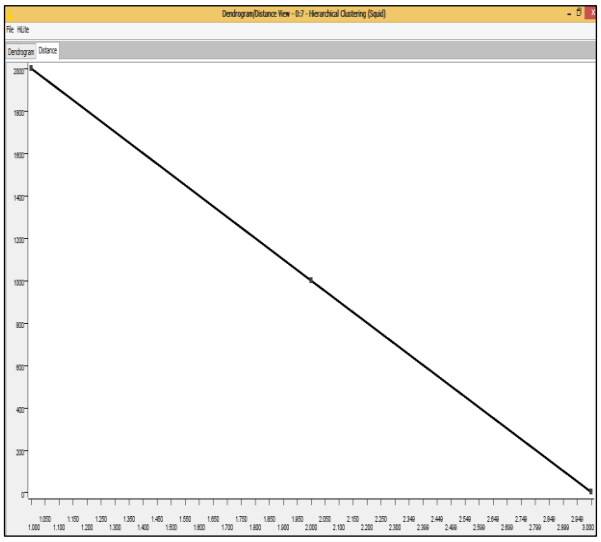


Figure 13. Distance between the Clusters for Squid

E. Statistics View

The statistics node calculates statistical values such as minimum, maximum, mean, and standard deviation values of the clusters. The statistics view shows the minimum price and maximum price of the Fish species with histogram. The statistics views of the Fish species as shown in figure 14.

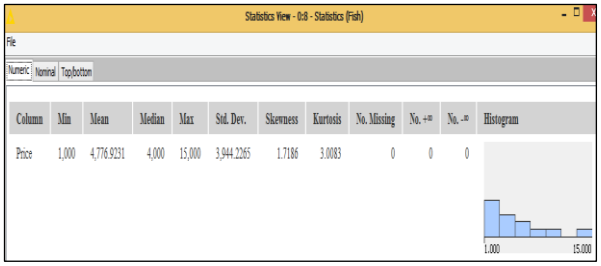


Figure 14. Statistics View for Fish

The statistics view shows the minimum price and maximum price of the Prawn species with histogram. The statistics views of the Prawn species as shown in figure 15.

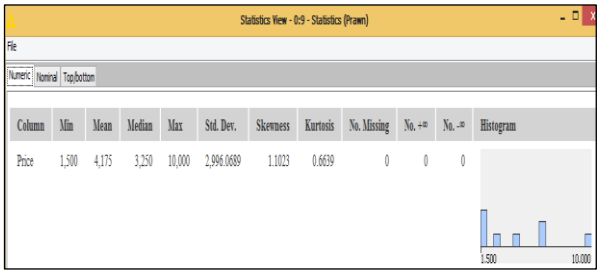


Figure 15. Statistics View for Prawn

The statistics view shows the minimum price and maximum price of the Squid species with histogram. The statistics views of the Squid species as shown in figure 16.

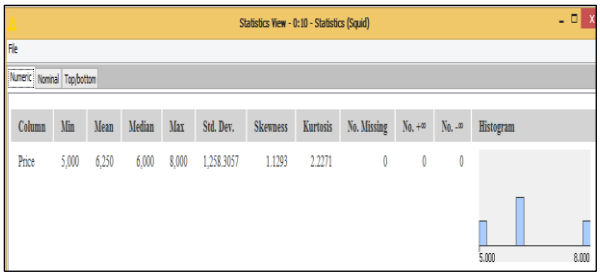


Figure 16. Statistics View for Squid

In table 3, the obtained results are described in terms of minimum, maximum, mean and standard deviation values of the species according to prices from the statistics view.

Table 3. Description of Statistics Data of the Marine Species

Species	Mini-mum	Maxi-mum	Mean	Std.
Fish	1,000	15,000	4,776.9231	3,944.2265
Prawn	1,500	10,000	4,175	2,996.0689
Squid	5,000	8,000	6,250	1,258.3057

V. Experimental Result

This paper describes the experimental result based on the workflow model using divisive hierarchical clustering (DIANA) approach. Statistical bar chart is used to analyse the price of each marine species in the Myeik Fish Auction market. The statistical bar chart shows the different prices of the marine species from the clustering of the data samples. So, the customers can know the price of the marine species in the Myeik Fish Auction Market. The following statistical bar chart is generated from the clustered data table.

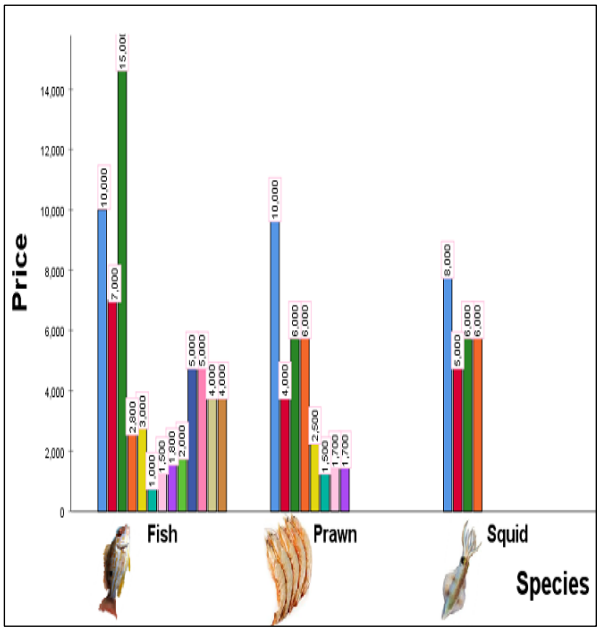


Figure 17. Statistical Bar Chart

VI. Conclusion

Although cluster analysis includes various methods, using the divisive analysis (DIANA) hierarchical clustering approach is more suitable identifying large clusters and producing the output in the form of dendrograms. This paper describes that the divisive hierarchical clustering method is useful for the Myeik Fish Auction Market to predict the price of the marine species for the customers with the obtained results analysis.

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Clustering Analysis of Confirmed COVID-19 Cases in Myanmar by Using K-Means Clustering

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***Abstract*:** Currently, we are facing one of the biggest health problems in the world which was named as "COVID-19 pandemic" by the World Health Organization (WHO). Not only global organizations but also individuals are trying and making effort together to stop the outbreak of the virus. In these cases, the data analysis becomes the main role for research. The Ministry of Health and Sports, Myanmar (MOHS) has confirmed that as of June 22 there have been 290 confirmed cases and six deaths in Myanmar. The purpose of this paper is to analyze the COVID-19 confirmed cases from the MOHS and cluster the cases by using K-means clustering method. Differences in age, regions, confirmed, recovered, deaths and local/travel history are analyzed. Moreover, how the cases can be grouped together by applying the K-means clustering method is also presented. The clustering result shows that the accuracy rate is 82.4% on this data.

***Keywords*:** Coronavirus, COVID-19, MOHS, K-means, Clustering.

I. Introduction

Novel coronaviruses are a large family of viruses that are known to cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) [2]. On December 2019, in the city of Wuhan, Hubei province in China, was reported an unknown pneumonia case to the World Health Organization (WHO). In January 2020, a previously unknown new virus was identified, subsequently named the 2019 novel coronavirus, and samples obtained from cases and analysis of the virus' genetics indicated that this was the cause of the outbreak. This novel coronavirus was named Coronavirus Disease 2019 (COVID-19) by WHO in February 2020 [2]. COVID-19 pandemic is growing rapidly in the world. Many countries around the world are struggling with challenges related to both health and economics. The COVID-19 pandemic, which has been spreading since late 2019, reached in Myanmar on March 2020.

The very first COVID-19 confirmed case in Myanmar was found in Chin state. This positive patient is 36 years old who had returned from the USA and the second is 26 years old who had returned from the UK. Myanmar, one of the developing countries, is also facing the consequences of COVID-19. The Ministry of Health and Sports (MOHS) [1] seeks to make various preparations to deal with the coronavirus infection in Myanmar. In the effort to prevent the spread of the virus, MOHS has set guidelines for the public society to follow. The potential for infection may be from ourselves and people around us, including family. Therefore, the MOHS recommends public health guidelines, self-isolation, and lock-down procedures for the public. The personal view of some people, this lock-down is that it effects the entire world economy particularly transportation because the people are in quarantine region [3].

According to public participation, the infection rate of Myanmar is a good position compared to other countries. Yangon, the country's largest city, is the epicenter of the epidemic. However, outbreak in other states and regions have been detected. There are 204 confirmed cases and 70.4% of infected people in Yangon. The rapid and correct detection of virus-related individuals is becoming a critical issue.

Clustering is the method of grouping data in a data set based on specific criteria. One of the most popular method of clustering, K-means clustering method is simple and extremely fast, so many applications have proven this to be highly effective way that can produce good clustering result. Clustering based-machine learning applications have been widely used in healthcare industry for various purposes [3]. K-means is a numerical, unsupervised, non-deterministic and iterative method. K-means Clustering can accept data from multiple datasets without class labels [4]. We aim to distinguish between the time series and the case situation (confirmed, recovered, and death cases) from different regions. This study reveals that the similar case situation can be grouped together easily by applying K-means clustering method. By analyzing these resulted clusters, important decision can be made by researchers.

II. Methodology

This section presents the applied method for the analysis of COVID-19 data, taken from MOHS data set. The data analysis has been performed using WEKA machine learning tool to obtain the different trends [5]. The methodology consists of these steps: data set collection, data set description and clustering for applied method.

A. Data Set Collection

A specific data set is needed to analyze data. In the present paper, we have collected and used the COVID-19 data of MOHS [1]. In the MOHS data set, the data were collected for 3 months from 23 March 2020 to 22 June 2020. The COVID-19 data set has on confirmed cases that is daily refreshed [6].

B. Data Set Description

The MOHS data set has all the attributes as shown Table 1. There are 8 attributes: Case_no, Date, Regions, Age, Gender, Recovered, Death, and Local/Travel_history. The age of the confirmed patients is categorized as 0-4, 5-14, 15-34, 35-59, 60 years and older.

Table 1. Description of Attributes Used in COVID-19 Data Set

Data Attribute	Description
Cases_no	Declare COVID-19 confirmed cases
Date	The date of the confirmed cases
Regions	The name of the state/division where the cases have occurred
Age	The age of the confirmed person
Gender	The gender of the confirmed person
Recovered	The number of patients receiving treatment and recovery
Death	The number of death cases due to the COVID-19 infection
Local/Travel_history	the person associated with confirmed cases/local transmission and indicates whether there is a travel history

The sample records from the data set is shown in Table 2.

Table 2. Sample Records of the COVID-19 Data Set

Cases_ no	Date	Region	Age	Gender	Recovered	Death	Local/Travel History
1	23/3/2020	Chin	36	Male	Yes	No	USA
2	23/3/2020	Yangon	26	Male	Yes	No	England
3	25/3/2020	Yangon	26	Male	Yes	No	England
4	27/3/2020	Mandalay	33	Male	Yes	No	USA
5	27/3/2020	Yangon	69	Male	No	Yes	Australia,Singapore
6	28/3/2020	Yangon	29	Male	Yes	No	England
7	28/3/2020	Naypyitaw	58	Female	Yes	No	Switzerland
8	28/3/2020	Yangon	60	Female	No	No	French
9	29/3/2020	Yangon	44	Male	Yes	No	Thailand
10	29/3/2020	Yangon	45	Male	Yes	No	Local tramsmission
11	30/3/2020	Yangon	66	Female	Yes	No	French
12	30/3/2020	Yangon	65	Male	Yes	No	French
13	30/3/2020	Yangon	61	Female	No	No	French
14	30/3/2020	Shan	24	Male	No	No	Thailand
15	31/3/2020	Yangon	45	Female	Yes	No	Local tramsmission

C. Applied Classifier Clustering

Clustering is a well-known unsupervised machine learning technique that is used to group data elements without advance knowledge of group definitions [7]. A good clustering method produces high quality clusters. It is the inter-cluster similarity is low and intra-cluster similarity is high [8]. A cluster is similar to the collection of data objects, so it can be grouped together as a single cluster. In this paper, the clustering technique is applied on the COVID-19 data set. It is useful because there are many cases and performs grouping of data without any particular data class. Here, the clustering method is useful to find the similarity of existing data in a cluster [4]. Training data that can be obtained from the MOHS data set is presented in the Table 3. This data is needed to convert into trainable input data format in WEKA.

Table 3. Training Data Samples on COVID-19 Data Set

Relation: MOHS

No.	1: Cases_ no	2: Date	3: Region	4: Age	5: Gender	6: Recovered	7: Death	8: Local/Travel History
	Numeric	Nominal	Nominal	Numeric	Numeric	Numeric	Numeric	Numeric
1	1.0	23/3...	Chin	4.0	1.0	1.0	0.0	1.0
2	2.0	23/3...	Yangon	3.0	1.0	1.0	0.0	1.0
3	3.0	25/3...	Yangon	3.0	1.0	1.0	0.0	1.0
4	4.0	27/3...	Manda...	3.0	1.0	1.0	0.0	1.0
5	5.0	27/3...	Yangon	5.0	1.0	0.0	1.0	1.0
6	6.0	28/3...	Yangon	3.0	1.0	1.0	0.0	1.0
7	7.0	28/3...	Naypyit...	4.0	2.0	1.0	0.0	1.0
8	8.0	28/3...	Yangon	5.0	2.0	0.0	0.0	1.0
9	9.0	29/3...	Yangon	4.0	1.0	1.0	0.0	1.0
10	10.0	29/3...	Yangon	4.0	1.0	1.0	0.0	0.0
11	11.0	30/3...	Yangon	5.0	2.0	1.0	0.0	1.0
12	12.0	30/3...	Yangon	5.0	1.0	1.0	0.0	1.0
13	13.0	30/3...	Yangon	5.0	2.0	0.0	0.0	1.0
14	14.0	30/3...	Shan	3.0	1.0	0.0	0.0	1.0
15	15.0	31/3...	Yangon	4.0	2.0	1.0	0.0	0.0

D. K-means Clustering for COVID-19

Clustering can be implemented using algorithms such as k-means, Hierarchical Clustering and Density-Based Clustering. In the present paper, k-means clustering has been applied because it is easy to implement and run, easy to customize, fast and widely used [5]. This method partitions the data into groups. Therefore, data with the same characteristics can be grouped into the same cluster [5]. The data set given in the K-means clustering method is divided into fixed number of clusters [8]. This method consists of two phases there are as follows:

1) Fix the k value in advance and choose k center in random manner.
2) Assign data objects to nearest center

The working flow of this study by using K-means clustering method is shown in Figure 1.

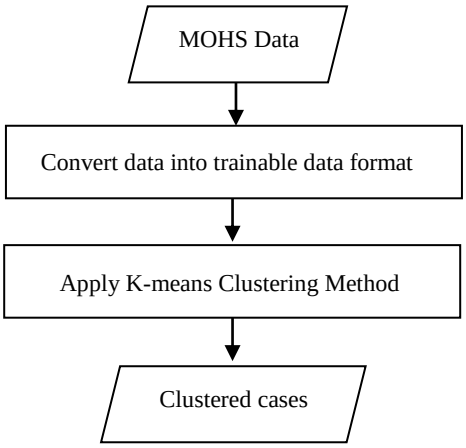

Figure 1. Work Flow of Propose Method

III. Result and Discussion

The purpose of the study is to analyze COVID-19 (confirmed, recovered, deaths) cases in the MOHS data set. From the K-means clustering technique, the value of k, the number of clusters, is taken as 3. Therefore, three-class of clusters (cluster 0, cluster 1, and cluster 2). Figure 2 is the scatter plot showing the relationship of regions and the confirmed cases situation. The scatter plot of the data with colors representing the true clustering labels. The cluster 0 is blue color, cluster 1 is red color and cluster 2 is pink color respectively. By applying K-means clustering on this data in WEKA, more data analysis can be performed; the correlation of each data attribute can be seen. By seeing these results, researchers can determine what actions are needed to control and how to stop the outbreak of this disease. The clustering result shows that the accuracy rate is 82.4% on this data. The accuracy of clustering is determined by the experiments with the three clusters already available in the MOHS data set.

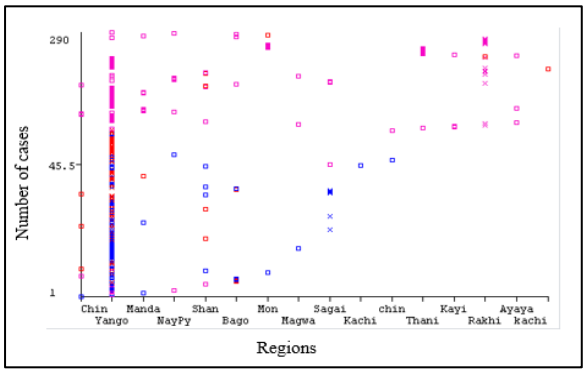

Figure 2. K-means Cluster the MOHS Data Set into 3 Clusters

The cases of COVID-19 (confirmed, recovered, deaths) by region is shown in Figure 3.

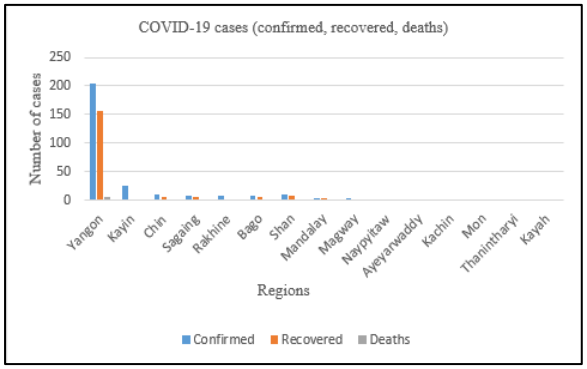

Figure 3. Comparison of COVID-19 (confirmed, recovered, deaths) Cases with Different Regions

Yangon has the highest confirmation rate to compare with the other regions. In Myanmar, 70.4% of the confirmed patients has in Yangon. The second of confirmed rate is Kayin and the least region is Thanintharyi. Now, Mandalay, Naypyitaw, Ayeyarwaddy and Thanintharyi are recovering from the virus, and the regions are no longer infected. In Myanmar, Kayah is the only one region that it is not outbreak of the virus.

According to the age group of infected patients, most patients are in the age group of 15-34 years in Myanmar. The percentage of these patients are 72.6% and the youngest group is 0.3% respectively. This result is shown in Figure 4.

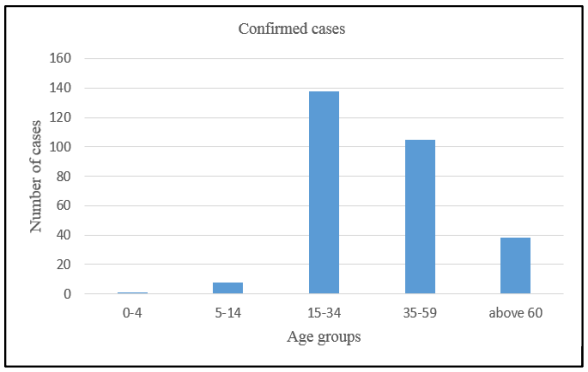

Figure 4. Age Distribution of Patients Infected from COVID-19

The outbreak of the COVID-19 in Myanmar can also be recorded on the time series by analyzing the data. In the MOHS data set, the COVID-19 confirmed cases was firstly found on 23 March and shown daily rates. The number of COVID-19 confirmation rate on the time series is shown in Figure 5.

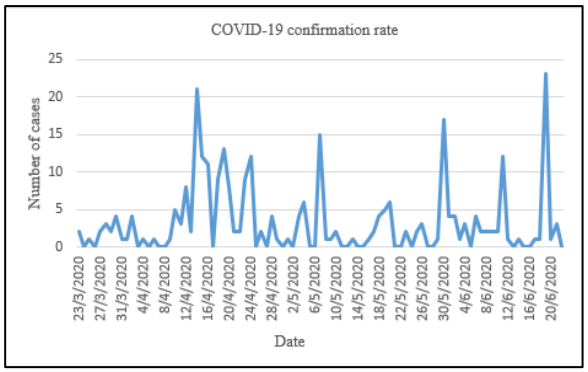

Figure 5. Number of COVID-19 Confirmed Cases in Myanmar

In Myanmar, 68.9% of all infections have recovered and mortality rate is extremely low. The number of COVID-19 recovered rate on the time series is shown in Figure 6.

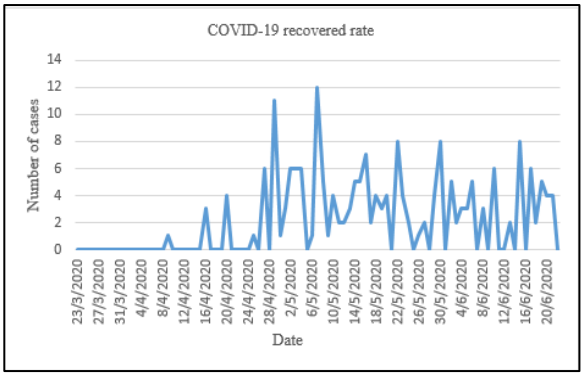

Figure 6. Number of COVID-19 Recovered Cases in Myanmar

In Myanmar, the death rate of infected patients is 2.1%. The highest percentage of deaths are the infected patients over 60 years of age. Most of the deaths are caused by the other disease symptoms. The number of COVID-19 death rate on the time series is shown in Figure 7.

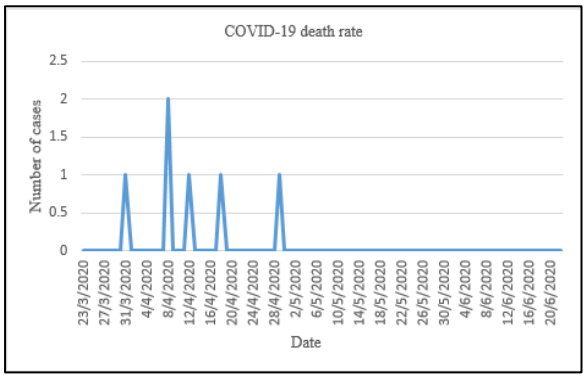

Figure 7. Number of COVID-19 Death Cases in Myanmar

On 19 June, the number of confirmed cases in Myanmar was the highest and recorded as the highest rate of confirmed cases in three months. All the infected patients returned to Myanmar from other countries and have a travel history. Figure 8 illustrates the comparison of local transmission and travel history with different country.

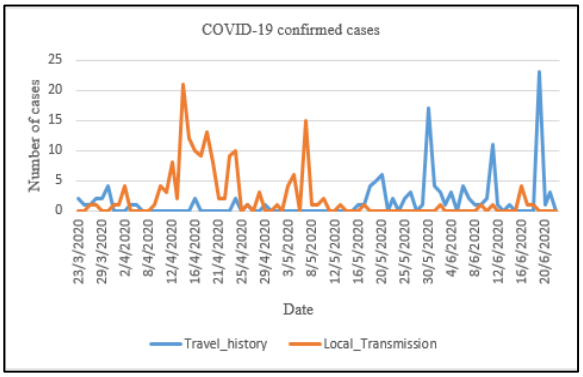

Figure 8. Comparison of Local Transmission and Travel History with Different Country

Figure 9 illustrates the confirmed patients who had infected from other countries. In Myanmar, the patients returned from India is the highest number of confirmed cases. Thailand is the second highest number of confirmed cases.

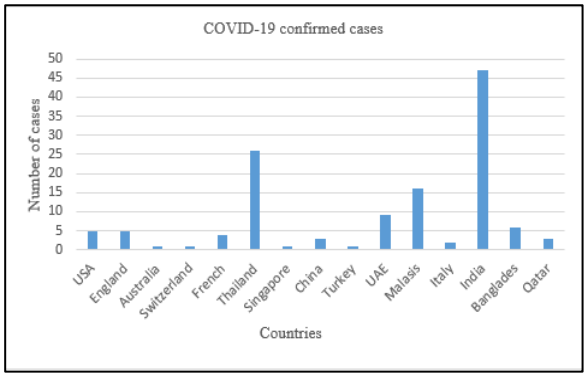

Figure 9. Number of Confirmed Patients Who Have Returned from Other Countries

IV. Benefits and Limitations

This research paper presents the analysis on the COVID-19 epidemic from the data of the Ministry of Health and Sports, Myanmar (MOHS). The data is collected and sorted by 3 months from 23 March 2020 to 22 June 2020.

In this study, public can know regions which occur the most common outbreaks of COVID-19. For example, Yangon is the region with the most confirmed cases and the largest population density. Therefore, the residents of Yangon should take care not to infect. They can find and avoid the most prevalent areas of infection. In terms of travel history, the number of confirmed cases among those returning from India and Thailand to Myanmar has increased. These countries are neighbors of Myanmar, so, public in the border areas should be careful special attention. The result of this analysis will also help the health staff in their duties and the authorities will be able to handle quarantine and self-isolation tasks.

V. Conclusions

In this research paper, from the data analysis, researcher is aware of the COVID-19 outbreaks, so they can act ahead of time. K-means is a typical clustering method that is used for large data sets. In this research paper, K-means clustering method is used in data from different regions of Myanmar obtained by MOHS data set. The study of this paper is to help policymakers and health staffs to coordinate health care resources and prevent the spread of disease. It is hoped that the findings will have some impact to control on Myanmar's confirmed COVID-19 diseases.

For future work, it can collect and analyze the COVID-19 data from all over the world. At the end of the COVID-19 period, the remaining data can be

collected and analyzed after June 22, 2020 in Myanmar.

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Implementation of Bank Marketing (Deposit) Classification Using Gradient Boosting Decision Tree (GBDT)

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Abstract: Bank Marketing (deposit) classification is a system that determines deposit applicants, either 'yes' (client subscribed) or 'no' (client did not subscribe) by analyzing customer's data. This is usually done by following the sample of past customers. Many models and algorithms have been developed to support deposit classification, which includes decision tree ensembles techniques. The decision tree is widely used in the classification process. The Gradient Boosting Decision Tree (GBDT) model is a powerful machine learning method that builds the decision trees to form an integrated ensemble model. This method uses the gradient of the loss function. The benefits of using the GBDT methods are: (1) It supports different loss functions and (2) It works the well with interactions. In this paper, GBDT algorithm will be implemented. This method was used to evaluate accuracy and execution time using the bank marketing (deposit) datasets available from the U. C. Irvine Machine Learning Repository.

Keywords: *GBDT, Classification, Decision Tree Ensembles, Boosting, Decision Tree*

I. Introduction

Decision Trees are supervised learning techniques used in data mining for classification and regression [1]. Ensemble integrated decision trees methods to produce better predictive performance than using a single decision tree. Ensemble decision tree techniques; it is used in many application areas such as data mining, machine learning, etc. Decision tree ensemble methods can be broadly divided into Bagging (Random Forest) and Boosting (Gradient Boosting Decision Tree).

Gradient Boosting is an iterative functional gradient algorithm, i.e. an algorithm which minimizes the loss function by iteratively selecting the function that indicates towards the negative gradient; a weak hypothesis. GBDT is a powerful and theoretically, an important machine learning method that establishes an additive ensemble of trees. It is an iterative procedure that guides the learning of a new tree, the gradient of the loss function. Only then can adding a new tree to the model improve its predictive performance. It is widely used in practice due to its high quality and high performance such as Light GBM, Cat boost, etc. These were particularly well handled with the real-world datasets, with heterogeneous and noisy data. [10]

In this paper, we propose to determine 'yes' (client subscribed) and 'no' (client did not subscribe) using the datasets selected by the customer to select the appropriate information for his or her financial situation.

The rest of this paper is organized as follows: Section II describe the related work. Section III discusses the background theories we use. Section IV illustrates the implementation of the GBDT algorithm using a dataset namely Bank Marketing data. Section V presents the experimental results and conclusion is given in Section VI.

II. Related Works

In [2], Gradient Boosting Machines (GBMs) tutorials, these are defined and illustrated by both theoretical framework and design options. We have discussed all the essential stages of designing a particular model for one's practical needs. The capabilities of the GBM were investigated on a set of real-world practical applications. Based on the experimental results on EMG robotic control data, the proposed method shows the accuracy and overall best results on real-world practical applications.

In [3] Application of selected supervised classification methods to bank marketing the campaign, classification methods such as decision trees, bagging, boosting, and random forests are compared using direct marketing campaign data of a Portuguese banking institution. Experimental results show that Random forest is the best of these methods, with accuracy and complex matrices.

In Predicting Bank Marketing Campaign success using machine learning, it proposes to increase customer rates for long-term deposit product such as CDs. Based on this deposit data, the machine learning model will determine which customers and who to sign up for. All of this was possible by implementing data science and machine learning methods in Python. The proposed method shows how powerful Python can be for applying data science [9].

III. Background Theory

A. Decision Tree Ensembles Techniques

Ensembles techniques are the learning algorithm that constructs a set of classifiers and hence classify new data points by taking a choice of their predictions. It is often must more accurate than individual classifiers that make them up. Decision Tree Ensembles can be divided into the following: (1) Bagging (Random Forest) and (2) Boosting (GBDT).

B. GBDT

The GBDT [6] is a widely used machine learning algorithm, due to its efficiency and accuracy. It uses boosting techniques to integrate individual decision trees. Boosting mean integrating the learning algorithm into a series of a strong learner from several consecutively connected soft learners.

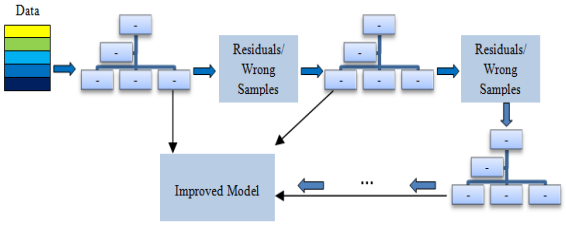

Figure 1. Gradient Boosting Decision Trees

Each tree undertakes to minimize the errors of the previous tree. Trees in boosting are weak learners. However, adding a series of trees and focusing on the errors from the previous one greatly enhances the accurate of the model. Once a new tree is added, it matches the modified version of the original datasets. The GBDT algorithm uses decision trees as weak learners. A loss function is used to detect residual function. [4].

Algorithms that optimize the cost function over function domain by selecting the function (concept of weakness) indicated by the intermediate calculation. The functional of boosting gradient perspective leads to the development of boosting algorithms in many areas of training and statistics. [5] Like other boosting techniques, GBDT combines a weak "learner" with an intermediate form as a strong learner. It is simplest to explain the least-squares regression setting, where the purpose is to "teach" a model $\boldsymbol{f}$ to predict values of the form $\hat{\boldsymbol{y}}=\boldsymbol{f(x)}$ by underestimating the mean squared error (MSE) where $\boldsymbol{i}$ indexes over some training set of size $\boldsymbol{n}$ of actual values of the output variable is $\boldsymbol{y}$:

- $\hat{y}_i$ = predicted value $\boldsymbol{f(x)}$
- $\boldsymbol{y_i}$ = real value
- $\boldsymbol{n}$ = number of samples in $\boldsymbol{y}$

Now let's think of an GBDT algorithm to increase gradient with $\boldsymbol{M}$ levels. Each $\boldsymbol{t\ (1 \le t \le M)}$ of each level of gradient boosting can be reversed if there is an incomplete model $\boldsymbol{f_t}$ (for low $\boldsymbol{t}$, this model may simply return $\hat{y}_i = \bar{y}$, is RHS is the mean of $\boldsymbol{y}$ value). In order to increase $\boldsymbol{f_t}$, the algorithm should add new estimators, $\boldsymbol{h_m(x)}$. Therefore,

$$\boldsymbol{f_{t+1}(x) = f_t(x) + h_t(x) = y}$$

Or, equivalent,

$$\boldsymbol{h_t(x) = y - f_t(x).} \quad \textbf{(1)}$$

Therefore, it will suit $\boldsymbol{h}$ to the residual $\boldsymbol{y - f_t(x)}$. As other boosting variants, each $\boldsymbol{f_{t+1}(x)}$ attempts to correct its previous errors $\boldsymbol{f_t}$. From the classification of function losses other than the square error of this concept and the classification of display problems, the residual gradients $\boldsymbol{y - f(x)}$ for the given model are given as negative gradients (with respect to$\boldsymbol{f(x)}$) of the squared error loss function$\frac{1}{2}(\boldsymbol{y - f(x)})^2$) for the given model. So, gradient boosting can be specialized to the gradient descent algorithm, and it generally involves "plugging in" the different losses and its gradient.

One of the problems that many variables supervise learning has is the disadvantage of input variable $\boldsymbol{x}$ expressed through output variable $\boldsymbol{y}$ and the probability distribution $\boldsymbol{P(x,\ y)}$. Training set $\boldsymbol{\{(x_i, y_i), \dots, (x_n, y_n)}$ (using known values of $\boldsymbol{x}$ and the corresponding values of $\boldsymbol{y}$) aims to find an approximation $\boldsymbol{\hat{f}(x)}$ to a function $\boldsymbol{f(x)}$ that minimizes the expected value of some specified loss function $\boldsymbol{L(y, f(x)):}$

$$\boldsymbol{\hat{f} = arg_f minE_{x,y}[L(y, f(x))]} \quad \textbf{(2)}$$

The gradient boosting method assumes the actual values as $\boldsymbol{y}$ and estimates the approximation $\boldsymbol{\hat{f}(x)}$ in the form of a weighted sum of function $\boldsymbol{h_i(x)}$from the base (or weak) learner in some classes $\mathcal{H}$.

$$\boldsymbol{\hat{f}(x) = \sum_{i=1}^{M} \gamma_i h_i(x) + const.} \quad \textbf{(3)}$$

In according with the principle of minimal risk, the method tries to find an approximation $\boldsymbol{\hat{f}(x)}$ that minimizes the average values of the loss function on the method set training method, i.e., minimizes the empirical risk. It starts with a model; it involves a constant function$\boldsymbol{f_0(x)}$, which is done greedily:

$$\boldsymbol{f_0(x) = arg_\gamma min \sum_{i-1}^{n} L(y_i, \gamma),} \quad \textbf{(4)}$$

$$\boldsymbol{f_t(x) = f_{t-1}(x) + arg_{h_t \in \mathcal{H}} min\ [\sum_{i=1}^{n} L(y_i, f_{t-1}(x_i) + h_t(x_i))]} \quad \textbf{(5)}$$

Where, $\boldsymbol{h_t \in \mathcal{H}}$ is a base learner function?

Unfortunately, choosing the optimal function $\boldsymbol{h}$ for each step for an unjust loss-function $\boldsymbol{L}$ is generally an computationally infeasible optimization problem. Therefore, we limit our approach to the simpler version of the problem.

The idea is to apply this minimum function (functional gradient descent) to the highest descent level. If we consider a continuous case, i.e. where $\mathcal{H}$ is a

set of different functions on $\boldsymbol{R}$, we will upgrade the model according to the following equations:

$$\boldsymbol{f_t(x) = f_{t-1}(x) - \gamma_t \sum_{i=1}^{n} \nabla f_{t-1} L\big(y_i, f(x_i)\big)}, \quad \textbf{(6)}$$

$$\boldsymbol{\gamma_t = arg_\gamma min \sum_{i=1}^{n} L\,(y_i, f_{t-1}(x_i) - \gamma \nabla f_{t-1} L\big(y_i, f_{t-1}(x_i)\big)} \quad \textbf{(7)}$$

Where the derivatives are respected to the functions $\boldsymbol{f_i}$ for $\boldsymbol{i} \in \{\boldsymbol{1}, \dots, \boldsymbol{t}\}$, and γ_t is the step length. In this distinct case, but, i.e. when the set $\boldsymbol{\mathcal{H}}$ is finite, we select the nearest candidate function $\boldsymbol{h}$ from the gradient of $\boldsymbol{L}$, which the coefficient $\boldsymbol{\gamma}$ may be the solution to a given problem, but not a given problem.

Algorithm: GBDT

Input: training set $\{(x_i, y_i)\}_{i=1}^{n}$, choice of the loss-function $L(y, f(x))$, number of iterations M.

Algorithm:

1. Initialize $\boldsymbol{f_0}$ model with a constant value:
2. For t=1 to M
   1) compute the negative gradient $\boldsymbol{\gamma_{it}}$:
   $$\boldsymbol{\gamma_{it} = -\left[\frac{\partial L(y_i, f(x_i))}{\partial f(x_i)}\right]_{f(x)=f_{t-1}}} \quad \textbf{(8)}$$
   2) fit a new base-learner function (or soft learner, e.g. tree) $\boldsymbol{h_t(x)}$, i.e. train it using the training set $\{(x_i, \gamma_{it})\}_{i=1}^{n}$.
   3) find the best gradient descent step-size $\boldsymbol{\gamma_t}$
   $$\boldsymbol{\gamma_t = arg_\gamma min \sum_{i=1}^{n} L\big(y_i, f_{t-1}(x_i) + \gamma h_t(x_i)\big)} \quad \textbf{(9)}$$
   4) update the model:
   $$\boldsymbol{f_t(x) = f_{t-1}(x) + \gamma_t h_t(x)} \quad \textbf{(10)}$$

3. Output $\boldsymbol{f_M(x)}$.

This is the maximum number of termination conditions for the proposed method. It builds the model with the advanced design like other boosting methods. It generalizes them by optimizing different loss performance.

C. Bank Marketing Dataset

The dataset used in this paper is the U. C. Irvine Machine Learning Repository [7], which has 4,119 customers and 21 categories. It contains information on both categorical (marital status, job type, education, etc.) and numeric (age, number of day since previous contact, etc.). The target variable is either binary "Yes" (client subscribed) or "No" (client did not subscribe). It defines all attributes (no missing attribute value). The purpose of the classification is to estimate whether the customer will sign up for a term deposit. Table 1 shows the inputs and outputs of the bank marketing.

Table 1. Input and Output Varieties of Bank Marketing Data

Attributes	Types	Values
age	numeric	20, 25, 29, 31, ...
job type	categorical	admin., blue-coller, entrepreneur, housemaid, management, retired, self-employed, services, student, technician, unemployed, unknown
marital	categorical	divorced, married, single, unknown
education	categorical	basic.4y, basic.6y, basic 9y, high. school, illiterate, professional. course, university. degree, unknown
default (has credit in default?)	categorical	no, yes, unknown
housing (has housing loan?)	categorical	no, yes, unknown
loan (pas personal loan?)	categorical	no, yes, unknown
contact (contact communication type)	categorical	cellular, telephone
month (last contact month of year)	categorical	jan, feb, mar, ..., nov, dec.
day_of_week (last contact day of the week)	categorical	mon, tue, wed, thu, fri
duration: last contact duration, in second	numeric	6, 17, 58, 97, ...
campaign (number of contacts performed during this campaign and for this client)	numeric	1, 2, 3 , ...
pdays (number of days that passed by after the client was last contacted from a previous campaign)	numeric	999 means client was not previously contacted
previous(number of contacts performed before this campaign and for this client)	numeric	0, 1, 2, ...
poutcome (outcome of the previous marketing campaign)	categorical	failure, nonexistent, success
emp.var. rate(employment variation rate – quarterly indicator)	numeric	-0.18, -1.1, 1.1, 1.4, ...
cons.price.idx(consumer price index – monthly indicator)	numeric	92.893, 93.994, 94.465, ...
cons.conf.Idx (consumer confidence index – monthly indicator)	numeric	-36.4, -42, -46.2, ...
euribor3m (euribor 3 month rate – daily indicator)	numeric	0.884, 1.313, 4.855, ...
nr.employed(number of employees – quarterly indicator)	numeric	5099.1, 5191, 5008.7, ...
y – has the client subscribed a term deposit	binary	yes, no

IV. Implementation

The implementation of proposed system is presented in this section. This implementation is based on the KNIME tools in the Microsoft access 2017 database. Firstly, users process data through a pre-processing function to identify features with values such as 'yes', 'no', 'unknown' and convert them to dummy variables. As a result, datasets become integers. Then it is easy to do through our chosen algorithm for meaningful result. We start with a constant value $f_0(x)$ and calculate negative gradient value (γ_{it}) and sort the base-learner function $h_t(x)$ according to equation (8) and (1) respectively and find the best gradient descent step-size γ_t in equation (9) and then update the function model. According to equation (10), the system program continues to operate until the stop criterion is complete. It displays the results (the user registers the deposit term) when the termination term is completed. Users use tree-based algorithms to check accuracy and error metrics for choosing the best performance. Typically GBDT is known for its best performance in supervised machine learning applications and has the highest accuracy.

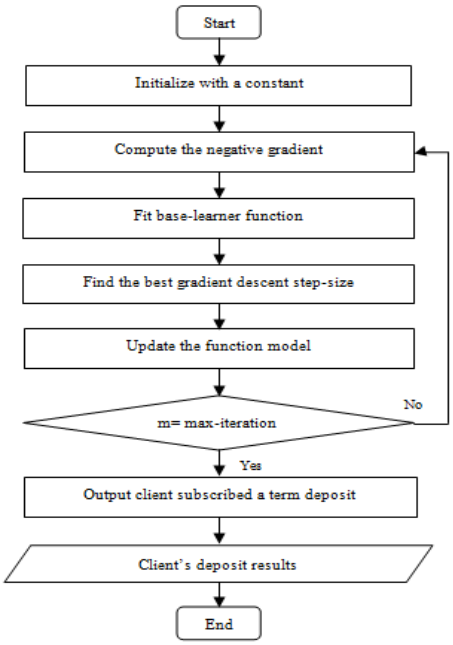

Figure 2. Flow of GBDT Method

Table 2. The Form of A Confusion Matrix with Classification error

y/ Prediction (y)	no	yes
no	TN (true negative)	FN (false negative)
yes	FP (false positive)	TP (true positive)
classification error: (FP + FN)/(number of instances)		

Performance statistics of each classification model are assessed using statistical accuracy, sensitivity and precision. It is true positive (TP); True Negative (TN); False positive (FP) and false negative (FN) are used. The percentage of true/false classification is the difference between the actual and predicted values of the variables. True Positive (TP) is an example, or in other words, the number of correct predictions. Positive prediction of the distinction occurs when the target attribute coincides with a positive prediction. True Negative (TN), for example, presents false or true prediction. False Positive (FP) is an example of the number of correct and incorrect estimates. Finally, a false negative (FN) is an example of a false prediction.

Classification accuracy is defined as the ratio of the number of cases correctly identified and divided by the total (TN+FN+TP+FP) and equals the sum of TP and TN.

$$Accuracy = \frac{TP+TN}{TN+FN+TP+FP} \quad (11)$$

Precision is defined as the number of true positives (TP) rather than the number of true positives and the number of false positive (FP).

$$Precision = \frac{TP}{TP + FP}$$

Sensitivity refers to the sum of TP and TP and FN, which refers to a positively defined positive rate. Sensitivity can be referred to as a true positive rate.

$$Sensitivity = \frac{TP}{TP + FN}$$

Specification refers to the rate of correctly defined negative and is equal to the ratio of TN to the total of TN and FP.

$$Specificity = \frac{TN}{TN + FP}$$

V. Experimental Result

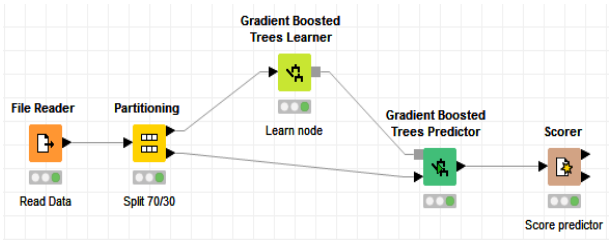

Figure 3. Workflow of GBDT Model on KNIME Tools

In the workflow of GBDT model, first, the data is read from the dataset. Dataset is then divided into training data (70%) and test data (30%). The purpose of the application is to find out the parameters of the model using the training data (depending on the training data) and apply. This is for test data to determine the model's performance and its predictability. In addition, users access the iterations and the mean square error (MSE) of the estimated squares and actual values (MSE) by training the data from the database.

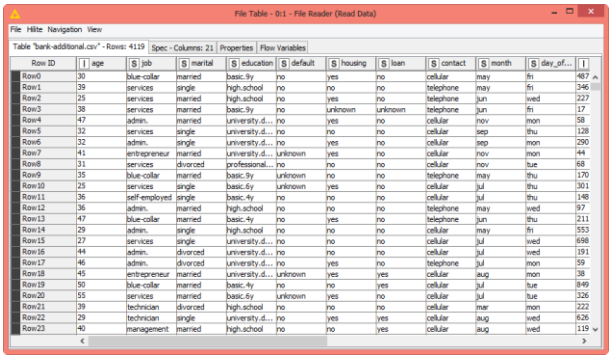

Figure 4. Read File of GBDT on KNIME Tools

Figure 4 show that the data is retrieved from bank marketing database. Then, figure 5 shows the division of training data 70%. Figure 6 also shows the gradient boosted tree model of GBDT method on KNIME tools. Figure 7 show the output data of Gradient boosted trees predictors.

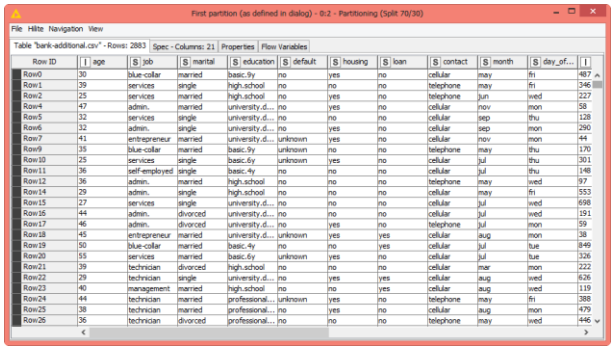

Figure 5. Training Data of GBDT on KNIME Tools

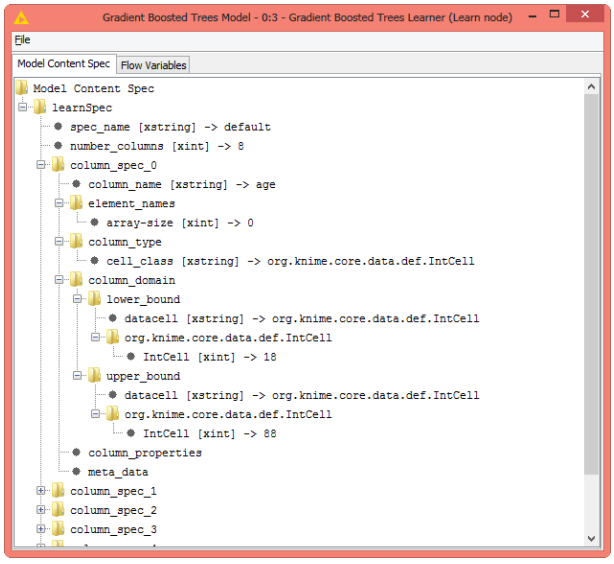

Figure 6. Gradient Boosted Trees Model on KNIME Tools

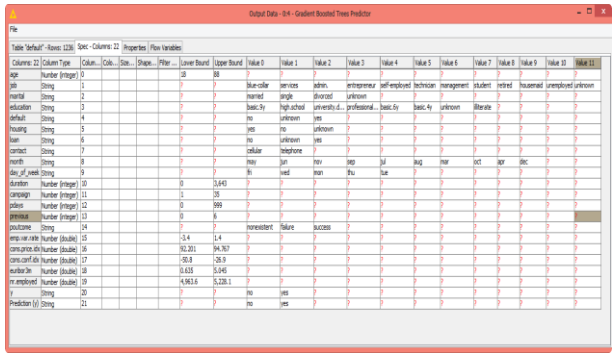

Figure 7. Output Data of Gradient Boosted Trees Predictor on KNIME Tools

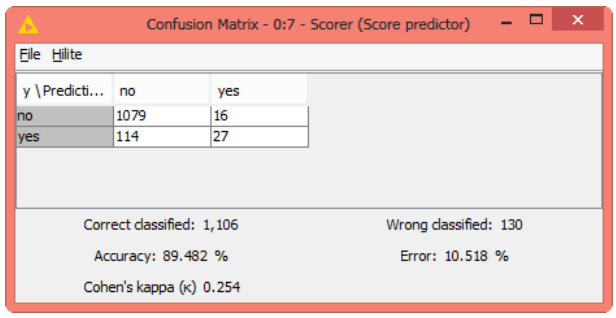

Figure 8. Score Predictor of GBDT Model

Figure 8 also show the accuracy and error in score predictor of GBDT method with depth 3, learning rate 0.1 and iteration 100.

Accuracy is calculated according to equation 11. To assess the performance of the system, the accuracy of the GBDT method for banking datasets is shown in Table 3. Test results of the system depend on iterations with depth 3, learning rate 0.1 and randomly data. The system is optimized with iteration 500 and depth 3.

Table 3. Experiment result of the system

Iteration	Accuracy (%)
100	92.3%
200	92.8%
300	92.9%
400	93.3%
500	93.9%

Figure 9 shows the accuracy statistics for iteration 500, depth 3, and learning rate 0.1.

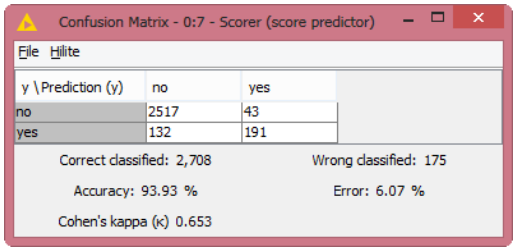

Figure 9. Scorer for Iteration 500, Depth 3 and Learning Rate 0.1

VI. Conclusion

The objective of this study is to create an effective tool to build the GBDT algorithm to help us correctly identify different types of database. This system is implemented by using GBDT. This system classifies banking marketing classes based on user data. The system is a specific process. The accuracy of the system depends on the depth, learning rate and number of iteration.

The accuracy is 94% with depth 3, learning rate 0.1, and 500 iterations. The advantages of this system are that there is no need for human expert to justify the deposit classification system. The system can be used for many organizations and it is easy to use. Fast and accurate decision can be made for deposit classification using this system.

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Classification of Myanmar's Myeik Pearl Color by Using Multilayer Perceptron

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***Abstract*:** In this paper, the mainly involves three steps: to extract Myanmar's Myeik pearl's delta colors, to recognize the color hexadecimal value and to classify the three color ranges of the Myeik pearl images. Traditional representations of colorful pearl images mainly include color distributions and statistical information based on uniform quantized color groups. This study proposes to characterize the color information of the pearl images using a learning strategy which generates adaptive color levels and to extract the the color levels percentage learned for the representation of the image. The database of pearl images set has been created using digitized images of the natural Myeik pearl images. The database comprises of 10 varieties features of the most common color algorithm .In this experiment contains 350 different pearl images. We have analyzed the effectiveness of VNN classifier and Multilayer perceptron machine learning algorithm.

***Keywords*:** Myanmar Myeik Pearl, Delta color, Classification, Vector Neural Network (VNN), Multilayer perceptron

I. Introduction

Pearls are a very popular organic gem and they have many features like other gems, such as color, size, luster, and shape. However, such a manual sorting task is relatively difficult in reality, since it requires the simultaneous consideration of multiple characteristics of the pearls. In addition, manual labor is tedious works. Therefore, this system is the extraction automatically and the classification of pearl classes. [1].

Pearl's luster depends on the reflection, refraction and diffraction of light from the translucent layers [3]. The golden pearls are increasingly cultivated in countries like Australia, Indonesia and our own Myanmar. Today, Myanmar's golden Southern Sea pearls are more popular around the world.

II. Background

A. Differences between Natural and Cultured Pearls

Natural pearls are made up of almost 100% calcium carbonate and conchiolin. It is believed that when microscopic invaders or parasites turn into bivalves and settle inside the shell, natural pearls form in a series of accidental conditions. Cultured pearls are the shell's response to tissue implants. A small piece of the donor shell mantle is transplanted into the recipient's shell, where the tissue forms that precipitates calcium carbonate tissues. [2].

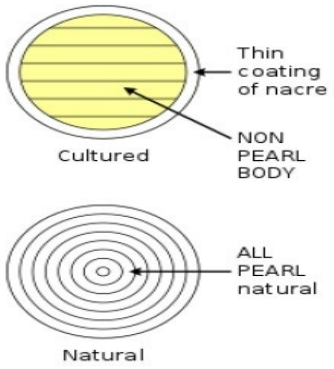


Figure 1. Cross Section Views of Cultured and Natural Pearls

In the above Figure 1 shows the differences between the cross sections views of Cultured and Natural pearls. Fine quality Natural pearls are very expensive jewels. Their values are determined similarly to those of other precious gems, according to size, shape, color, quality of surface, orient and luster.Myeik pearl is natural pearls and the most popular in the world.

B. Color Ranges of South Sea Pearls

The intermediate colors of pearls are often called yellow and champagne. These colors can be beautiful in it, but the most valuable is gold. South Sea pearls are very large and tend to have thick nacre. Moreover, not all golden South Sea pearls are as perfectly spherical as other seawater pearls [4].

Figure 2. Three Color Ranges of South Sea Pearls

In the above Figure 2 illustrates the typical colors of South Sea Pearls. These main characteristics are subdivided into four groups. They are size, shape, color and lusters of Pearls. Some colors are more sought after than others. South sea pearls, or pearls that are mostly cultured in Australia and South East Asia, usually come in hues of white and champagne. The mainly three types of pearls are White range, Black range and Yellow range classes.

III. Related Work

Pearl's color is an important feature and they are including the hue and its color depth. Computer Vision is used to process the pearl image after transforming it from RGB to HSV color model, which can illustrate the hue and color depth information of pearl. According to the histogram of V (Value) weight, the bright area is extracted by Ostu Segmentation and the average value of H (Hue) and S (saturation) are proposed by Chunyu Tian [12].

Qi Xuan and colleagues discussed the design a pearl classification machine, based on which multi-view images of massive pearls can be automatically collected, and the pearls can be classified with a relatively high accuracy utilizing a novel MS-CNN algorithm[13].

Heriberto and Luis presented a hybrid approach to solve the multi-ellipse fitting problem based in initializing PEARL method with solutions taken from a multi-objective genetic algorithm [14].

IV. Myeik Pearl Color Extraction and Classification System

In this section, we describe the proposed system with the main processes in the proposed system. Firstly, the data flow diagram is shown in the following in the Figure 3.Moreover, we are briefly explained the Hexadecimal value of color images to extract color images, the Vector Neural Network used for to recognize of Pearl images and finally the Multilayer perceptron machine learning algorithm to classify three color Pearl ranges classes discussed in the followings.

(1)Selecting the quantization delta values for the specific Myanmar Myeik pearl images from Pearl database

(2) Checking the delta values from these images

(3) Finding the hexadecimal values from the images

(4) Calculating these 10 color value features by using the Vector Neural Network and extracting the most common result percentage color value

(5) Decoding the desired result color and Pearl range class values outputs by using Multilayer perceptron.

(6) Saving the results in the Pearl Database of the desired color range class.

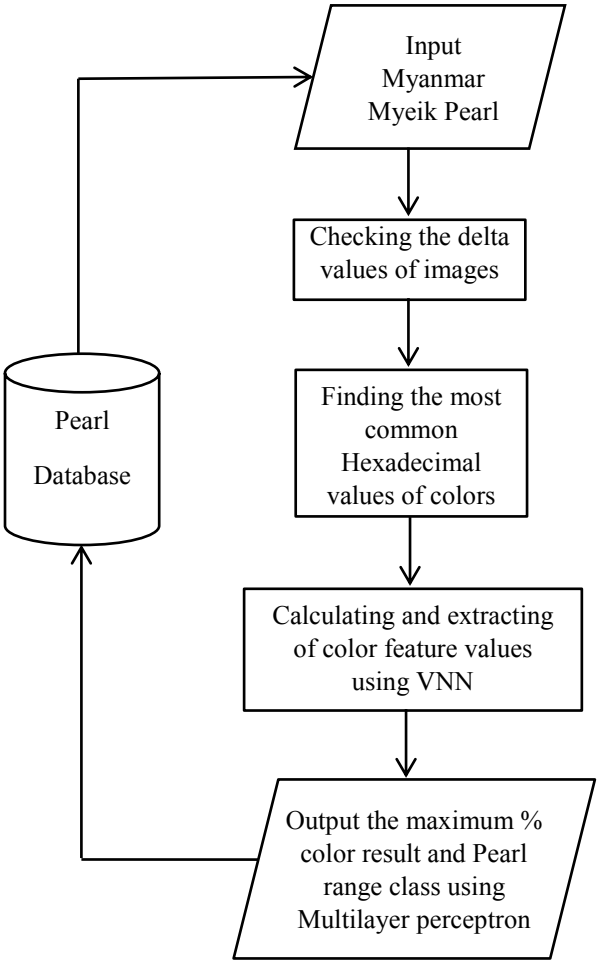


Figure 3. Data Flow Diagram of the Myanmar Myeik Pearl Color Classification System

A. Hexadecimal value of color images

In this paper used the hexadecimal value of the delta value of pearl images (white to black colors, #000000h to #FFFFFFh).In the following Table 1 is shown the RGB notation and values.

Table 1. **RGB Notation and Values**

Notation	RGB Triplet
Arithmetic	(1.0,0.0,0.0)
Percentage	(100%,0%,0%)
Digital 8 bit per channel	(255,0,0) or #FF0000h
Digital 12 bit per channel	(4095,0,0)
Digital 16 bit per channel	(65535,0,0)

A color space describing colors close to human perception is crucial in calculating color difference based on color perceptual similarity. The RGB color space, which is normally used in the frame grabber of color-processing systems, does not carry direct information about the color [5].

B. Vector Neural Network

In the process of pattern recognition, it is a special Neural Network classifiers are widely used for their recognition power. To use a new and special Neural Network classifier, there is a Vector Neural Network introduced by the Russian [10-11].

After features extraction step from these Pearl images, classification and recognition process must be carried out for extracted features. Bearing the calculating speed in mind, authors chose Vector Neural Network classifier for their work of Myanmar Myeik Pearl color recognition system. For the time being, real features of Pearl images have already been extracted to get ready for testing or analyzing VNN. These features are now stored in Pattern Database.

Let us consider a recognition problem of an input feature vector of a segmented image having N features. In pattern database, let, there will be M patterns $\{X_\mu\}$. $X_\mu = \{\vec{x}_{\mu 1}, \vec{x}_{\mu 2}, ..., \vec{x}_{\mu N}\}$ $\mu = \overline{1, M}$. $\vec{x}_{\mu i}$, $i = \overline{1, N}$ - unit vector of ith neuron directing to one direction of q-dimension space [11]. An input vector must be compared to get the most similar one in the pattern database.

This q-dimensional Parametric Vector Neural Network (VNN) can be considered as a two-layer Neural Network. Each neuron $\vec{x}_{\mu i}$ is coded to q-dimensional space before input to the network. All the input neuron is connected with each output neuron of Vector Neural Netwok. N-size output vector, which is considered to get the exact number of pattern, which is the most similar to the input. Each $\vec{x}_\mu$ must be in $Y_\mu = (\vec{y}_{\mu 1}, \vec{y}_{\mu 2}, ..., \vec{y}_{\mu n})$. "*n*" is the output neuron count and in this paper the value of *n* is 5 which mean maximum number of pattern. Y_μ Is the output number of the PVNN getting by decoded from the unit output vector $\vec{y}_{\mu 1}, \vec{y}_{\mu 2}, ..., \vec{y}_{\mu n}$. $\vec{y}_{\mu i}$ is the ith digit of Y_μ .

Synaptic mutual matrix T is calculated as the following formula in Equation (1).

$$T_{ij} = \sum_{\mu=1}^{M} \vec{y}_{\mu i} \, \vec{x}_{\mu j}^{T} \, , \; i = \overline{1, n} \, , j = \overline{1, N} \qquad (1)$$

Where $\vec{x}_{\mu j}^{T}$ is the transpose matrix of $\vec{x}_{\mu j}$.

Synaptic mutual matrix T_{ij} between ith and jth neurons is defined by (qxq) matrix. In this work, q is denoted 10.

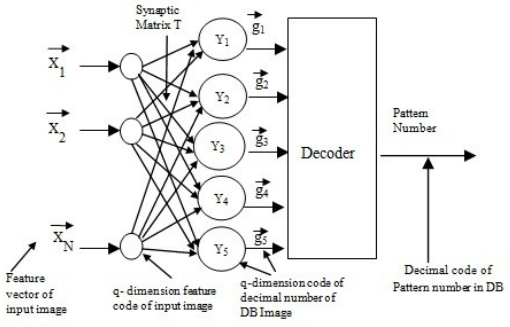


Figure 4. Vector Neural Network

After that, using pattern number in Database (DB) and coded features of that image, Synaptic matrix T is created. Once it is created, it will be used to classify the input pattern determining whose image number in DB is the most similar to that of input one. Output neuron number is depending on the DB size (training pattern count). In fact, output neuron count is actually digit count of the total training images. In the above Figure 4, the Vector Neural Network is demonstrated how it works on the four output neurons. This type of Neural Network is very fast and suitable for pattern recognition process.

The ($q \times q$)-matrixT_{ij} described in the above equation is simply multiplied by the input vector. This matrix affects the vector $z_j \in R_q$, converting it in a linear combination of basis vectors. This combination is an analog of the packet of quasi-monochromatic pulses that come from the jth neuron to the ith one after transformation in the inter connection. After decoding the h_i , $i = \overline{1, 5}$, a decimal number is obtained in this values. This number is the database pattern number which is most similar to the input one [6].

C. Multilayer Perceptron

Multilayer Perceptron machine learning algorithm is a combination of Perceptron layers aiming to solve multiclass problems [2]. The Neural Network architecture is composed of neuron layers, such that each output feeds the input neurons at the following layer. The first layer, denoted by A, has N_A neurons, where N_A has the same dimensionality of the feature vector, while the last layer, denoted by Q, has N_Q neurons, which stands for the number of the classes.

This neural network assigns a pattern vector p to a class are in the following Equation (2) and (3), where ωm if the *m-th* output neuron achieves the highest value, m = 1, 2, . . .,N_O.

Each input layer corresponds to a weighted sum of the previous layer. Let $J - 1$ be the previous layer of J, such that each input $I^J{}_j$ in J is given by:

$$I_j^J = \sum_{k=1}^{N_{J-1}} \omega_{jk} \quad O_k^{J-1} \qquad (2)$$

$$O_k^{J-1} = \emptyset \left(I_k^{J-1}\right) \qquad (3)$$

where j = 1, 2, . . .,N_J, being N_J and N_{J-1} the number of neurons at the layer J and $J-1$, respectively, w_{jk} stands for the weights that modify the k^{th} output of layer $J - 1$, i.e., $O^{J-1}{}_k$, and $\varphi(\cdot)$ corresponds to the activation function. The Multilayer perceptron method consists of a deep, fully Vector Neural Network that learns a patch-wise end-to-end mapping from RGB values [4].

V. Proposed Finding the Most Common Color Finding Hexadecimal Algorithm

The most common colors algorithm can be used to get the maximum percentage of colors in an image. It needs variable; "image" value and to upload the filename of the image you want to process. In this testing program most common 10 colors "count" should be returned values and the amount of gap when quantizing color values used "delta" value and width and height of the desired Pearl image. The proposed the most common 10 colors finding Hexadecimal value algorithm is shown in the following Figure 5.

Algorithm 1: Most common color finding **Hexadecimal** Value algorithm

```
Set the color value, count, delta=16, width, height;
for color=1 to 10 do
 begin
  if (delta > 2)
  begin
   half_delta ⟵ delta / 2 - 1;
  end
  else
  begin
   half_delta ⟵ 0;
  end
  size ⟵ GetImageSize;
  scale⟵1;
  if (size>0)
  scale⟵min(width/size, height/size);
  totalpixelcount ⟵0;
  for y = 0 to y < height do
   begin
   for x = 0 to x < width do
     begin
     totalpixelcount ⟵ totalpixelcount ;
     colors ⟵ imagecolorsforindex;
     if ( delta > 1 )
     begin
     colors[red]⟵ (colors[red])+half_delta)/delta)
                  *delta;
     colors[green]⟵ colors[green])+half_delta)/delta)
                  *delta;
     colors[blue]⟵ (colors[blue])+half_delta)/delta)
                  *delta;
    if (colors[red] >= 256)
    begin
       colors[red] ⟵ 255;
    end
    if (colors[green] >= 256)
    begin
      colors[green] ⟵ 255;
    end
    if (colors[blue] >= 256)
    begin
      colors[blue] ⟵ 255;
    end
    end
    return hexa(colors[red],colors[green],colors[blue]);
   end
  end
 end
End for
```

Figure 5. Most Common Color Finding Hexadecimal Value Algorithm

Finally, according from this color finding algorithm, it returns the 10 maximum colors values from the image in an array, ordered in descending order, where the keys are the colors, and the values are the count of the color.

VI. Experimental Results

A. Myanmar Myeik Pearl Datasets

One of the important factors that improve recognition accuracy is the quality of the pearl images. It is imperative to resolve various problems that occur in the original, such as the image distortion of the colors and the background noise that may occur during digitizing steps. The aim of our work is to develop new algorithms that can achieve high recognition accuracy. Obtaining high recognition accuracy on Myanmar Pearl image data sets is a difficult problem for which many different solutions have been proposed. In this experiment, the Myeik Pearl images tested with over 350 images. In this testing included the yellow, green, gray, black and white pearl images but some pearl colors are blending color in the images and the sample images are illustrated in the following Figure 6.

Figure 6. Sample Myanmar Myeik Pearl Images

B. Feature extraction of Myanmar Myeik Pearl Color

This is developed to carry out the color feature extraction processing system. After extraction each delta color values, there is a need to name this image and save all the features of it with the given name for the next step of Myanmar Myeik Pearl Color recognition system using Vector Neural Network for extracting name of colors. In this tested for the color features. The user interface system is illustrated as shown in the following Figure 7.

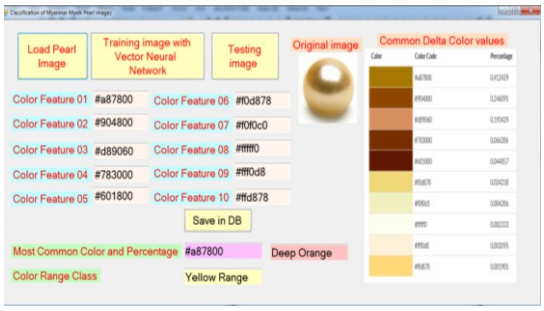
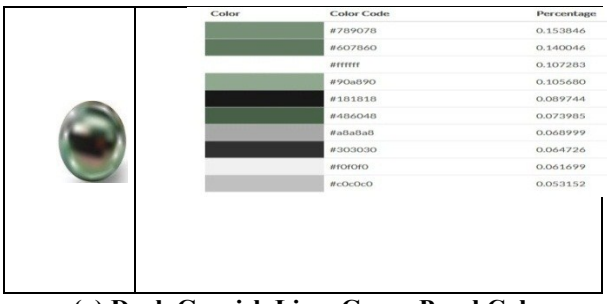


Figure 7. Calculating the Most Common Color of 10 Hexadecimal Values from Myeik Pearl Images

Feature extraction is an essential step for Myanmar Myeik pearl color classification System. Myeik pearl features are not like other cultured pearls. In this work, 10 features are extracted for Myeik Pearl by using the most common 10 color finding Hexadecimal value algorithm. In this paper, many challenges of to extract the color of pearls because mixing or blending color of pearls; this means over 10 colors mixed over the surface of the pearl image [7].An application is developed to carry out the feature extraction process of Myeik pearl image. Firstly to load the desired image. After extraction of each image, this color and save all the features of hexadecimal values of images. Next, training and testing steps are using Vector Neural Network classifier is tested 350 various images.

In this experimental results, from this Figure 7 so the most possible color is the first position, as the color feature 01 value. The most common hexa value is "#a87800", maximum percentage is 0.412429, color name is "Deep orange" and the color range class is "Yellow range" accurate result outputs.



(a) Dark Grayish Lime Green Pearl Color

(b) Slightly Desaturated Pink Pearl Color

Figure 8. Sample Myanmar Myeik Pearl Colors Extraction with Delta Color Codes

As we mentioned above the descending percentage of image and the user interface of the developed system is illustrated in the above Figure 8. (a) to (b) especially tested with other color of Myeik pearl images. In a RGB color space, hex value is composed of Red, Green and Blue. For example in the Figure 8.(b),the hexadecimal color #c07890 has RGB values of R:192, G:120, B:144 and CMYK values of C:0, M:0.38, Y:0.25, K:0.25.The same finding color changed to decimal code to color name in the Figure 8.(a) to (b). Its decimal value is 12613776 and the name of color is "**S**lightly desaturated pink" pearl color [8]**.**

C. Multilayer Perceptron Classify Neural Network Analysis

Back propagation algorithm in MLP neural network was used this analysis [9]. We have chosen to have the 10 color feature extraction (Feature 01 to Feature 10) validation for the test option to maintain the consistency of the experiments. In this paper, "Multilayer perceptron neural networks" was applied the Weka GUI chooser to classify the Myanmar Myeik pearl dataset.

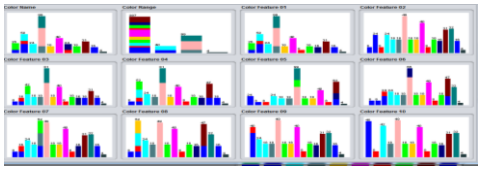


Figure 9. Visualization of the Myeik Pearl Dataset

In this above Figure 9 the visualization of Myeik pearl dataset includes 12 attributes; this includes the Color Name (Dark Orange etc.), Color Ranges (Yellow Range, Black Range and White Range).Feature 01 means the most common maximum % from the desired pearl image. Feature 02 includes the second maximum % color values to Feature 10 includes the minimum % color values. The following Table 2 shows the confusion matrix for a Multilayer Perceptron classifier is explained below: Accuracy (AC) is defined as the ratio of the correctly predicted data to the total number of data and is calculated as follows in the Equation (4)[10].

Table 2. Confusion Matrix

		Predicted	
		Negative	**Positive**
Actual	**Negative**	a	b
	Positive	c	d

$$AC = \frac{ad}{a+b+c+d} \quad (4)$$

*** Stratified Cross Validation ***

*** Summary ***

Correctly Classified Instances	350	100%
Incorrectly Classified Instances	0	0%
Kappa Statistics	1	
Mean Absolute Error	0.0016	
Root Mean Squared Error	0.0026	
Relative Absolute Error	0.5681%	
Root Relative Squared Error	0.7%	
Total Number of Instances	350	

*** Detailed Accuracy By Class ***

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	Yellow Range
	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	Black Range
	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	White Range
	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	Color Range
Weighted Avg.	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	

*** Confusion Matrix ***

a	b	c	d	classified as
207	0	0	0	a = Yellow Range
0	40	0	0	b = Black Range
0	0	99	0	c = White Range
0	0	0	4	d = Color Range

Figure 10. Classification Results Myeik Pearl Color Range Classification System

The recall or true positive rate (TP) is the ratio of positive cases that were correctly identified. The false positive rate (FP) is the proportion of negative cases that were incorrectly classified as positive .The true negative rate (TN) is defined as the proportion of negatives cases that were classified correctly and is calculated the desired image dataset. The false negative rate (FN) is the proportion of positives cases that were incorrectly classified as negative, as follows .Finally, precision (P) is the proportion of the predicted positive cases that were correct [10]. Precision accuracy is calculated the Correctly is nearly 100% and Incorrectly nearly 0 % in the above Figure 10.According from the above testing results, the mean absolute error is 0.0016.Root mean square error is 0.026.Relative absolute error is 0.5681%.Root related square error is 0.7%.The total number of instances is tested with 350 Myeik pearl color features dataset.

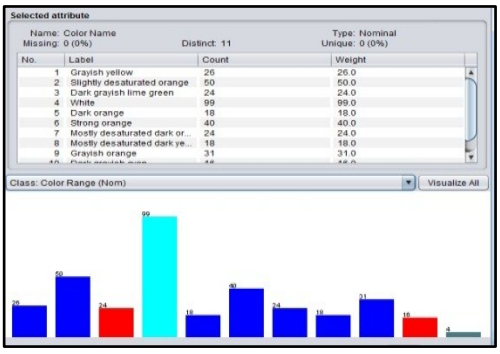


Figure 11. Myeik Pearl Color Attributes

The total number of pearl color attributes is 350 Myeik pearl color features images dataset as shown in the above Figure 11.

As we mentioned above in the Figure 10, the Confusion matrix values are the "Yellow range" is 207, the "Black range" is 40 and the "White range" is 99 from total 350 and the classification of the Myeik pearl color range image results are illustrated in the following Figure 12.The "X axis" is illustrated the color ranges and the "Y axis" is shown the color predicted values, the results are tested with 350 pearl images.

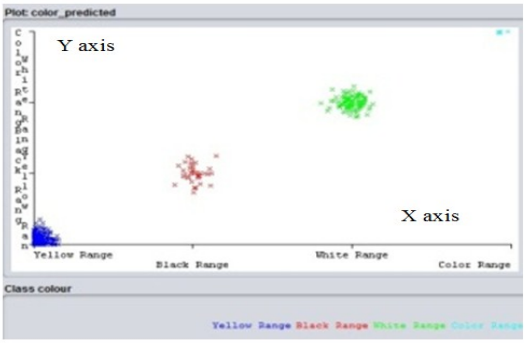


Figure 12. Classification of Color Ranges for Myeik Pearl Color

VII. Conclusion and Future Work

In this research paper we used three main algorithms. Firstly, the most common color finding Hexadecimal value algorithm used for finding the 10 maximum color hexa values from the desired Myeik pearl images. Secondly, the Vector Neural Network algorithm demonstrated to extract the color feature values and to recognize the name of the desired color in the database decoded with the accurate results with 350 images of Myeik pearl dataset. The main contribution of this paper to classify the Yellow range, White range and Black range of Myanmar Myeik pearl colors easily with a novel technique by using Multilayer perceptron. The

classification results showed that the Multilayer Perceptron had a higher predicted accuracy in comparison with neural networks. In our future research, Myanmar Myeik pearl images will be considered for other features classification of the pearl grading system.

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Detection of Spam Email by Using Support Vector Machine (SVM) Algorithm

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***Abstract*:** Most of the people are using email for their working environment. Email takes part the essential role of people daily life. Some people use unwanted commercial emails such as spam in order to disturb the confidential information and unauthorized access. They use spam email as spammer. The huge amount of spam email can happen the consuming of mail servers' storage capacity and the congestion of network bandwidth. Most of the researchers have been used machine learning algorithms in order to detect spam emails. In this paper, we propose a spam email detection model by using Support Vector Machine (SVM). We can detect spam emails from incoming emails. We will use Spam email dataset for detecting of spam emails. We will evaluate the detection system by accuracy and false detection rate.

***Keywords*:** Spam Email, Detection, Support Vector Machine, False Detection Rate, Accuracy.

I. Introduction

In the communication system, emails take part the essential role of our daily activities. We use email in both social communication and working environments. Nowadays, some people are facing unwanted commercial emails problems [1]. These emails are called spam emails. They used this email as a spanner for destroying of many websites and working environments. They have destroyed the power of CPU and mail servers. These emails can cause the consumption of network bandwidth and hard disk space. Spam emails can annoy in working environments [2]. They are very dangerous. These emails are distributors of malware. According to the AV-TEST institutes email detection system, it has been detected spam emails into three categories. They are unsolicited of advertising email, distributed spam email by URL (Unified Resource Location) and distributed spam emails by attached files [3]. According to their detection system, the most obvious countries in suffering of spam emails are that Turkey is 23.4% in last 14 days, United States is 17.9% in last 60 days and Russia is 13.2% in last 180 days [4].

Most of the researchers on spam email detection have used machine learning (ML) algorithms. This machine learning algorithm can give 99.9 percent of accuracy [5]. In the machine learning based spam emails detection system, there are many methods in detection. They are content based detection method by machine learning algorithm, case based spam detection by machine learning algorithm, heuristics based spam detection by machine learning algorithm and previous likeness based spam detection by machine learning algorithm and adaptive spam detection method. In this paper, I have been detected spam email by using Support Vector Machine algorithm. The objectives of the paper are to detect spam email by using support vector machine (SVM) algorithm, to reduce the over fitting problem of dataset and to a bound on test error rate. The organization of the paper is as follow. I will discuss related works of my research in section 2. I will present the background theory of my propose method in section 3. I will also discuss the propose system design in section 4. I will describe result and discussion in section 5 and I will conclude my paper in section 6.

II. Related Works

Many researches have been used variety of spam email detection techniques with machine learning algorithms. Support Vector Machine (SVM) can be used efficient classification method for spam email detection [6]. It is supervised machine learning techniques. SVM can be used a good classifier for sparse data. It can get required precision and recall rate. It can get high classification accuracy. It uses the kernel function that is one of the main ideas of machine learning algorithm that can be used in spam email detection. Another machine learning algorithm, Decision Tree has been used for spam email detection [7]. But it has more training time than SVM algorithm. It needs variable feature execution of input dataset. It has some advantages. The capacity of decision tree algorithm can solve unambiguous values of problems and decisions. The major problem of decision tree is over fitting problem of training dataset. Another machine learning algorithm, Naive Bayes can be used in spam email detection [8]. It has simplicity and quick convergence. It needs small amount of training dataset. It can be used in spam email detection problems including two or more classes. It cannot use in irrelevant features of dataset. But it has a small amount of training time to detect spam emails. Evolutionary algorithm (EA) can also be used in spam email detection and filtering [9]. It does not have any sophisticated computation of mathematics. It can give optimized solution for recognition. Genetic algorithm is one of the EA algorithms that can be used in spam email detection. There are two common approaches for spam email detection. They are knowledge engineering and spam emails filtering by machine learning

algorithm. Emails can be classified as spam or not by using knowledge engineering. But machine learning approach provides more efficient than knowledge engineering in spam emails filtering.

III. Background Theory

A. Spam Emails Filtering Process

Email message consists of two components. They are header and body. The header describes the information about the email. The body describes the main part of the email. The header consists of the subject of the email, the sender and the receiver. The body consists of the context of the data that has been described in header. All emails need to send via sever to the Message Transport Agents (MTAs) [10]. It is the office of organization mails. The header can detect the route of the emails passed through the server. The email needs to pass through at filtering. The filtering process can be seen in Figure 1. In the spam email filtering process, the incoming mail needs to pass through the tokenization process. In the tokenization process, it is needed to remove the words from the body of the email and divide into small sequence of symbols. It is called token. These tokens are needed to pass through the feature selection phase. In feature selection process, when the message size is larger than normal, it can condense a small one. And the next process is email spam filtering process. In this stage, many kinds of techniques need to filter the spam emails.

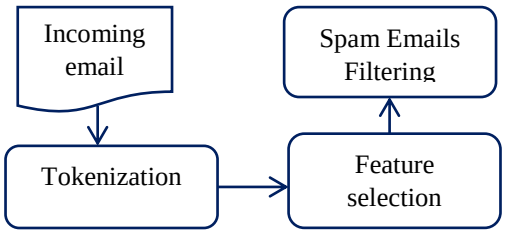


Figure1. Spam Email Filtering Process

B. Support Vector Machine (SVM) Algorithm

Machine learning algorithm can be used in spam email detection. There are two types of machine learning algorithm. They are supervised machine learning algorithms and non-supervised machine learning algorithms. Support Vector Machine (SVM) algorithm is a supervised machine learning algorithm. It can be used in spam emails detection. A Support Vector Machine (SVM) algorithm can use for classification problems between two groups [11]. It is needed to consider two classes such as black and white. There are two features, x and y. It is also needed to consider a pair of (x,y) coordinates and a classifier. We have been plot the labeled training data on a plane that can be seen at Figure 2.

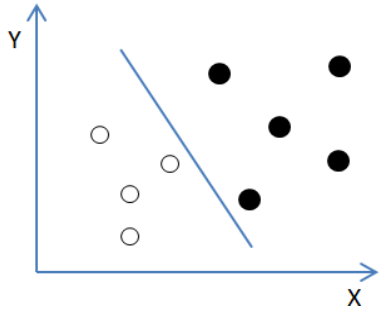


Figure 2. Linear Support Vector Machine (SVM)

The pseudo code of SVM algorithm can be seen in Figure 3.

Input:
- N_{in} (the number of input vectors)
- N_{sv} (the number of support vectors)
- N_{ft} (the number of features in a support vector)
- $SV[N_{sv}]$ (support vector array)
- $IN[N_{in}]$ (input vector array)
- b^* (bias)
- γ (distribution function)
- α^* (weight vector)
- k (kernel function)
- SV[j] (Support vector of j)

Output:
- F (decision function output)

```
for i ← 1 to N_in by 1 do
    F = 0
    for j←1 to N_sv by 1 do
        dist = 0
        for k ←1 to N_ft by 1 do
            dist +=(SV[j].feature[k]- IN[i].feature[k])^2
        end
        k = exp(-γ × dist)
        F += SV[j]. α* × k
    end
    F = F + b*
end
```

Figure 3. Pseudo Code for Support Vector Machine

In SVM algorithm, it is needed to use the number of input vectors, number of support vectors, number features in a support vector, support vector array, input vector array and bias as input data. The output of SVM algorithm is decision function. A SVM takes this data points and separate with hyper plane. This is called decision boundary. The goal of SVM is the maximize the margins from the two classes.

IV. Proposed SVM Based Spam Email Detection System

There are many researches about the detection of spam email by SVM algorithm. In this paper, we have been used email signature dataset. Most of the spam email detection systems face the over fitting problem. Therefore, we have used 10-fold cross validation method in order to solve the over fitting problems. This is the difference between previous researches and our research. We have been detected spam emails by using Support Vector Machine (SVM) algorithm. We need to use spam emails dataset. Firstly, we need to use incoming email and email dataset as input data. Secondly, we need to prepare emails data at preprocessing state. In this stage, we need to remove unnecessary parts of emails. Thirdly, we need to extract malicious features from the incoming emails data. Fourthly, we need to train these data by SVM to generate the model. Finally, we need to test data by SVM and generate the classification results. The step by step process of spam email detection by SVM can be seen in Figure 4.

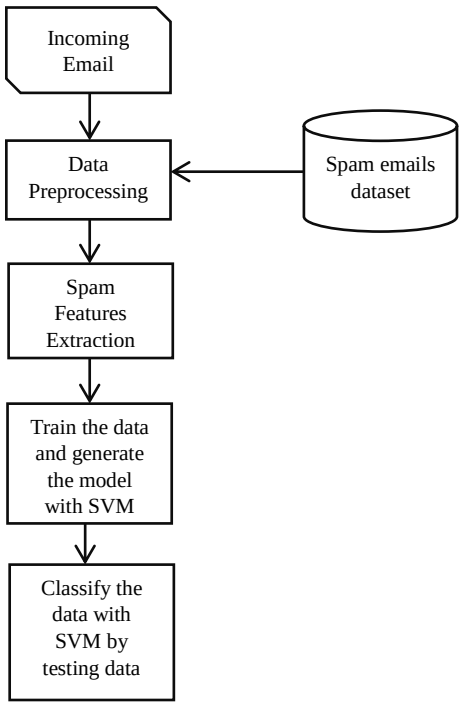


Figure 4. Architecture of Spam Email Detection by SVM

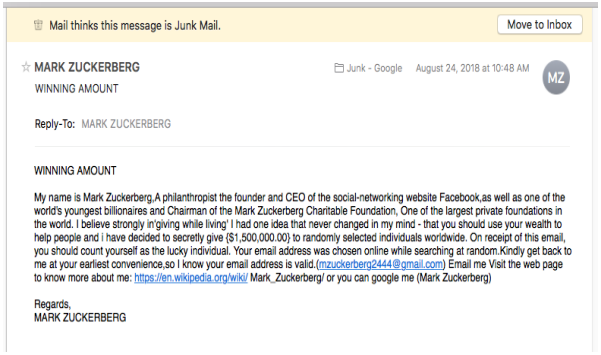
The pseudo code for spam email detection by SVM can be seen in Figure 5. In this pseudo code, we need to input x as email sample message for classification. We need to use TrainingDS as training dataset, a kernel function $\{k_1,k_2,\ldots,k_n\}$. We also need to use the number of elements according to the number of input TraningDS. We need to produce a trained SVM classifier f(x) with kernel function (k). In the training and testing dataset splitting, K-fold cross validation method is used. The trained generated model is tested with TestingDS. We also need to generate the classification accuracy for evaluation purposes. Finally, we need to generate the classification report for spam email detection.

```
Input: email message x for classification, TrainingDS for
       training dataset, a kernel function (k)
for i =1 to num
set k = k_i
for j = 1 to q
produce a model from TraningDS by SVM with classifier f(x)
and kernel function k and compare the classifier f(x) by using
k-fold cross validation.
Classify the incoming email with TestingDS by SVM and
generate the results
Keep the classifier with good accuracy
End for
End for
Return the classification result
End
```

Figure 5. Pseudo Code for Spam Email Classification by Support Vector Machine

V. Experiments and Discussion

Most of the spam emails deliver from commercial, fraudulent or malicious intent. The example of spam email can be seen in Figure 6. In this email, sender is Mark Zuckerberg, the founder and CEO of Facebook Social media. He said that he has been selected the receiver email as randomly. He would like to give $15,000,000 to receiver. He has been send the link to check about himself. Normally, this is very lucky email from the CEO. We need to consider the email address of the sender is real or not. It is needed to check this email. Most of the spam emails consist of check words such as capital letter, address, email, credit card information, money, donate, invite, winning, projects, table, journal and conferences. According to check words, this email consists of capital letter, email, winning, money and invite.


Mail thinks this message is Junk Mail. Move to Inbox

MARK ZUCKERBERG Junk - Google August 24, 2018 at 10:48 AM

WINNING AMOUNT

Reply-To: MARK ZUCKERBERG

WINNING AMOUNT

My name is Mark Zuckerberg,A philanthropist the founder and CEO of the social-networking website Facebook,as well as one of the world's youngest billionaires and Chairman of the Mark Zuckerberg Charitable Foundation, One of the largest private foundations in the world. I believe strongly in'giving while living' I had one idea that never changed in my mind - that you should use your wealth to help people and i have decided to secretly give {$1,500,000.00} to randomly selected individuals worldwide. On receipt of this email, you should count yourself as the lucky individual. Your email address was chosen online while searching at random.Kindly get back to me at your earliest convenience,so I know your email address is valid.(mzuckerberg2444@gmail.com) Email me Visit the web page to know more about me: https://en.wikipedia.org/wiki/ Mark_Zuckerberg/ or you can google me (Mark Zuckerberg)

Regards,
MARK ZUCKERBERG

Figure 6. Sample Spam Email

In the experiment of spam emails detection system, we have been used Spambase dataset from UCI machine learning dataset repository. These dataset contains 58 attributes. All of these attributes are continuous values. They are word_freq_make,

word_freq_address, word_freq_all, word_freq_all, word_freq_3d, word_fred_our, over, remove, internet, order, mail, receive, will, people, report, addresses, free, business, email, you, credit, yours, font, OOO, money, hp, hpl, george, 650, lab, labs, telnet, 857, data, 415, 85, technology, 1999, parts, pm, direct, cs, meeting, original, project, re, edu, table, conference, ;, (, [, !, $, 3, capital_run_length_average, captial_run_length_longest and captial_run_length_total.

One of the columns from these dataset has class. This class is either spam email or ham mails. Firstly, we need to do data preprocessing stage before classification of spam emails.

In supervised machine learning algorithm, data preprocessing stage is very important because the data in which is in incomplete manner for pre-processing. Some of the machine learning algorithm can extract the knowledge from the dataset and features. In this paper, we have been removed unnecessary attributes from the dataset. Secondly, feature extraction is also important process in classification method. We have been select important features for spam emails and removed irrelevant features from the dataset. This can save in running time complexity and space complexity. It can also be improved in the classification performance. After being feature generation process, we gave these features set as input to the SVM algorithm. SVM is implemented in K-fold cross validation in training and testing dataset. In this paper, we have been used 10-fold cross validation method. It means that the entire dataset, Spambase is divided with 9 (10 - 1) partitions. We have been done nine times. The experiment of dataset partition can be seen in Table 1.

After generating the SVM model, we have been generated the classification result. In the generating of the classification result, we have been calculated the evaluation measurements.

Table 1. Dataset Splitting by 10-fold Cross Validation

No.	Splitting Rate	Training Dataset (%)	Testing Dataset (%)
1	0.1	10	90
2	0.2	20	80
3	0.3	30	70
4	0.4	40	60
5	0.5	50	50
6	0.6	60	40
7	0.7	70	30
8	0.8	80	20
9	0,9	90	10

We have been done our experiment as according to Table 1.In this paper, we have been measured accuracy and precision of classification results. The accuracy and precision can be calculated in Equation 1 and 2.

$$Accuracy\ for\ detection\ of\ Spam\ email = \frac{TP+TN}{TP+FP+FN+TN} \quad (1)$$

$$Precision\ for\ detection\ of\ Spam\ emails = \frac{TP}{TP+FP} \quad (2)$$

From these equations, TP means the True Positive, TN means the True Negative, FP means the False Positive and FN means the False Negative in spam emails detection. The accuracy for detection of Spam email is the ratio of correctly classified to the total observations. The precision for detection of spam emails is the ratio of correctly predicted positive classification to the total predicted positive classification. In the evaluation of spam emails detection system, we have been compared the classification result of SVM with other machine learning algorithms, KNN and Naïve Bayes. We have been classified these dataset by using KNN and Naïve Bayes in Weka tool. The comparison for the overall classification experiment of SVM, KNN and Naïve Bayes can be seen in Figure 7.

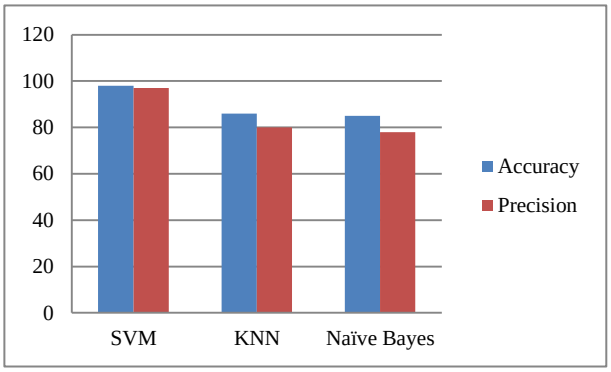


Figure 7. Comparison for Experimental Results

According to the comparison of experimental results, the accuracy and precision of SVM algorithm is about 98% and 97%, the accuracy and precision of KNN algorithm is about 86% and 80%, and the accuracy and precision of Naïve Bayes algorithm is about 85% and 78%.

VI. Conclusion

Although many researchers have been proposed spam emails detection method, the challenges of spam emails detection research is active research field for academic and industry. In this paper, we have been proposed the spam emails detection by SVM algorithm. We have analyzed and literature reviewed of related research. We have been evaluated our generated classification result by comparing with other machine learning algorithm. In the future work, we will propose spam emails elimination method on real world.

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COVID-19 Disease Information Retrieval System Using TF-IDF Based KNN Classifier

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Abstract: Today, information retrieval (IR) is useful for searching specific information. Information retrieval is the science of searching web pages, for information within web pages. So, this system is implemented as the information retrieval system to retrieve COVID-19 disease information. For IR process, this system uses the TF (term-frequency)-IDF (inverse document frequency) based KNN (k-nearest neighbour) classifier. By using this system, the user can easily know the required information about the today suffered COVID-19 disease. This system retrieves the related information via the user query if the user wants to know about COVID-19 that caused in the world. By searching the needed information, this system is useful to prevent people illness during COVID-19 wave.

Keywords: COVID-19, IR, KNN Classifier.

I. Introduction

Today, vast amount of information in various complex forms have been growing explosively owing to the rapid progress of information collection tools, advanced database technologies, and World-Wide Web (WWW) technologies. Two kinds of innovations are generally used to defeat information over-burden: information retrieval (IR) and recommender frameworks. Information retrieval is one the retrieval frameworks which is perusing through documents and searching for explicit information. IR is the study of looking for documents, for information within documents and for metadata about documents, and that of looking social database and the World Wide Web. So, this system is actualized as the information retrieval framework to retrieve required information.

For information retrieval, this system uses the TF-IDF based KNN classifier. By utilizing TF-IDF strategy, this system calculates the weight of each keyword from each web page. Then, this system classifies the most relevant query relevance web page by using KNN classifier. By retrieving required COVID-19 information, this system is useful for medical domain in Myanmar.

II. Related Work

In 2018, A. Moldagulova and R. B. Sulaiman [1] presented the document classification based on KNN algorithm by using term vector space reduction. This system used KNN classifier for handling unstructured text data in particular document classification problems. Most document classification methods dependent on term vector space model of portrayal of unstructured printed information. The term vector space model is anything but difficult to actualize, gives uniform portrayal to archives. This framework decreased the element of the term-document matrix.

In 2018, I. Rasheed, V. Gupta and H. Banka [2] described the peculiarities of Urdu text classification of news origin. K-closest neighbour (KNN) was estimated on the grouping of Urdu text utilizing WEKA (Waikato Environment Knowledge Analysis) apparatus. The appraisal was completed on a generally huge assortment of Urdu text having more than 16678 records containing news stories from the day by day Roshni, a Urdu paper. TF-IDF weighting plan was utilized for include determination and extraction of information. In this framework, dataset was planned according to TRC (text recovery gathering) network standard.

III. Information Retrieval (IR)

Information retrieval (IR) frameworks are web indexes such as Google, which distinguish those documents on the World Wide Web that are pertinent to a lot of given words. IR is the investigation of helping users to discover information that coordinates their information needs. Actually, IR studies the acquisition, organization, storage, retrieval, and distribution of information. Generally, IR is about document retrieval, emphasizing document as the essential unit. A good IR system is able to accept a user inquiry, comprehend from the user query what the user requires, search a database for applicable documents, retrieve the documents to the user, and rank the documents as indicated by their pertinence [4, 5].

There are four main IR models: Boolean model, vector space model, language model and probabilistic model [6].

IV. Vector Space Model (VSM)

In VSM, a document is then spoken as a vector of term weights. The quantity of dimensions in the vector space is equivalent to the quantity of terms utilized in the overall documents assortment. Term weight in a document is determined by utilizing TF-IDF strategy, where TF is a element of the quantity of events of the term inside the document and IDF is an inverse function of the total number of documents that contains the term. This representation prompts the utilization of the vector inner product as the measure of similarity between the query and a document [3, 7].

A. Term Frequency–Inverse Document Frequency (TF-IDF)

In this scheme, a document in VSM is represented as a weight vector, in which each component weight is computed based on some variation of TF or TF-IDF scheme. In this scheme, N be the total number of documents in the system and df_i be the number of documents in which term t_i appears at least once. f_{ij} be the raw frequency count of term t_i in document d_j. Normalized method is more precise than the original term frequency method. Then, the normalized term frequency (denoted by tf_{ij}) of t_i in d_j is given by

$$tf_{ij} = \frac{f_{ij}}{\max\{f_{1j}, f_{2j}, \ldots, f_{|v|j}\}} \quad (1)$$

The inverse document frequency (denoted by idf_i) of term t_i is given by:

$$idf_i = \log \frac{N}{df_i} \quad (2)$$

The final TF-IDF term weight is given by:

$$w_{ij} = tf_{ij} \times idf_i \quad (3)$$

A query q is represented in exactly the same way as a document in the document collection. The term weight w_{iq} of each term t_i in q can also be computed in the same way as in a normal document, or slightly differently. In the following equation, "0.5" is constant value.

$$w_{iq} = 0.5 + \frac{f_{iq}}{\max\{f_{1q}, f_{2q}, \ldots, f_{|v|q}\}} \times \log \frac{N}{df_i} \quad (4)$$

B. K-Nearest Neighbour Classifier

K-nearest neighbour (KNN) classifier is the most commonly used classification method. KNN algorithm is as follows:

Input parameters: Data set, k
Output: Classified test tuples

- Step 1: Store all the training tuples.
- Step 2: For every inconspicuous tuple which is to be classified, KNN classifier computes the distance of concealed tuple with all the training tuples by utilizing Manhattan distance method. Manhattan distance between data tuples X and Y is computed as:

$$\sum_{1 \le i \le n} |x_i - y_i| \quad (5)$$

- Step 3: Find the k nearest training tuples to the inconspicuous tuple.
- Step 4: Assign class which is generally regular in the k nearest training tuples to inconspicuous tuple [8].

V. Covid-19 Disease

Coronavirus disease 2019 (COVID-19) is an irresistible illness brought about by severe acute respiratory syndrome coronavirus (SARS-CoV-2).

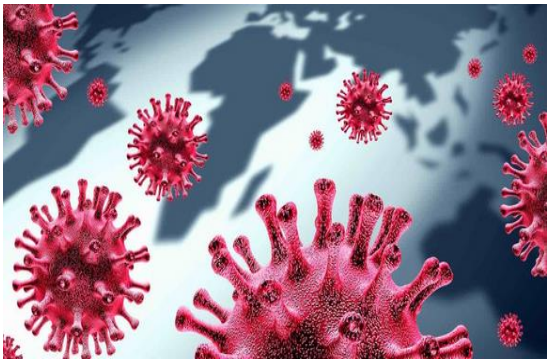

Figure 1. Corona Virus

Corona virus is shown in Figure 1. Common symptoms include fever, cough, fatigue, Regular side effects incorporate fever, hack, exhaustion, brevity of breath and loss of smell and taste. The infection is principally spread between individuals during close contact, frequently by means of little beads delivered by hacking, wheezing and talking [9].

VI. Proposed System Design

At first of the system, the user must input query to retrieve required COVID-19 information. Training web pages are stored in the system database. Each web page contains COVID-19 disease information. In this system, there are three steps that are pre-processing step, weight calculation step and KNN classification step.

In the pre-processing step, this system removes stopwords and extracts keywords from the user query and each training web page. Stopwords are "on", "in", "of" and so on. And then, this system calculates the weight of each term by using TF-IDF weighting method. After calculating each term weight, this system classifies the most query relevance web pages by using KNN classifier. Finally, this system displays the results to the user. Proposed system design is shown in Figure 2.

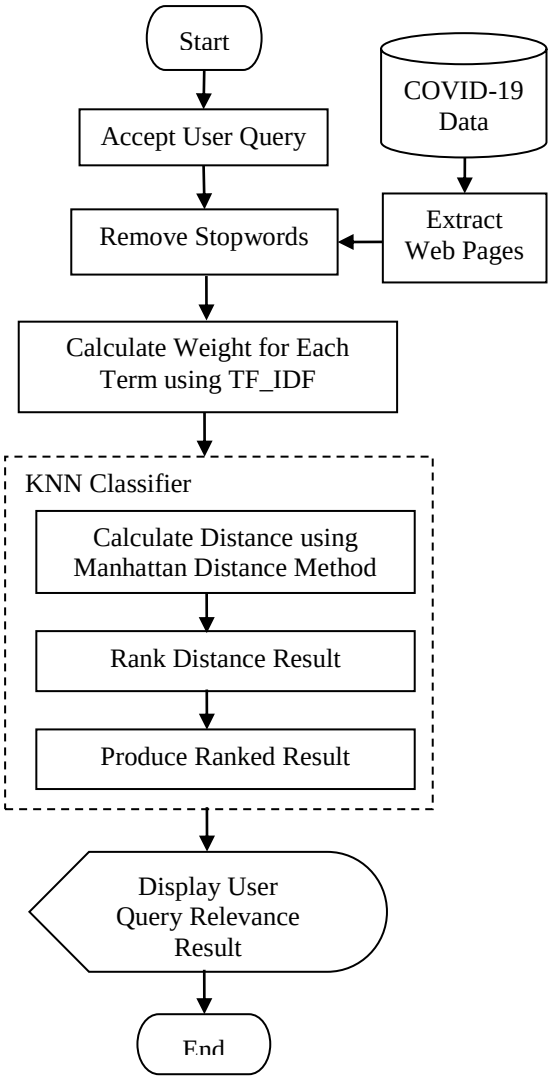

Figure 2. Proposed System Design

A. Implementation of the System

This system is implemented as the COVID-19 information retrieval system by using TF-IDF based KNN classifier. As a sample, three web pages are stored in the database as the training data. By using links of the web pages, these pages are stored in the database. Each web page is relevance to the COVID-19 disease information. For sample calculation, these web pages are as follows:

- Web page1: COVID-19 pandemic in Myanmar is part of the worldwide pandemic of coronavirus disease 2019.
- Web page2: Coronavirus was confirmed to have reached Myanmar on 23 March 2020.
- Web page 3: Symptoms of COVID-19 are sore throat, diarrhea, headache and conjunctivitis.

At first of the system, the user input query. In this sample, the query is "***Coronavirus in Myanmar***". After inputting the input query, the proposed system removes stopword from each web page and user query. And then, this system extracts terms (keywords) to calculate weight of each terms. By using weight of each term, the proposed system calculates the distance between the user query and each web page.

Sample weight calculation for "COVID-19" is as follows:

- $TF_{\text{"COVID-19", web page1}}$ = COVID-19 (1)/ max{COVID-19 (1), pandemic (2), Myanmar (1), part (1), worldwide (1), coronavirus (1), disease (1), 2019 (1)} = 1/2 = 0.5
- $IDF_{\text{"COVID-19", web page1}}$ = log 3/ 2 = 0.1761
- $W_{\text{"COVID-19", web page1}}$ = 0.5 * 0.1761 = 0.088

Weight of each term in web page 1, 2, 3 and query are shown in Table 1, 2, 3, and 4.

Table 1. Weight of Each Term in Web Page 1

ID	Terms	TF	IDF	Weight
1	COVID-19	0.5	0.1761	0.088
2	pandemic	1	0.4771	0.4771
3	Myanmar	0.5	0.1761	0.088
4	part	0.5	0.4771	0.2385
5	worldwide	0.5	0.4771	0.2385
6	coronavirus	0.5	0.1761	0.088
7	disease	0.5	0.4771	0.2385
8	2019	0.5	0.4771	0.2385

Table 2. Weight of Each Term in Web Page 2

ID	Terms	TF	IDF	Weight
1	coronavirus	1	0.1761	0.1761
2	confirmed	1	0.4771	0.4771
3	reached	1	0.4771	0.4771
4	Myanmar	1	0.1761	0.1761
5	March	1	0.4771	0.4771
6	2020	1	0.4771	0.4771

Table 3. Weight of Each Term in Web Page 3

ID	Terms	TF	IDF	Weight
1	symptoms	1	0.4771	0.4771
2	COVID-19	1	0.1761	0.1761
3	sore	1	0.4771	0.4771
4	throat	1	0.4771	0.4771
5	diarrhea	1	0.4771	0.4771
6	headache	1	0.4771	0.4771
7	conjunctivitis	1	0.4771	0.4771

Table 4. Weight of Each Term in Query

ID	Terms	TF	IDF	Weight
1	coronavirus	1	0.1761	0.1761
2	Myanmar	1	0.1761	0.1761

After calculating each weight, this system classifies the KNN classifier. In this sample, this system uses K=1. So, this system retrieves the most relevant web page. To calculate the distance, this system uses the Manhattan distance method from KNN classifier. If the distance result is "0", this points out the most relevance. The distance results are as follows:

- Distance between web page 1 and Query = 0.1761
- Distance between web page 2 and Query = 0
- Distance between web page 3 and Query = 0.3523

According to the distance result, the web page 2 is the most relevance with the user query. So, this system produces web page 2 as a result because this web page consists of the most query relevance COVID-19 information. By using the proposed system, the user must obtain the precise and relevance information about COVID-19.

B. Experimental Result of the System

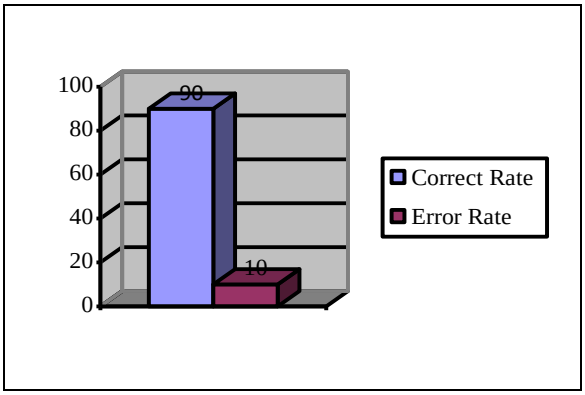

Figure 3. Experimental Results of the System

The accuracy result is shown in Figure 3. To show the performance of the system, this system is tested by using 100 training web pages that is related with COVID-19 data. For query relevance retrieval, this system uses different queries.

This system can't retrieve the relevance information if the user query is an ambiguous user query. To measure the performance of the system, this system uses the precision method. Precision is the percentage of retrieved documents that is relevant to the query. Precision method is as follows:

$$\text{precision} = \frac{\left|\{\text{relevantDocs}\} \cap \{\text{retrievedDocs}\}\right|}{\left|\{\text{retrievedDocs}\}\right|} \quad (6)$$

Because of this system can't solve the semantic problem, this system obtains 90% correct results and 10% error results.

VII. Conclusion

In this system, information retrieval system is presented to retrieve information of COVID-19 information. The proposed system is implemented based on the vector space model. By using KNN classifier, this system is easy for the user to obtain data relevant to a given query and to do automatically. And then, this system helps to minimize the time required to find information. Similarity between a document and query is determined to retrieve user query relevant information. By using this system, searchers do not waste valuable time viewing misleading documents.

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Data Storage Approaches of RDF Data Management Systems: A Study

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***Abstract*:** Semantic Web is the cornerstone of the traditional Web with the feature of allowing computers to intelligently understand and easily explore the information resources published on the Web. During couples of decades, the popularity of Semantic Web is increased in both academic and industry. RDF is a data model standardized by W3C for the Semantic Web. With the widespread usage of RDF data in many real-world applications, efficient management of the RDF data becomes a critical issue to solve. This paper provides a comprehensive study of different RDF data storage and querying techniques that lead to an efficient RDF data management system (RDF store). This paper tends to give general knowledge for the ones who are interested in Semantic Web and RDF data management from the database perspective. Although there are many other surveys on RDF stores, our study tends to give knowledge with simple explanations.

***Keywords*:** Semantic Web, RDF, RDF data management, data storage, SPARQL query processing

I. Introduction

Nowadays, the nature of the WWW (World Wide Web) has evolved from a web of documents to a web of data (Linked data). Traditionally, a web document has been published on the web and links are created between them. However, these links only allow to traverse the document space without understanding the relationships between documents and without linking to specific information. Linked data/ Semantic Web provides the ability to create meaningful links between data on the Web (Berners-Lee et al. 2001). The use of Linked data technologies has transformed the nature of traditional Web from a space of connecting documents to a global space where pieces of data from different domains are semantically linked and integrated to create a global data network. This launches new opportunities for applications such as search engines, knowledgebase, and various domain-specific systems. The Web of Linked data allows applications to operate on the global data network and join data from different data sources. Moreover, this enables applications to return comprehensive results as new data on the web [1].

RDF is a W3C's standardized data model that provides the format to describe the web resources as triples in the form (S, P, O), where S means subject, P means predicate, and O means object, respectively. In principle, RDF is designed to flexibly model the Semantic Web data in a semi-structured manner. During these decades, RDF is gaining widespread usage and popularity in different domains such as the Semantic Web, Linked Data, social networks, bioinformatics, and business intelligence [10].

With the widespread usage of RDF data in many real world applications, efficiently management of the RDF data becomes a critical issue to solve. Different techniques such as relational, clustered property table, and vertical partitioning techniques etc. have been developed to obtain efficient RDF data stores. Our contribution in this survey is reviewing on different RDF data storage methods based on the database is used as backend storage or not. The former type is called as non-native RDF storage method, and the next one is defined as native RDF storage method. The main goal of this article is to provide the knowledge and experience to the ones who are starting to study RDF data management system especially on centralized data. In this paper, we would not consider other RDF data management system based on the facts such as distributed RDF storage and query language characteristics.

The remaining part of the paper is organized in this way: Section II provides the explanation of RDF data model and nature of SPARQL query. In Section III, different non-native RDF storage methods which use relational/column-oriented database as backend storage. Another RDF storage methods, native RDF storage methods, are discussed in Section IV by focusing on indexing techniques. As a final part, conclusion is presented in Section V.

II. Preliminary Concepts

Fundamental definition of RDF data model, nature of SPARQL query, and problem in the query processing are explained in this section. The explanation tends to provide background knowledge that will assist to completely understand the whole article.

A. RDF

RDF (Resource Description Framework) is defined as a standard data model by W3C – an international standards organization for the World Wide Web. RDF dataset is a group of triples in the form of <subject,predicate,object>. An example triple is given in Figure 1. . It is the N-Triple serialization format.

```
<http://example.name#BobSmith>
<http://xmlns.com/foaf/0.1/study>
<http://example.name#FundamentalDatabase> .
```

Figure 1. Example one RDF Triple

Subjects, predicates, and objects are expressed with URIs. Each part of the triple is separated by whitespace and terminated by '.' after each triple. Subjects and objects represent the web resources, and predicates describe the relationships between subjects and objects. Sometimes, predicate is also called as property.

B. SPARQL

SPARQL is the standard query language for accessing the data in RDF format. A SPARQL query contains a set of triple patterns. Structure of a triple pattern is likes as triple, but variables (unbound values) are represented with "?" (Question mark). A query is said to be "complex" when it contains many triple patterns. For handling the complex queries, the systems require too much time because they needed many join operations according the number of triple patterns contained in them.

The SPARQL query can be classified into four types based on their joining style, chain, star, tree, and cycle. They are not discussed here due to space consideration. Typical execution plan of a SPARQL query is described in Figure 2.

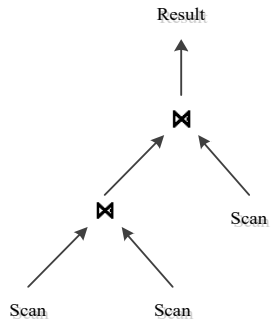

Figure 2. Typical Execution Plan of a SPARQL Query

The plan includes two operators, scan and join, to acquire the answers of the query. Number of scan operations are contained as the number of the triple patterns in the query, and number of join operators is less than one on the number of the query's triple patterns.

C. Problem in SPARQL Query Processing

Given a SPARQL query, execution time of the query is increased according to the number of triple patterns contained in it. Theoretically, (n-1) joins are required to process a query with n triple patterns. Let consider an example SPARQL query with 3 triple patterns.

```
SELECT ?student
WHERE {
    ?student type undergraduate student .
    ?student study ?course .
    ?course taughtBy "Dr. X" .
}
```

Figure 3. An Example SPARQL Query with 3 Triple Patterns

The query wants to retrieve names of the undergraduate students who study the course which is taught by "Dr. X". For the example query, three scan operations and two join operations are needed to retrieve the desired data. Problem is performing join operations on false positive intermediate results can delay the query execution time. Therefore, many researchers consider different data storage and querying methods to overcome the problem. To reduce the query execution time, researchers have made the considerations based on three factors: (i) reducing number of join operations, (ii) reducing intermediate results to each join operations, and (iii) optimizing order of join operations.

III. RDF Data Storage

RDF data management systems can be subdivided into two categories depending on the database is used as backend storage or not. If the RDF stores use relational/NoSQL database as their persistent storage, these stores are defined as non-native RDF stores. And if the RDF stores try to store the data closer to its triple nature, they are called as native storage.

A. Non-native RDF Data Storage

Various techniques have been developed for storing RDF data in relational databases. As all we have known, relational database has gained the great work on making the data management to be efficient, scalable and robust. So earlier RDF triple stores use RDBMS as their backend storage with relational model. Non-native RDF stores can be categorized as follows: relation-based (triple table), clustered property table, and vertical partitioning based RDF stores.

1) Triple Table

Triple table is the most straightforward approach among various RDF data storage methods. It directly maps the RDF triples into relational model. Each RDF triple (subject, predicate, object) is stored in a single large table with three columns. Each column is for subject, predicate and object respectively.

The triple table approach may be the appropriate one when the input query is small. But when the input query is large (complex), the system take too much time to execute the query because it needs to make many self-joins over the table. Moreover, when the dataset is large, it cannot well handle the storing of whole RDF dataset. Figure 4 shows the storage architecture of triple table

approach. Strings are used instead of URIs to be simplify in illustration.

Subject	Predicate	Object
Peter	graduatedFrom	MIT
Peter	advisor	Lisa
Lisa	type	Professor
Peter	takes	Algorithms
Peter	type	Graduate Student
MIT	type	University
James	type	Professor
James	worksFor	Computer Science
Computer Science	subOrganizationOf	InfoLab
Computer Science	type	Department
James	memberOf	InfoLab
James	teaches	Algorithms
Algorithms	type	Course

Figure 4. Triple Table Approach

2) Clustered Property Table

Researchers consider another technique to fulfill the weaknesses of triple table approach by focusing to retrieve the desired data without doing expensive self-joins. The technique is grouping the subjects of all RDF triples which have the same set of properties (common properties) to store together in a table. Each row in the table represents one or more RDF triples, so it can reduce the storage space requirement. The data storage architecture of clustered property table is described in Figure 5.

Subject	graduatedFrom	advisor	takes	type
Peter	MIT	Lisa	Algorithms	Graduate Student

Subject	type
Algorithms	Course

Subject	subOrganizationOf	type
Computer Science	InfoLab	Department

Figure 5. Clustered Property Table Approach

Other advantage of property table approach is that join operations on the subject column can be avoided. In this way it can speed up the execution time of the queries which has the triple patterns with same properties. But the approach is still expensive for the queries with the triple patterns which are not included in the common properties. Moreover, it has the drawback because RDF has the semi-structured nature and no fixed schema. So the property table approach need to store many NULL values for each property in a given cluster. The second drawback is in storing the multi-valued properties. Jena [4] and 4Store [5] used this approach for storing and querying RDF data.

3) Vertical Partitioning

Vertical partitioning approach [3] stores the RDF data into *n* two-column tables where *n* is the number of unique properties in the data. The first column of each table is for subject and the second column is for the object with that respective subject. This approach uses the column-oriented database as its storage backend.

teaches

Subject	Object
James	Algorithms

(a)

graduatedFrom

Subject	Object
Peter	MIT

(b)

type

Subject	Object
Lisa	Professor
Peter	Graduate Student
MIT	University
James	Professor
Computer Science	Department
Algorithms	Course

(c)

Figure 6. Vertical Partitioning Approach (a) for 'teaches' property (b) for 'graduatedFrom' property (c) for 'type' property

The advantage is that it can avoid reading the entire row from disk as in relational databases. So the approach can reduce the execution time of the queries with the same property. But data insertion may be slow because multiple tables need to be accessed only for the same subject. X. Wang et. al [2] uses this vertical partitioning approach to develop an efficient RDF storage and indexing scheme, CHex.

IV. Native RDF Data Storage

Native RDF data stores is the storing the data from scratch. Neumann et. al [6] propose RDF-3X with sextuple indexing method to overcome the problem of expensive self-joins. Sextuple indexing is the constructing the indexes in possible six ways, all permutations of subject-property-object. All the indexes are stored in a compressed clustered B+ tree and also sorted in lexicographic order. It performs the B+ tree index look-up to avoid from reading the unnecessary data blocks. In this way, RDF-3X can enhance the query processing time. But it has the cost of storage space and data maintenance.

Hexastore [7] constructs the indexes as in RDF-3X. It uses the dictionary encoding to reduce the storage space of storing URIs. Dictionary encoding generate a unique numerical identifier for every URI and literal of all RDF triples. Hexastore supports both single triple pattern look-up and fast merge-join of any pair of two

triple patterns. Although it uses dictionary encoding to minimize the space requirement, it needs five time space required than triple table approach. And Hexastore has lower data searching time compared to RDF-3X as it stores the triples in vector storage schema instead of B+ tree structure.

K. Kim et. al [8] proposed a triple filtering method - RP-filter. The main idea of RP-filter is to reduce the number of intermediate results before join operations, which would not be included in final result. RP-filter is the path-based index. Length of the path is limited by a parameter – MaxL. RP-filter can process path queries. The path queries has the limitation on the number of triple patterns because length of the RP-filter index is not exceed the value of MaxL. Moreover, it could not support graph-structured queries. To solve these issues, the authors considered another indexing method – RG-index [9]. Frequent subgraph mining technique is used to construct the RG-index. RG-index is the set of discriminative and frequent graph patterns from the RDF data graph. RG-index could well process graph-structured queries, but it takes too much time to construct the indexes as graph mining is NP-complete.

V. Conclusion

As we earlier said, Semantic Web is the cornerstone of the WWW with the feature of allowing computers to intelligently understand and easily explore the information resources published on the Web. So efficiently storing and management of RDF data is important for both semantic web and database communities as all of the semantic web data are represented and integrated in RDF data format. The main purpose of this study is to provide the knowledge about the nature of RDF data model and structure of a SPARQL query. And the knowledge on how work the execution plan of a SPARQL query, what is the problem in the query processing, and how researchers have tried to solve the problem by focusing on which factors (in section II (A, B, C), respectively). And then the basic two types of RDF data storage approaches, non-native and native, are discussed although different types can be sub classified based on other factors such as structures of indexes, distributed (Apache Hadoop, Apache Spark, etc.,), or cloud-based. But here in this study, only two types of data storage approaches had been described for the purpose of getting clear knowledge to the readers with clear and simple explanations.

Currently, numerous DF triple stores are emerged with different storage approaches. But many challenges are still remained in query performance and scalability when the query is complex and dataset is very large (triples in billions). Thus, considering the indexes which cover the structure and content of the RDF data becomes a flexible way for gaining good result in both query processing and scalability with data set's size.

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E-commerce and E-business

Analysis of Optimized Profit System for Bakery Shop Using Sensitivity Analysis

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Abstract: Linear Programming (LP) model is employed in determining production mix and associated total profit for the bakery shop. The proposed system focuses on developing a production mix which gives maximum profit at given cost, demands and availability of raw materials. This system uses Penalty method to solve the LP problem and to reach the optimal results. This system can also find the optimal condition by using Sensitivity Analysis instead of resolving the entire problem as a new problem with new parameters. Finally, the system supports with sensitivity report presented with the range both lower and upper over which the LP model parameters can change without affecting the current optimal solution. The system is intended to support the production managers with the optimal production plan which gives the maximum profit.

Keywords: Penalty method, Sensitivity Analysis, optimal condition, maximum profit

I. Introduction

Linear programming is a widely used field of optimization for several reasons. Many practical problems in operations research can be expressed as linear programming problems. linear programming was heavily used in the early formation of microeconomics and it is currently utilized in company management, such as planning, production, transportation, technology and other issues. Although the modern management issues are ever-changing, most companies would like to maximize profits and minimize costs with limited resources. Therefore, many issues can be characterized as linear programming problems [1].

A product manufacture has fixed amounts of different resources such as ingredients that form the product, selling prices, capitals, product demands from the market and in-stock raw materials. These resources can be combined to produce several different products. The decision maker wished to produce the combination of products that will maximize total income [4]. This paper introduces product planning system with sensitivity reports for solving product planning. This process includes the optimal product plan about product planning strategies which has to get sale revenue.

Mathematical programming works to be used in business economics more than thirteen year ago.

In production, operational research methods are used in order to find the optimal products produced based on available resources such as maximum demands, minimum demands and capital. Today, it is important for every product manager to know how much and what kind of products should be produced to be able to meet complicated characterizing the status of production enterprise and not to exceed the organizational resources as well as obtain the maximum profit and minimum cost [7]. In this system, Linear Programming model is best applied where a manufacturer wants to develop a production schedule and an inventory policy that will satisfy sale demand in the future period. These schedule and policy will enable the production company to satisfy the basic feasible solution and with the search of optimum solution [8]. Linear Programming could be used to provide uninterrupted production by optimizing production process for efficiency.

This system is aimed forecasting the number of each product to be produced in order to maximize profit that will also satisfy the constraints of cost, maximum and minimum demands associated with production process. To implement a production planning system for bakery process were built general Linear Programming model and it was solved by Penalty method. The constraints are subjected to available capital amount, maximum and minimum demands of the chosen products. After getting result of optimal product mix and the profit, then sensitivity analysis is performed to determine the range for the unit profit for each product (cj, objective function's coefficient) that keeps the current optimal condition and optimal product mix remain unchanged. And, the system also analyzes right hand side (RHS) values of the constraints (b_k, availability of resources, such as, capital amount, maximum and minimum demands for each product) over which the current optimal condition remains unchanged [6].

II. Related Work

Product manufacture today faces economic and environmental pressures. Product prices are falling but their product costs are raising. Thus, it is needed to evaluate new production alternatives plans which tell what kinds of products should be produced more to reach maximize profit. Operation Research (OR) is one of the popular managerial decision-making tools.

Linear Programming methods are mostly applied to improve production planning system. Linear Programming can be applied to various fields of study. It is used most extensively in business and economics, but can also be utilized for some engineering problems. Industries that use linear programming models include transportation, energy, telecommunications, and manufacturing. It has proved useful in modeling diverse types of problems in planning, routing, scheduling, assignment, and design [5].

III. Operation Research (OR)

Operation Research (OR) is concerned with optimal decision making in and modeling of deterministic and probabilistic system that originate from real life. These applications, which occur in government, business, engineering, economics and the natural and social sciences, are characterized by the need to allocate limited resources [2].

A. Linear Programming (LP)

LP is a mathematical method for determining a way to achieve the best outcome such as maximum profit or lowest cost in a given mathematical model for some list of requirements represented as linear relationships. Linear Programming is a specific case of mathematical programming or mathematical optimization. More formally, Linear Programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. Linear programming can be applied to various fields of study [8].

B. Structure of Linear Programming (LP) Model

The general structure of any LP model essentially consists of three components:

1) The activities (variables) and their relationships

The activity values represent the extent to which *each activity is performed. These are represented by x1,* x2,…, xn. For example, in a product-mix problem, the activities of interest are the production of several products under consideration. These activities are also known as decision variables because they are under the decision maker's control. These decision variables usually inter-related in terms of consumption of limited resources. All decision variables are continuous, controllable and non-negative. That is x1 ⩾ 0, x2 ⩾ 0,⋯, xn ⩾ 0 [9].

2) Objective function

The objective function of each LP problem is a mathematical representation of the objective in terms of a measurable quantity included with profit, cost, etc. It is represented in one of two forms : Optimize (Max or Min) Z= c1x1 + c2x2 +…+ cnxn where Z is function of x1, x2,…, xn. x1, x2, …, xn are decision variables. c1, c2, …, cn are parameters of the respective variables x1, x2,…, xn.

3) Constraints

These are certain limitations on the use of limited resources such as capital, demands, raw materials etc. Such constraints must be expressed as linear equalities or inequalities in terms of decision variables. These constraints are satisfied with simplex method [2].

C. General Mathematical Model of LP Problem

The general Linear Programming problem with n decision variables and m constraints can be started in the following form. The value of decision variables x1, x2,… , xn can be calculated so as to Optimize (Max or Min) Z= c1 x1 + c2x2 +…+ cnxn Subject to the linear constraints, a11x1 + a12x2 +⋯+ a1nxn (⩽, =, ⩾) b1 a21x1 + a22x2 +⋯+ a2nxn (⩽, =, ⩾) b2 am1x1 + am2x2 +⋯+ amnxn (⩽, =, ⩾) bm and x1, x2,⋯, xn ⩾ 0. The above formulation can also be expressed in a compact form using summation sign:

Optimize (Max or Min) $Z=\sum_{j=1}^{n} cjxj$

Subject to the linear constraints

$Z=\sum_{j=1}^{n} aijxj$ (⩽, =, ⩾) bi ; i=1,2,⋯,m

and xj ⩾ 0; j=1,2,⋯,n (non-negativity conditions)

The use of the simplex method to solve an LP problem requires this problem to be converted into its standard form. To convert inequality constraints into standard form, three types of additional variables are added namely

(i) slack variables (s)
(ii) surplus variables (-s) and
(iii) artificial variables (A)

Table 1. Standard Form Conversion

Types of Constraint	Extra variable to be added
≤	Add only slack variable (+s)
≥	Subtract surplus variable and add artificial variable (-s + A)
=	Add only artificial variable (+A)

D. Modeling for Product Planning

Table 2. Product Planning Problem Related Data

Resources	Resources usage per unit			Amount of available
	Product x_1	Product x_1	Product x_1	
Capital	C_1	C_2	... Cn	C
Max demand	dmax 1	dmax 2	…dmax n	Dmax

Min demand	dmin 1	dmin 1	…dmin n	Dmin
Profit	I1	I2	…In	

Max (profit) = I1 x1 + I2x2 +...Inxn
Total max demand:dmax x1 +dmax x2 + ... +dmax xn ≤ Dmax
Total min demand:dmin x1 +dmin x2 + ... +dmin xn ≤ Dmin
Available capital: c1x1 + c2x2 + ... + cnxn ≤ C where x1, x2, xn ≥ 0

I = profit per unit in each product

c = cost per unit in each product

C= availability of Capital (kyats)

dmax = maximum demand for each product

Dmax = total maximum demand

dmin = minimum demand for each product

Dmin = total minimum demand

The product planning problem is one of the most studied optimization problems in production. It involves the establishment of a product plan for the current year. A bakery industry has C kyat(s) in capital for investment and Dmax and Dmin which are exported units to market. The product manager wants to know how much and what products to be produced in order to maximize profit. Let xj be the number of units to be produced (j=1,2,…,n) . Let cj be the amount of cost needed per unit of activity j. Let lj be the number of labor needed per unit. Let Ij be the amount of profit per unit. Let dmax j be maximum demand and dmin j be minimum demand for each product respectively. All data required for product plan in problems are shown in Table 2.

E. Penalty Method

If an LP has any ≥ or = constraints, a starting basic feasible solution may not be readily apparent. The Penalty method is a version of the Simplex Algorithm that first finds a basic feasible solution by adding "artificial" variables to the problem. The objective function of the original LP must be modified to ensure that the artificial are all equal to 0 at the conclusion of the simplex algorithm [3].

IV. Sensitivity Analysis

Sensitivity analysis is used to determine how "sensitive" the optimal solution if the data values are changed. This analysis includes analyzing the objective function coefficient (cj) or profit contribution per unit of decision variable and the RHS value of a constraint (bi) or availability of resources [6].

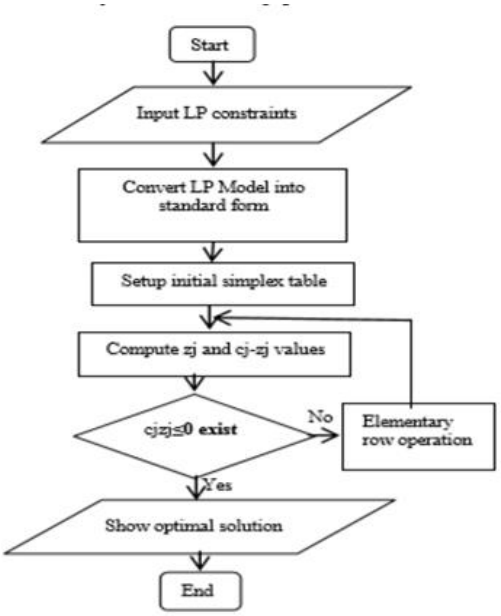

Figure 1. Process Flow of Penalty Algorithm for Maximization Case

The changes in cj include two parts such as change in coefficient of non-basic variable and change in coefficient of basic variable. Although the coefficient of non-basic variables are changed, it cannot effect on the value of the objective function and optimal solution if cj-zj ⩽ 0. If the coefficient of basic variables are changed, the upper and lower range of values within each cj can lie without changing the optimal product mix and optimal condition. Thus, the value of the objective function is changed by the following linear inequality.

$$Min\left\{\frac{C_j - Z_j}{y_{kj} < 0}\right\} \geq \Delta C_{Bk} \geq Max\left\{\frac{C_j - Z_j}{y_{kj} > 0}\right\} \quad (1)$$

where,

ΔC_{BK} = amount of change in the profit c_j

y_{kj} = entry in non-basic variable column

Any change in the availability of resources does not affect the optimal solution if cj-zj ⩽ 0. However, it affects the value of basic variable and the value of objective function according to the range of values using the following linear inequalities.

$$Min\left\{\frac{x_{Bi}}{\beta_{ik} < 0}\right\} \geq \Delta b_k \geq Max\left\{\frac{-x_{Bi}}{\beta_{ik} > 0}\right\} \quad (2)$$

$$x_B = B^{-1}b \geq 0 \quad (3)$$

where,

B^{-1} = matrix of coefficients corresponding to slack variables in the optimal simplex table.

Δb_k = amount of change in the resource k.

x_B = basic variables appearing in B column of simplex table.

V. Experimental Results

In experiment, this system is intended to support the production planning system of Bakery shop by using Penalty method and Sensitivity analysis. It has two parts such as finding the optimal solution for maximum profit and modifying the product data.

A. Finding Optimal Solution

Figure 2. Choice The Products

Figure 3. Calculation Unit Profit

Firstly, user can choose the products to be produced from the product list. Then, the unit profit can be calculated based on selling price and unit cost as shown in Figure 2 and Figure 3.

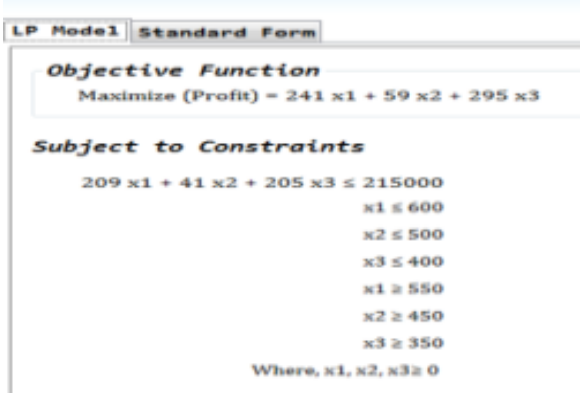

Figure 4. LP Model Formulation

As shown in Figure 4, system formulates the objective function that can give maximum profit according to unit profits of each product and subject to constraints which includes relationships between decision variables and maximum demands. Then, the system converts these constraints into standard form by adding slack or artificial variables.

Table 3. Initial Table

CB	B	XB	X1	X2	X3	S1	S2	S3	S4	S5	S6	S7	A1	A2	A3
0	s1	215000	209	41	205	1	0	0	0	0	0	0	0	0	0
0	s2	600	1	0	0	0	1	0	0	0	0	0	0	0	0
0	s3	500	0	1	0	0	0	1	0	0	0	0	0	0	0
0	s4	400	0	0	1	0	0	0	1	0	0	0	0	0	0
-M	A1	550	1	0	0	0	0	0	0	-1	0	0	1	0	0
-M	A2	450	0	1	0	0	0	0	0	0	-1	0	0	1	0
-M	A3	350	0	0	1	0	0	0	0	0	0	-1	0	0	1
	Cj		141	59	295	0	0	0	0	0	0	0	-M	-M	-M
	Zj		-M	-M	-M	0	0	0	0	M	M	M	-M	-M	-M
	Cj-Zj		141+M	59+M	295+M	0	0	0	0	-M	-M	-M	0	0	0

Key Row

Key Column

Key Value

Iteration 1

Introduce variable x_3 into the basic and remove A_3 from the basic by applying the following row operations.

Row 1 (new) =Row 1 (old)-205 Row 7(new)
Row 2 (new) = Row 2 (old)
Row 3 (new) = Row 3 (old)
Row 4 (new) = Row 4 (old)-Row 7 (new)
Row 5 (new) = Row 5 (old)
Row 6 (new) = Row 6 (old)
Row 7 (new) = Row 7 (old)

Table 4. Solution after Iteration 1

CB	B	XB	X1	X2	X3	S1	S2	S3	S4	S5	S6	S7	A1	A2	A3
0	s1	143250	209	41	0	1	0	0	0	0	0	205	0	0	-205
0	s2	600	1	0	0	0	1	0	0	0	0	0	0	0	0
0	s3	500	0	1	0	0	0	1	0	0	0	0	0	0	0
0	s4	50	0	0	0	0	0	0	1	0	0	1	0	0	-1
-M	A1	550	1	0	0	0	0	0	0	-1	0	0	1	0	0
-M	A2	450	0	1	0	0	0	0	0	0	-1	0	0	1	0
295	x3	350	0	0	1	0	0	0	0	0	0	-1	0	0	1
	Cj		141	59	295	0	0	0	0	0	0	0	-M	-M	-M
	Zj		-M	-M	295	0	0	0	0	M	M	-295	-M	-M	-M
	Cj-Zj		141+M	59+M	0	0	0	0	0	-M	-M	295	0	0	0

Iteration 2

Introduce variable x_1 into the basic and remove A_1 from the basic by applying the following row operations.

Row 1 (new) =Row 1 (old)-209 Row 5(new)
Row 2 (new) = Row 2 (old) – Row 5 (new)
Row 3 (new) = Row 3 (old)
Row 4 (new) = Row 4 (old)
Row 5 (new) = Row 5 (old)
Row 6 (new) = Row 6 (old)
Row 7 (new) = Row 7 (old)

Table 5. Solution after Iteration 2

CB	B	XB	X1	X2	X3	S1	S2	S3	S4	S5	S6	S7	A1	A2	A3
0	s1	28300	0	41	0	1	0	0	0	209	0	205	-209	0	-205
0	s2	50	0	0	0	0	1	0	0	1	0	0	-1	0	0
0	s3	500	0	1	0	0	0	1	0	0	0	0	0	0	0
0	s4	50	0	0	0	0	0	0	1	0	0	1	0	0	-1
141	x1	550	1	0	0	0	0	0	0	-1	0	0	1	0	0
-M	A2	450	0	1	0	0	0	0	0	0	-1	0	0	1	0
295	x3	350	0	0	1	0	0	0	0	0	0	-1	0	0	1
		Cj	141	59	295	0	0	0	0	0	0	0	-M	-M	-M
		Zj	141	-M	295	0	0	0	0	-141	M	-295	-M	-M	-M
		cj-zj	0	59+M	0	0	0	0	0	141	-M	295	0	0	0

Iteration 3

Introduce variable x_2 into the basic and remove A_2 from the basic by applying the following row operations.

Row 1 (new) =Row 1 (old) - 41 Row 6(new)
Row 2 (new) = Row 2 (old)
Row 3 (new) = Row 3 (old) - Row 6 (new)
Row 4 (new) = Row 4 (old)
Row 5 (new) = Row 5 (old)
Row 6 (new) = Row 6 (old)
Row 7 (new) = Row 7 (old)

Table 6. Solution after Iteration 3

CB	B	XB	X1	X2	X3	S1	S2	S3	S4	S5	S6	S7	A1	A2	A3
0	s1	9850	0	0	0	1	0	0	0	209	41	205	-209	-41	-205
0	s2	50	0	0	0	0	1	0	0	1	0	0	-1	0	0
0	s3	50	0	0	0	0	0	1	0	0	1	0	0	-1	0
0	s4	50	0	0	0	0	0	0	1	0	0	1	0	0	-1
141	x1	550	1	0	0	0	0	0	0	-1	0	0	1	0	0
59	x2	450	0	1	0	0	0	0	0	0	-1	0	0	1	0
295	x3	350	0	0	1	0	0	0	0	0	0	-1	0	0	1
		Cj	141	59	295	0	0	0	0	0	0	0	-M	-M	-M
		Zj	141	59	295	0	0	0	0	-41	-59	-295	141	59	295
		cj-zj	0	0	0	0	0	0	0	141	59	295	-M-141	-M-59	-M-295

Iteration 4

Introduce variable s_1 into the basic and remove s_1 from the basic by applying the following row operations.

Row 1 (new) =Row 1 (old)/205
Row 2 (new) = Row 2 (old)
Row 3 (new) = Row 3 (old)
Row 4 (new) = Row 4 (old)-Row 1 (new)
Row 5 (new) = Row 5 (old)
Row 6 (new) = Row 6 (old)
Row 7 (new) = Row 7 (old)+Row 1 (new)

Table 7. Final Table

CB	B	XB	X1	X2	X3	S1	S2	S3	S4	S5	S6	S7	A1	A2	A3
0	s7	48.04878	0	0	0	0.0049	0	0	0	1.0195	0.2	1	-1.02	-0.2	-1
0	s2	50	0	0	0	0	1	0	0	1	0	0	-1	0	0
0	s3	50	0	0	0	0	0	1	0	0	1	0	0	-1	0
0	s4	1.95122	0	0	0	-0.005	0	0	1	-1.02	-0.2	0	1.0195	0.2	0
141	x1	550	1	0	0	0	0	0	0	-1	0	0	1	0	0
59	x2	450	0	1	0	0	0	0	0	0	-1	0	0	1	0
295	x3	398.0488	0	0	1	0.0049	0	0	0	1.0195	0.2	0	-1.02	-0.2	0
		Cj	141	59	295	0	0	0	0	0	0	0	-M	-M	-M
		Zj	141	59	295	0	0	0	295	159.9	0	0	141	59	295
		cj-zj	0	0	0	0	0	0	-295	-159.9	0	0	-M-141	-M-59	-M-295

In this table, it is observed that all cj-zj ≥ 0. Thus, an optimal solution has arrived at with value of variables:

x1 =550
x_2=450
x_3=398
$Z=141x_1+59x_2+295x_3= 221,524$
Thus, the system can give the decision to produce –

Bread = 550 unit
Plain Cake = 450 unit
Large Plain Cake = 398 unit

And, this optimal product distribution makes total maximum profit of **221,524 kyats.**

B. Modifying Product Data using Sensitivity Analysis

In Sensitivity Analysis, there are two parts such as Profit Analysis and Resources Analysis. The Profit Analysis shows the information for changes in coefficient of basic variable. The changes between the upper and lower range on profit contribution cannot change the optimal condition and the optimal product mix. As shown in Table 8(a) and 8(b), the optimal product mix and optimal condition remains the same, as long as the Δ Cj values between the following ranges.

Table 8(a). Profit Analysis

Additional Increment

Xk	ΔCj	Upper Bound	Lower Bound
x1(Bread)	Δ C1	59.756099	0
x2(Plain Cake)	Δ C2	0	0
x3(Large Plain Cake)	Δ C3	0	-58.61244...

Table 8(b). Profit Analysis

Range in Profit Contribution

Xk	Cj	Upper Bound	Lower Bound
x1(Bread)	C1	300.756099	241
x2(Plain Cake)	C2	59	59
x3(Large Plain Cake)	C3	295	236.3875586...

Result

Total profit value remains unchanged as long as

$300.756099 \geq C_1 \geq 241$
$59 \geq C_2 \geq 59$
$295 \geq C_3 \geq 236.3875586$

In the Resources, the system displays the information about the changes in availability of resources shown in Table 9(a) and 9(b). The changes that occur between the upper and lower Range on 'Variation in Resource k cannot change the optimal

condition (the next step cannot occur). But the optimal product mix and the total profit are changed. The optimal condition remains the same, as long as the b_k values between the following range.

Table 9(a). Resources Analysis

Amount of Change in Resource k

xB	Δbk	Lower Bound	Upper Bound
B1	Δb1	0	0
B2	Δb2	0	0
B3	Δb3	0	0
B4	Δb4	0	1299.51246

Table 9(b). Resources Analysis

Variation in Resource k

xB	bk	Lower Bound	Upper Bound
B1	b1	215000	215000
B2	b2	600	600
B3	b3	500	500
B4	b4	400	1700

Result

Total optimal condition remains unchanged as long as

$$215000 \leq B_1 \leq 215000$$
$$600 \leq B_2 \leq 600$$
$$500 \leq B_3 \leq 500$$
$$400 \leq B_4 \leq 1700$$
$$550 \leq B_5 \leq 550$$
$$450 \leq B_6 \leq 450$$
$$350 \leq B_7 \leq 350$$

VI. Conclusion

This paper implements the evaluating of production plans for bakery shop that makes the optimal product mix which gives the maximum profit within the given constraints. In order to aid the development of sustainable business in the economic level, the usage of linear programming model system is proposed. This system is more suitable for those especially who decide the product plan.

This system also supports the production manager with the sensitivity report. This report determines to maintain the optimal profit condition according to the result ranges of profit and available resources. Consequently, the production manager can find the optimal condition by using sensitivity analysis instead of resolving the entire problem as a new problem with new parameters.

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Neural Network and Image Processing

Pattern Classification for Digits Using Back Propagation Algorithm

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Abstract: A Neural Network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. Neural Networks have been trained to perform complex functions in various field of application including pattern recognition, identification, classification, speech, vision and control system. Today neural network can be trained to solve problems that are difficult for conventional computers (or) human beings. This paper regards on the classification of pattern using training set patterns. This research contains two phase, training and testing. This paper trains the printed digits with several font styles by using back propagation algorithm. If a digit with unknown style enters the network, the network will give the knowledge of this pattern from its training set. This paper uses printed digits for training patterns. Pattern classification can be used in many applications such as banking system and application form. Pattern classification can be applied by pattern recognition. This paper emphasizes on training capacity of Neural Networks.

Keywords: Neural Network, back propagation, logistic, Multilayer Perceptron, weight

I. Introduction

The process of recognizing printed character from pixel information falls into a field of artificial intelligence called pattern or image recognition. Lots of work has been done in this field recently, and most techniques for pattern and image classification make use of neural networks. Artificial Neural Network consists of many interconnected processors known as neurons that perform summing function [2]. This paper implements such a neural network in order to "learn" to recognize general features of printed characters. The trained network can then be fed new inputs, which it then attempts to recognize and categorize properly.

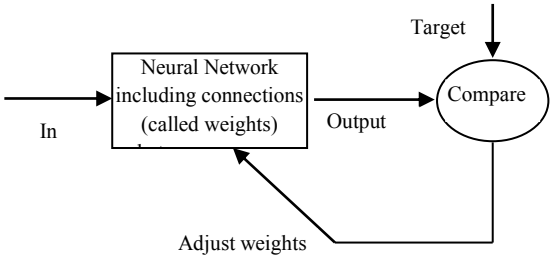


Figure 1. Neural Network Block Diagram

II. Background Theory

A. Architecture of Neural Networks

1) Feed-forward Networks

Feed-forward ANNs allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down.

2) Feedback Networks

Feedback network scan have signals travelling in both directions by introducing loops in the network. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic.

B. Network layers and Learning Process

The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "**input**" units is connected to a layer of "**hidden**" units, which is connected to a layer of **"output"** units shown in figure 2.

- The activity of the input units represents the raw information that is fed into the network.
- The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units.
- The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

All learning methods used for adaptive neural networks can be classified into three major categories:

Supervised learning which incorporates an external teacher, so that each output unit is told what its desired response to input signals ought to be. During the learning process global information may be required. Paradigms of supervised learning include error-correction learning, reinforcement learning and sophisticated. An important issue concerning supervised learning is the problem of error convergence, ie the minimization of error between the desired and computed unit values. The aim is to determine a set of weights

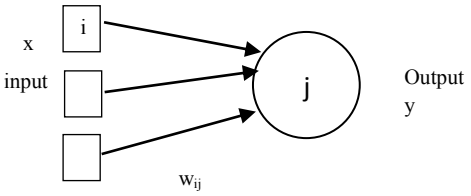
which minimizes the error. One well-known method, which is common to many learning paradigms is the least mean square (LMS) convergence.

Unsupervised learning uses no external teacher and is based upon only local information. It is also referred to as self-organization, in the sense that it self-organizes data presented to the network and detects their emergent collective properties.[5]

Reinforcement Learning is a hybrid learning method in that no desired outputs are given to the network, but the network is told if the computed output is going in the correct direction or not [3].

When using neural network, we can use three types of activation function for backpropagation algorithm.[1] They are

1. Threshold



$$\varphi(v) \text{ also known as } f(net_j) = \begin{cases} 1 \; if \; net_j \geq 0 \\ 0 \; if \; net_j < 0 \end{cases} \quad (1)$$

$$net_j = \sum_{i=1}^{n} x_i w_{ij} \quad (2)$$

net_j is the resultant combined input to unit j shown on above diagram.

x_i is the output from unit i and n is the number of impinging connections. φ(v) is defined as activation function.

2. Logistic also known as sigmoid

$$\varphi(v) = \frac{1}{1+exp^{-net}} \quad (3)$$

3. Piecewise linear function

$$\varphi(v) = \begin{cases} 1 \; if \; net \geq +0.5 \\ v \; if + 0.5 > net > -0.5 \\ 0 \; if \; net \leq -0.5 \end{cases} \quad (4)$$

From all of these three methods, this paper uses sigmoid function because this method can give not only for output result which is closer to the target value but also can solve for nonlinear problems. Style of network in this paper is MLP (Multilayer Perceptron) or MNN (Multilayer Neural Network). MNN solve the classification problem for nonlinear sets by employee hidden layers, whose neurons are not directly connected to the output. The additional hidden layers can be interpreted geometrically as additional hyperplane, which enhance the separation capacity of the network.

The first step in backpropagation learning is of course the *initialization* of the network. An important aspect of back propagation training is the proper initialization of the network [4]. It is also important to note that if all the weights start out with equal values and if the solution requires that unequal weights be developed, the system can never learn. This is because the error is propagated back through the weights in proportion to the values of the weights. This means that all hidden units connected directly to the output units will get identical error signals, and, since the weight changes depend on the error signals, the weights from those units to the output units must always be the same. This problem is known as the *symmetry breaking* problem. The problem of development of unequal weights can be counteracted by starting the system with random weights.

Back propagation is a supervised learning technique used for training artificial neural networks. It is most useful for feed-forward networks (networks that have no feedback, or simply, that have no connections that loop). The term is an abbreviation for "backwards propagation of errors". Backpropagation requires that the transfer function used by the artificial neurons (or "nodes") be differentiable.

The summary of the technique is as follows:

1. Present a training pattern to the neural network. Initialize the connection weight between neurons/nodes of layers randomly with numbers from a suitable. The learning parameter is η and the momentum is α. Select the parameter η and α.
2. Randomly take one input/target pair (x,t) of the training set for further steps and mark it as used.
3. Do the forward calculation using the following equation
   $net_j = w_0 x_0 + \sum_{i=1}^{n} x_i w_{ij}$(including bias input) (5)
   Bias input x_0 is always 1.
   $f(net_j) = \frac{1}{1+exp^{-net}}$ (6)
4. Compare the network's output to the desired output from that sample. Calculate the error in each output neuron for backward calculation using the following equations.
   $\delta_{output} = (t_j - o_j) o_j (1 - o_j)$[for output layer] (7)
   $\delta_{hidden} = o_j (1 - o_j) \sum \delta_k w_k$ [for other hidden layer, o_j is actual output from calculation] (8)
5. Calculate the weight changes and update the weights
   $\Delta w = \eta \delta_{output} x$ (for first epoch) (9)
   $\Delta w = \eta \delta_{output} x + \alpha \Delta w_{ij}(n)$ (10)
   (that's for all other epochs) [1]
   New weight, $w_{(n+1)} = \Delta w + w_{old}$ (11)
6. Repeat from step 2 while there are unused pairs in the training.
7. REPEAT from step 2 until the stop condition is TRUE.

Training continue until the overall error in one training cycle is sufficiently small. The stop condition is

given by sum squared error (sse). The acceptable error sse has to be selected very carefully, If the selected sse is too large, the network is under trained and lacks in performance. As the algorithm's name implies, the errors propagate backwards from the output nodes to the inner nodes. So technically speaking, back propagation is used to calculate the gradient of the error of the network with respect to the network's modifiable weights. Back propagation usually allows quick convergence on satisfactory local minima for error in the kind of networks to which it is suited.

Algorithm is central to much current work on learning in neural network. The algorithm gives a prescription for changing the weights w_{ij} in any feed forward network to learn a training set of input-target pair (x, t).

The back propagation algorithm defines two sweeps of the network: first a forward sweep from the input layer to the output layer, and then a backward sweep from the output layer to the input layer. The forward sweep propagates input vectors through the network to provide outputs at the output layer. The backward sweep is similar to the forward sweep, except that error values are propagated back through the network to determine how the weights are to be changed during training. The network can be used to adaptively modify the weights and biases needed to produce the desired output, given the provision of sufficient training patterns.

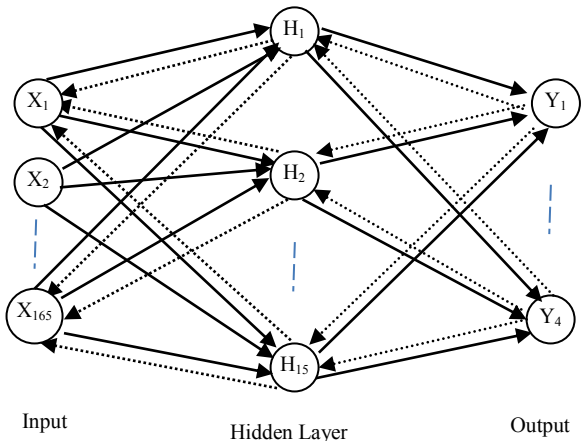


Figure 2. Neural Network Architecture Used in this Paper

In figure 2, Solid lines show the forward propagation of signals and the dash lines show the backward propagation of errors. (δ).

III. Experimental Results

Pattern classification plays an important role in real world system. A standard feed forward neural network was used to classify the digits. For pattern classification, this paper consists of *two phases*. The first is the training phase and then the testing phase. Training phase consists of two parts. The first part is initializing training data and the second is learning module. For initializing training data, it consists of capturing sample digits for training data set. And it defines size of weight matrix for data normalization. The size of weight matrix used in this paper is (15*11).

Before network training, program defines relatively input/output pairs because network used in this paper is supervised back propagation algorithm. In initialization, defines range of weight for initial value. Range of weight used in this research is defined as between (-0.5 and 0.5). Configuration parameters include learning rate, momentum, size of hidden layer, predefined sum squared error (sse) and maximum epoch. Learning rate used in this paper is 0.3 and momentum is 0.8 and size of hidden layer is 15 and sse is 0.01 and maximum epoch (iteration) is 8000.

In learning module, import data (digits) to the training network. Then the network calculates the net input and actual output for each hidden neuron. And also, it calculates the net input and actual output for each output layer neuron by using sigmoid activation function. And then the network computes error between target and actual output from the network. And then change and update weights depending on predefined sum squared error and maximum epoch. Training program continues till these two conditions have not reached shown in figure 3. In training program, extraction the feature for input data by using cropping button of Matlab's built in service. In this preprocessing stage, training program translates the input digits to the only binary numbers 0's and 1's.

In the training process, input image can be any file type such as monochrome bit map or JPEG or 256 color bit map etc. If file type of input image is except monochrome bit map, training program converts them into monochrome bit map. In the preprocessing stage, feature dimensions were not absolutely clear in the beginning, the network program was done with various number of inputs, hidden layer and output neurons. Finally, the network is settled with the following configuration.

The 165 input layer neurons represent the number of features per input digit. The 15 hidden layer neurons which varied this number is found out that a higher number does not yield better results. The network consists of only 4 output layer neurons because the desired pattern is only 10 digits.

(eg.0 0 0 0 =0, 0 0 0 1=1 etc)

The analysis of the results was done in Matlab. The training was stopped when the maximum number of epoch was reached (8,000) or when the sum squared error dropped below 0.01. The state of a network, i.e. the weights (knowledge), were written to disk every 200 epochs. The system is trained more than five times with training data set to get the acceptable knowledge (*w1* that is the weight matrix from the input layer to the hidden layer and *w2* that is from the hidden layer to the

output layer). The training data set contain five styles of each digit.

A. Preprocessing Stages

The following figures show the preprocessing stages used in this paper.

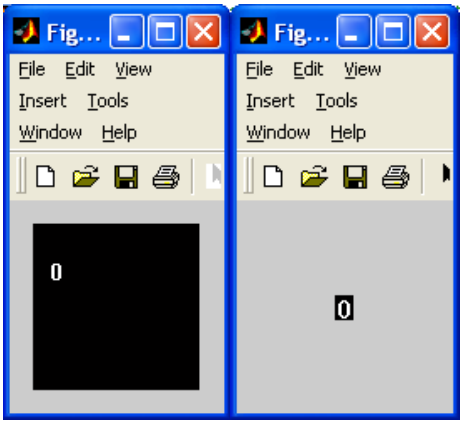


Figure 3. Original Image and Cropping Image of Number Zero

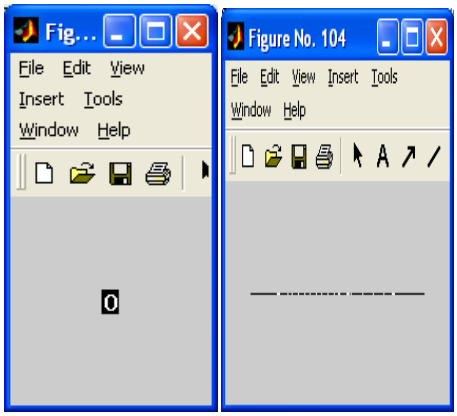


Figure 4. Normalized Image and Binary Row Vector Image for Number Zero

Figure 5. Binary Values in Preprocessing Stage for Number Zero

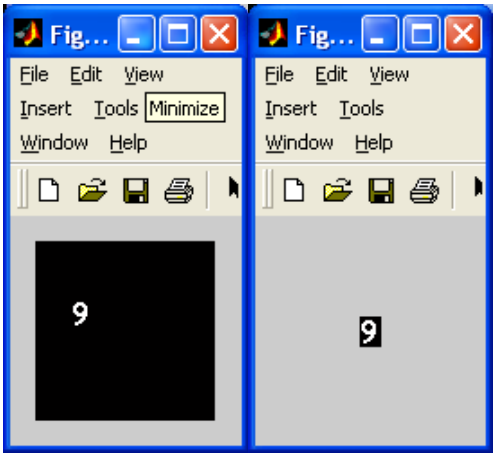


Figure 6. Original Image and Cropping Image of Number Nine

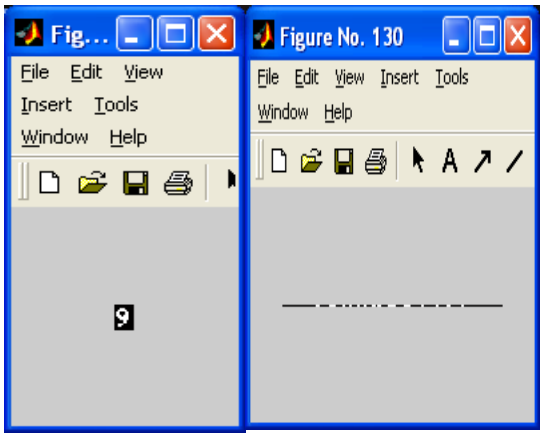


Figure 7. Normalized Image and Binary Row Vector Image for Number Nine

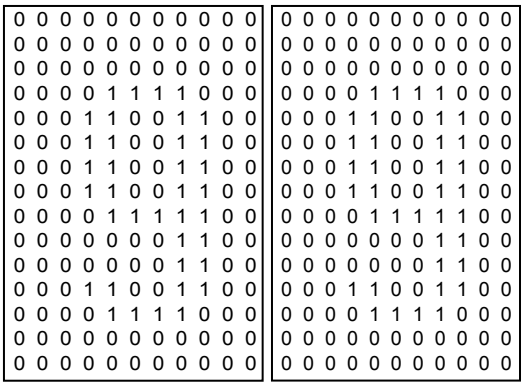


Figure 8. Binary Values in Preprocessing Stage for Number Nine

B. Training Phase

The training phase of the system is shown in the following figure 9.

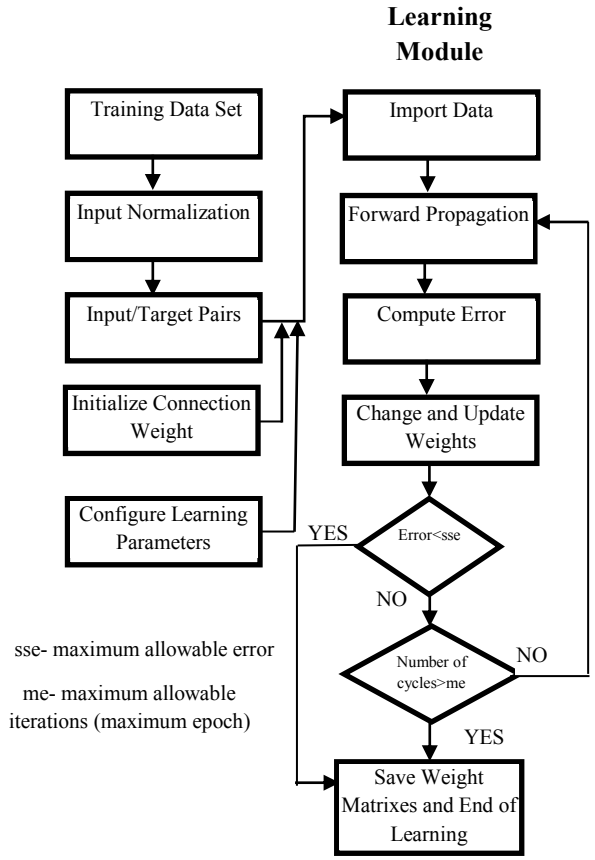


Figure 9. Flow Chart for Training Program

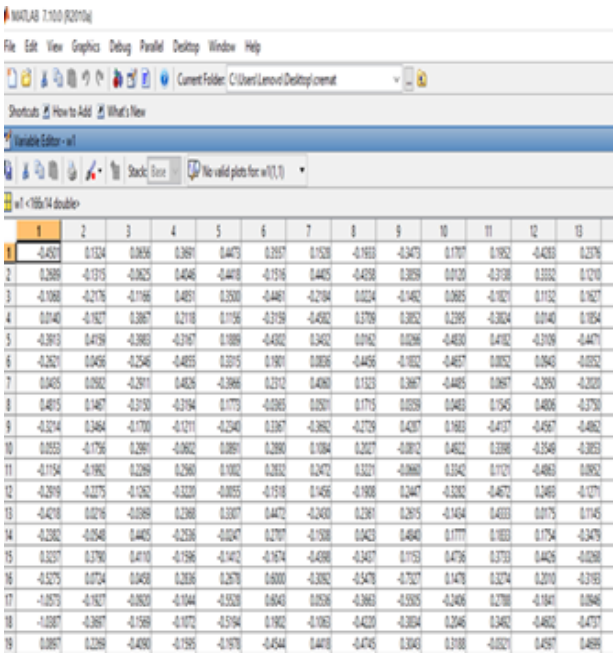


Figure 10. Knowledge (weight) from Training

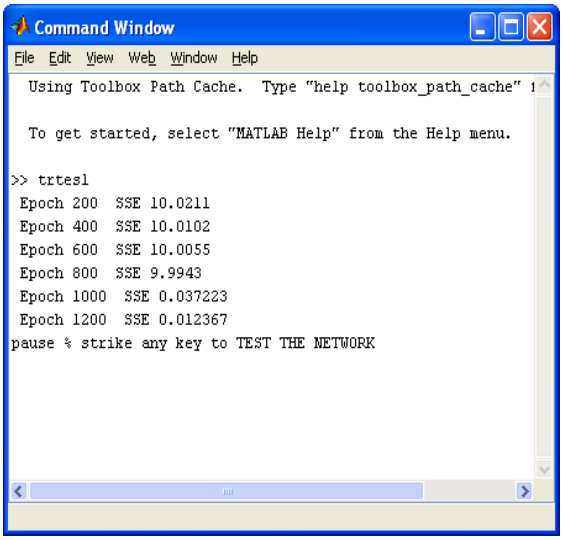


Figure 11. Performance Result for Training Network

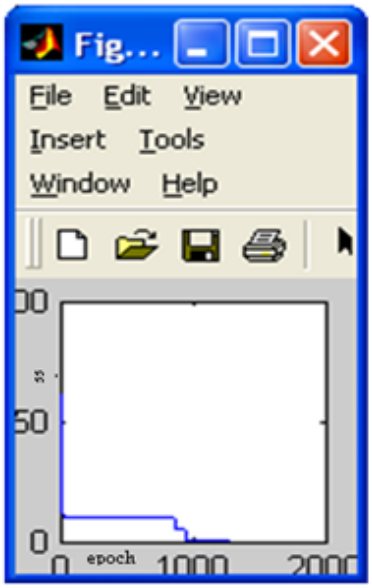


Figure 12. Result Curve from Training Program to Converge Acceptable Error

C. Testing Phase

In testing phase, the digits are captured from the testing data set. The testing network consists of only forward propagation. The testing network uses the trained network's weight as its knowledge. As the network is testing network, it does not need target output and need statistical analysis shown in figure 4. If the user gives the testing input to the testing network, the network will show its related output to the user. The system is tested with various font styles which are from the training or testing data set. Among them the one font type Candara output is shown in table 1and the testing phase of the system is shown in figure 13.

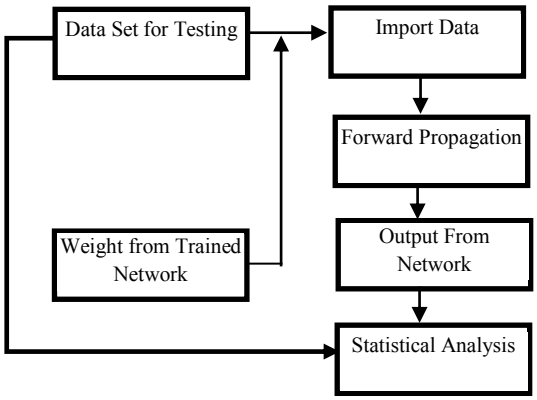


Figure 13. Flow Chart for Testing Program

Table 1. Testing Results for 0-9 Printed Digits

Target Output	Acceptable Error	Actual Output from Testing Network				Digits in English
0000	0.01	0.016524	0.000545	0.002856	0.000896	Zero (0)
0001	0.01	0.008932	0.005696	0.006324	1	One (1)
0010	0.01	0.000193	0.004643	0.99853	0.005147	Two (2)
0011	0.01	0.000222	0.004497	0.99578	0.99951	Three (3)
0100	0.01	7.89E05	0.99283	0.00047	0.004609	Four (4)
0101	0.01	0.001569	0.99877	0.003857	0.99987	Five (5)
0110	0.01	0.005058	0.99938	0.99021	0.005902	Six (6)
0111	0.01	4.09E07	0.99294	0.99998	0.99408	Seven (7)
1000	0.01	0.98805	0.000528	0.012758	0.012253	Eight (8)
1001	0.01	0.98717	0.000934	8.67E07	0.99619	Nine (9)

IV. Discussion

A small number of neurons in the hidden layer are insufficient to extract key features in the printed digits. In all cases with 5 neurons in the middle, both the training and testing accuracy fared poorly. A large number of neurons in the middle layer help the accuracy; however there is probably some upper limit to this which is dependent on the data being used. Additionally, high neuron counts in the hidden layers increase training time significantly.

A low learning parameter causes the network to learn quite slowly, but helps the network converge to a solution quite well. However, too low learning parameters could increase the chances of reaching local minimums rather than global minimums. A high learning parameter seems to seriously affect the accuracy of the test classification, since the weights and objective function end up diverging. Accuracy is increased by increasing the number of cycles.

V. Conclusion

While the implementation of the fully connected back propagation network gave reasonable results toward recognizing printed characters, it has some major deficiencies. The most notable is the fact that it cannot handle major variations in translation, rotation, or scale. While a few simple pre-processing steps can be implemented in order to account for these variances, in general they are difficult to solve completely.

Additionally, fully-connected networks completely ignore the general topology of the input image, and instead rely on almost pixel-perfect feature detection.The back propagation neural network discussed and implemented in this paper can also be used for almost any general image recognition (or) pattern classification applications such as face detection and fingerprint detection.

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Embedded System

Microcontroller Based Temperature and Humidity Measuring System Using DHT11 Sensor

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***Abstract*:** In this research, a microcontroller based temperature and humidity measuring system using DHT11 sensor is described. The system is designed and developed by using the DHT11 digital temperature and humidity sensor, PIC16F628A microcontroller and a 16×2 liquid crystal display (LCD). PIC16F628A microcontroller is the heart of the whole system and it is used for receiving the digital output data of DHT11 sensor, processing to give out measurement results and interfacing with LCD. The internal oscillator of 4 MHz frequency is used as the oscillator of PIC16F628A microcontroller. The measurement results of temperature and humidity can be seen on LCD. The required circuit design is performed with CircuitMaker 2000 software. The software developed for PIC16F628A microcontroller is performed using MPLAB IDE (v8.50) software and the source code is written with Assembly programming language. The measurable ranges of constructed thermo hygrometer are from 0°C to 50°C for temperature and from 20 %RH to 95 %RH for humidity.

***Keywords*:** Temperature, Humidity, DHT11 sensor, PIC16F628A microcontroller, LCD.

I. Introduction

Within the human body, energy is produced by the metabolism of foods. Approximately 1800 kilocalories of energy per day are metabolized by the average person while resting, more if doing strenuous activities. Over half of this energy is converted to heat. Without some way to remove this internally-produced heat energy, the body temperature would increase indefinitely. Under certain atmospheric conditions (high temperature and high humidity), it becomes difficult for the body to remove this excess heat. In the other extreme, problems also arise when the body loses heat too rapidly under conditions of cold temperatures and strong winds. The ideal conditions for a resting human body fall into a range called the thermal neutral zone, where the air temperature is between 20°C and 25°C, or (68-77)°F, with little wind and moderate relative humidity [1].

Temperature is a measure of the warmth or coldness of an object or substance with reference to some standard value [2]. Humidity is the concentration of water vapour present in the air. Relative humidity is expressed as a percentage. In general, the relative humidity will vary inversely with air temperature so that the relative humidity is highest when the temperature is lowest, and vice versa. From the above description, a thermometer and humidity meter is required to know the surrounding temperature and humidity. In this research, a thermo hygrometer is constructed to monitor both temperature and humidity simultaneously.

II. General Description of the Constructed System

In this section, the general description of the constructed system is discussed. Firstly, the whole system is discussed using block diagram. Then, the background information of the electronic components used in this research are also described.

A. Block Diagram of the Whole System

The developed temperature and humidity measuring system contains four main units and they are DHT11 sensor, main control unit (MCU), display unit and power supply unit.

The functions of DHT11 sensor are to detect the surrounding temperature and humidity and, also to give out the digital serial data. The functions of main control unit are to acquire serial data of DHT11 sensor, convert it into measurement results, and send the temperature and humidity results to display unit. The temperature and humidity measurement results are displayed on LCD. The function of power supply unit is to provide regulated DC +5 V for other units. The block diagram of temperature and humidity measuring system is shown in Figure 1.

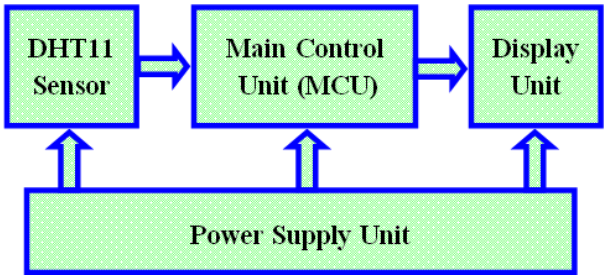

Figure 1. Block Diagram of Temperature and Humidity Measuring System

B. DHT11 Sensor

DHT11 (Digital Humidity and Temperature) sensor is a low cost humidity and temperature sensor with a single wire digital interface. The sensor senses the temperature and humidity of the surrounding and gives a calibrated digital signal output. It has a low power operating range (3V to 5V). The component is 3-pin single row package and the major feature of this sensor is that the data for both temperature and humidity is available on a single data pin of the sensor.

The sensor is calibrated and doesn't require extra components so it can get right to measuring relative humidity and temperature. DHT11sensor can measure temperature from 0 to 50 °C with an accuracy of ±2°C and relative humidity ranging from 20 to 95 %RH with an accuracy of ±5 % [3]. The DHT11 sensor used in this research has three connection pins namely VCC (5V), DATA and GND (Ground). The photograph of DHT11 sensor is shown in Figure 2.

Figure 2. Photograph of DHT11 Sensor

C. PIC16F628A Microcontroller

PIC is the family of Reduces Instruction Set Computer (RISC) microcontrollers made by Microchip Technology. It is generally regarded that PIC stands for Peripheral Interface Controller, although General Instruments' original acronym for the PIC was "Programmable Intelligent Computer". F is the referred to flash program memory.

The PIC16F628A is chosen in this research because of its economical and low cost, available of the chip and its related software and developer. The PIC16F628A is 18-Pin Flash-based member of low cost, high performance, 8-bit microcontroller. All microcontrollers employ an advanced RISC architecture. The PIC16F628A have enhanced core features, eight-level deep stack, and multiple internal and external interrupt sources. A total of 35 instructions (reduced instruction set) are available, complemented by a large register set.

PIC16F628A device have integrated features to reduce external components, thus reducing system cost, enhancing system reliability and reducing power consumption. The PIC16F628A has two ports, PORTA and PORTB. Some pins for these I/O ports are multiplexed with alternate functions for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin [4]. The pin diagram and photograph of PIC16F628A microcontroller are shown in Figure 3 and Figure 4.

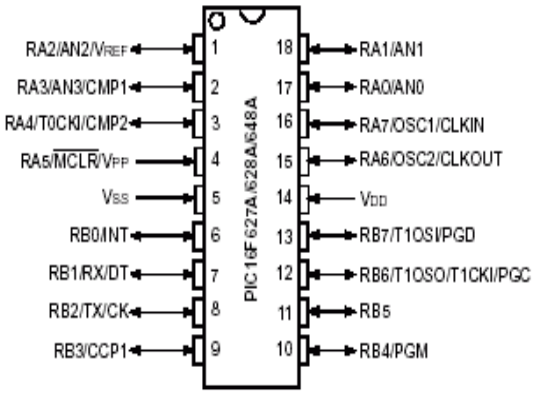

Figure 3. Pin Diagram of PIC16F628A Microcontroller

Figure 4. Photograph of PIC16F628A Microcontroller

D. 2-Line 16-Character LCD

The alphanumeric Liquid Crystal Display (LCD) modules can display characters, numerals, symbols and some limited graphics. Alphanumeric LCD modules are intelligent peripherals which can communicate, bi-directly, within the master system. A (5 x 7) dot, 2 lines 16 characters and matrix modules (LCD) is used in the constructed system. It has a Hitachi type HD 44780 IC. Most LCD modules conform to a standard interface specification [5]. The pin layout and photograph of 2-line 16-character LCD module are Figure 5 and Figure 6 respectively.

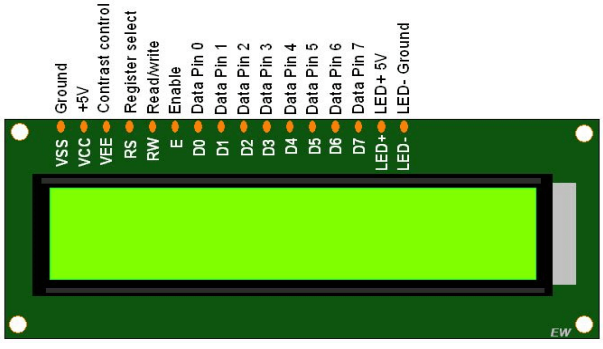

Figure 5. Pin Layout of 2-line 16-character LCD

Figure 6. Photograph of 2-line 16-character LCD

III. Circuit Construction of the Whole System

In this section, the circuit construction of the whole system is described in detail. The whole system consists of DHT11 sensor circuit, main control circuit, display circuit, and power supply circuit.

In DHT11 sensor circuit, it is used a single wire bus for communication with PIC16F628A microcontroller. GND pin of DHT11 sensor is connected to the ground and VCC pin DHT11 is applied +5 V directly. DATA pin of DHT11 sensor is pulled-up using 4.7 kΩ resistor and it is fed to RB0 of PIC16F628A microcontroller.

In the main control circuit, pin-4 of microcontroller applied +5 V by inserting 2 kΩ resistor and the reset condition is not used. The internal oscillator of 4 MHz frequency is used as the clock circuit for PIC16F628A microcontroller and therefore other external oscillator is not required in the developed system. In the pin configuration, RB0 of PIC16F628A microcontroller is used as digital input to receive the output of DHT11 sensor. RB2 to RB7 of microcontroller are used as digital outputs to interface with LCD. Therefore, TRISB of microcontroller is configured as b'00000001'. PORTA of microcontroller is not used in this work.

In display circuit, VSS pin of LCD is grounded and VCC pin is applied +5V. The contrast control pin of LCD is connected to the voltage divider output of 5 kΩ variable resistor. In connection of voltage divider circuit, the first pin of variable resistor is applied +5V, the second pin is voltage divider output and the third pin of variable resistor is connected to the ground. The contrast of LCD character can be controlled by turning variable resistor. Register select and Enable pins of LCD are controlled by RB2 and RB3 of PIC16F628A microcontroller respectively. Read/write pin of LCD is directly grounded. The interfacing between PIC16F628A microcontroller and LCD is performed with four bits mode. Therefore, Data pin-4 to pin-7 of LCD are connected to RB4 to RB7 of PIC16F628A microcontroller respectively. The LCD back light pins such as LED+ and LED- are applied 5V.

In the power supply circuit, a 9 V battery is used as power source of the whole system. The positive node of 9V battery is smoothed with 100 µF capacitor and it is connected to the input of L7805 voltage regulator and the common node of the L7805 is grounded. The output pin of regulator produce regulated +5V which is also filtered using 0.1 µF capacitor. An LED is also provided at the output of +5 V to indicate the power status of the system.

The DHT11 sensor circuit, main control circuit, display circuit and power supply circuit are fitted together to form the complete circuit of the whole system. The schematic diagram of the constructed temperature and humidity measuring system is shown in Figure 7.

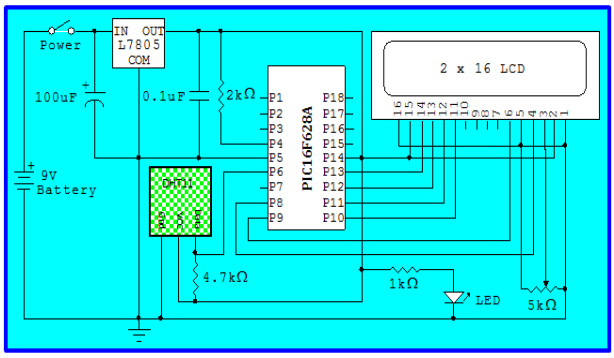

Figure 7. Schematic Diagram of the Constructed Temperature and Humidity Measuring System

A. Control Program Development

In the control program development section, the program code (Thermo_hygro.asm) file is developed in the text editor. The source code is written with Assembly programming language and built into (Thermo_hygro.hex) file using MPLAB IDE v8.50 software. The obtained (Thermo_hygro.hex) file is imported to the PICkit 2 v2.61 software. Then, it is downloaded from the USB port of the personal computer into the PIC16F628A microcontroller with the help of PICKIT2 programmer board. The snapshots of MPLAB IDE v8.50 software and PICkit 2 Programmer software are shown in Figure 8 and Figure 9 respectively. The photograph of PICKIT2 programmer board is also shown in Figure 10.

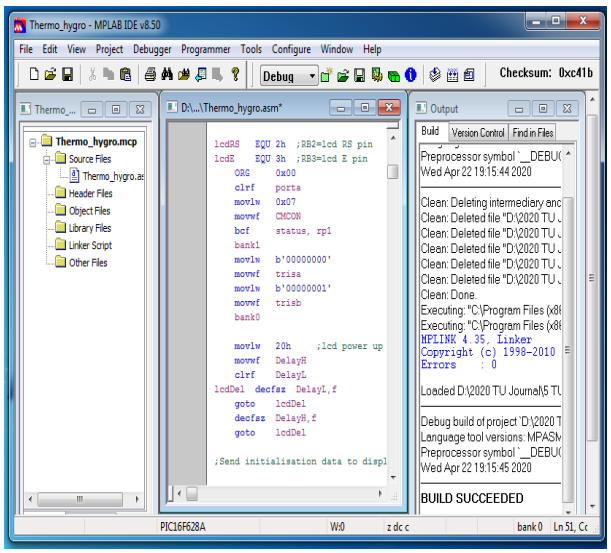

Figure 8. Snapshot of MPLAB IDE v8.50 Software

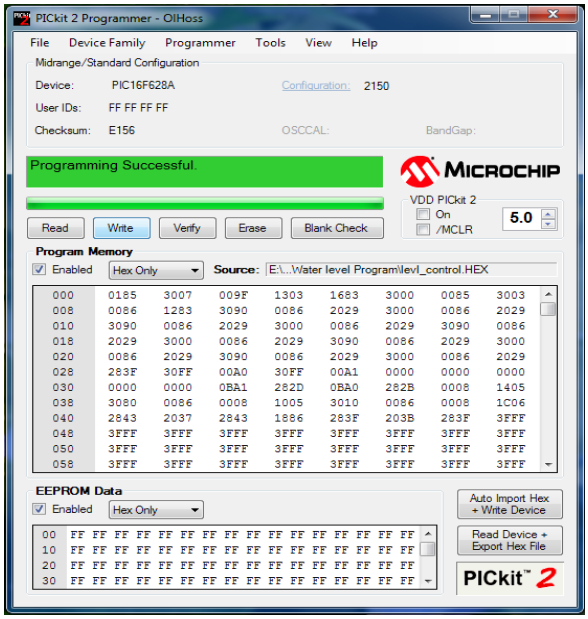

Figure 9. Snapshot of PICkit 2 Programmer Software

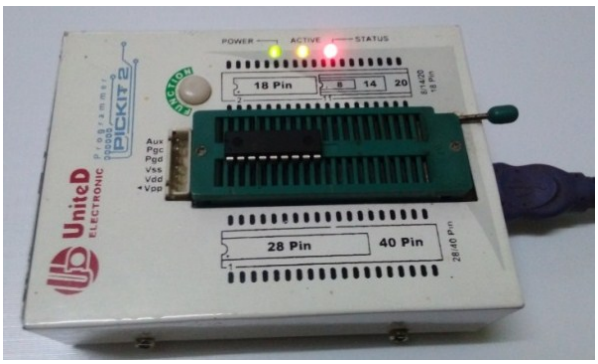

Figure 10. Photograph of the PICKIT 2 Programmer Board

B. Discussions

Homes, schools, universities and hospitals should have a thermometer and hygrometer to measure the temperature and humidity for health, research, and storage. Therefore, a temperature and humidity measuring system is developed in this research. The system is one of the applications of a DHT11 sensor. In the develop system, it consists of two main sections, and they are hardware section and software section.

In the hardware section, DHT11 sensor circuit, main control circuit, display circuit, and power supply circuit are designed and constructed. DHT11 sensor circuit detects room temperature and humidity of surrounding. The main control circuit controls the whole system and processes for measurement. The display circuit shows the temperature and humidity measurement results. The power supply circuit provides regulated +5V for the whole system.

In the software development section, the control program is written with Assembly programming language and built by using MPLAB IDE v8.50 software. The developed temperature and humidity measuring system can measure the temperature value of (0 ^{o}C - 50 ^{o}C) and the humidity value of (20 %RH – 95 %RH). The photograph of constructed temperature and humidity measuring system is also shown in Figure 11.

The DHT22 sensor is also available in the market. The DHT22 sensor has better humidity measuring range, from 0 to 100 %RH, while the DHT11 sensor humidity range is from 20 to 80 %RH. But there are two specifications where the DHT11 sensor is better than the DHT22 sensor. The first one is that the sampling rate of the DHT11 is 1 Hz or one reading every second, while the DHT22 sampling rate is 0.5 Hz or one reading every two seconds. The second is that the DHT11 sensor has smaller body size than DHT22 sensor. The operating voltage of both sensors is from 3 V to 5 V. Therefore DHT11 sensor is used in this research work.

Figure 11. Photograph of Constructed Temperature and Humidity Measuring System

C. Experimental Testing of the System

Firstly, a regulated +5 V power supply circuit is constructed using 9 V battery, L7805 regulator and other required components. The circuit is tested by using multi-meter to know that whether the output voltage is 5 V or not. Then, the interfacing between PIC16F628A and 2-line 16-character LCD is performed using 4-bit mode. The LCD character display program is developed and installed into PIC16F628A microcontroller. The LCD shows the characters such as “Temperature” and “Humidity”. After finishing these experiments, DHT11 sensor is fitted in the circuit. DATA pin of DHT11 sensor is pulled-up using 4.7 kΩ resistor and also applied to RB0 input of PIC16F628A microcontroller. Finally the complete program code is developed and written into PIC16F628A microcontroller. The developed system is ready to monitor the temperature and humidity of surrounding.

The whole system is experimentally tested by using table lamp and air cooler to perform with various

temperature and humidity values. Firstly the developed system is tested with table lamp and its photograph is shown in Figure 12. Then, the system is placed in front of the air cooler and the temperature and humidity are measured. The photographs of testing the system with air cooler are shown in Figure 13.

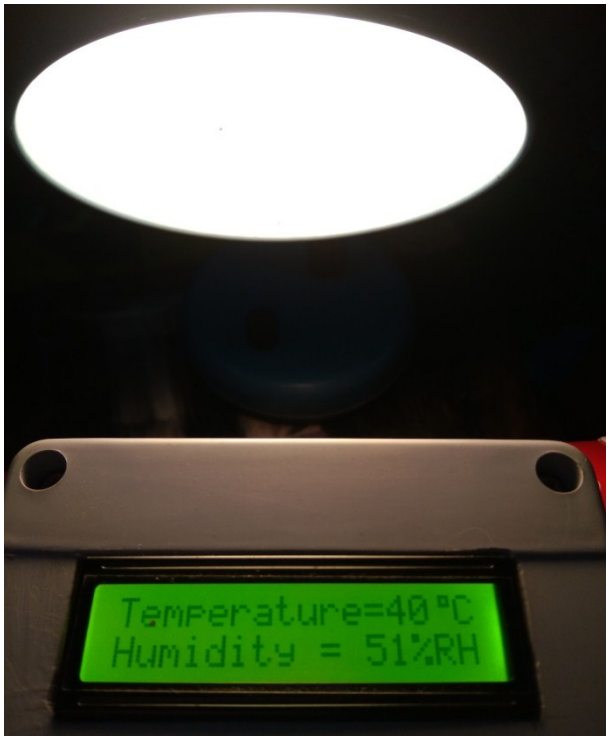

Figure 12. Photograph of Testing the Developed System with Table Lamp

(a)

(b)

(c)

Figure 13. Photographs of Testing the Developed System with Air Cooler

IV. Conclusion

In this research, a microcontroller based temperature and humidity measuring system is designed, developed and tested successfully. The developed system can measure the temperature and humidity simultaneously. The performance of the developed system is reliable and therefore it is also suitable for weather station to measure the room temperature and humidity values. The system can also be used at laboratory to monitor the setting temperature while performing experiments.

This research is also useful for studying how to use DHT11 sensor, how to interface PIC16F628A microcontroller and LCD, and how to develop an Assembly source code for PIC microcontroller. Based on the constructed research framework, other researches such as temperature and humidity based air cooler control system, programmable room temperature controller, etc can also be constructed.

Acknowledgment

We are deeply thankful to Dr Si Si Khin, Pro-Rector, Yadanabon University for her kind permission to undertake this research.

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Dual Axis Solar Tracking System

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***Abstract*:** The dual axis solar tracking system can track sun's radiation not only horizontal but also vertical axis. They use the same rule as the mountings of astronomical telescopes. To achieve the most effect, the tool tracks seasonal variations and daily scales. The system focuses on the design and implementation of the automated dual-axis solar tracker prototype based on the microcontroller, with its solar panel parameter, with its use. This system ensures the perspective of the solar panel. The device can monitor 12 months of sunlight in a matter of minutes by implementing an automatic mechanism. The system checks the position of the sunlight and control the motion of a solar battery so that radiation of the sun comes normally to the surface of the solar panel. The electrical power generated by a solar panel can be used for wide range of application. This system is the most suited technology to improve the efficiency apartment of the solar cells by tracking the sun.

***Keywords*:** Solar System, Solar Panel, LDR, Arduino, Servo Motor, Bread Board, Power Supply**.**

I. Introduction

Energy is the main driving factor in global society. The world population is enhancing day-to-day and demand for energy is raising consequently. Oil and coal are the main source of energy nowadays but there is a fact that the fossil fuels are limited and hang strong pollution. Even the price of petroleum has been increasingly year by year and the previsions on the medium term there are not quite encouraging. Major sources of renewable energy have been identified as fossil fuel substitutes. Nowadays, generators are easily useable in the market, but it can be costly if used longer. If this system is used, solar power can be stored through the battery and can be used when needed.

II. Operation of the Block Diagram

LDRs are used as the primary light sensors in Figure 1. Two servo motors are determined to the structure that holds the solar battery. LDRs sense the quantity of sunlight falling on them. Four LDRs are separated into top, bottom, left and right. If the bottom LDRs receives more light saturation, the servo motor moves in the bottom direction. The analog values from two left LDRs and two right LDRs are compared for angular deflection of the solar battery. If the left side of LDR obtains more light intensity than the right side, the horizontal servo motor will move in the left direction. If the right side of LDR receives more light intensity, the servo motor moves in right direction.

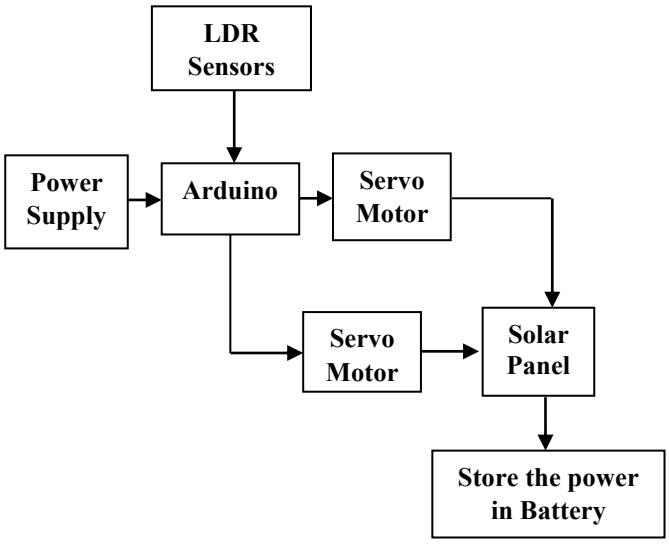

Figure 1. Block Diagram of System

III. Implementation of the System

This system is one of the embedded systems. The software program and hardware circuit are interfaced to design this solar tracking system. There are two parts in this system, i.e. hardware implementation and software implementation.

A. Hardware Implementation

In this system, Arduino UNO is used as microcontrollers to connect other devices. LDRs are connected to the analog pins of Arduino (A0, A1, A2, A3), and GND is Ground. Orange (PWMs) of two servos are connected to digital pins of Arduino (9, 10), Red (+5V) is connected to the 5V of Arduino and Brown (GND) is connected to the GND (Ground) of Arduino. The schematics diagram of the system is shown in Figure 2.

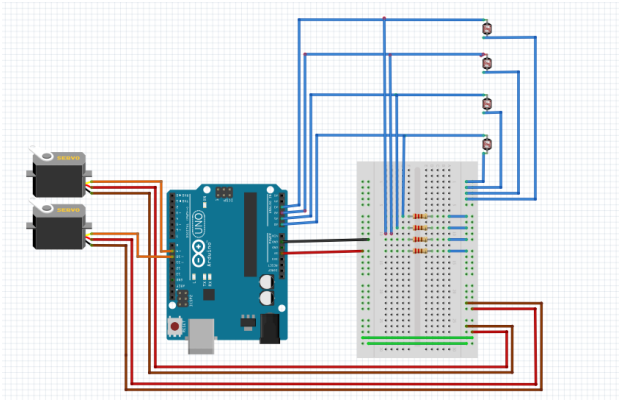

Figure 2. Schematic Diagram

B. Software Implementation

Arduino IDE is used to write the arduino program to upload it to the Arduino UNO Board. Figure 3 is illustrated the simulation of the Arduino IDE.

Figure 3. Simulation of the Arduino IDE

C. System Design

The system's flowchart shows the steps of the system. Firstly, the LDRs read the light saturation of the sun. When the light reach upon the LDR (east) and LDR (west), it calculates the perspective of the light intensity, and then it make the servo motor to move to the greater position. The solar panel moves to the calculated position the solar panel collects energy from sunlight in order to produce electricity. Otherwise, when the light reaches upon the LDR (north) and LDR (south), it will do the same task as the east and west. Figure 4 is illustrated the Flowchart of the system.

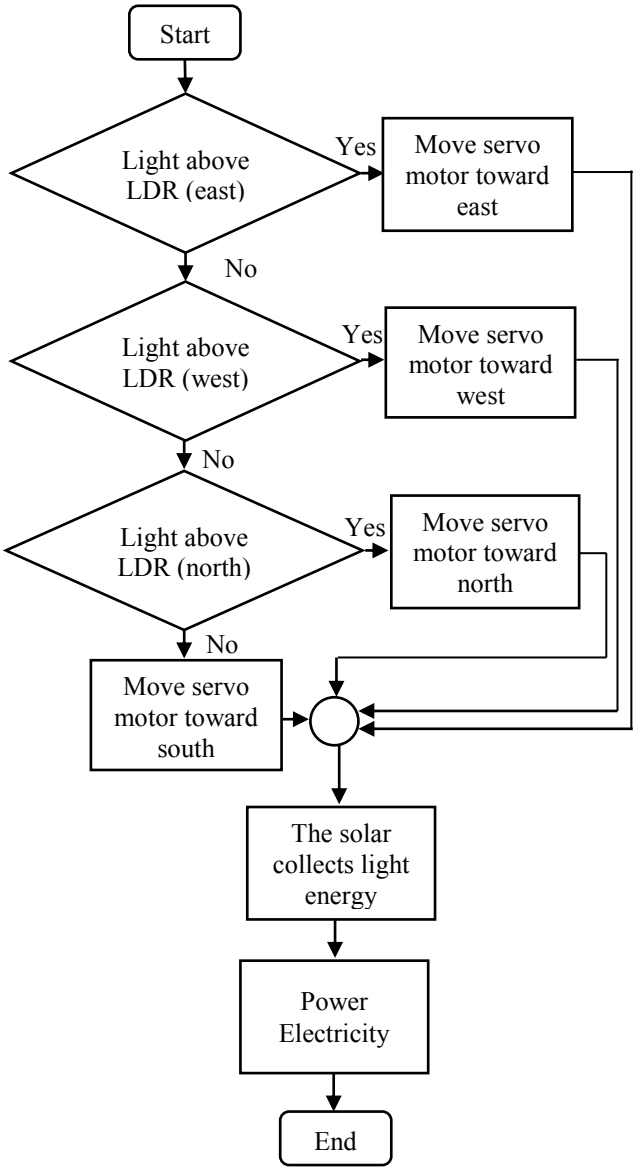

Figure 4. Flowchart of the System

D. Implementation Setup

In this system, microcontrollers need to connect to other devices. So the Arduino UNO is used as a microcontroller. Arduino's analog pin must be connected to the LDR and the GND works as the ground. Digital pin of Arduino needs to connect to two Orange servos (PWMs), the 5V of Arduino is need to connect Red (+5V) and as finally Brown (GND) is connect to the GND (Ground) of Arduino. The schematics diagram of the system is shown in Figure 5.

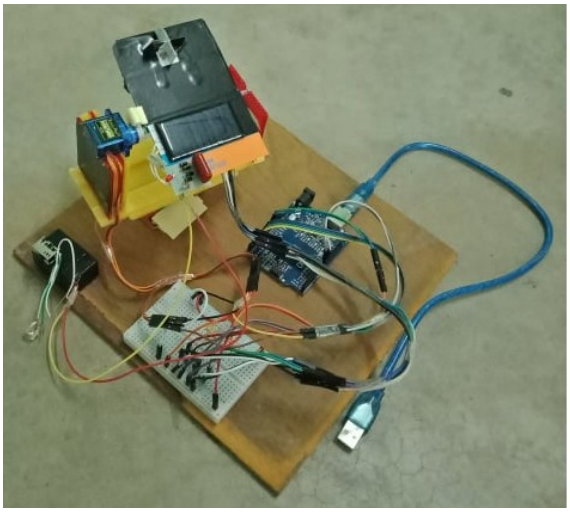

Figure 5. System Design

IV. Conclusions

The system is presented a means of tracking the sun's position by using microcontroller and LDR sensors. In particular, it shows a perfect working device for the production of solar cells by placing the sunlight in the most intense light conditions. The attractive characteristic of the designed solar tracker is simple mechanism to operate the system. In a conclusion, this mechanism could be manifested in wide range of applications that is solar tracking such as parabolic trough collector, solar dish, lens and other PV systems to collect maximum radiation from sun.

V. Advantages and Disadvantages

The advantages of this system are shown in following:

- Due to direct sunlight, solar tracks generate more electricity than their stationary units.
- There are several types of solar tracker, such as single-axis and dual-axis trackers, that help you find the best place for different work areas. Where there is no light, solar power generators are very useful for people. Installation size: Local climate; Latitude and electricity requirements are important considerations that can influence the type of solar power tracker that is best for you.

The disadvantages of this system are as following:

- Their operating equipment is slightly cheaper than solar trackers and is due to the more sophisticated technology and components required for their operation.
- Limit power density.
- Solar cells must be converted to AC when used in current DC distribution grids.

VI. Limitations and Further Extensions

This system will need to clean the LDR sensor once per month. The output voltage of the solar will be shown in the future. There is an idea that is to install the solar on the moving vehicle such as ships and trains.

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[9] Lampang, Phidsanoluk "Power plant with an installed power of 120 MW DC", Thailand.

Microcontroller Based 8 × 8 LED Dot Matrix Display System

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***Abstract*:** The purpose of this research is to construct a microcontroller based 8 × 8 LED dot matrix display system. The whole system is constructed by using sixty four light emitting diodes (LEDs), eight C9013 transistors, CD4017 counter and PIC16F628A microcontroller manufactured by Microchip Technology. PIC16F628A microcontroller is used as the main control device of the whole system. The internal oscillator of 4 MHz frequency is used as the oscillating circuit of microcontroller. The performances of PIC16F628A microcontroller are to control the row LEDs and also to produce the timing signal for CD4017 counter. The CD4017 counter and C9013 transistors are used to control all LEDs of each column by using multiplex method. The total of sixty four LEDs is used to construct in the form of 8 × 8 dot matrix display. The source code for PIC16F628A microcontroller is written by using Assembly language and compiled by using MPLAB IDE software. To download the machine code from the computer to PIC16F628A microcontroller, PICKIT 2 programmer board is used.

***Keywords*:** PIC16F628A microcontroller, Assembly language, 8 × 8 LED dot matrix, CD4017 counter.

I. Introduction

One major development, made possible by the enormous advances in solid state technology, is the "digital revolution". Circuits are designed to implement the basic digital logic functions fundamental to all digital systems. Digital electronics therefore compasses the design, manufacture, and use of circuits for processing information in digital form [1]. Nowadays, the advertisement displays can be seen everywhere in the every city. These are applied by using various technology such as solid state display, neon display etc. LED dot matrix display system is one of the most popular displays in these days. The display system that is constructed here is a microcontroller based 8 × 8 LED dot matrix display system.

Display systems are classified into single line displays, and multiline displays. Displays boards of any length and breadth can be made by combining more than one of these standard units. These display units are capable of displaying messages of any kind, including alphanumeric, numbers etc., in static or scrolling formats. This research is based on microelectronic technology for LED display.

PIC16F628A microcontroller has been chosen for this research. It fetches the instructions from its program memory one by one, decodes their instructions, and then carries out the required operations [2]. It is used for row control and to drive the column control IC (CD4017) of the display system. C9013 transistors switch each LED column. The block diagram of the constructed display is shown in Figure. 1.

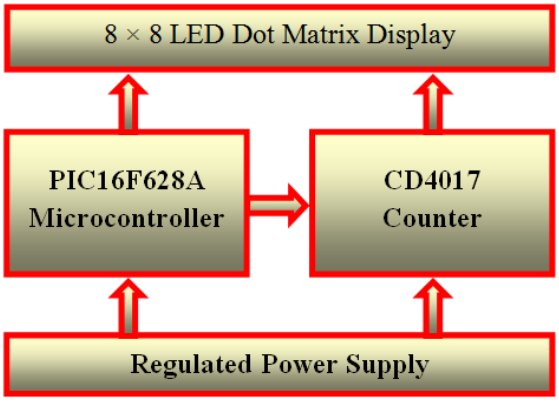

Figure 1. Block Diagram of the Constructed Display System

The functions of PIC16F628A microcontroller are to control the row LEDs and to produce the timing signal for CD4017 counter. The function of CD4017 counter is to receive the timing signal of microcontroller and, to control the column LEDs. The function of 8 × 8 LED dot matrix display is to show the English characters. The function of regulated power supply is to provide +5 V for the whole system.

II. General Information of Electronic Components Used

In this research, PIC16F628A microcontroller, CD4017 counter, C9013 transistor and other electronic components are used. The general descriptions of these components are also discussed in this section.

A. PIC16F628A Microcontroller

PIC is the family of Reduces Instruction Set Computer (RISC) microcontrollers made by Microchip Technology. It is generally regarded that PIC stands for Peripheral Interface Controller, although General Instruments' original acronym for the PIC was

"Programmable Intelligent Computer". F is the referred to flash program memory.

The PIC16F628A is 18-Pin Flash-based member of low cost, high performance, 8-bit microcontroller. All microcontrollers employ an advanced RISC architecture. The PIC16F628A have enhanced core features, eight-level deep stack, and multiple internal and external interrupt sources. A total of 35 instructions (reduced instruction set) are available, complemented by a large register set. The PIC16F628A has two ports, PORTA and PORTB. Some pins for these I/O ports are multiplexed with alternate functions for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

The PIC16F628A can be operated in eight different oscillator options. The user can program three configuration bits (FOSC2 through FOSC0) to select one of these eight modes:

(a) LP Low Power Crystal

(b) XT Crystal/Resonator

(c) HS High Speed Crystal/Resonator

(d) RC External Resistor/Capacitor (2 modes)

(e) INTOSC Internal Precision Oscillator (2 modes)

(f) EC External Clock In [3]

The pin diagram and photograph of PIC16F628A microcontroller are shown in Figure 2 and Figure 3 respectively.

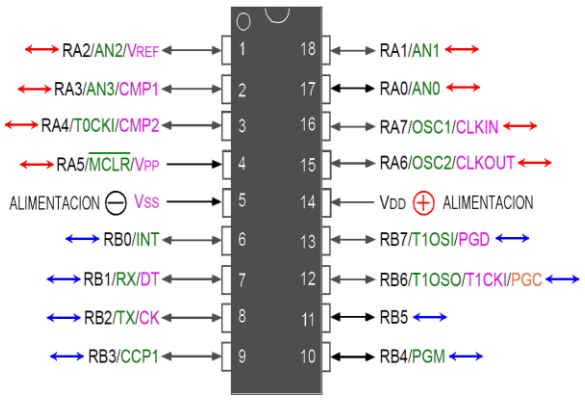

Figure 2. Pin Diagram of PIC16F628A Microcontroller

Figure 3. Photograph of PIC16F628A Microcontroller

B. Transistor

A transistor can act as an amplifier or even a switch when it comes to electronic signals and is made of semiconductor. The norm of a transistor is that it will usually have three terminals: emitter, base and collector for connection purposes in an external circuit. Nowadays, it is commonly used in modern electronic devices due to its functionality. In this research, C9013 npn transistor is used. The pin diagram and photograph of C9013 transistor are shown in Figure 4.

.

Figure 4. Pin Diagram and Photograph of C9013 Transistor

C. CD4017 Decade Counter

CD4017B and CD4022B are 5-stage and 4-stage Johnson counters having 10 and 8 decoded outputs, respectively. Inputs include a CLOCK, a RESET, and a CLOCK INHIBIT signal. Schmitt trigger action in the CLOCK input circuit provides pulse shaping that allows unlimited clock input pulse rise and fall times.

These counters are advanced one count at the positive clock signal transition if the CLOCK INHIBIT signal is low. Counter advancement via the clock line is inhibited when the CLOCK INHIBIT signal is high. A high RESET signal clears the counter to its zero count.

The decoded outputs are normally low and go high only at their respective decoded time slot. Each decoded output remains high for one full clock cycle. A CARRY-OUT signal completes on cycle every 10 clock input cycles in the CD4017B or every 8 clock input cycles in the CD4022B and is used to ripple-clock the

succeeding device in a multi-device counting chain. Some features of CD4017 counter are

(a) High speed 16 pin CMOS Decade counter
(b) Supports 10 decoded outputs
(c) Wide supply voltage range from 3V to 15V, typically +5V
(d) TTL compatible
(e) Maximum Clock Frequency: 5.5Mhz
(f) Available in 16-pin PDIP, GDIP, PDSO packages [4].

The pin diagram and photograph of CD4017BE counter are shown in Figure 5 and Figure 6 respectively.

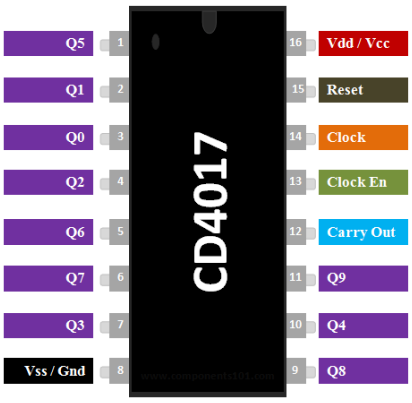

Figure 5. Pin Diagram of CD4017BE Counter

Figure 6. Photograph of CD4017BE Counter

III. System Hardware Connection

The system hardware is constructed by using sixty four light emitting diodes, eight C9013 transistors, CD4017BE counter and PIC16F628A microcontroller. The PIC16F628A has an internal oscillator and configure to operate at 4 MHz frequency. The display system is designed as eight rows and eight columns dot matrix. The anodes of each row LEDs are connected together and the obtained each row LEDs are controlled by RB0 (pin-6) to RB7 (pin-13) of PIC16F628A microcontroller.

The cathodes of each column LEDs are connected together and the obtained each column LEDs are controlled by Q0 (pin-3) to Q7 (pin-6) of CD4017BE decade counter through C9013 transistors. The complete circuit of the whole system is as shown in Figure 7.

Depending on the complexity of the program, the LEDs will display different effects. Only one column of LEDs turns ON at a time. PORTB of PIC16F628A microcontroller drive the LEDs via 100 Ω resistors and the cathodes are connected together and taken to the 0 V rail via a sinking transistor. The eight sinking transistors are turned ON (one at a time) by the outputs of a CD4017BE decade counter. CD4017BE has 10 outputs with one output going HIGH at a time. It is firstly reset by taking pin 15 HIGH then LOW and keeping LOW this allows to 'clock'.

The first output (pin 3) of CD4017BE goes HIGH and this is connected to the first transistor via a 1 kΩ based resistor. The transistor turns ON and the LEDs are turned ON by delivering current from the microcontroller. When any of the output lines of the microcontroller goes HIGH (RB0 to RB7), the corresponding LEDs are illuminated. The 100 Ω resistor limits current about 25 mA as this is the maximum current each output is designed to deliver. The output lines of the CD4017BE correspond to PORTB and by turning OFF these lines, clocking the CD4017BE then turning ON the outputs again, the second column of the LEDs will be illuminated. This is repeated for the third, fourth and other columns.

The power supply unit contains a step-down transformer which reduces the line voltage to 9 V ac. Bridge rectifier circuit converts this to dc voltage. The rectified dc voltage is then filtered by 1000 µF capacitor. Input line voltage variation and output current variation may cause transient effect in dc output voltage. It is eliminated by a monolithic type, three terminal voltage regulator (LM7805). The output of regulator IC LM7805 is + 5 V dc. This output is also filtered using 0.1 µF capacitor.

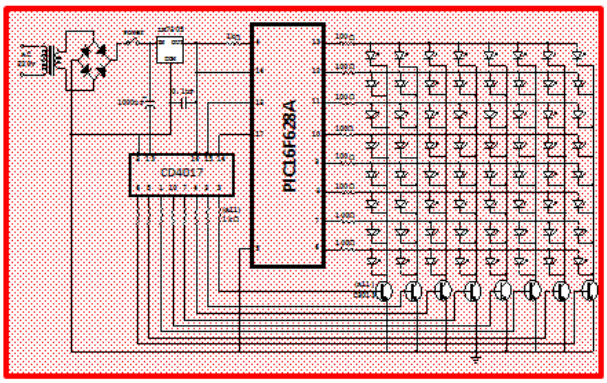

Figure 7. Complete Circuit of the Whole System

A. Loading for Program Memory

There are five major requirements to load a program in the memory of PIC microcontroller. They are personal computer, complier or assembler software, programmer software, programmer and PIC microcontroller. A personal computer, programmer and programmer software are used to download the contents of the HEX file from the computer to PIC.

Firstly, programmer software and complier software are installed into the personal computer. Then we write a program by using a text editor. And then it is changed into the hex file or machine language (the only understandable language for PIC) automatically using MPASM assembler software. Lastly, load the program (hex file) into the memory of microcontroller via USB port, which is connected to the programmer by using the programmer software.

After completing the loading process, microcontroller can do specific operation by executing the instructions, which were stored in the program memory. Loading process for microcontroller is shown in Figure 8.

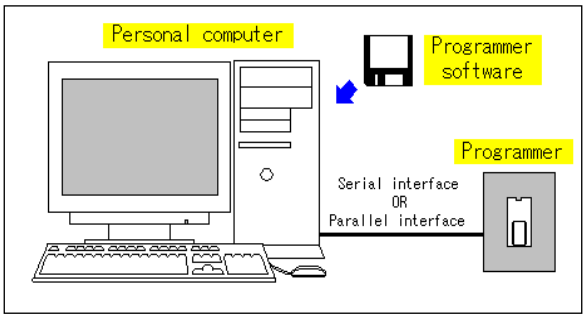

Figure 8. Loading Process for Microcontroller

B. Programming and Downloading

In the programming and downloading section, the source code (dot_matrix.asm) file is developed in the text editor. The source code is written with Assembly programming language and compiled into (dot_matrix.hex) file using MPLAB IDE software. The resultant (dot_matrix.hex) file is imported to the PICkit2 software. Then, it is downloaded from the USB port of the personal computer into the PIC16F628A microcontroller with the help of PICkit 2 programmer board. The photograph of the PICkit2 programmer board is shown in Figure 9. The photographs of MPLAB IDE and PICkit2 software screens are shown in Figure 10 and Figure 11 respectively.

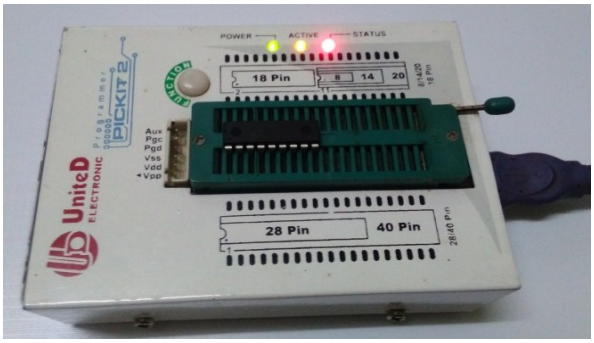

Figure 9. Photograph of PICkit2 Programmer Board

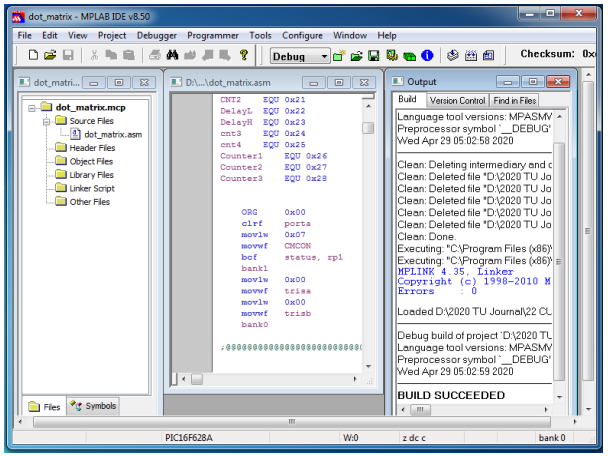

Figure 10. Photograph of the MPLAB IDE Software Screen

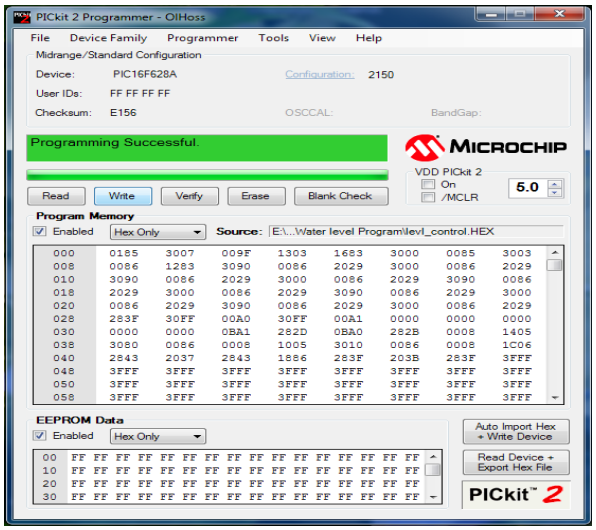

Figure 11. Photograph of the PICkit2 Software Screen

C. Discussion

The constructed system is the fundamental of an electronic notice board and it contains two main sections namely hardware section and software section. In the hardware section, the system is designed and constructed using PIC16F628A microcontroller, CD4017 decade counter, LEDs and other required electronic components. In the software section, the control program is written with Assembly programming language and compiled by MPLAB IDE software. The constructed system can be used as an advertisement display. By modifying the control program, the display running words can be changed. The system can be made larger and longer display pattern by cascading another LEDs dot-matrix patterns and CD4017BE decade counter. The photographs constructed display screen are shown in Figure 12.

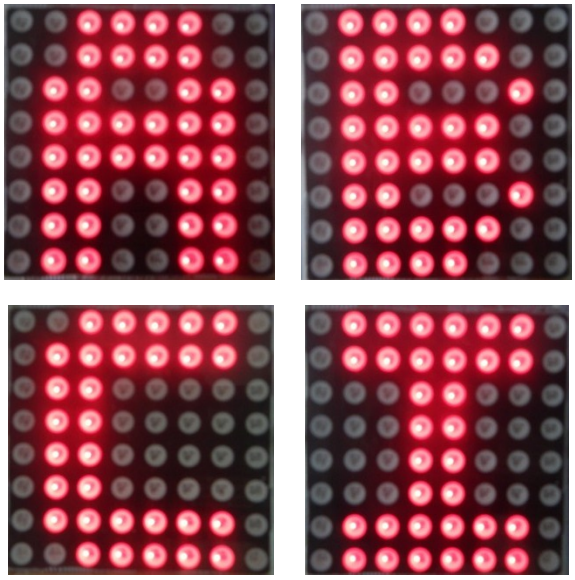

Figure 12. Photograph of Constructed Display Screen

Nowadays, LED dot matrix displays are used in destination signs on public transport vehicles and variable-message signs on highways. LED displays are capable of providing general illumination in addition to visual display, as when used for stage lighting and other decorative purposes. The most prominent feature of the LEDs is that they consume less energy than the common lighting sources. The LED dot matrix displays produce less heat. By using LED dot matrix displays, the messages become live and attractive. Multiple animated messages on displays arrest public attention easily than the other sources of advertisement. LED displays can offer higher contrast ratios than a projector and are thus an alternative to traditional projection screens, and they can be used for large, uninterrupted video walls. Therefore LED dot matrix displays are widely used in various applications.

LEDs are very energy efficient light emitting device. The power consumption of the developed LED dot matrix display for full display is 6.4 W. The power consumption of displaying English character "A" is 3.5 W. The lifespan of LED is 100000 hours, and therefore LED dot matrix displays are suitable for long life display. After the LED displays work for a long time, their brightness will drop. Because of the attenuation of the brightness of each LED, the brightness of the whole screen will also decrease. Therefore, higher brightness LEDs should be used. The size of each LED affects the resolution of the screen display, and 3 mm diameter LEDs are used in this research. Therefore, the constructed LED dot matrix display is suitable for improving display system as electronic notice board.

IV. Conclusion

In this research work, a microcontroller based 8 × 8 LED dot matrix display system has been designed, developed and tested successfully. It can be used as electronic notice board. By using seven-segment display, the numbers and some English characters can be display, but it cannot display Myanmar characters. By modifying control program, the constructed system can display the running message in English language as well as in Myanmar language. At present work, Myanmar character words cannot be displayed clearly. To display all of 33 Myanmar character words, four 8 × 8 LED dot matrix displays must be cascade and the control program must also be modified. Moreover, the power supply circuit must also be modified to increase the output current.

Since other external components are not needed, the design is relatively compact. By using a microcontroller it can obtain the advantages of light weight, low power consumption, better reliability and precise timing sequence. By studying the developed system, the university students can obtain the knowledge that how to construct the display system by using LED, microcontroller and counter. The students can also develop other improved larger display for notice board.

Acknowledgments

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We are very deeply grateful to Professor Dr Mya Mya, Head of Department of Physics, and University of Myitkyina for her advice to carry out this research.

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Infrared Transceiver Based Intruder Alert System Using Microcontroller

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***Abstract*:** The purpose of this research is to construct an infrared transceiver based intruder alert system using microcontroller. In this research work, the whole system consists of hardware connection and software development. In the hardware connection section, an infrared transceiver module is used to sense the intruder motion of restricted area. PIC16F628A microcontroller is used as the main processing device of the whole system. A relay is also used to switch-on or switch-off the AC 220 V for electric bell. An electric bell and a buzzer are used as sound alert devices. In the software development, the source code for PIC16F628A microcontroller is written with Assembly programming language. The MPLAB IDE (v8.50) software is used to compile the Assembly code and it creates the machine code for microcontroller. The PICkit2 programmer software and PICKIT2 programmer board are also used to write the machine code from the computer into microcontroller. When the intruder comes into the restricted area of the developed system, the buzzer will beep continuously and the electric bell will also ring.

***Keywords*:** Infrared transceiver, Intruder alert, PIC16F628A microcontroller, Assembly code, Electric bell.

I. Introduction

In our daily life, the security is an important part of homes, departments, banks, hotels, shops and offices. Burglar and safety alarms are found in electronic form nowadays. They are constructed based on motion detection in which infrared (IR) sensor, ultrasonic sensor and motion sensor are used. In the traditional security systems, when an intruder is detected, the audible alarm will produce. The sensors continuously monitor the movement of intruder.

The intruder alert systems should be installed in the homes, departments, universities and other buildings to secure their family, teachers, students and their properties. The intruder alert systems can also keep our family safe from potential break-ins by burglars. Therefore, an infrared transceiver based intruder alert system is designed and constructed based on motion detection technique. The developed system is designed to produce beep sound from the buzzer and also to produce the loud alarm sound when an intruder motion is detected by the infrared transceiver.

II. General Descriptions of the System

Firstly, the general descriptions of the constructed intruder alert system are discussed by using the block diagram. Then, the general features of infrared transceiver module and PIC16F628A microcontroller are also described.

A. Block Diagram of the Whole System

The infrared transceiver based intruder alert system consists of six main units and they are infrared transceiver, main processing unit, buzzer, AC 220 V switching unit, electric bell and regulated power supply unit.

The functions of infrared transceiver are to sense the incoming intruder and to send the output signal for main processing unit. The functions of main processing unit are to receive the output signal of infrared transceiver, to activate buzzer, and also to send the switching signal for AC 220 V switching unit. The function of buzzer is to produce beep sound. The function of AC 220 V switching unit is to switch-on or switch-off the power of electric bell. The function of electric bell is to ring loud alert sound when the intruder is detected by the sensor. The functions of regulated power supply unit are to provide DC +12 V for AC 220 V switching unit, and +5 V for the remaining sections. The block diagram of the developed intruder alert system is shown in Figure1.

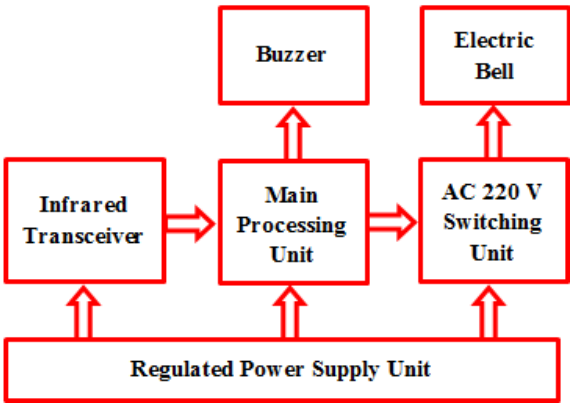


Figure 1. Block Diagram of the Developed Intruder Alert System

B. Infrared Transceiver

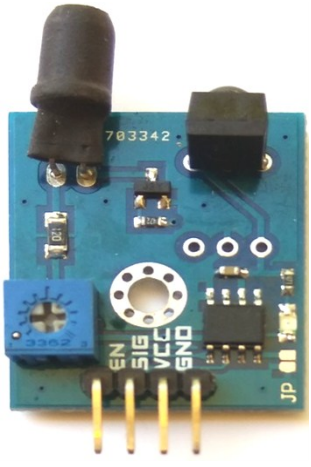
An infrared light emitting diode (LED) is a solid state lighting (SSL) device that emits light in the infrared range of the electromagnetic radiation spectrum. Infrared detectors are little microchips with a photocell that are tuned to listen to infrared light. The output of IR detector sends a low signal while it detects the 40 kHz IR signal, and a high signal while it does not. In an infrared transceiver, both infrared light emitting diode and infrared detector are fitted together in one single unit for sending and receiving infrared data.

In this research, the infrared transceiver module (KC-38IR) is used to sense the incoming intruder. It consists of four connection pins to interface main processing unit. They are GND (Negative power supply), VCC (Positive power supply), SIG (Signal output pin) and EN (Signal output enable pin) [1]. It has built-in IR transmitter and IR receiver that send out IR energy. The sensor module looks for reflected IR energy to detect presence of any obstacle in front of the sensor module. The module has on board potentiometer that lets user adjust detection range. The sensor has very good and stable response even in ambient light or in complete darkness. The output of the sensor is HIGH logic level when obstacle is not detected and LOW logic level when obstacle is detected.

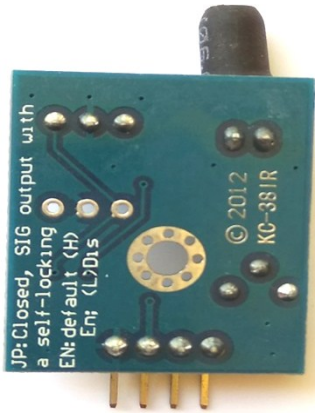
The features of the infrared obstacle avoidance proximity sensor module are

(a) LM393 comparator based detection circuit is very stable and accurate
(b) On board potentiometer sets obstacle detection range
(c) On board obstacle detection LED indicator
(d) Male header for easy connection and
(e) Good accuracy: By use of Infra-red LED transmitter the module performs well in Ambient light.

The photograph of infrared transceiver module (KC-38IR) is shown in Figure 2.



(a) Front view



(b) Back view

Figure 2. Photographs of Infrared Transceiver Module (KC-38IR)

C. PIC16F628A Microcontroller

PIC is the family of Reduces Instruction Set Computer (RISC) microcontrollers made by Microchip Technology. It is generally regarded that PIC stands for Peripheral Interface Controller, although General Instruments' original acronym for the PIC was "Programmable Intelligent Computer". F is the referred to flash program memory.

The PIC16F628A is chosen because of its economical and low cost, available of the chip and its related software and developer. The PIC16F628A is 18-Pin Flash-based member of low cost, high performance, 8-bit microcontroller. All microcontrollers employ an advanced RISC architecture. The PIC16F628A have enhanced core features, eight-level deep stack, and multiple internal and external interrupt sources. A total of 35 instructions (reduced instruction set) are available, complemented by a large register set. The PIC16F628A has two ports, PORTA and PORTB. Some pins for these I/O ports are multiplexed with alternate functions for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

The PIC16F628A can be operated in eight different oscillator options. The user can program three configuration bits (FOSC2 through FOSC0) to select one of these eight modes:

(a) LP Low Power Crystal
(b) XT Crystal/Resonator
(c) HS High Speed Crystal/Resonator
(d) RC External Resistor/Capacitor (2 modes)
(e) INTOSC Internal Precision Oscillator (2 modes)
(f) EC External Clock In [2]

The pin diagram and photograph of PIC16F628A microcontroller are shown in Figure 3 and Figure 4 respectively.

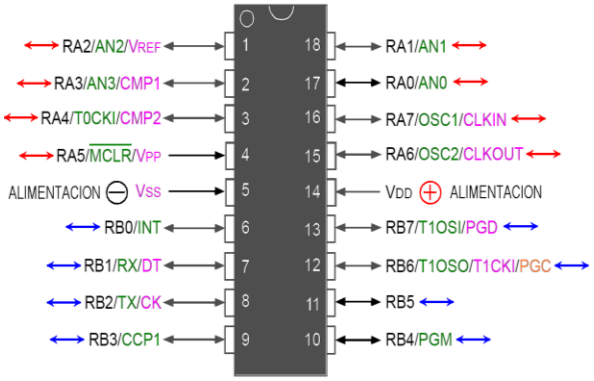


Figure 3. Pin Diagram of PIC16F628A Microcontroller

Figure 4. Photograph of PIC16F628A Microcontroller

D. Voltage Regulator

The three-terminal positive voltage regulators are available in the market. These regulators can provide local on-card regulation. The features of these regulators are internal current limiting, thermal shut-down and safe area protection. If adequate heat sinking is provided, they can deliver over 1 A output current [4]. Although the regulators are designed as fixed voltage, these devices can be used with external components to obtain adjustable voltages and currents. Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In this research, L7812 voltage regulator is used for AC 220 V switching unit and L7805 is also used for the remaining components. The L7805 and L7812 voltage regulator produce regulated DC +5 V and DC +12 V respectively. The pin diagrams of L7805 and L7812 positive voltage regulators are shown in Figure 5.

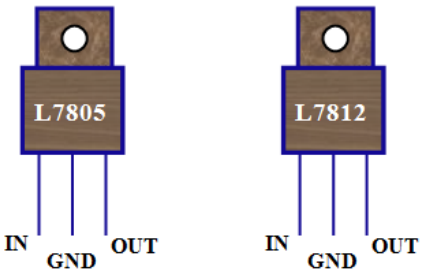


Figure 5. Pin Diagrams of L7805 and L7812 Positive Voltage Regulators

E. Relay

Relays are most commonly used switching device in electronics. There are different types of relays and they operate at different voltages. The main part of a relay is the coil at the centre. Usually relays are used to turn on a second circuit. The first circuit activates the relay which then turns on the second circuit.

There are two important parameters of relay, and they are trigger voltage and load voltage and current. The trigger voltage is the voltage required to turn on the relay that is to change the contact from Common (NC) to Common (NO). The load voltage and current is the amount of voltage or current that the NC, NO or common terminal of the relay could withstand [3]. A relay has five connection pins and they are:

(a) Coil End 1: It is used to trigger (On/Off) the relay, normally one end is connected to 12 V and the other end to ground.
(b) Coil End 2: It is used to trigger (On/Off) the Relay, Normally one end is connected to 12 V and the other end to ground
(c) Common (COM): It is connected to one end of the load that is to be controlled.
(d) Normally Close (NC): The other end of the load is either connected to NO or NC. If connected to NC the load remains connected before trigger.
(e) Normally Open (NO): The other end of the load is either connected to NO or NC. If connected to NO the load remains disconnected before trigger.

Transistors and ICs must be protected from the brief high voltage produced when a relay coil is switched off. In this research, a protection diode (1N4001) is connected backwards across the relay coil to provide this protection. In this research, a 12 V relay is used for switching AC 220 V of electric bell and its photograph is shown in Figure 6.

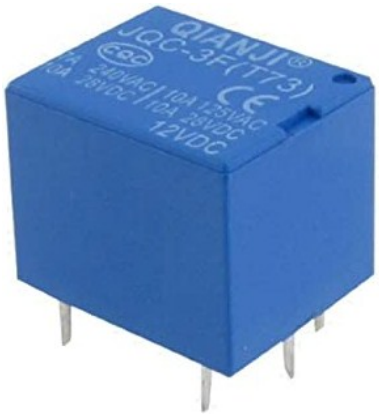


Figure 6. Photograph of Relay

III. Hardware Connection of the System

The infrared transceiver based intruder alert system is constructed by using KC-38IR module, PIC16F628A

microcontroller, relay and other required electronic components.

The KC-38IR transceiver module contains built-in IR transmitter and IR receiver. In circuit connection, VCC of the transceiver module is applied +5 V directly, and EN pin is also applied +5 V by inserting 1 kΩ resistor. GND pin is grounded, and SIG pin is filtered by 0.1 µF capacitor to remove unwanted noises. The SIG pin of KC-38IR transceiver module is initially in the digital HIGH state. When the obstacle is detected, that pin will change into digital LOW state. The output states of SIG pin are monitored by RA2 of PIC16F628A microcontroller.

In the PIC16F628A pins configurations, RA2 of PIC16F628A microcontroller is used as digital input to monitor the SIG pin of KC-38IR transceiver. RB4 of PIC16F628A is used as digital output to control the signal LED. RB6 of microcontroller is used as digital output to produce the activation signal for AC 220 V switching circuit. RB7 of microcontroller also is used as digital output to control buzzer. The internal oscillator of 4 MHz frequency is used as oscillating circuit of the microcontroller by configuration program software.

In alarm circuit connection section, RB4 of PIC16F628A is connected to the anode of LED by inserting 1 kΩ current limiting resistor and the cathode of LED is grounded. In the buzzer section, RB7 of PIC16F628A is connected to the base of BC547 transistor by inserting 1 kΩ resistor. The emitter of transistor is grounded and the collector drives the buzzer. In the AC 220 V switching section, it is used DC +12 V supply to one end of the relay's coil and the other end to ground through a BC547 transistor. A diode is also connected across the coil of the relay. The purpose of the diode is to protect the switch from high voltage spike that can produced by the relay coil. The collector of transistor controls relay with the help of BC547 transistor. An AC 220 V electric bell is connected at the output of the relay.

In the regulated power supply circuit, the main voltage is reduced to AC 12 V by using step-down transformer. This AC voltage is rectified by full wave bridge diode. The output of bridge diode is smoothed by 2200 µF capacitor. The filtered voltage is regulated by L7812 and L7805 voltage regulators. The output of L7812 produces regulated +12 V and the output of L7805 produces regulated +5 V. The output of +5 V line is also filtered by 0.1 µF capacitor to remove high frequency noises. A power status LED is also provided at the output of L7812 regulator. The schematic diagram of the infrared transceiver based intruder alert system is shown in Figure 7.

In circuit operation, when the intruder is detected by the infrared transceiver, the sensor produces the signal to the microcontroller. This signal is received by RA2 of microcontroller. At this time, RB4, RB6 and RB7 of PIC16F628A microcontroller produce the activation signals for LED, electric bell and buzzer. The photograph of the infrared transceiver based intruder alert system is also shown in Figure 8.

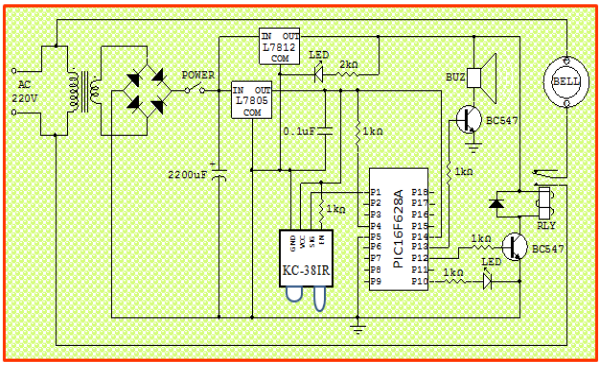


Figure 7. Schematic Diagram of Infrared Transceiver Based Intruder Alert System

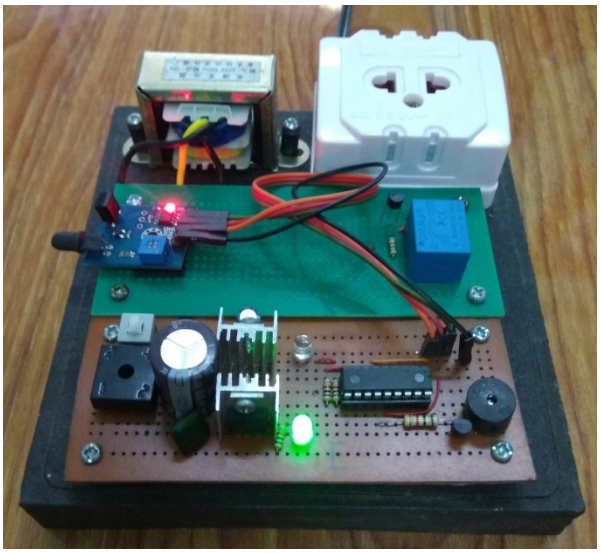


Figure 8. Photograph of Infrared Transceiver Based Intruder Alert System

A. Software Development

In the software development section, the source code for PIC16F628A microcontroller is written with Assembly programming language. There are many Assembly languages and Microchip's PIC Assembly language is used in this research. Firstly, the source code "IR_alert.asm" file is written in the notepad. Then, it is compiled into machine code by using MPLAB IDE (v8.50) software. Next, the machine code "IR_alert.hex", file imported to the PICkit 2 v2.61 software. And then the machine code is downloaded from the USB port of the computer to the PIC16F628A microcontroller by using PICKIT2 programmer board. The photographs of the MPLAB IDE v8.50 software screen and PICkit 2 v2.61 software screen are shown in Figure 9 and Figure 10 respectively.

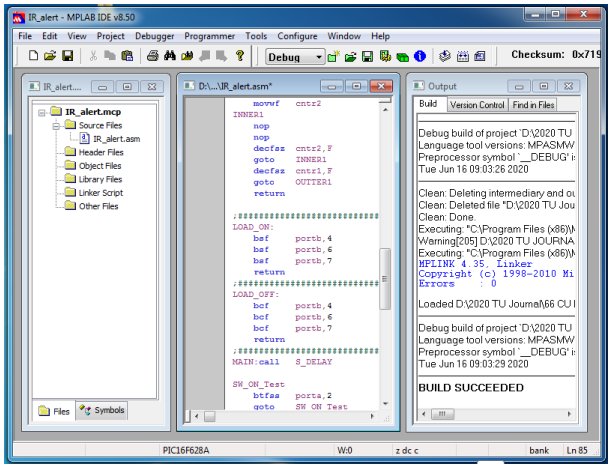


Figure 9. Photograph of the MPLAB IDE v8.50 Software Screen

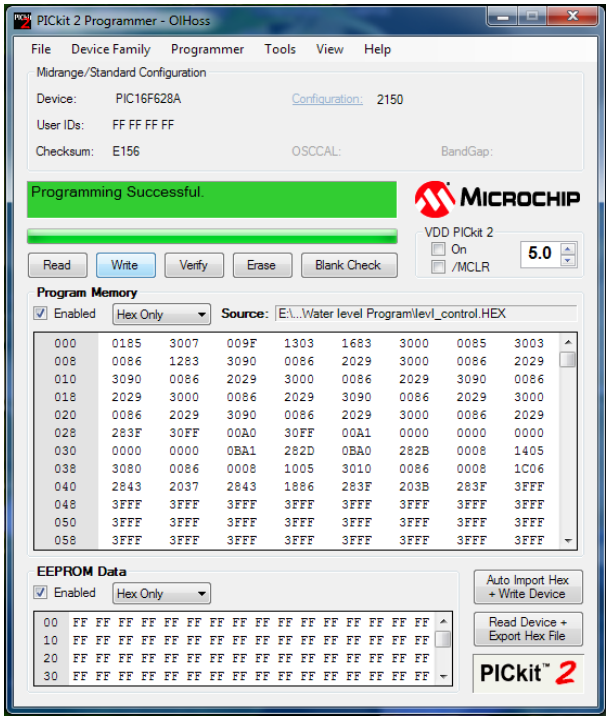


Figure 10. Photograph of the PICkit 2 v2.61 Software Screen

B. Discussion

The main goal of this research is to design and construct an infrared transceiver based intruder alert system. The developed system is designed to perform for beeping buzzer and ringing electric bell when the intruder is detected by the sensor. KC-38IR infrared transceiver module is used as intruder detection device and PIC16F628A microcontroller is used as the main processing component for the whole system. In the performance of the whole system, when the intruder is not occurred, the LED, buzzer and electric bell will not activate. When the intruder comes into the restricted area of the developed system, the LED will light, buzzer will beep continuously and the electric bell will also ring. If the loud alert sound from the electric bell is not required, the AC power plug of the electric bell can be removed from the AC outlet of the system. The developed infrared transceiver based intruder alert system can sense the intruder within the range of 7 ft well. The detection range can also be changed by tuning built-in preset. Microchip's PIC Assembly language is used to develop the control program for PIC16F628A microcontroller. The photograph of testing the constructed system is shown in Figure 11.

Figure 11. Photograph of Testing the Constructed System

IV. Conclusion

In this research, an infrared transceiver based intruder alert system has been designed, constructed and experimentally tested. The constructed system can be used as 24 hours security for homes, banks, schools, universities and industries. By using the constructed system, it can help to protect our homes while we are away, when we are sleeping, or during times when we are preoccupied with household responsibilities. Moreover, by studying the developed system, the university students can obtain the knowledge for how to interface infrared transceiver and microcontroller, and how to control AC 220 V with relay. Therefore, we hope that the developed system is useful for practical purpose and electronic laboratory. By modifying this research frame, student counter for class room and people counter for cinema can also be developed. To perform this, liquid crystal display (LCD) or seven-segment display can be added to the developed system. The multi-door security system can also be developed by adding more infrared transceivers, and the output of infrared transceivers can also be amplified by using transistors or operational amplifiers. The developed system can also be modified into wireless security system by cascading GSM module or WIFI module.

The developed system can only detect the intruder in-front of it. Therefore it is needed to rotate the infrared transceiver for precise information about the surroundings. It can be performed by mounting the infrared transceiver on a servo motor. Another feature can be added to the developed system by using digital camera, and the information of intruder can also be viewed by smart phone or computer. By modifying hardware and software of developed system, the system can able to track the activity of any intruder, and it can also view the essential places.

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Cryptography

Artificial Neural Network-based Cryptanalysis of Block Cipher

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***Abstract*:** The use of intelligent technique (backpropagation neural network) in solving cryptanalysis problem is considered in this paper. The modern versions of cryptosystems are still following the similar classical concept; however, the main purpose of cryptography is to secure the transmitting message from one place to another. As a result, it is still prudent to apply certain attacks on classical ciphers and it should be studied their evolution aspects before using them with more complex modern ciphers. This is quite justifiable considering the nature of intelligent techniques artificial neural network, thus, the decryption process of block cipher, Data Encryption Standard (DES) is simulated with backpropagation algorithm in this paper. A neural networks-based simulator is developed with known plaintext and ciphertext approach and then the given ciphertext is decrypted. Over 90% of fitting rate are compared with the plaintext in experimenting the proposed model.

***Keywords*:** ANN, Cryptography, Cryptanalysis, Machine Learning

I. Introduction

The security in transmitting the data can be achieved by using a tool called cipher. The original data called plaintext can be converted to encrypted data called ciphertext and also vice versa by using the cipher. The cipher utilizes the security key to determine the relationship between the plaintext and the ciphertext. The cryptographic techniques developed quickly due to the rapid development of computational resources. Despite the development of mathematical and technological complexity, the newly proposed cryptosystems still follow the similar concept of the classical ciphers. The block cipher such as Data Encryption Standard (DES) is a symmetric cipher and takes part as a crucial role in communication security [1]. The new kind of techniques which can expand the computational power requirement such as increasing the complexity of ciphering, expanding the key space are used in modern cryptosystems to handle the cryptanalysis. Thus, in cryptanalysis methods, intelligent technique called artificial neural network technique is applied to carry out some security problems in block cipher algorithms.

The cryptanalysis means trying to break the cryptosystems or ciphers by using unauthorized ways to access the information in that system. Thus, cryptanalysis works against cryptography. The cryptanalyst tries to find any weakness in the cryptographic system to get either the source of information such as the plaintext data or the security key used in the cipher. The cryptanalysis sometime involves in an attack. If this attack is successfully applied, then the cryptographic system is said to be broken. Cryptography and cryptanalysis together form the field of cryptology [2], [3]. On the other hand, there has the same rule in artificial neural network (ANN) as cryptography in information processing. The characteristics of nonlinear massive parallel-distributed processing, high-speed information processing and the uncertain information processing capability are included in neural network algorithm. More work is needed to shed the light on various aspects of cryptanalysis and cryptographic issues can be solved by using neural networks to get the new research idea for cryptography.

The data encryption standard algorithm is selected to be used as a case study for proposed ANN-based cryptanalysis approach. To create the mapping relation between the original data and encrypted data, a backpropagation neural network model is proposed. The binary string which is the resulted ciphertext of DES cipher is used as the input of the proposed model after performing some preprocessing. Then, the output of the proposed model (predicted plaintext) is compared with the original plaintext to analyze the differences. The proposed model achieves the fitting rate of over 90% by comparing with the original plaintext. The experimental error rate can be controlled to less than 10% in proposed ANN-based model.

The remain of this research is organized with 6 parts. Some related works for the proposed model are presented in Section 2. Section 3 summarizes the block cipher in generic way. The intelligent techniques of ANNs is discussed in Section 4. In section 5, the proposed model is discussed in detail. Then, Section 6 presents the results of the experiment and discusses them. Finally, the paper is concluded in section 7.

II. Related Works

Bafghi and et al. proposed a system to reduce the loss function of ANN. They solved the issues of finding the least-weight multibranch path between two known

nodes in the differential operation graph of block cipher [4].

The black box characteristics of neural network is combined with the system identification technology to create a cryptanalysis system by Alallayah and et al. in 2010. They simulate the neural model to guess the keys from a given ciphertext [5].

In 2012, a known plaintext attack is proposed based on neural network technique by Alani and et al. They attacked the classical DES as well as the multiple encryption, 3DES cryptosystem [6].

Most of the aforementioned method did not try to reveal the plaintext sequence directly and that systems are very costly.

III. Block Ciphers

Block cipher is an encryption method that processes the input stream as groups of bytes that are fixed in size, typically 64, 128 or 256 bits long. The state of a block cipher is reset before processing each block. The number of bits in a block is called the block length. Thus, each block cipher divides the input message "M" (plaintext) into a sub group $(m_1, m_2, \dots, m_n)$, $(m_{n+1}, m_{n+2}, \dots, m_{2n})$, . . . and encodes them according to a certain set of encoding algorithms under the control of the security key S = $(s_1, s_2, \dots, s_x)$. Finally, it produces a group of encrypted message "E" (ciphertext) $(e_1, e_2, \dots, e_n)$, …, $(e_{n+1}, e_{n+2}, \dots, e_{2n})$. The Figure 1 shows the typical model of a block cipher. If the block cipher is used with the same security key, the input message group with length i will be transformed equally, thus the only transformation rules for a group will need to be studied [7]. Generally, there are five ingredients including plaintext message "M", encrypted message "E", security key "S", encryption transformation "X", and decryption transformation "Y" consists in a cipher and the cipher can be specified as follow [8]:

Let M= $\{m_1, m_2, \dots, m_n\}$ is a set of original messages (plaintext),

$E = \{e_1, e_2, \dots, e_n\}$ is a set of encrypted message (ciphertext),

$S = \{s_1, s_2, \dots, s_n\}$ is a set of secret keys,

$X = \{x_1, x_2, \dots, x_n\}$ is a set of encrypt rules and

$Y = \{y_1, y_2, \dots, y_n\}$ is a set of decrypt rules.

Then, $\forall s \in S, \exists x_s \in X, y_s \in Y : y_s(x_s(m)) = m,$

$(\forall m \in M), x_s: M \to E, y_s: E \to M.$

The data encryption standard (DES) algorithm input 64-bits plaintext m and performs the encrypting process 16 rounds. The DES algorithm uses 56-bits key. Then, the DES algorithm output 64-bit ciphertext. In this paper, DES is selected as a cased study because of its ease of changing the security key, faster network level speed, faster encryption rate and reduced impact of other factors. The DES algorithm can be summarized as follow:

- Accept 64-bits message
- Perform initial replacement (IP)
- Separate the input into two 32 bits parts (L_0, R_0)
- Add the key
- Perform the operation $f, f: \{0,1\}^{32} \times \{0,1\}^{48} \to \{0,1\}^{32}$ (16 rounds)
- Exchange $L_0 and\ R_0$
- Perform inverse replacement (IR)
- Output 64-bits encrypted the message

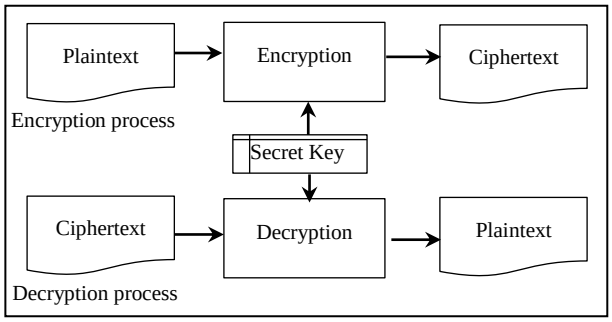

Figure 1. Typical Block Cipher

IV. Artificial Neural Network

Artificial Neural Networks are numerical models that use a gathering of basic computational units called neurons that connect with each other to build a network. There are many types of ANNs; each type is suitable for one or more problems depending on the problems itself. Hence, the important thing in ANNs is how to design the topology of ANN that can better describe the problem then solving it by using very simple principles to obtain very complex behavior [9], [10]. ANNs can model human brains and use nervous system to solve the problems by learning it with a true example and giving a chance to generalize all solutions. Because the nature of ANNs that simulate the brain and use parallel processing rather than serial computation we can put ANNs in multiple fields according to the huge capabilities that ANNs can introduce [11].

Back-propagation neural network is a multilayer forward network that is based on the error rate for propagation. The backpropagation neural network is the most famous algorithm among the artificial neural network until now. The BP neural network applies the error rate to estimate the error rate of the adjacent predecessor layer of the output layer. Then, the BP neural network use that error rate to estimate the error rate of the previous layer. In this way, the error rate of all other layer are estimated [12]. The main ingredients of the backpropagation neural network topology are

input layer, hidden layer and output layer as shown in Figure 2.

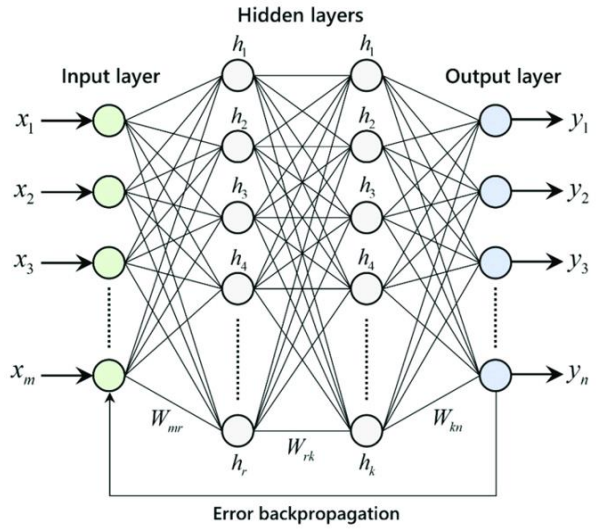

Figure 2. Artificial Neural Network Model

The main usage of backpropagation neural network is the classification purpose because of its fault tolerant, high self-learning and self-adaptive abilities. Hence, the backpropagation neural network computes the output from the continuous learning, it can reflect the dynamic configuration including the network weights and thresholds. Thus, it can be used to simulate the relationship mapping of input and output. The error rate of the backpropagation neural network becomes stable after performing the several trainings. After that, the local optimum can be achieved from the final collection of certain network parameters. There will be a tiny effect on the global training results even when the local nerve unit of backpropagation neural network is damaged [13]. For this reason, backpropagation neural network-based classifier is modified to realize the regression model of backpropagation neural algorithm in proposing our model.

V. Cryptanalysis Based on ANN

To perform the cryptanalysis based on the artificial neural network, an ANN model is firstly proposed. In the forward propagation process of the proposed model, $a_0 = x$ is used for input layer, $z = \sigma(w_1 x + b_1)$ is used for layer 1 and $y = \sigma(w_2 z + b_2)$ is used for layer 2. For back propagation process, the loss function is defined as $= \frac{1}{2}[f(x) - y]^2$. The error function for layer 2 is defined as $Error = \delta_2 = \frac{\partial L}{\partial b_2} = \frac{\partial K}{\partial k_2}\frac{\partial k_2}{\partial b_2}$ and $\frac{\partial L}{\partial \omega_2} = \frac{\partial L}{\partial k_2}\frac{\partial k_2}{\partial \omega_2}$. The error function for layer 1 is defined as $Error = \delta_1 = \frac{\partial K}{\partial k_1} = \frac{\partial L}{\partial k_2}\frac{\partial k_2}{\partial z}\frac{\partial z}{\partial k_1} = (y - f(x)\omega_2 \odot \sigma'(z) \odot \sigma'(k_1))$ s.t $k_1 = \omega_1 x + b_1$ and $\odot$ is the multiplication of the corresponding position of the matrix and then $\frac{\partial L}{\partial \omega_1} = \frac{\partial L}{\partial k_1}\frac{\partial k_1}{\partial \omega_1} = \delta_1 x$.

Then, the various text document is created with different plaintext and the same keys by using the block cipher, DES-ECB (data encryption standard with electronic codebook mode). Thus, each plaintext file contains 3.2 million-bit binary number. The 1000 files of plaintext cipher text pairs are created with California Institute of Technology Caltech-256 dataset [14]. According to the limitation of computing power, the ciphertext are compressed by doing the same processing. Then, an eight bits binary number are extracted from the begin to end in turn to convert to a decimal number. Thus, each ciphertext becomes a 100000 × 1 matrix. The similar processing is also performed on plaintext and each plaintext also becomes a 100000 × 1 matrix. Finally, all of the preprocessed data are input into proposed ANN model and the output is obtained. The resulted output is compared with the plaintext. Each decimal digit of the resulted output is converted to binary format. The high digits are filled with 0 (if necessary) and all bits are connected to restore the plaintext.

The mean squared error of the result is defined and the original plaintext is used as the evaluation criteria for the experiment. The output matrix of the proposed neural network model is $A' = (a'_{ij})$, the processed plaintext text matrix is $A = (a_{ij})$, and the evaluation criterion is

$$error = \sum \frac{(a_{ij} - a'_{ij})^2}{n}$$

The experimental process can be summarized as follow:

1. the known plaintext is encrypted with DES-ECB to obtain the corresponding ciphertext
2. the known ciphertext is processed and converted into a format that can be fed into the neural network
3. the neural network model is changed from the classification model to the regression model
4. the internal parameters of the proposed neutral network model are constantly adjusted until the best training effect is achieved
5. the improved model is used to compute the plaintext when the error rate is stable at an acceptable level

VI. Result and Discussion

The parameters of the proposed model are constantly adjusted, after repeating the training process. Over 1000 of trainings are performed by using the sigmoid activation function. The error rate of the proposed model becomes stable around 10%. The Figure 3 represents the error curve of decent process in the proposed model. From figure 3, it can be concluded

that the convergence of the proposed model is stable. From the numerical experimental result, the model is seen to be effective.

In the encrypt/decrypt processes of the cipher, the correlation between data is very huge and it can inevitably lead to unpredictable and unreliable networks. Thus, the experiment is conducted by encrypting the input with DES block of constant keys, however, special attention is keeping while determining the number of training to control neural networks. The over-trained network may cause the over-fitting that, it may affect the prediction accuracy of the plaintext outside the training set and cause the excessive error rate.

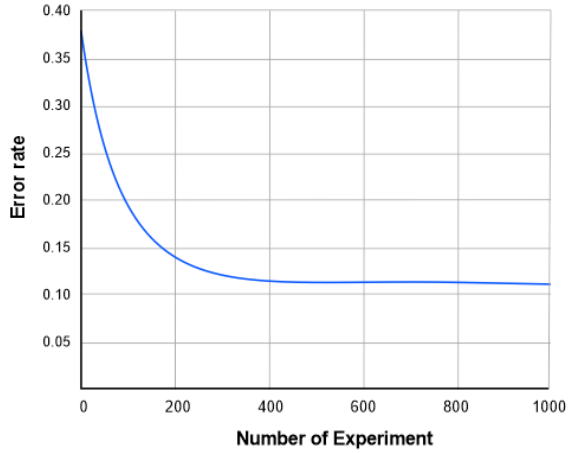

Figure 3. Error Curve of Descent Process in Proposed Model

In the proposed model, however, the weight is optimized using the steepest decent method; the difference in the output of the neural network is the best for estimating the several different weight initial values. Since, the selection of the learning rate effectively determines the size of the step in modifying each weight in multidimensional weight space. When a very large learning rate is used, the local minimum will continuously overrun and it may cause the oscillation and gradually converge to a low error rate. When a very low learning rate is used, too much iteration may be required and it may affect the performance of the neural network.

VII. Conclusion

In this paper, artificial neural network, is used to proposed a cryptanalysis model. In the proposed model, the mean-square error for analyzing the output is also defined. The sufficient number of samples have to be implied, the weight and biases of the neurons in each layer has to be adjusted to improve the model. The classical cipher DES is selected for case study in this paper, however, DES algorithms itself is not used in commercial applications because majority of modern cipher are still using the basic principle of DES. As the future work, the new approaches for selecting weight of neural network as well as the training adaption for the neural network can be developed to enhance the neural network. Moreover, the stronger encryption algorithm will be analyzed in future.

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Image Encryption and Decryption with Key Generation Using DES Algorithm

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***Abstract*:** Data communication is an important aspect of our living. Computer security is needed to protect data and to thwart the hackers. Security require the integration of people process and technology. Strong information encryption and decryption scheme are crucially important for information technology. Nowadays secret sharing is one popular method for distribution a secret amongst a group of participants, each of which is allocated a share of the secret key. In this paper, to make encryption process, symmetric key cryptography that uses the same key for encryption of plain image also generates cipher image. Decryption of the cipher image to get the original plain image is done by decryption. This method is used to secure data for transmission over open networks such as the internet. When applying DES algorithm for the images it first converts the image into bytes which are then converted into bits. The 64 bits bytes code is then iterated using initial permutation, final permutation and the fiestel cipher. The end result will be a set of 64 bits cipher byte. The triple DES algorithm is based on the DES algorithm itself its uses same method as that of the DES algorithm but the difference is that it uses three keys rather than just one. For the encryption process it initially encrypts the data using just one key and then decrypts the data using another different key and then finally encrypt the data again using another key. For the decryption process it is the reverse of the encryption process. Using DES and key generation implemented shows that security service and attacks, unauthorized person between sender and receiver sites don't allow in the communication channel in this system. These are suitable to build a secure system in the military environment, video communication and so on.

***Keywords*:** DES, Decryption, Encryption, Symmetric key, Security.

I. Introduction

Todays connected society requires secure information system to preserve data privacy and authentication in critical applications. Information security is a major issue today for any company or individual who conducts business electronically [1]. Computer application need to protect their data from an authorized access. The most important security tool is cryptography that it provides stronger methods of authentication. Cryptography is based on symmetric key or asymmetric keys. The most popular symmetric cryptographic algorithms Data Encryption Standard is used in this system [2].

This system intendeds to implements secure system for critical applications. The Data Encryption Standard algorithm has emerged to be the most commonly used in varying application because it is still reasonably secure. Describe the design, implementation and testing of a security system that enhances the capability of small business to protect information within the boundary of their networks by using DES algorithm.

Within the specific network, transactions are encrypted, decrypted and processed by the internal control and Employee agents. In the system, at the encryption site, DES takes a 64-bits plainimage and ceate a 64-bits cipherimage. At the decryption site, DES takes a 64-bits cipherimage and create a 64-bits block of plainimage[3]. The same 56-bit cipher key is used for both encryption and decryption.

II. Related Works

The general idea behind symmetric-key ciphers will be introduced here using examples form cryptography. The need to protect database, would be an every growing one especially so in this age of e-commerce. Many conventional database security systems are bugged with holes that can be used by attackers to penetrate the database. Data communication is an important aspect of living and protection from data misuse is important. Cryptographic techniques are extremely critical to the development and use of defense information systems and communication networks. This system concerned with the system that includes triple DES, AES, RSA, RC5, RC6 [4] and so on which is uses image and text with encryption and decryption. In addition the statistical characteristics of the encrypted digital image can be uniformed by diffusion technique of Cat Chaotic Map [5].

III. Security Services of Cryptography

Authentication – this service provides the authentication of the party at the other end of the line. In connect-oriented communication, it provides authentication of the sender or receiver during the connection establishment. In connectionless communication, it authenticates the sources of the data.

Data Confidentiality – it is designed to protect data from disclosure attack. It is designed to prevent snooping and traffic analysis attack.

Integrity – integrity of information refer to protecting information from being modified by authorized parties.

Non repudiation – a security service that protects against repudiation attack by either the sender or the receiver of the data.

Access Control – it provide protection against authorized access to data.

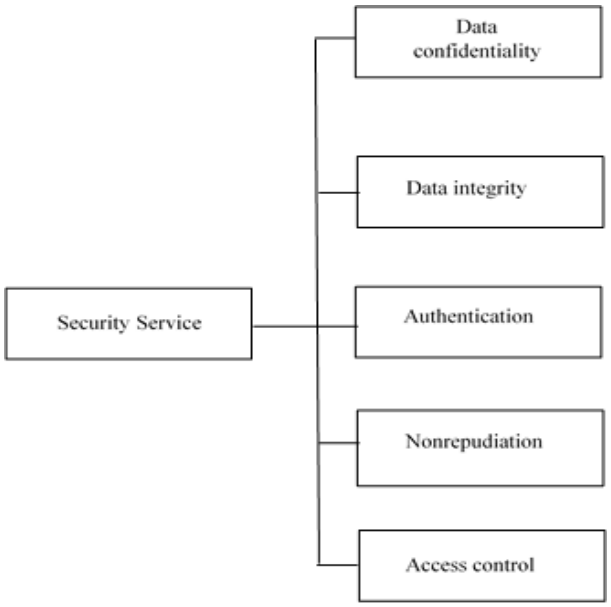

Figure 1. Security Services

A. Symmetric Key Cryptography

In symmetric key encipherments sometimes called secret key encipherment or secret key cryptography [6]. Cryptanalysis is used to secure data for transmission over open networks such as the internet. The symmetric key is encouraging the use of large key sizes and complex algorithm to achieve an unbreakable state. Symmetric key cryptography also called secret key cryptography is a method that uses the same key for encryption of plaintext to generate the cipher text and decryption of the cipher text to get the original plaintext. It is done for the following Figure 2.

Figure 2. Symmetric Key Encryption

IV. DES Algorithm

DES stand for data encryption standard is a symmetric key block cipher. It is used 64-bit plaintext and is used 56 bit key that is illustrated in the following Figure 3.The encryption process is made of two permutations (p-boxes), which it call initial and final permutations, and 16 feistel rounds. Each round of DES is a feistel ciher with two elements. Each of these elements is invertible. The following steps by steps encryption process in the following Figure 4.

- The 64-bit plaintext was fed initial permutatuion it is 64 bits output and then it was checked in the IP, see Table 1.
- For round 1 , the 64-bit palintext was divided into two 32-bits ,left and right.
- Right 32 bits plaintext was fed into the Expansion P-box table when that its output is 48 bits, it was XOR-ed the first sub keys K1, its output is 48 bits, used Table 3.
- $S\_boxes = E(R(x)) \oplus K$
- The S-boxes do the real mixing it has 8 S-box and then each its own table, eight tables, in the step was used table 4. The value of the inputs and the values of the outputs are given as decimal numbers to save space. These need to be changed to binary.
- The round 1 of the output is 48-bit that it was fed 8 S-boxes that each S-box was divided into 6-bit input and output is 4-bit, The output result is 32 bits.
- The last operation in the DES function is a straight permutation with a 32 bit input and a 32 bit output. The input/output for this operation is shown in Table 4.
- For round in DES, using mixer and swapper create the cipher and reverse cipher, each having 16 rounds. The cipher is used at the encryption site. The reverse cipher is used at the decryption site.
- At the encryption site, round 1 used K1 and round 16 used K16. At the decryption site round 1 uses K16 and round 16 uses K1.

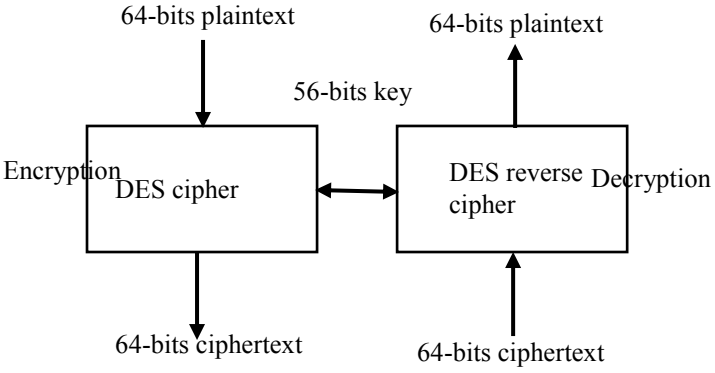

Figure 3. Overview of DES

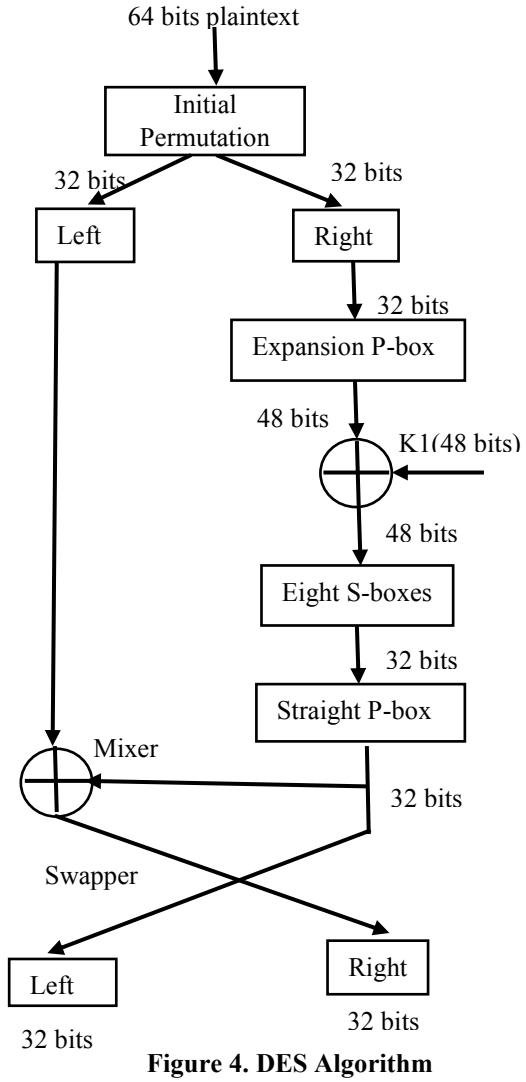

Figure 4. DES Algorithm

Table 1. Initial Permutation

40	08	48	16	56	24	64	32
39	07	47	15	55	23	63	31
38	06	46	14	54	22	62	30
37	05	45	13	53	21	61	29
36	04	44	12	52	20	60	28
35	03	43	11	51	19	59	27
34	02	42	10	50	18	58	26
33	01	41	09	49	17	57	25

Table 2. Final Permutation

32	01	02	03	04	05
04	05	06	07	08	09
08	09	10	11	12	13
12	13	14	15	16	17
16	17	18	19	20	21
20	21	22	23	24	25
24	25	26	27	28	29
28	29	30	31	32	01

Table 3. Expansion P-box Table

16	07	20	21	29	12	28	17
01	15	23	26	05	18	31	10
02	08	24	14	32	27	03	09
19	13	30	06	22	11	04	25

Table 4. Straight Permutation Table

58	50	42	34	26	18	10	02
60	52	44	36	28	20	12	04
62	54	46	38	30	22	14	06
64	56	48	40	32	24	16	08
57	49	41	33	25	17	09	01
59	51	43	35	27	19	11	03
61	53	45	37	29	21	13	05
63	55	47	39	31	23	15	07

A. Key Generation Algorithm

The key generation process, the first round k1, key with parity bits is fed into the parity, it output is generated cipher key that it is 56 bits and then it is divided into two parts, see shift left is 28 bits in which it is used inputs into the compression P_box, output is round key1 48bits and then repeat action its round (K2, K3,…..,K16) , as shown in Figure 5.

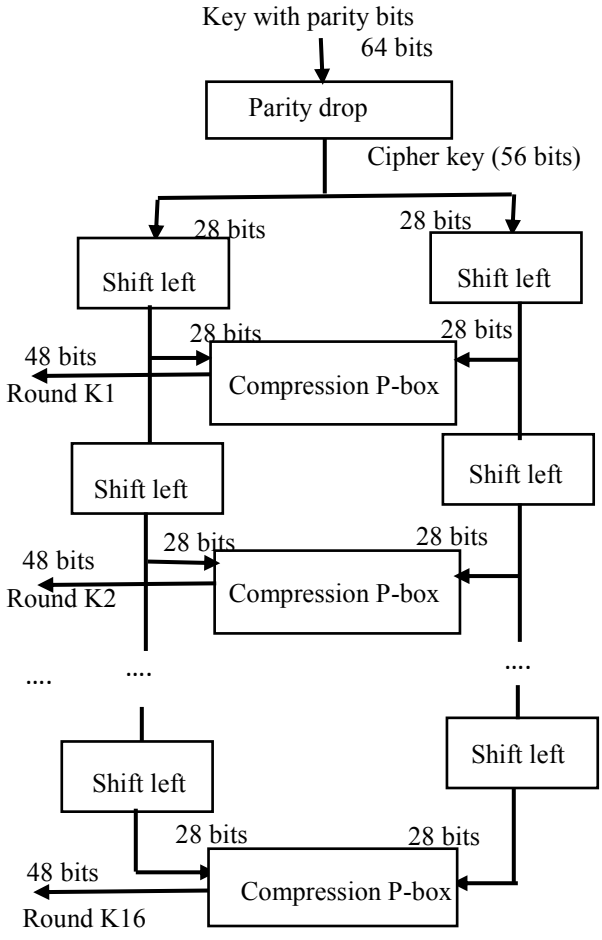

Figure 5. Key Generation

```
Key_Generator(keyWithParties[64],roundKeys[16,48],
Shifttable[16])
{
  permute(64,56,keyWithParties,cipherKey,
  ParityDro   pTable)
Split(56,28,cipherKey,leftKey,rightKey)
{
shiotLeft(leftKey,ShiftTable[round])
shitLeft(rightKey,ShiftTable[round])
combine(28,56,leftKey,rightKey,perRoundKey)
       permute(56,48,perRoundKey,RoundKey[round],
       KeyCompressionTable)
}
}
shiftLeft(block[28],numOfShifts)
    {
       for (i=1 to numOfShifts )
   {
      Temp ← block[1]
      for(j=2 to 28)
          {
               block[j − 1] ← block[j]
}
                  block[28] ← Temp
    }
}
```

B. Triple DES Working

Triple DES uses total three DES Keys say K1, K2 and K3, each of 56 bits. This does not include parity bits. The encryption algorithm is:

CipherText = $E_{K3}(D_{K2}(E_{K1}(\text{plaintext})))$
Where, DES encrypt with K_1, DES decrypt with K_2, then DES encrypt with K_3.
Decryption is the reverse:
PlainText = $D_{K1}(E_{K2}(D_{K3}(\text{ciphertext})))$
Where, DES decrypt with K_1, DES encrypt with K_2, then DES decrypt with K_3.

C. Statistical Analysis

Statistical analysis has been performed on the proposed image encryption algorithm to demonstrate its superior confusion and diffusion properties which strongly resist statically attacks. This is shown by a test of histograms on the original image and on the correlations of adjacent pixels in the encrypted image.
1. Histogram of the encrypted images: Select a several 256 grey-scale of size 256x256 that have different contents and calculate their histograms. From that Figure 6 one can notice that the histogram of the ciphered image is fairly uniform and is significantly from that of the originalimage.
2. Correlation of two adjacent pixels: To test the correlation between two vertically adjacent pixels two horizontally adjacent pixels, and two diagonally adjacent pixels, respectively, in a ciphered image, the following procedure was carried out. First, randomly select 1000 pairs of two adjacent pixels from an image. Calculate the correlation coefficient of each pair by using the following two formulas.

$$\mathrm{Cov}(x,y) = \frac{1}{N}\sum_{i=1}^{N}(x_i - E(x))(y_i - D(x)) \quad (1)$$

Where x, y are grey scale values of two adjacent pixels in the image. In numerical computation, the following formulas were used. Figure 7 and 8 shows the correlation distribution of two horizontally adjacent pixels in plain image and that in cipher image. The correlation coefficients are 0.9865 and 0.0276 respectively, which are far apart. Similar results for diagonal and vertical directions were obtained, which are found in Table 5.

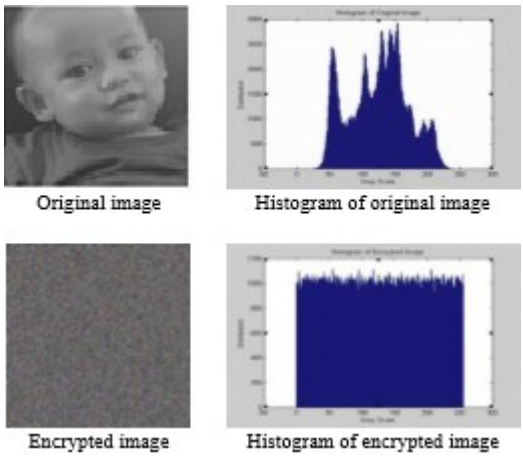

Figure 6. Histograms of Image Encryption

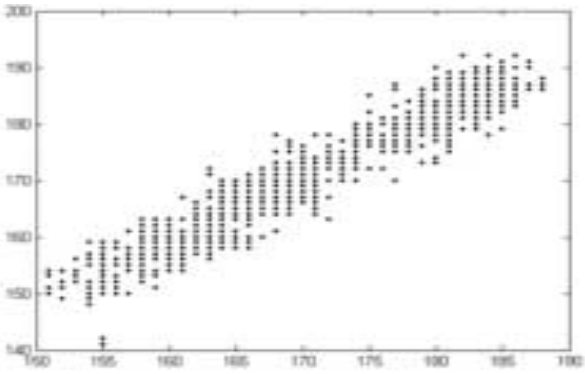

Figure 7. Correlation of Two Horizontally Adjacent Pixels in the Original Image

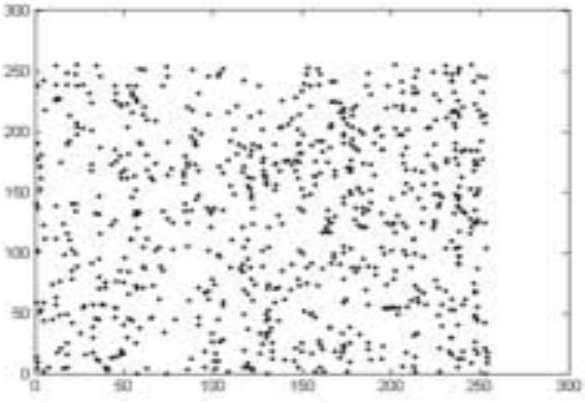

Figure 8. Correlation of Two Horizontally Adjacent Pixels in Encrypted Image

Table 5. Correlation Coefficients of Two Adjacent Pixels in Two Images

	Original Image	Encrypted Image
Horizontal	0.9865	0.0276
Vertical	0.9988	0.0410
Diagonal	0.8430	0.0602

V. Experimental Results

In the digital world, security is very important that authorized person is checked between communication entities.in this system, image encryption and decryption DES algorithm that it is symmetric key block cipher which it is used same key both communication sites and then it give strongly security for digital image. The proposed system has been designed for sending or receiving information from a destination using cryptographic network. There are two main parts in this system: encryption and decryption process. Encryption has to be done on sender's site and decryption on receiver's site.

As for the sender site, the image had to be passed to the final heart of the process of our proposed system , image encryption process in Figure 9 and 10 in which this offer the cipher image which is totally concealed from the plain image. Then the encrypted image can transmit into the communication network channel with high confidentiality.no one can translate this encrypted image to original image without knowing the encrypted key.

At the receiver site, the authorized person retrieve the transmitted image by first applying decryption process as illustrated in Figure 11. Retransformation has to be done to accept the decrypted image in Figure 12 and then this is intended to the recipient by the remote sender. Using DES algorithm purpose security service and attack is used in the system.

Triple DES provides a better quality encryption process. DES provides better performance encryption and decryption process. For encryption process, triple DES will be increased time than DES but security wise Triple DES outperformed the DES process by generating a better and more secured encrypted file. The results also proved that triple DES algorithm was very difficult to crack because the use 64 bits three different keys in which it is given more security than DES.

A. Image Encryption

In the encryption process consists of DES algorithm and Secret key, firstly the system input is original image is fed algorithm and then it using encrypted image with the round key that it generated in the key generation, cipher image is output of the system Finally, plain image is encrypted image with security in communication that process as shown in the following Figure 10.

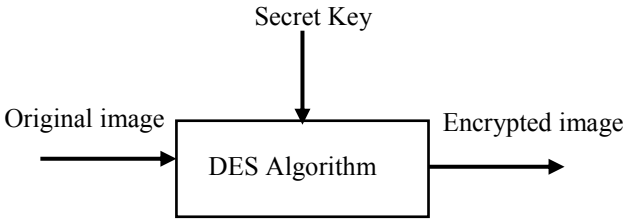

Figure 9. DES Image Encryption Process

Figure 10. Image Encryption

B. Image Decryption

In the decryption process, original image is achieved using reverse process and then same key is used to decrypt, to achieve the original image and then it is achieved decrypted image which process as shown in the following Figure 12.

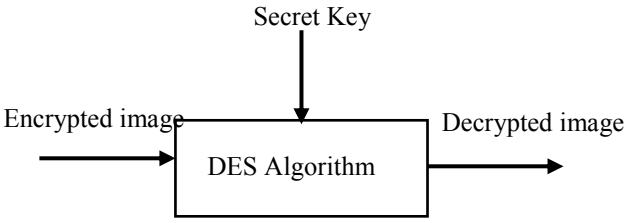

Figure 11. DES Image Decryption Process

Figure 12. Image Decryption

Table 6. Comparison of Encryption and Decryption Time

Type of Algorithm	Image size	Encryption time	Decryption time
DES	100*110 jpg	00:2:10	00:1:50
Triple DES	100*110 jpg	00:3:00	00:2:10

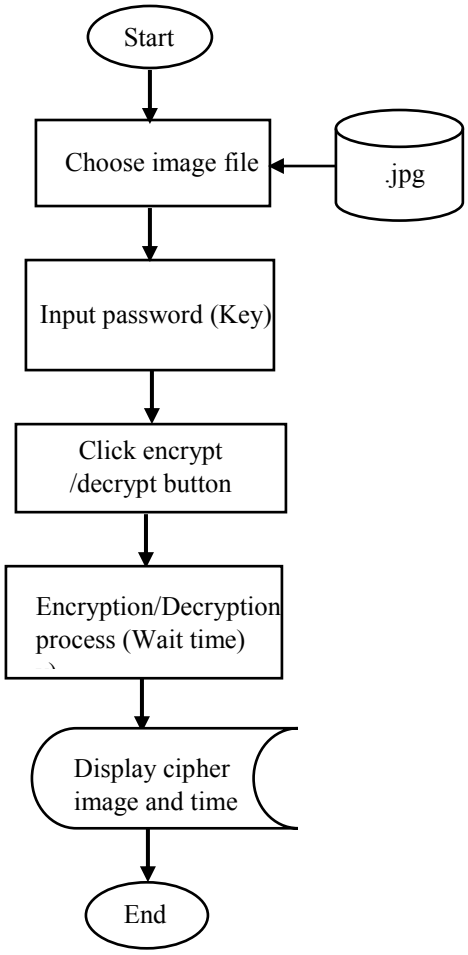

Figure 13. System Flowchart

VI. Conclusions

In this paper, the security mechanisms of DES was successfully designed for research work. By applying MATLAB program, one can send or retrieve important information to remote location of the concealing it during transmission. For security system, check authenticate achieved correct recipient, the system verifies the password before accessing the transmitted image. Image encryption and decryption prevented authorized person between two sites in the communication channel because DES algorithm has using big key sizes control the attacks. In this system, DES algorithm is done the unauthorized person don't take security for image, and then it the system is used for security in the military.

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Developing Digital Signature for Short Message Using RSA Public Key Cryptosystem

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Abstract: This paper presents implementing the system for digital signature providing origin authentication. The system can prove the source of the data origin or the identity of the sender. Growing Networks as well as increasing internet applications and rising demands for using these applications define needs for higher security for the internet environment. Digital Signature fulfills most of the security demand aspects for most applications. In this project, digital signature is implemented using RSA (Rivest, Shamir, Adleman) public (asymmetric) key algorithm which uses two types keys one private and one public. The message is encrypted by the sender's private key and the receiver only decrypted the encrypted message using the sender's public key associated with the private key verifying that the sender is the owner of the message sent. The algorithm is implemented by C Language.

Keywords: Security, Digital Signature, Public Key, Private Key, RSA algorithm, Authentication.

I. Introduction

After being Internet Evolution, threat Evolution appears and therefore both Network Security and Information Security become the most important issues nowadays. Since digitization has been changing the world incredibly for many decades, digitized security types are included to be considered. CIA triangle defined for three security goals, Confidentiality, Integrity and Availability, are inclusively considered for both Network and Information Security although Network Security issue is quite different from Information Security issue. There are many security services to provide these security goals and various mechanisms and techniques are developed to build these services [1]. Digital signature is one of these mechanisms used to meet security requirement involving in our environment. For example, using digital signature can provide data integrity or source authentication services for financial transactions such as banking applications. It can also be used for applications such as software distribution, contract management software and all other cases important for forgery cases. This paper represents developing the system that can be used to provide digital signature service for short message (character length of 25). When the system is developed, C language will be used.

II. Digital Signature

As the data are sent through the untrusted network, it cannot be expected that they are unaltered in transit or they actually come from the trusted entity. In real world, to prove the document comes from the expected entity, conventional signature is used as part of this document and it is included on that document. Like conventional signature, Digital signature can prove the owner of data generated called origin authentication. Unlike conventional, it is a method of authentication for electronic information by using some encryption technique instead of manual signature on the document [4]. Another important concept is conventional signature mostly use a single signature for all documents to be unique whereas digital signature must generate different signatures for different messages to be sent to prevent from the intruder getting the signature and replaying this same signature any more.

Digital Signature can be built using several public key encryption schemes, example, RSA, EIGamal, Schnorr, DSS and ECDSA [1]. In this paper, RSA algorithm is only presented and the rest are abandoned for future work. Since all public key cryptosystems are very slow and therefore digital signatures obtaining direct encryption from arbitrary messages causes the system to be inefficient. In reality, digital signature is usually created by encryption hashing function which is generated from the original input message. In this system, according to performance requirements, only short message is input to get digital signature without using actual hash function (instead XOR operation with left-shift is used). Detail operation will be presented in implementation session.

For origin authentication, privacy or data confidentiality is not taken into account, therefore, the message to be sent is plain-text and the intruder can access it and read it obviously. The only thing that has to be done is to prove the message is actually sent by the sender expected. To do this, conceptual building block includes two portions, signing process (at the sender side) and verifying process (at the receiver side) as shown in Figure 1.

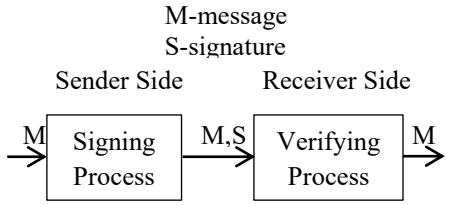

Figure 1. Block diagram of Digital Signature Process

The private key of the sender must be used to encrypt the message and this encrypted message as digital signature of the sender and the original plain-text message are sent to the other side. Then, the receiver can decrypt this encrypted message or digital signature with only sender's public key to get the original message. It is obvious that changing very small data in plain-text will mismatch for verifying process and that violates integrity of the message. In addition, an assurance can also be provided by handing this Digital Signature as a proof with the help of third-party. Indeed, not only providing origin authentication, digital signature can also provide other security services, data integrity and non-repudiation [1].

III. RSA Asymmetric Key Algorithm

RSA algorithm is an asymmetric key encryption algorithm. As it is asymmetric, it does not use the same shared key, it uses both public and private key of the sender or receiver to encrypt/decrypt the message. RSA algorithm has two important roles whether whose (sender or receiver) key-pair (e, d) is used for encryption/ decryption process. The receiver's key-pair is used for getting data privacy or confidentiality. On the other hand, the sender's key-pair is used if it needs the digital signature or data integrity. RSA algorithm takes two public keys and one private key for overall (Signing/Verifying) process. Key generation process is presented in subsequent session.

A. Public and Private Key Generation

For RSA algorithm two public keys and one private key can be generated from two large prime numbers 'p and q'. The security of algorithm is independent of algorithm itself. It depends on how much difficult for factoring the composite of these two large prime numbers, recommended size is at least 512 bits to 2048 bits, and therefore, it is very important to maintain these two prime numbers as secrecy. In this system, the values of prime numbers are specified in the range of $20<p\&q<200$ because compulsory mathematical operation (modulo exponential with large exponents in this case) cannot be handle by the usual C programming language. The set of all primes between 20 and 200 are shown in Figure 2. Beyond this numbers, special purpose GNU Multiple Precision (GMP) Arithmetic Library will be necessary. This part is extended for future work. Block diagram of key generation process is shown in Figure 3 and algorithm used [1] is described in Algorithm A.1.

```
Prime numbers between 20 and 200 are:
 23  29  31  37  41  43  47  53  59  61  67  71  73
 79  83  89  97 101 103 107 109 113 127 131 137 139
149 151 157 163 167 173 179 181 191 193 197 199
```

Figure 2. Prime Set between 20 and 200

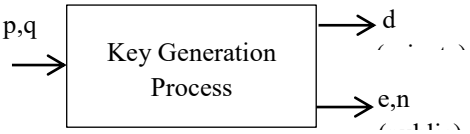

Figure 3. Block Diagram of Key Generation

1) Algorithm A.1

RSA_Key_Generation {
Select two primes p and q such that p! = q
n = p*q
$\phi(n) = (p-1) *(q-1)$
select e
// ($1< e < \phi(n)$ && e is coprime to $\phi(n)$)
find d
// ($d*e \equiv 1 \bmod \phi(n)$)
public keys <= (e, n)
private key <= d
return public and private keys
}

B. Signing Process

Signing the message is performed in the sender side. In signing process, digital signature is produced by encrypting the input message with the use of private key. Block diagram of signing process is shown in Figure 4. The plain-text message is signed by encryption with sender's private key to get digital signature and both message M and Signature S are then sent to the other side.

The major operation used in signing process is modular exponentiation. But the weak point here is that most of the languages implementing cryptographic algorithm has no adequate operator that can efficiently manipulate modular exponentiation. In such case, Fast Exponentiation or square-and-multiply method presented in the latter session can likely be used to get efficient manipulation for required mathematical operation. The algorithm used in signing process is presented in Algorithm B.1 [1].

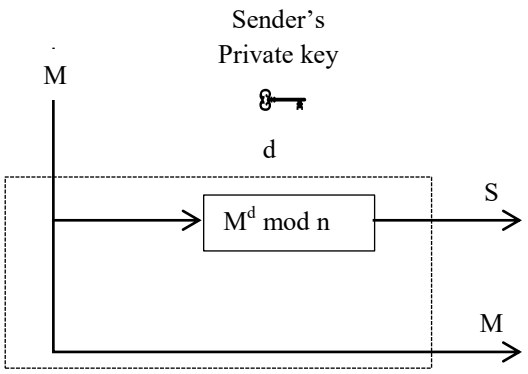

Figure 4. Block Diagram of Signing Process

1) Algorithm B.1

```
RSA_Dig_Sign_Encryption (M, d, n) {
    S <= Fast_Exponentiation (M, d, n)
    return S
}
```

C. Verifying Process

Verifying the digital signature is occurred in the receiving side. The receiver received the plain text message M and its associate digital signature S. In verifying process, the sender's public key is used to decrypt the signature and get the message M'. This decrypted message M' is compared the original plain-text message M which is sent by the sender. Any mismatch between the two messages indicates that the message would be interrupted in transit or source violation might be occur. The block diagram for verifying process is shown in Figure 5.

As signing process, verifying also use modular exponentiation using sender's public key instead of private key. The algorithm used for verifying is presented in Algorithm C.1.

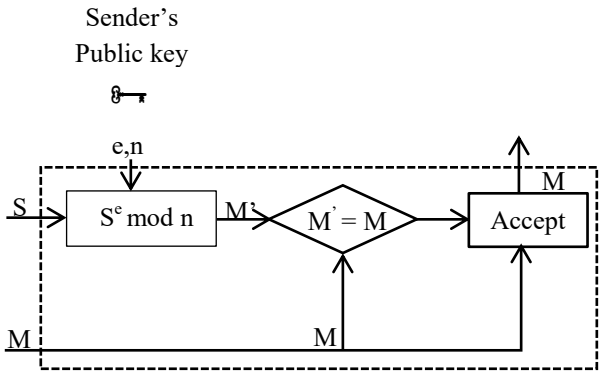

Figure 5. Block Diagram of Verifying Process

1) Algorithm C.1

```
RSA_Dig_Sign_Decryption (S, e, n) {
    M' = Fast_Exponentiation (S, e, n)
    return M'
}
```

D. Fast Exponentiation

Fast exponentiation is efficient method for calculating large exponent. For example, to find out $y = a^x \bmod n$ where x is a very large number. Fast exponentiation treats the exponent x as a binary number as shown in equation (1) and apply square-and-multiply method. The algorithm used is in Algorithm D.1.[1]

$$x = x_{n_b-1} * 2^{k-1} + \cdots + x_1 * 2^1 + x_0 * 2^0 \quad (1)$$
$$y = a \wedge (x_{n_b-1} * 2^{k-1} + \cdots + x_1 * 2^1 + x_0 * 2^0)$$

By applying square-and-multiply method

$$y=(a^{2^{n_b-1}} or 1) * (a^{2^{n_b-2}} or 1) * \ldots * (a^2 or 1) * (a\ or 1)$$

1) Algorithm D.1

```
Square_and_Multiply (a,x,n) {
    y <= 1
    for i=0 to n_b -1
    {
        if (x_i =1) y<= a*y mod n
        a<= a^2 mod n //except last iteration
    }
    return y
}
```

IV. Implementing Digital Signature System

In this section, implementation of the whole system using C language is presented by dividing four parts (1) key generation, (2) message input (3) signing and (4) verifying.

A. Key Generation

As the system is using public key cryptosystem, both private-public key pair, one is multiplicative inverse of other, must be generated. As described in Algorithm A.1, the two prime numbers p and q are initially input as secret. Then, public key e will be randomly selected from the possible public key-set and its private pair d is generated. The system can generate all possible public keys depend on the input prime numbers.

In this sample case, the system gets 179 and 197 as two input primes and generates 14784 possible public keys. It then randomly selects 11969 as public key and its private pair 31077 is created. Sample results can be seen in Figure 6 and Figure 7.

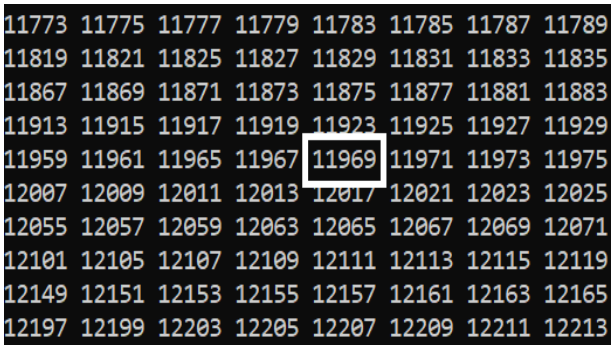

Figure 6. Public Key Set

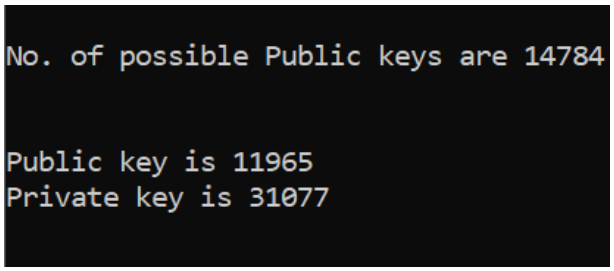

Figure 7. Key-pair

B. Message Input

The next part is implementing getting input message. The system is restricted to get the message length of only twenty-five consecutive characters (including both Lower/Upper Cases) without using spacing. If the input message length is shorter than pre-defined length, the padding will be added to fulfill the length. If the input message is longer than defined length, the system will only take twenty-five characters. Before receiving the input message, a character table shown in Figure 8. is primally created. In character table, the Upper-Case and Lower-Case characters are assigned with the integer value because the RSA algorithm used in this system manipulates number only. When the system gets the message, the individual input character is altered to the integer value according to character table. This value is shifted left six times and exclusively OR with the previous value (initially set as '0'). This concept is included instead of actual hashing function before creating digital signature although it is not actually one-way hashing function. [1].

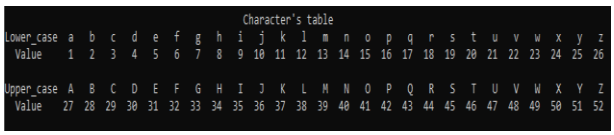

Figure 8. Character Table

C. Signing

After that, the message to be sent is input to the system and digital signature is produced. The input message "DigitalsignatureFormation", its unencrypted message integer value "2624" and encrypted digital signature value S "27773" can be seen in Figure 9.

Figure 9. Signing the Message

D. Verifying

The receiving part has the same implementation for getting plain-text message, that is, divide each character, left-shifting, input to the XOR operation, and getting the message value M. The next part is to decrypt the digital signature S and recover the message value M'. If there is no interruption (both human interruption or noise) to the message and sign in transit, the values M and S will not be changed. Then, the received value M and decrypted value M' will be identical and authentication will also completely succeed. A small change in the message at least one digit will occur mismatch between M and M', therefore, authentication will be failed. Sample test with both situations can be seen in Figure 10. In this figure, only one digit is altered as "digitalsignatureFormation" but the message value changed to 1344 from 2624 and therefore authentication failed. Authentication will not be succeeded unless both the original message and the sign value (that proves the source or data origin or entity) are correct.

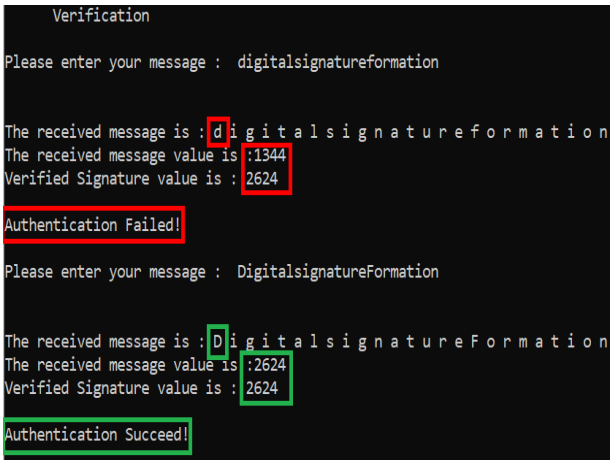

Figure 10. Verifying the Message

V. Discussion and Conclusion

A. Discussion

In this session, experimental results from various sample tests are examined. From that, three observations will be discussed.

1) First Observation

Firstly, observation is examined for keeping the two primes p and q constant and using the same message value M for the message "DigitalsignatureFormation". Upon this, different randomly generated key-pairs are used to sign/verify it and the findings point out that signing and verification are exactly match for these different keys. Because of pages limitation, only ten testing results are included in presentation. The results

are shown in Table 1. It can be seen that all signature values 'S' is unique for all tests.

Table 1. Testing Results from First Observation

p=179,q=197,message=>DigitalsignatureFormation

Pub_key	Prv_key	Authentication_Succeed		
e	d	M	S	M'
34239	20535	2624	9706	2624
891	25099	2624	28758	2624
1763	32731	2624	17902	2624
2547	34299	2624	26570	2624
2973	16957	2624	26846	2624
11969	31077	2624	27773	2624
32157	31541	2624	33398	2624
32713	32113	2624	569	2624
33249	13985	2624	3105	2624
33783	9535	2624	19394	2624

2) Second Observation

Second observation is quite different from the first. Keep only the message that means M is constant for all tests, but the rests are different. As described above, because of limitation, only ten experimental results are shown in Table 2.

It can be generally found that choosing larger prime numbers produce greater key domain. Consequently, it provides much number of different key-pairs and more difficult to guess them. Therefore, it is more difficult to break the system and more secure it. The system with large set of key domains might support applications like banking that needs providing for digital signatures for many users when secret information is provided. In addition, it can somewhat prevent phishing attack.

Table 2. Testing Results from Second Observation

Signature Values for different p and q M=2624

p	q	No. of key-pairs	e	d	S
41	67	640	1483	2227	41
53	71	1152	673	3137	919
67	83	1600	257	2885	806
97	101	2560	9197	8933	1379
107	113	4992	307	2939	10179
127	139	4752	3785	15725	14090
149	157	6912	19861	11197	3665
163	167	8856	18481	14605	11167
173	191	12096	17033	20537	32403
193	199	11520	21349	23149	19340

3) Third Observation

Final findings that is shown in Table 3. keep only the two primes p and q constant. All other things including message and key-pair are different for various testing. It can be clearly seen that the system has a weak point. The system produces the same message value M for the message "DigitalSignatureFormation" and "DIGITALSIGNATUREFORMATION". For cryptanalysis point of view, it can be said that the system is subject to second preimage attack. This weak point can help the intruder to replace the message with the false one. Analyzing this weak point is not within the scope of this paper and therefore left for next study.

Table 3. Testing Results from Third Observation

P= 137, q =163, e 17257, d 21769

Message_Input	M	S
DigitalSignatureFormation	**1472**	**2819**
digitalsignatureformation	1344	527
DIGITALSIGNATUREFORMATION	**1472**	**2819**
DigitalSignatureApprovals	3328	1452
digitalsignatureapprovals	640	6933
DIGITALSIGNATUREAPPROVALS	3840	18695
RSAdigitalsignaturesystem	64	1666
RSADigitalSignatureSystem	1728	11753
RSAdigitalsignatureSYSTEM	2112	8843

VI. Conclusion

In this work, a digital signature system is completely implemented. According to first and second observations, there is no doubt that the system can provide digital signatures for up to about 30000 users under currently used prime number range. To get for more users, prime set from the number greater than 200 will be selected and the system will be modified by using GMP library. To analyze which public-key pair within the same prime number pair is more secure is not included in this research. However, awareness will be very important issue for the system builder because of the result from third observation. It leads the future work to be security-analysis of the system for each key-pair for all possible messages. For the current developing system, it is generally said that choosing larger prime number is more secure. It will be more difficult for the intruder to break greater key-domain than smaller key-domain.

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Wireless Application

Global System for Mobile Communications Based Intruder Security System

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***Abstract*:** The aim of this research is to construct a Global System for Mobile Communications (GSM) based intruder security system using passive infrared (PIR) sensor. In this research work, the whole system is implemented by combining the technologies of hardware and software. In the hardware section, the main control and processing device of the whole system is PIC16F628A microcontroller manufactured by Microchip Technology Inc. HC-SR501 PIR sensor is used to detect the intruder movement of specific area. An Arduino UNO module is also used to interfac with SIM900A GSM module. A SIM900A GSM module is used to send the SMS message to predefined phone number. The developed system also provides AC 220V outlet for multi-purpose uses such as lighting and alarm devices. In the software section, the control program for PIC16F628A microcontroller is written with Assembly programming language and compiled by MPLAB IDE (v8.50) software. The source code for Arduino UNO is written with C language with the help of Arduino IDE (1.8.12) software. When the intruder motion is detected by the PIR sensor, the buzzer will produce the alarm sound and the SIM900A GSM module will also send the SMS message to the predefined phone number.

***Keywords*:** Intruder security, SIM900A GSM module, PIR sensor, PIC16F628A microcontroller.

I. Introduction

In our daily life, the security is an important part of homes, departments, banks, hotels, shops and offices. Burglar and safety alarms are found in electronic form nowadays. They are constructed based on motion detection in which infrared (IR) sensor, ultrasonic sensor and motion sensor are used. In the traditional security systems, when an intruder is detected, the audible alarm will produce. The sensors continuously monitor the movement of intruder.

In this research, a GSM (Global System for Mobile Communication) based intruder security system is constructed based on motion detection technique. The constructed intruder alarm system is one of security system that truly related to burglar or safety alarm system. The developed system is designed to produce alarm sound and also to send SMS (short message service) message to predefined phone number when an intruder is detected by the PIR (Passive Infrared) sensor.

II. Background Information of Developed System

In this section, the general descriptions of the developed intruder security system are discussed by using the block diagram. Then, the general features of PIR sensor, SIM900A GSM/GPRS module, Arduino UNO module and PIC16F628A microcontroller are also described.

A. Block Diagram of the System

The constructed intruder security system contains seven main sections and they are PIR sensor, PIC16F628A microcontroller, Arduino UNO, GSM module, alarm unit, AC 220V outlet, and regulated power supply.

The functions of PIR sensor are to sense the intruder motion and also to produce the signal output. The functions of PIC16F628A microcontroller are to receive the signal output of PIR sensor, to control alarm unit, AC 220V outlet, and Arduino UNO. The function of Arduino UNO is to interface with GSM module. The function of GSM module is to send SMS message to predefined phone number. The function of alarm unit is to produce alarm sound when the intruder motion is detected. The AC 220V outlet provides 220V for security light or electric bell. The function of regulated power supply is to provide +5 V for other sections. The block diagram of the constructed intruder security system is shown in Figure1.

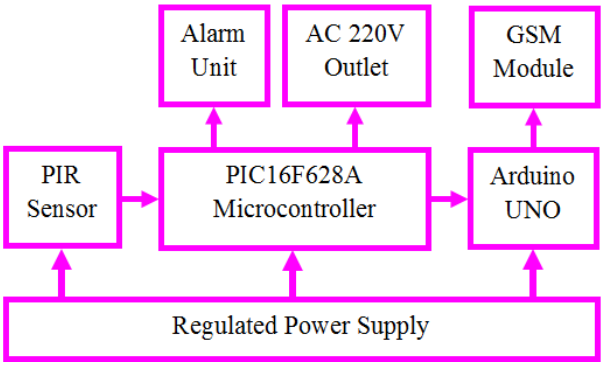

Figure 1. Block diagram of the Intruder Security System

B. Passive Infrared (PIR) Sensor

An electronic motion detector contains a motion sensor that transforms the detection of motion into an

electric signal. The passive infrared (PIR) sensor requires an initial stabilization time of about 10 s to 60 s in order to function properly. During this time, the sensor gets familiar with the surrounding environment, and any motion in its field of view should be avoided. The PIR sensor can detect a typical range of 20 feet, and is designed to adjust to slowly changing conditions. However, any sudden change in the profile (e.g. human body motion) is responded by the sensor. Therefore, the PIR sensor module should not be placed near a heater, AC outlet or anything that could create a rapid change in the surrounding environment.

PIR sensor modules usually have 3-pin connection and they are V_{cc}, Output, and Ground. The features of HC-SR501 passive infrared (PIR) motion sensor are:

(a) Dimension: 3.2 cm x 2.4 cm x 1.8 cm
(b) Working Voltage Range: DC 4.5 V to 20 V
(c) Current drain: < 60 µA
(d) Voltage Output: High/Low level signal: 3.3 V /0 V output
(e) Detection distance: 3 m to 7 m (can be adjusted)
(f) Detection range: < 140°
(g) Delay time: 5 s to 200 s (can be adjusted)
(h) Blockade time: 2.5 s (default)
(i) Work temperature: -20 °C to +80 °C, and
(j) Trigger Method: L unrepeatable trigger / H repeatable trigger [1].

The photographs of HC-SR501 passive infrared motion sensor are shown in Figure 2.

(a) Front view

(b) Back view

Figure 2. Photographs of HC-SR501 PIR Sensor

C. SIM900A GSM/GPRS Module

The SIM900A is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption.

GSM is the Global System for Mobile Communication. The GSM network differs from the analog mobile network such that subscription and mobile are separated. The GSM module has many uses in many applications, including transfer of data between two machines in different places and remote control of a device. In this research, a SIM900A GSM module is used to send the SMS (short message service) from the constructed system to specified phone number. The supply voltage range of SIM900A GSM module is 3.2 V to 4.8 V. The module consumes around 300 mA current while under normal operating conditions, and around 2 A current during transmit bursts [2]. The photograph of SIM900A GSM/GPRS module used in this research is shown in Figure 3.

Figure 3. Photograph of SIM900A GSM/GPRS Module

D. ARDUINO UNO Module

The Arduino Uno is an embedded board with 14 digital input/output pins (of which 6 can be used as pulse width modulation outputs), 6 analog inputs, a 16 MHz crystal oscillator, ATMEGA328, a USB connection, a power jack, and an In-circuit system. The top row of the Arduino has 14 digital pins, labeled 0-13. On the bottom left row, it has 3.3 V or 5 V supply and GND. On the bottom right row, it also contains the analog input pins, labeled A0-A5.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or

battery to get it started. The Arduino Uno board differs from all preceding embedded boards in that it does not use the FTDI (Future Technology Device International) and USB-to-serial driver chip.

The Arduino ATMEGA328 has 32 kB of flash memory in which 0.5 KB is used for the boot loader. It also has 2 KB of static random access memory (SRAM) and 1 KB of Electrical Erasable Programmable Random Only Memory (EEPROM) which can be read and written with the EEPROM library [3]. The photograph of the Arduino UNO module is shown in Figure 4.

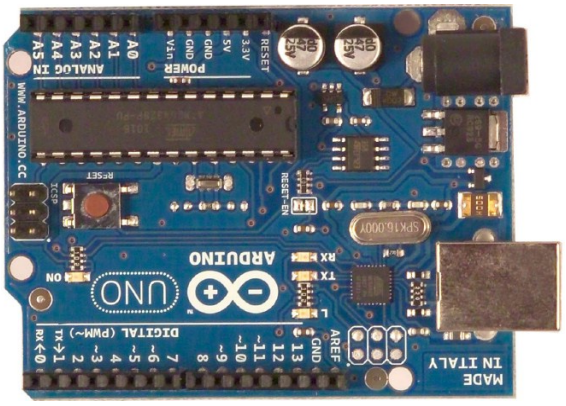

Figure 4. Photograph of Arduino UNO

E. PIC16F628A Microcontroller

PIC is the family of Reduces Instruction Set Computer (RISC) microcontrollers made by Microchip Technology. It is generally regarded that PIC stands for Peripheral Interface Controller, although General Instruments' original acronym for the PIC was "Programmable Intelligent Computer". F is the referred to flash program memory.

The PIC16F628A is chosen because of its economical and low cost, available of the chip and its related software and developer. The PIC16F628A is 18-Pin Flash-based member of low cost, high performance, 8-bit microcontroller. All microcontrollers employ an advanced RISC architecture. The PIC16F628A have enhanced core features, eight-level deep stack, and multiple internal and external interrupt sources. A total of 35 instructions (reduced instruction set) are available, complemented by a large register set. The PIC16F628A has two ports, PORTA and PORTB. Some pins for these I/O ports are multiplexed with alternate functions for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

The PIC16F628A can be operated in eight different oscillator options. The user can program three configuration bits (FOSC2 through FOSC0) to select one of these eight modes:

(a) LP Low Power Crystal
(b) XT Crystal/Resonator
(c) HS High Speed Crystal/Resonator
(d) RC External Resistor/Capacitor (2 modes)
(e) INTOSC Internal Precision Oscillator (2 modes)
(f) EC External Clock In [4]

The pin diagram and photograph of PIC16F628A microcontroller are shown in Figure 5 and Figure 6 respectively.

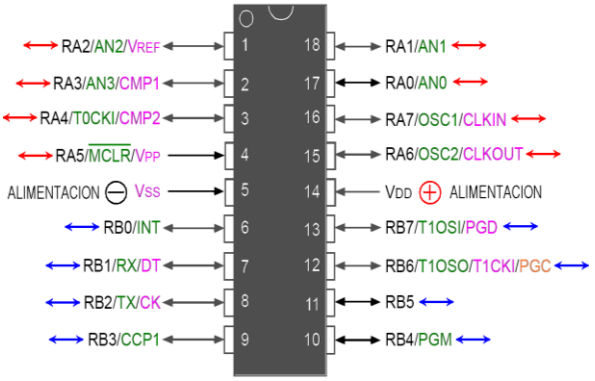

Figure 5. Pin Diagram of PIC16F628A Microcontroller

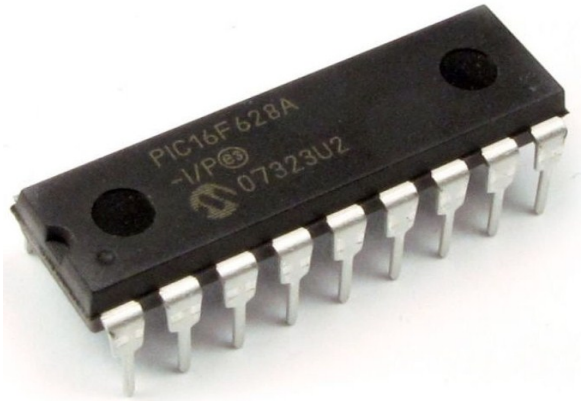

Figure 6. Photograph of PIC16F628A Microcontroller

III. Hardware Connection of the System

The GSM based intruder security system is designed and constructed using modern electronic components. The main processing device of the develop system is PIC16F628A microcontroller.

In the PIC16F628A configuration, the internal oscillator of 4 MHz frequency is used as oscillating circuit of the microcontroller. In the digital input/output configuration, RA2 of PIC16F628A microcontroller is used as digital input to monitor the output of PIR sensor. RB7 of PIC16F628A is used as digital output to control the relay for switching AC 220V outlet. RA1 of microcontroller is used as digital output to provide the trigger signal to the Arduino UNO module.

In Arduino pin configuration, D2 and D3 of Arduino are used to perform serial communication with SIM900A GSM module and D7 is used to receive the trigger signal of PIC16F628A microcontroller. In circuit connection, Vcc pin of Arduino UNO module and IN+ pin of LM2596 module are connected to +12 V rectifier output. Gnd pin of Arduino UNO module and

IN- pin of LM2596 module are grounded. The output of LM2596 module is set to 4.2 V and it is applied to Vcc of SIM900A GSM module. D2 of Arduino is used as Rx pin and D3 of Arduino is used as Tx pin. Therefore, D2 pin of Arduino is connected to the Tx pin of GSM module and D3 pin of Arduino is connected to the Rx pin of GSM module. The communication between Arduino and GSM module is used as serial method.

In AC outlet connection, RB7 of PIC16F628A is connected to the base of BC547 transistor by inserting 1 kΩ resistor. The emitter of transistor is grounded and the collector drives the relay.

In the regulated power supply circuit, AC 220 V main line is stepped-down to AC 12 V. It is converted into DC voltage by using full wave bridge rectifier. The output of rectifier is filtered with 1000 µF capacitor. The filtered voltage is applied to the input of LM332 voltage regulator. The output terminal of LM332 produce regulated +5 V. The output of +5 V line is filtered by using 0.1 µF capacitor. The DC 12 Vis also regulated by LM2596 module for GSM module and an LED is also provided at the output of LM2596 to indicate the status of power supply. The schematic diagram of the GSM based intruder security system is shown in Figure 7.

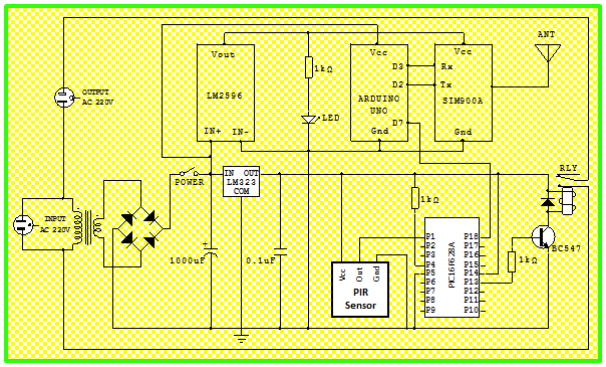

Figure 7. Schematic Diagram of GSM Based Intruder Security System

A. Software Development

In the software development section, there are two main parts in which the one is software development for PIC16F628A microcontroller, and the other is for Arduino UNO.

For the software development for PIC16F628A microcontroller, the control program is written with Assembly programming language. Firstly, the source code "Intruder_Alarm.asm" file is written in the notepad. Then, it is compiled into machine code by using MPLAB IDE (v8.50) software. The obtained "Intruder_Alarm.hex", file is downloaded from the USB port of the personal computer to the PIC16F628A microcontroller by using PICKIT2 programmer board. The photographs of the MPLAB IDE v8.50 software screen and PICkit 2 v2.61 software screen are shown in Figure 8 and Figure 9 respectively.

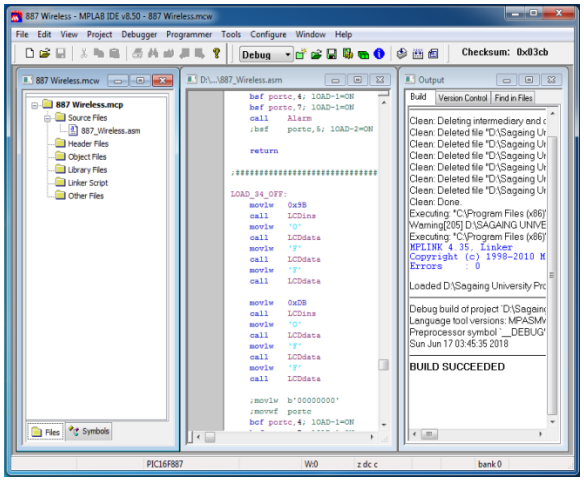

Figure 8. Photograph of the MPLAB IDE v8.50 Software Screen

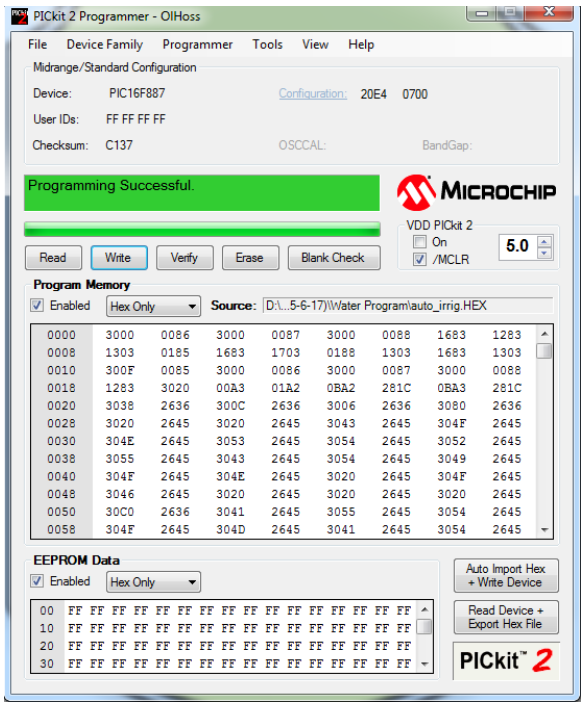

Figure 9. Photograph of the PICkit 2 v2.61 Software Screen

For the software development for Arduino UNO, the control program is written with C programming language. It has two main functions "setup()" function and "loop()" functions. The setup part is where the code is written so that the program runs. The loop part is where the code is written so that the program runs with repetition until the power off. The program code is compiled by using Arduino 1.8.12 software. Then the machine code is uploaded into Arduino UNO. The photograph of Arduino 1.8.12 software screen is also shown in Figure 10.

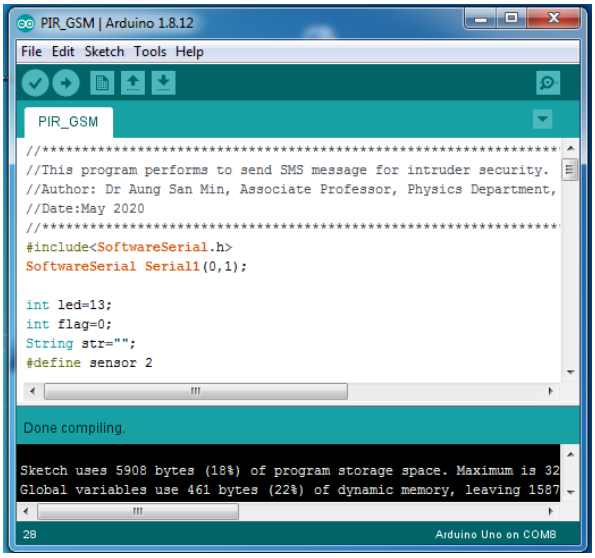

Figure 10. Photograph of the Arduino 1.8.12 Software Screen

B. Discussion

In this research work, a GSM based intruder alarm system is designed and constructed for multi-purpose security. The developed system is designed to perform for beeping buzzer and sending SMS from the constructed system to specified phone number when the intruder is detected. PIR sensor is used as intruder sensing device and PIC16F628A microcontroller is used as the main control device of the whole system. A SIM900A GSM module is used as SMS message sending device. In system operation, when the intruder is not detected, the buzzer will not activate. When the system detects the intruder, buzzer will produce alarm sound and AC 220 V outlet will open. At this time, the GSM module will send the SMS message "HAY!!! Incoming Intruder" to the specified phone number. The photographs of testing the developed system and the snapshot of SMS messaging in mobile phone are shown in Figure 11 and Figure 12.

To improve the performance of the developed system, PIR sensor should detect the motion around 360 degrees and it can be done by using the combination of a servo motor and PIR sensor. Moreover, a powerful security system can also be obtained by capturing the image of the intruder with the use of a camera. If the PIR sensor detects the movement of intruder, the servo motor will rotate to the direction of that movement. Then, the camera will track and capture the moving intruder, and will also send the live broadcast to a receiving host such as computer or mobile phone. In the future work, the developed system will be modified, and an advanced surveillance system will be developed by using a lot of PIR sensors and cameras to monitor essential areas.

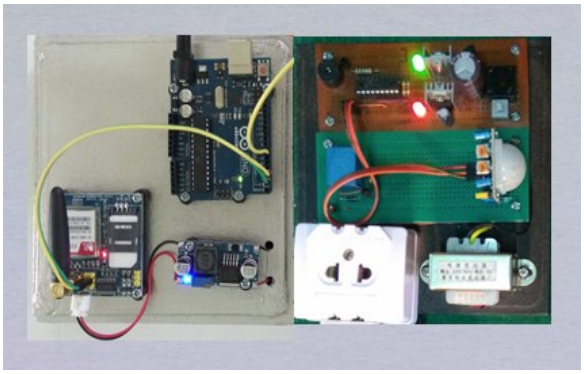

Figure 11. Photograph of Testing the Constructed System

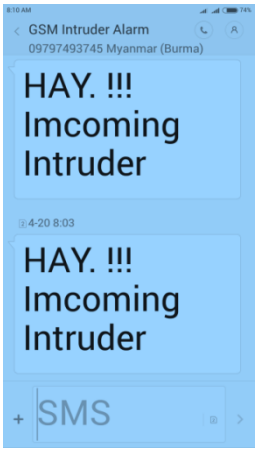

Figure 12. Snapshot of SMS Messaging in Mobile Phone

C. Advantages and Limitation of the System

This research work is one of the applications of PIR sensor and GSM module for security system. The developed system can be used in homes, departments and industries as SMS based domestic security system. It can be used for intruder detection at both day time and night time. Moreover the system is fully automated and therefore it does not require any human interaction for system operation. Since the developed system performs with the use of GSM technology, it can be obtained remote indication through SMS.

In the limitation of the developed system, it can cause the false alarms that involve the beeping buzzer alarm and sending SMS message when anyone of family enters the specific area. The system also requires for detecting gas leakage, smoke and fire. More PIR sensors should be placed at the specific area in which it is required for the sufficient signal strength from PIR sensor to main control unit. A backup battery should also be included in the developed system to perform 24 hours system operation. When the mobile network is fail, the system cannot deliver the SMS message to the specified mobile phone number.

IV. Conclusion

In this research, a GSM based intruder security system has been designed, developed and tested successfully. The PIR sensor used in this research can detect the intruder motion in the range of 20 feet well. The constructed system is suitable for the 24 hours security. For completing industrial security system, gas leakage detection circuit, overheat alarm circuit, fire and smoke detection circuit, and automatic water sprinkler circuit should be included. By adding the oxygen gas sensor and modifying the program code, the developed system can be applied in hospitals to detect the leakage in oxygen gas cylinders, as it can also cause fire. By studying the developed system, the university students can obtain the knowledge for how to apply PIR sensor and microcontroller, and how to interface Arduino and GSM module. The developed system is useful for practical purpose and scientific laboratory.

Acknowledgments

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The Usage of Wireless Notice Board Using GSM Module with Arduino

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Abstract: Wireless Notice Board with Arduino controller circuit is a simple system. This system emphasizes as a creative rather than a compelling manner of informing the message to the people who using an electronic display board which is integrated the GSM technology of SIM 900A. This system helps them to pass the messages without any preferred delay just by sending a SMS. This method is more authentic than the usual way of writing the messages on notice board. This method can be used in many general places such as mall, big constructions, education institutions, organization, hotels, offices and traffic management to promote the more secure system and also make easily in the zero-hour time and we can avoid various risk such as papers impairments by unauthorized people. This system can be used to promote their private situation.

Keywords: GSM, wireless notice board, SIM 900A, Arduino Uno, SMS

I. Introduction

In this paper, wireless notice board is chosen for promoting their modern lives because it has a very wide range rather than just being an ordinary notice board. In this system, a message or notice can be displayed to display device like liquid crystal display, and this message can be simply posted or changed from anyplace in the world, with the service of the SMS facility. Notice boards are commonly used in passing from primary schools to many corporations to deliver messages at great. The GSM modem receives a message from the authorized phone. The microcontroller on UNO board extracts this message and displays it on the LCD board. Serial communication is used in the whole process to transfer information from GSM module to UNO board and from UNO board to the LCD display.

II. Background Theory

Notice board is a primary device in institution/organization. The proposed system is used to design a wireless notice board using Arduino. The GSM modem receives the SMS from an authorized user. The modem transmits the stored message through the input port to the Arduino Uno board. The Arduino validates the SMS and then displays the message on the LCD display board.

A. Arduino Microcontroller

Today, the most prevalent open source software and hardware technology in embedded world is Arduino. Arduino board designs for use a variety of microprocessors and controllers. In this system, Arduino UNO R3 board is used as an open source hardware and it uses ATmega328 as its microcontroller. UNO R3 board has the total of the fourteen digital I/O pins and the six analog input pins. To upload the programs into UNO board is easilv done by using USB cable.[3]

Figure 1. Front and Back View of the Arduino Uno

This auxiliary microcontroller has its own USB bootloader, which allows advanced users to reprogram it. The Arduino has an extensive set of support libraries. The ATmega328 has 32 kilo bytes of flash memory and 2 kilo bytes of Static RAM and 1 kilo byte of EEPROM.

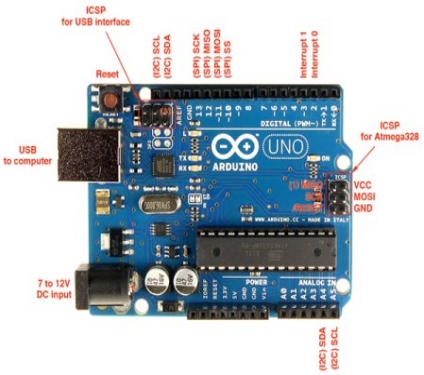

Figure 2. Arduino Pin Diagram

1) I/O Ports of UNO R3

All of the digital I/O pins on the Uno board can be used for input or output. These ports operate at 5 volts. In addition, some pins have specialized functions.

1. Pin 0 and 1 are used to receive (RX) and transmit (TX) receptively between UNO and other devices such as computer for serial communication.

2. Pin 2 and 3 are used to trigger an interrupt.

3. Pin 3, 5, 6, 9, 10, and 11 are used to provide Pulse Width Modulation (PWM) output.

4. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

5. The pin 13 is special case for testing the program. This pin is connected the LED and show the output status for coding of its value (ON or OFF). Figure 3 shows the pins assignment for Arduino and table 1 lists pin functions of the Arduino Uno R3.[2]

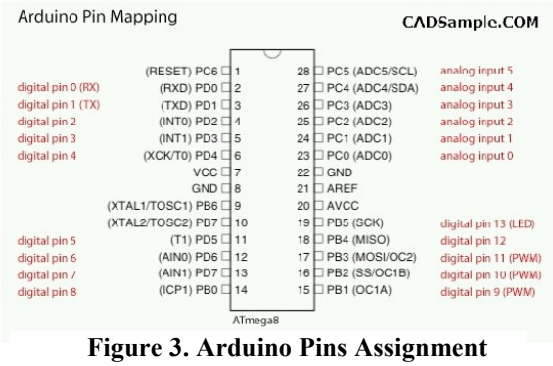

Figure 3. Arduino Pins Assignment

Table 1. Arduino Uno R3 Side

Pin no.	Function of Arduino Uno
0(Rx)	to receive TTL serial data
1(Tx)	to transmit TTL serial data
2,4,7	can be configured to trigger on interrupt on low value (or) a change in value
3,5,6	Provide 8 bit PWM output with the analogWrite () function

2) GSM module (SIM 900A)

The 900 in SIM900 GSM Module supports communication in 900MHz band. SIM is the acronym for Subscriber Identity Module. It is a chip-on small card consisting of user's information such as phone book. User can alter the operator on the same handset as per convenience. At present, dual SIM handset share is also available in the market where we can use two operators on the same handset. GSM module is used in many communication devices which are based on GSM (Global System for Mobile Communications) technology. GSM module acts as a communicating medium. It is used to interact with GSM network using a computer. GSM module only understands AT commands and can respond accordingly. GSM technology offers user the facility to send message from anywhere in the world and still it will be display in the notice board. This is a very low cost and simple Arduino GSM and GPRS module. Table 2 describes the pin functions of the GSM module.[1]

Table 2. GSM Module Side

Pin no.	Function of GSM Module
Tx	To transmit serial communication
Rx	To receive serial communication

3) Power Requirements for GSM module

Many companies in mobile world manufacture the GSM modules. The supply power for these GSM modules are different. The GSM module used in this system requires 12 for input voltage. Other GSM modules may be in 15 volts and some other which need only 5 volts. [6]

4) Booting up the GSM

1. The SIM card is inserted and locked to the module.

2. The adapter is connected to module and turned ON.

3. Now, user waits just a minute to confirm the status LED is blinking.

4. Once the connection is established successfully, the status LED will blink continuously every 3 seconds.

Figure 4. GSM Module (SIM 900A)

5) Hardware Connections of GSM Module

There are two ways of connecting GSM module to Arduino. In any case, the communication between Arduino and GSM module is serial. So, users supposed to use serial pins of Arduino (Rx and Tx). In this method, users connect the Tx pin of GSM module to Rx pin of Arduino and then Rx pin of GSM module is also connected to Tx pin of Arduino. Now, they connect the ground pin of Arduino to ground pin of GSM module. The three connections are made and the wiring is over. Now different programs can be loaded to communicate with GSM module and make it work. The SIM900A module has 6 pins in which two pins for Vcc and Gnd and the reset are 3VR & 3VT (3volt Rx & Tx) and 5VR, 5VT (5volt Rx & Tx) and the connections are made as follows:

- Vcc to 5V
- Gnd to Gnd
- 5VR to UNO digital pin 9
- 5VT to UNO digital pin 10

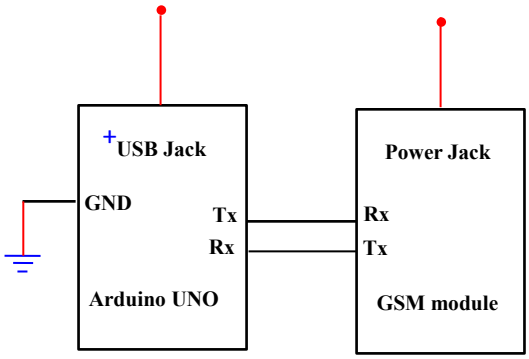

Figure 5. Making Connections

Table 3. AT Commands

Command	Description
AT	To test good or bad GSM module
ATA	Command for answer
ATD	Command for Dial
ATH	Hang up call
ATL	Monitor speaker loudness
ATM	Monitor speaker mode
ATO	Go on-line
ATP	Set pulse dial as default
ATT	Set tone dial as default
AT+CSTA	Select type of address
AT+CRC	Cellular result codes
AT+CSMS	To select the service for message
AT+CPMS	Perferred message storage
AT+CMGF	Message format
AT+CSCA	Service centre address
AT+CSMP	Set text mode parameters
AT+CSDH	To show the parameters for text mode
AT+CSCB	To select the message types of cell broadcast
AT+CSAS	For saving settings
AT+CRES	Restore settings
AT+CNMI	New message indications to TE
AT+CMGL	List messages
AT+CMGR	Read message
AT+CMGS	Send message
AT+CMSS	Send message from storage
AT+CMGW	Write message to memory
AT+CMGD	Delete message
AT+CNMI=2,1,0,0,0	Auto message received

To control the GSM modems, AT commands are used. AT stands for attention and it can be classified into four groups. They are test commands, read commands, set commands and execution commands. Some types of AT commands are listed in table 3.[5]

6) Liquid Crystal Display (LCD) and Resistor

In this system, a 16x2 LCD (Liquid Crystal Display) is used to display given information. A 16x2 LCD means two rows and 16 columns characters array. So, it can display 16 characters per row and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. Figure 6 shows the pin diagram of the 16x2 LCD and table 4 lists pin functions of the LCD.[4]

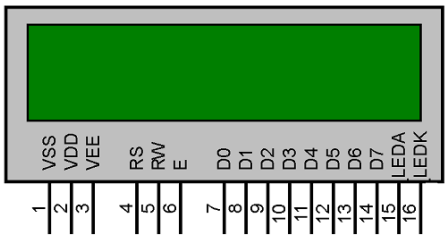

Figure 6. Pin Diagram of 16x2 LCD

Table 3. LCD Side

Pin no.	Function of LCD
4(RS)	Register select signal
6(E)	Operation(data read/write) enable signal
11,12,13,14(D4-D7)	Four high order bi-directional three-state data bus line used for data transfer between the MPU.

A resistor is an electrical component that can be used to control the flow of electrical current. It is a passive element which absorbs only power from some of other circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

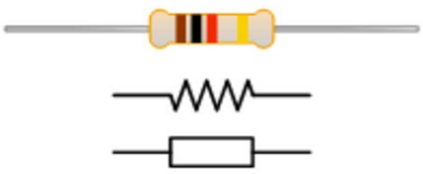

Figure 7. Resistor Symbols

III.Software and Hardware Implementation

By using Proteus, we can easily generate schematic captures, develop printed circuit board and also simulate microprocessor. Proteus is a simulation software and developed by Lab Center Electronic. It has a wide range of components in its database. Using these components, users can design almost any kind of circuit and can test and debug it. It also provides a powerful working environment.

A. Arduino Implementation

1) Open Arduino IDE

There are two mandatory functions in the Arduino coding environment.

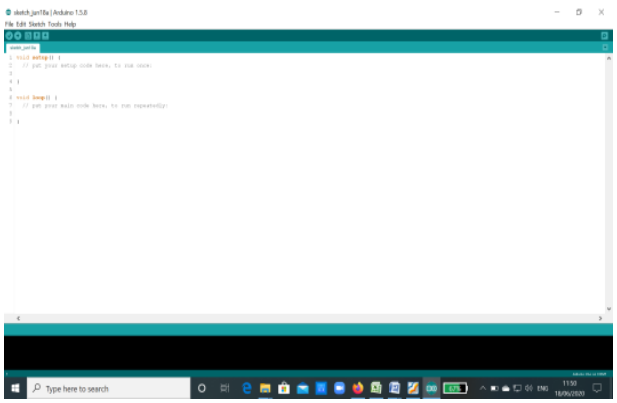

Figure 8. Open Arduino IDE

2) Compilation

These compilation states generate the hex code needed for microcontroller board. User can see the compilation status on Status Display bar. Figure 9 shows the compilation of the sketch program for the Arduino Uno.

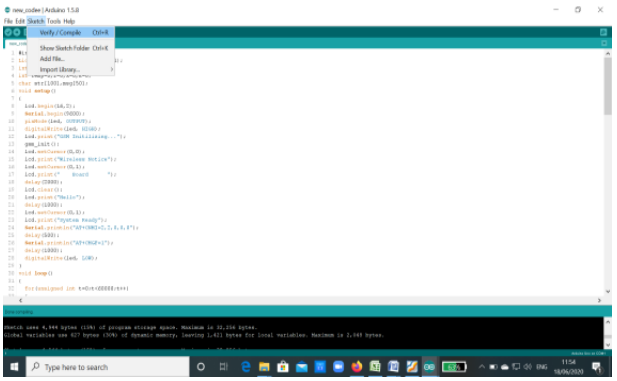

Figure 9. Compilation

3) Uploading the program

Before users upload the program, users need to be connected UNO board to computer via USB cable and check the appropriate COM port number. To upload the program's hex code to desired microcontroller board, users make sure that the selected board from Tool menu is Arduino UNO for this researched system. The uploading program to Arduino Uno is shown in figure 10.

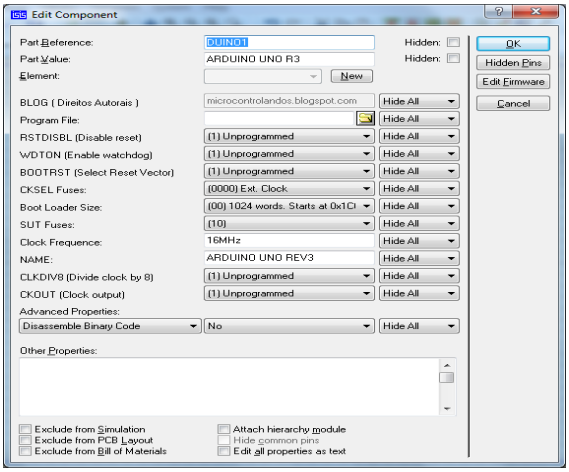

Figure 10. Uploading the Program

B. Proteus Simulation

1) Overview of Proteus

Proteus is a simulation software that is developed by Lab center Electronic. It can easily generate schematic captures, develop PCB and simulate microprocessor. Proteus has a wide range of components in its database. Using these components can design almost any kind of circuit and can test and debug it. Proteus provides a powerful working environment. The different electronic circuit with all necessary components can be designed by the user and easily accessible from the simple effective interface like signal generators, power supply, simple resistor and different microcontroller or microprocessor.

2) Create Proteus Simulation

To Create a new project, users click new project button in ISIS mode. To test uno simulation, they already need to add uno library to proteus package. Then they click Arduino Uno R3 controller card from capture button and then click the component button under device for picking components. The hex file output from Arduino Uno R3 is loaded to desired microcontroller in proteus. And then users can click the run simulation button at bottom left corner and observe Arduino UNO simulation. The final UNO simulation diagram is shown in figure 11.SIM 900A is not included in proteus simulation mode. So, SIM 900D is used instead of SIM 900A. But in this real system is designed with SIM900A module. Proteus simulation design for wireless notice board is shown in figure 11.

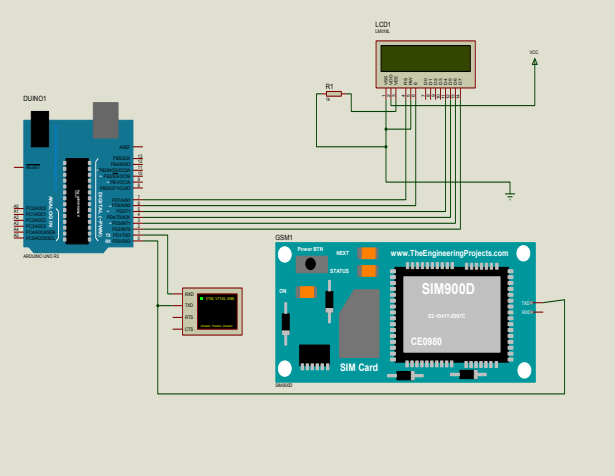

Figure 11. Proteus Simulation Design for Wireless Notice Board Using GSM and Arduino

IV. Experimental Result

This system is set up with one Arduino board, LCD board, GSM module, power adapter and 9V battery. Arduino board controls the LCD display. GSM Modem is used to receive message from the authorized user. This GSM modem requires a SIM card from a wireless carrier in order to operate. The messages sent from the phone is transferred to LCD display through Arduino kits. The notices sent through the mobile scrolls in the display unit. The experimental result is shown in the following figure 12.

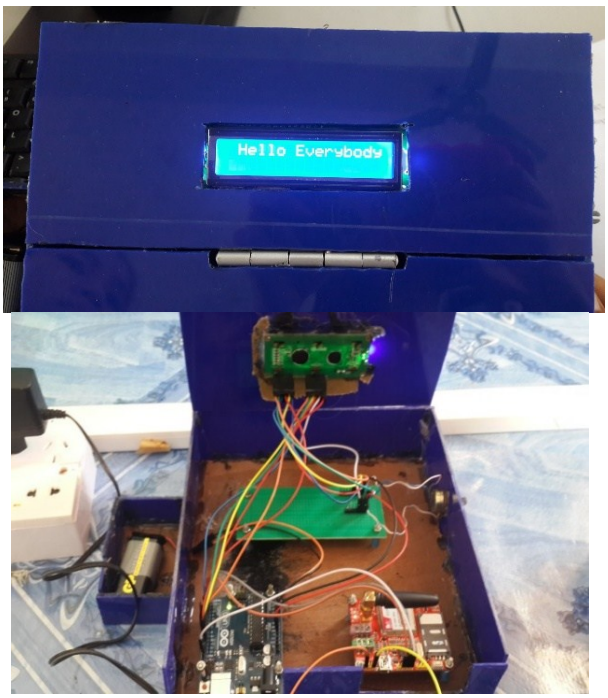

Figure 12. Experimental Result for Wireless Notice Board Using GSM and Arduino

V. Conclusion

This simple prototype can send SIM messages from any phone to GSM module (SIM900A) which is built in experiment board. GSM module (SIM900A) receives that SMS and sends it to Arduino. Arduino sends the extracted message to LCD display. The motivation is to facilitate the users to display notice without using paper, white board, etc. At any time, the user can add or remove or alter the text according his requirement. This system provides availability due to development of a low system.

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Electronic and Control

Egg Incubator System Using W1209 Temperature Controller

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***Abstract*:** This paper describes the design of an egg incubator which is powered W1209 temperature controller. Egg production of eggs is an important factor to consider when working on poultry farms. The Incubator system regulates the temperature through the sensor. For moisture, it always measure water and fill it in a water pan. The essential elements for the efficiency of egg capacity include correct internal temperature and humidity and temperature increase. In this paper Walt 60 lamps are used to obtain the appropriate temperature to the tubers for using the bulb. Water is heated by the bulb and converted into steam by using the fan and circling it with a fan. It provides the needed ventilation and humidity and improves egg fertility within the incubator depends on the various types of eggs. The temperature and humidity must be adjusted.

***Keywords*:** W1209 digital temperature controller, 60W bulb, 12v fan, water pan, foam box**.**

I. Introduction

The purpose of this paper is to describe the requirements of a good machine. Accurate temperature in the incubator is the main cause of overheating which can cause serious damage to the egg [2]. The correct temperature inside the machine is important. Temperatures more than low temperatures can adversely affect egg growth. To achieve equilibrium temperature, the machine must be calculated proportionally and not too long. In order to keep the temperature inside the machine, the w1209's temperature sensor is set to position the sensor.

Within the machine low ventilation causes a lack of oxygen in the lungs and death of the egg. With the inlet air filter installed, you can adjust the cooling system and heat pump for excessive temperature inside the machine. Clean the interior with warm soapy water before using the machine. Make sure to keep the temperature and temperature stable when dry. Then place the machine in a stable temperature setting

Some factors such as temperature, humidity and egg conversion can damage some eggs. Therefore, the eggs need to be monitored regularly and the temperature must be set to the specified temperature. If the temperature is low, the temperature inside the incubator into consideration bulb is ON and the fan is OFF. When the temperature is above the specified bulb is OFF and the fan is ON [8]. A foam box material is used in order to prevent surrounding air into the box.

II. W1209 Digital Temperature Controller

The W1209 is an incredibly inexpensive, high-performance heat controller. This module temperature sensor can control power from most types of electronics based on sensor temperature. This module has embedded microcontrollers, but programming knowledge is not required. The W1209 module contains three buttons. This buttons allow to adjust various parameters, including turning the temperature on or off. The relay board can convert a maximum 240V AC to 5A or 14V DC 10A. The current temperature is indicated by using 7segment LEDs.

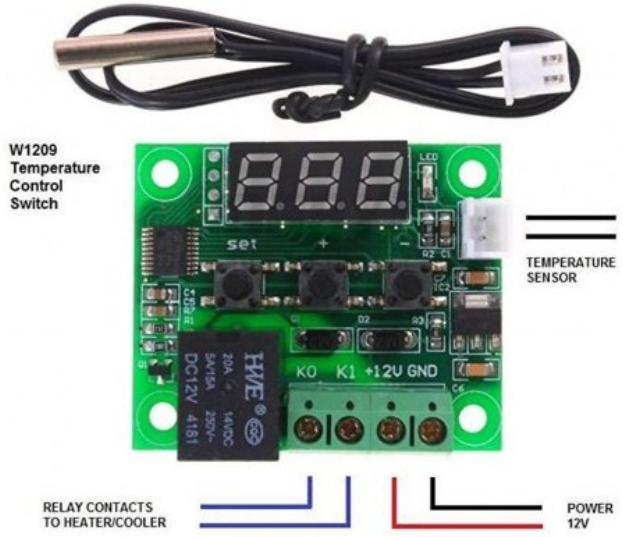

Figure 1. W1209 Digital Temperature Controller

- Displaying the current temperature:

The heater will usually display the current temperature in ° C.

The following points will be adjusted as follows:

- Setting the trigger temperature

Press the 'SET' button to set the keypad temperature. Temperatures (° C) 0.1 ° C the '+' and '-' buttons can be used. If the key is not pressed for 2 seconds, the button stores the temperature and the display returns to its current temperature.

- Setting the parameters
  Press the 'SET' button for at least 5 seconds to set any parameter. The seven segment display should now display 'P0'. Pressing the '+' or '-' buttons will run various parameters (P0 to P6).Once a parameter has been set; press the set button to exit the option.
- Setting the cooling or heating parameter P0
  This parameter is at P0, there are two settings in C and H.When the temperature is set H, the relay will lose power. Use this setting to control the heater
- Setting the hysteresis parameter P1
  P0 specifies how much temperature must be changed before changing the situation.For example, set the temperature at 2 °C and set the temperature down to 37°C, the power will not be depleted until the temperature drops to 35°C.
- Setting upper limit of the thermostat parameter P2
  This parameter can be set to the maximum key temperature limit. It can be used as a security to prevent accidental overheating by the user.
- Setting lower limit of the thermostat parameter P3
  This parameter can set the lowest temperature.
- Setting temperature offset correction parameter P4
  P4 setting configuration is 0 because there is a difference between the temperature and the actual temperature.
- Setting the trigger delay parameter P5
  This parameter allows for relay delay of the relay when the button temperature is reached.so delay parameter P5 is setting 0.
- Setting the high temperature alarm parameter P6
  The value for this parameter will be set when the temperature is reached at this setting.The default setting is OFF.

III. Temperature, Humidity, Ventilation and Turning

A. Temperature

The egg temperature must be set to W1209 at digital temperature to be 98°F-100°F at the time of egg hatching. Make sure the maximum temperature in the machine does not exceed 102°F. Make sure that the minimum temperature in the machine must not be below 97°F. The Fahrenheit unit can be converted to Celsius using the Fahrenheit formula.

$$°C = (°F - 32) \times 5/9 \quad (1)$$

Within the machine make sure the operating system is working properly check the temperature by using a thermometer separately. If the temperature inside the machine is stable and certain to be exact, eggs can be started inside the machine. Eggs placed inside the incubator must not be a cracked egg, a sharp egg, an overgrown egg, a defective egg, or a spawning egg. Collected eggs must not exceed one day[7]. If eggs are over a week, the rate of fertility is reduced. Before laying eggs inside the machine, lay the thin slices of paddy, then the first 50 eggs will be added to the machine on the first day. Start the device and turn on the power button.

Within the machine, the temperature must be heated up to 21days temperatures must be provided continuously. The incubation temperature is 21 days continuously, the temperature must be adjusted to 100 °F 1 to 18 days and 98 °F must be set for the last 19, 20, 21 days. Eggs in machine to get the correct temperature the large egg should be shaped like a light bulb. Turn around once every eight hours to ensure that the eggs are not overheated and that the egg shells will be properly heated. The follow of the table 1 shows the condition of incubator for various type of egg.

Table 1. **Condition of Incubator for Various Type of Egg**

Requirements	Chicken	Turkey	Duck	Quail
Incubation Periods (day)	21	28	28	18
Temperature(°F)	100	99	100	100
Humidity	50-55%	52-57%	50-55%	50-55%
Do not Turn Eggs After	18	25	25	15
Humidity last 3days	65-70%	65-70%	65-70%	65-70%
Open ventilation more	18	25	25	14

B. Humidity

The During egg incubation, the temperature and humidity must be constantly monitored. The humidity in the machine should be adjusted to 50-55% from 1 to 18 days. Keep the water in water pan to keep it full in order not to be dry the water. Adjust the humidity by 65-70% for the remaining 19, 20, 21 days [6,10]. Throughout the egg incubation period humidity levels make sure the date is correct to adjust the settings. During heating inside the machine only when needed turn on incubator this can cause the temperature and humidity inside the incubator to affect the success of the egg hatch. As the egg yolk grows, the humidity will need to be higher. Especially on 19, 20, 21days humidity needs to be raised.

C. Ventilation

The machine is well ventilated and kept in a well-ventilated room. The room must be kept clean. To improve the internal air flow of the machine, through the air pump through the fan, foam box for ventilation to the outside and outside make sure that it is properly maintained and repaired. The correct temperature in the

machine humidity is correct if the air is clean and air-conditioned, all ventilation must be properly proportioned.

D. Turning

This process requires rotating one egg three times a day. It protects the egg shells by turning the egg. By turning the egg temperature and humidity were reached. The embryo is the only at the top of the yellow. If the egg is not turned, the yellow yolk goes up to the top of the egg shell. As a result, developing embryo between the yellow and the egg shell cuts can be lethal. After 18 days, do not turn the eggs [9].

IV. Check the Eggs with Electric light

Electric light can be found between the fetus and the embryo. Figures 2 shown in detected no embryo and good egg check with electric light. Figure 3 shows is the process stage in the incubator day to day egg change the chick. On the first day, the bulls begins eye appeared. on second day the bull eye will begin to form. The vessels begin to appear on third day. The blood vessels will begin to appear on the fourth day. On 5th day, the blood vessels begin to form. On the 6th day, the beak begins. On the 7th day, the beak will appear form. Head will appear on 8th days. On the 9th day, the head will become even more prominent. On the 10th day, the beak will become more prominent. The 11th day the beak will become stronger. On 12th day, the beak will grow even bigger. Legs will begin to appear on 13th day. On 14th day the feather will begin appeared. On the 15th days the feathers will become even more prominent. On 16th day, the hearts begin to form. On 17th day converts the beak to air bag. The embryo appears on the 18th day. On 19th day, egg yolk enters the embryo. On the 20th day, the outer shell begins to crack. On the 21 days Chickens are born.

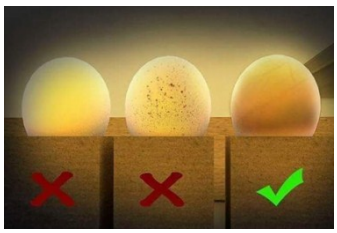

Figure 2. Detected No Embryo and Good Egg

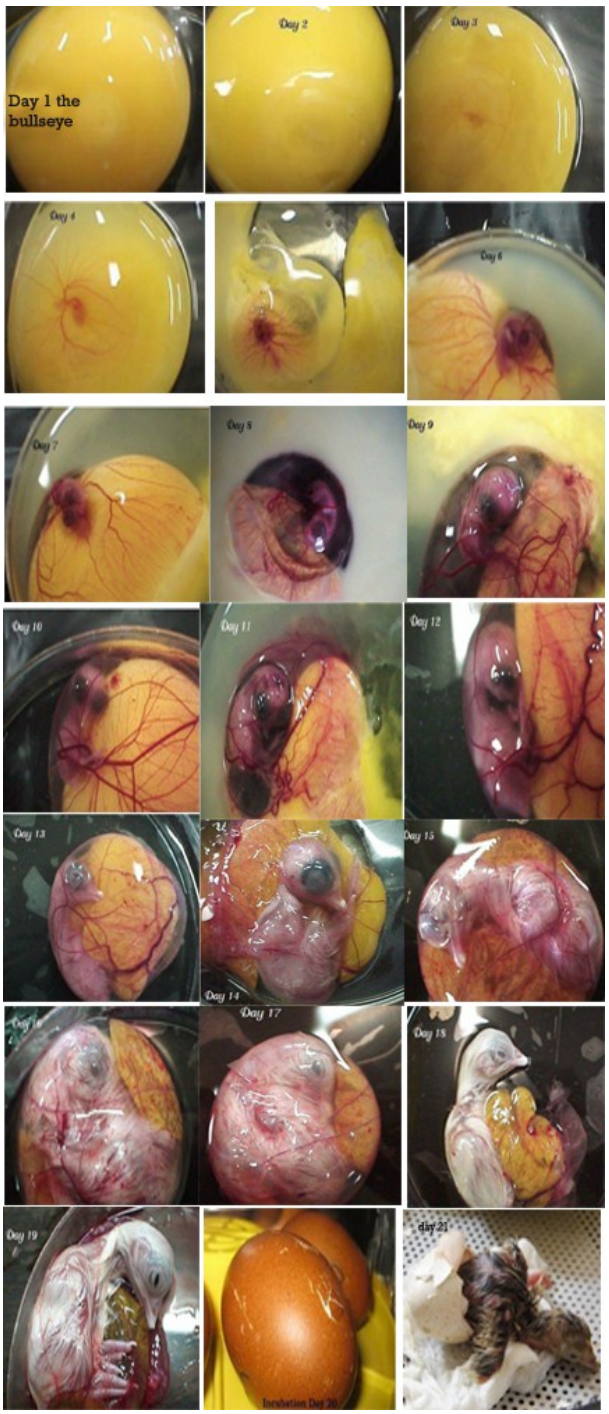

Figure 3. Embryo Process in the Incubation

V. Methodology

A. Block Diagram

The microcontroller is configuring to regulate the temperature of the incubator. Figure 4 shows the block diagram of the incubator with temperature sensor interfacing with the microcontroller, and by monitoring the temperature of the vicinity. 12V dc fan is used to facilitate regulation of temperature and humidity in the incubator by keeping them within required ranges of preset values. 60W bulb is used to provide warmth within the incubator. Water pan is used to provide the relative humidity in the incubator.

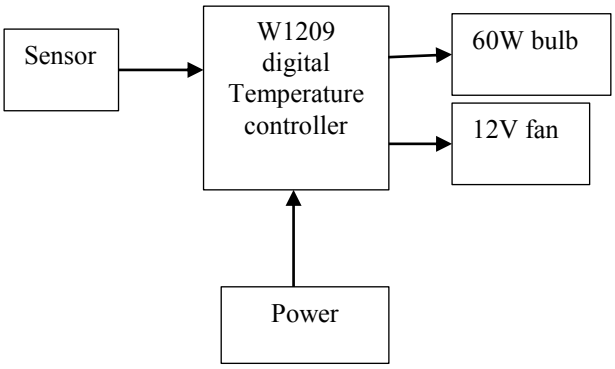

Figure 4. Block Diagram for Egg Incubator

B. Mechanical Design

Figure 5. Design for Egg Incubator

In machine design, the focus is on egg production. When the egg incubator was built, the foam box was used to facilitate transport. In egg incubator machines eggs are 50- 55 eggs can add. The size of the Egg Incubator is 31.2cm high x 45.7cm wide x 60.8cm long.60 watt bulbs are placed on the wall of the foam box. Eggs are used to heat 60W bulbs. Refer to figure 5 below; show the design for egg incubator. This machine consists of the 60w bulbs and water pan, 12v fan, W1209 digital Temperature controller.

C. Flow Chart

Figure 6 shows the flow chart of egg incubator. Firstly, the eggs are added into the machine. Depending on the specified temperature, the system will operate automatically. The maximum temperature inside the machine is 102 ° F. The minimum temperature must be at 97 ° F. Therefore, the bulb will rise to 102° F. The bulbs are automatically cut off at 102 ° F and then heated decrease to 97 ° F using the fan will work automatically. At 97° F, the fan will shut off and the bulbs are on automatically the temperature will rise to 102° F. Therefore, the temperature in the Egg Incubator is between 97 ° F and 102 ° F. In this system, the bulb is used to increase the temperature, and the fan is used to reduce the temperature.

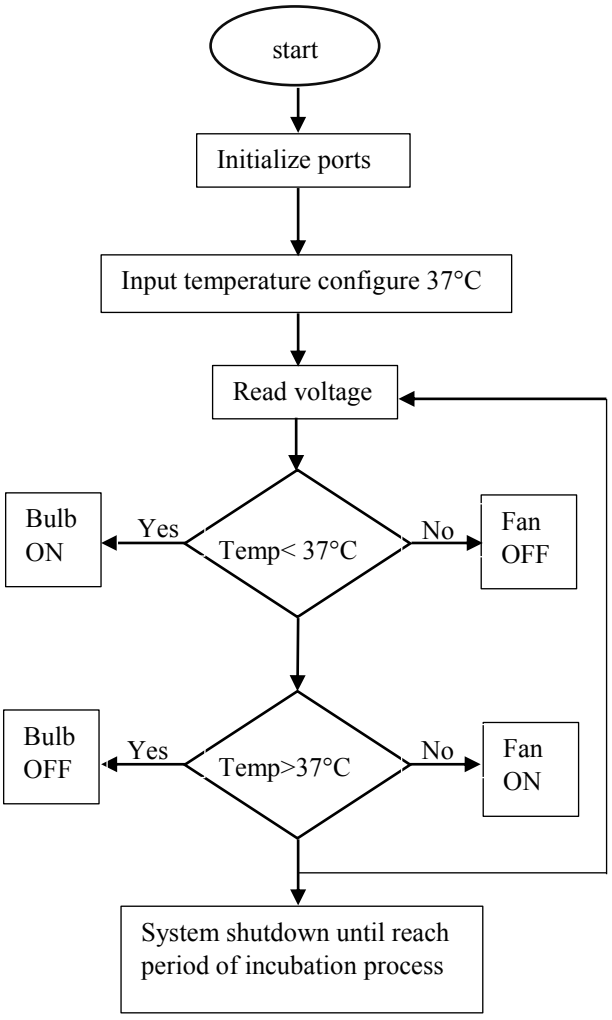

Figure 6. Design for Egg Incubator

VI. Hatch Time

There are five key points in warming a chick.

- required Temperature
- Get fresh air
- Get enough light
- Get enough nutrition food
- Clean drinking water

The daily temperature for chicks is 35 ° C for 1 day to 3 days, 33 ° C for 4 days to 7 days, 31° C for 8 day to 14 days, 29 ° C for 15 days to 21 days, 27 ° C for 22 days to 28 days, 24 ° C for 29 to 35 days and 23 ° C for 36 to 42 days.

Figure 7. Chicks Warm Brooder

VII. Comparison Result

Figure 8 shows the comparison result curve in the incubator on 18th day. For the normal of the temperature must be adjusted to 98 - 102 °F must be set and humidity in the machine should be adjusted to 50-55% from 1 to 18 days.

For the embryo death, if the temperature drops below 98°F and the humidity rise above 75 %, the embryo will not grow and die.

For the abnormal, when the temperature rises above 102°F and the humidity drops below 30 %, the embryo develops polio when the temperature rises.

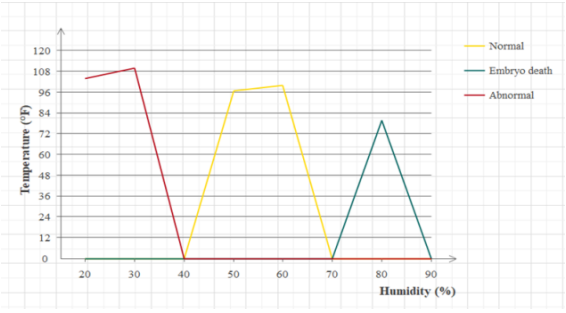

Figure 8. Comparison Result Curve in the Incubator on 18th day

Figure 9 shows the comparison result curve in the incubator on the last 3th day. For the normal of the temperature must be adjusted to 90 - 92 °F must be set and humidity in the machine should be adjusted to 65-70% at the last 3 day.

For the embryo death, if the temperature drops below 92 °F and the humidity rise above 80 %, the embryo will not grow and die.

For the abnormal, when the temperature rises above 93°F and the humidity drops below 35 %, the embryo develops polio when the temperature rises.

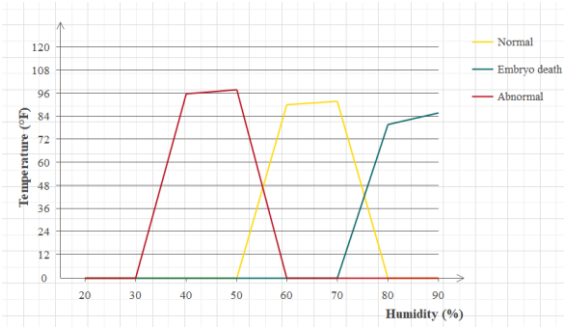

Figure 9. Comparison Result Curve in the Incubator on the Last 3th day

VIII. Conclusion

From the implementation of the design, it is clear that the temperature of the eggs remains constant unlike the natural method where most times the mother chicken is not available to seat on the eggs. The constructed incubator can accommodate hundreds of eggs which the natural method is short of doing. Apart from that, the eggs fertilized well with little or no affected eggs. The egg is put into a machine and then heated into a chick. A chick is born from a single cell and comes out of a viable egg.

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Mathematical Computing

Real Life Application of Laplace Transform Theory in the Field of Cryptography

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***Abstract*:** The concept of Laplace Transform plays a vital role in wide fields of science and technology such as electric & communication engineering, and solution of partial differential operation, etc. In this paper, the application of Laplace Transform in Cryptography is presented. In today IT environment, we have been experiencing various types of crimes. Protection against cybercrime is very challenging task among all other crimes. Various applications are developed to protect sensible data or information from hackers. Electronic data security in areas such as internet transactions, mobile phone transactions, transmitting financial information, security of ATM cards, computer passwords etc, which we use in our daily lives, become important. In this paper, application of Laplace Transform theory in cryptography in both data encryption and decryption, is presented. Matlab software is the best suitable application for solving Laplace transform equation, otherwise C# application shall be used as well. This paper intends to contribute for application of engineering mathematics such as Laplace transform in the development of software application for electronic data security.

***Keywords*:** cryptography, encryption. Decryption, Laplace transform, security

I. Introduction

Mathematical theories have been used in solving different complex problem in different engineering disciplines. Off the various mathematical theories, Laplace Transform is a very powerful tool in solving liner Ordinal differential equations and initial value problems. (Kreyszig, 2006) With the development in information technology and its application in different business transactions, information or electronic data security, cyber security become very important in day to day business transactions and protection of cyber related crimes. Therefore the research study of application of Laplace Transform in the field of cryptography is presented in this paper as a contribution to help solve the above mentioned challenges and issues.

II. Objective

The objective of this paper is to introduce the application of Laplace Transform theory in the field of cryptography which develops secure communications techniques that allow only the sender and intended recipient of a message to view its contents for electronic data security.

III. Literature Review

A brief review on the definition and application areas of cryptography and Laplace Transform theory are presented in this section.

A. Cryptography

Cryptography is a method of storing and transmitting data in a particular form so that only those for whom it is intended can read and process it. It is the field of encrypting information or digital data by using mathematics, computer science and engineering approaches. In today's world, cryptography is also often used to provide security in computer based systems or applications like e-business, e-marketing, e-science, e-government and e-signature. (Duz, 2017)

Message that is going to be transmitted or stored is plain text. Anyone can read plaintext. The method by which we can hide the actual meaning of plaintext is called Encryption. The result of encryption which results in unreadable gibberish is called Cipher text. The method by which the original meaning of cipher text can be recovered is called Decryption. Simply the process of converting Cipher text to plaintext is called Decryption. (Mohamed Barakat, Christian Eder, Timo Hanke, 2018)

B. Laplace Transform

Transformation in mathematics deals with the conversion of one function to another function that may not be in the same domain.

Laplace transform is a powerful transformation tool, which literally transforms the original differential equation into an elementary algebraic expression. This latter can then simply be transformed once again, into the solution of the original problem.

This transform is named after the mathematician and renowned astronomer Pierre Simon Laplace who lived in France.

$$\mathcal{L}\{f(t)\}=F(S)=\int_0^\infty f(t)e^{-st}\,dt$$

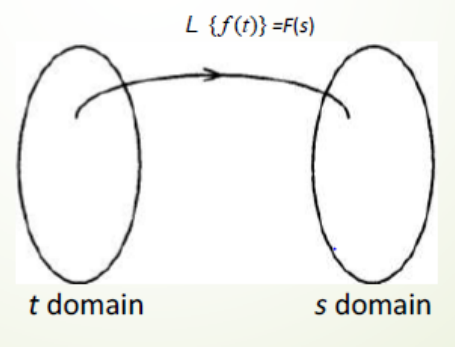

Figure 1. Laplace Transform Function

In order to apply the Laplace transform to physical problems, it is necessary to invoke the inverse transform. If L{f(t)}= F(s), then the inverse Laplace Transform is denoted by;

$$\mathcal{L}^{-1}\{F(s)\}=f(t),\qquad t\geq 0$$

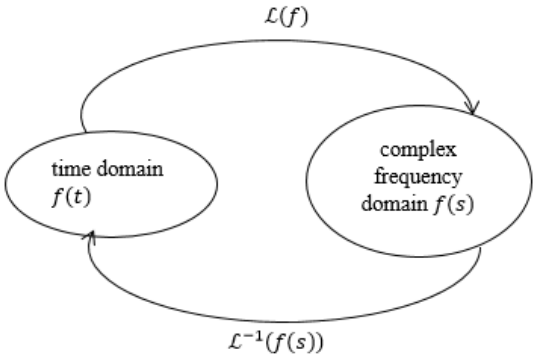

Figure 2. Inversed Laplace Transform Function

If $f(t)$ is a function defined for all positive value of t. then the Laplace transform of $f(t)$ is defined as

$$\mathcal{L}\{f(t)\}=F(S)=\int_0^\infty f(t)e^{-st}\,dt.$$

Linear property of Laplace Transforms:

$\mathcal{L}\{f(t)\}=F(S)$ and $L\{g(t)\}=G(S)$ then

$$\mathcal{L}\{c_1f(t)+c_2g(t)\}=c_1\,\mathcal{L}\{f(t)\}+c_2\mathcal{L}\{g(t)\}$$

$c_1F(S)+\ c_2G(S)$ Where c_1 and c_2 are constants

Laplace Transform of Elementary Functions:

1. $\mathcal{L}[t^n]=\frac{n!}{s^{n+1}}$ Where n is positive integer
2. $\mathcal{L}^{-1}\left[\frac{1}{s^{n+1}}\right]=\frac{t^n}{n!}$ Where n is positive integer
3. $\mathcal{L}[te^{at}]=\frac{1}{(s-a)^2}$
4. $\mathcal{L}^{-1}\left[\frac{1}{(s-a)^2}\right]=te^{at}$

IV. Applications of Laplace Transform to Cryptography

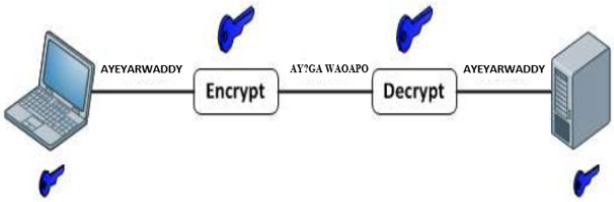

Figure 3. Cryptographic Presentation

A. Encryption

Consider standard expansion

$e^{at}=1+\frac{at}{1!}+\frac{a^2t^2}{2!}+\frac{a^3t^3}{3!}+\ldots$, Where a is any number

And $te^{at}=t+\frac{at^2}{1!}+\frac{a^2t^3}{2!}+\frac{a^3t^4}{3!}+\ldots$, where a is any number

Suppose sender wants to send the message "AYEYARWADDY"

Table 1. Alphabet Allocation Tables

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

R	S	T	U	V	W	X	Y	Z	Space	.	,	?	!	"	"
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Let the given message be "AYEYARWADDY". It is equivalent to.

Table 2. Allocation in Example

"	A	Y	E	Y	A	R	W	A	D	D	Y	"
31	0	24	4	24	0	17	22	0	3	3	24	32

Write these numbers as the coefficient of te^{at}, we have

$$f(t) = te^{at} = 31t + 0 \times \frac{at^2}{1!} + 24 \times \frac{a^2t^3}{2!} + 4 \times \frac{a^3t^4}{3!} + 24 \times \frac{a^4t^5}{4!} + 0 \times \frac{a^5t^6}{5!} + 17 \times \frac{a^6t^7}{6!} + 22 \times \frac{a^7t^8}{7!} + 0 \times \frac{a^8t^9}{8!} + 3 \times \frac{a^9t^{10}}{9!} + 3 \times \frac{a^{10}t^{11}}{10!} + 24 \times \frac{a^{11}t^{12}}{11!} + 32 \times \frac{a^{12}t^{13}}{12!}$$

Suppose if we take a=2, we get

$$f(t) = te^{2t} = 31t + 0 \times \frac{2t^2}{1!} + 24 \times \frac{2^2t^3}{2!} + 4 \times \frac{2^3t^4}{3!} + 24 \times \frac{2^4t^5}{4!} + 0 \times \frac{2^5t^6}{5!} + 17 \times \frac{2^6t^7}{6!} + 22 \times \frac{2^7t^8}{7!} + 0 \times \frac{2^8t^9}{8!} + 3 \times \frac{2^9t^{10}}{9!} + 3 \times \frac{2^{10}t^{11}}{10!} + 24 \times \frac{2^{11}t^{12}}{11!} + 32 \times \frac{2^{12}t^{13}}{12!}$$

$$f(t) = te^{2t} = 31t + 0 \times \frac{t^2}{1!} + 96 \times \frac{t^3}{2!} + 32 \times \frac{t^4}{3!} + 384 \times \frac{t^5}{4!} + 0 \times \frac{t^6}{5!} + 1088 \times \frac{t^7}{6!} + 2816 \times \frac{t^8}{7!} + 0 \times \frac{t^9}{8!} + 1536 \times \frac{t^{10}}{9!} + 3072 \times \frac{t^{11}}{10!} + 49152 \times \frac{t^{12}}{11!} + 131072 \times \frac{t^{13}}{12!}$$

Taking Laplace transform on both side, we get

$$\mathcal{L}[te^{2t}] = \mathcal{L}\left[31t + 0 \times \frac{t^2}{1!} + 96 \times \frac{t^3}{2!} + 32 \times \frac{t^4}{3!} + 384 \times \frac{t^5}{4!} + 0 \times \frac{t^6}{5!} + 1088 \times \frac{t^7}{6!} + 2816 \times \frac{t^8}{7!} + 0 \times \frac{t^9}{8!} + 1536 \times \frac{t^{10}}{9!} + 3072 \times \frac{t^{11}}{10!} + 49152 \times \frac{t^{12}}{11!} + 131072 \times \frac{t^{13}}{12!}\right]$$

$$= \frac{31}{s^2} + 0 \times \frac{2}{s^3} + \frac{96}{2!} \times \frac{3!}{s^4} + \frac{32}{3!} \times \frac{4!}{s^5} + \frac{384}{4!} \times \frac{5!}{s^6} + 0 \times \frac{6}{s^7} + \frac{1088}{6!} \times \frac{7!}{s^8} + \frac{2816}{7!} \times \frac{8!}{s^9} + 0 \times \frac{9}{s^{10}} + \frac{1536}{9!} \times \frac{10!}{s^{11}} + \frac{3072}{10!} \times \frac{11!}{s^{12}} + \frac{49152}{11!} \times \frac{12!}{s^{13}} + \frac{131072}{12!} \times \frac{13!}{s^{14}}$$

$$\frac{1}{(s-a)^2} = \frac{31}{s^2} + 0 \times \frac{1}{s^3} + 288 \times \frac{1}{s^4} + 128 \times \frac{1}{s^5} + 1920 \times \frac{1}{s^6} + 0 \times \frac{1}{s^7} + 7616 \times \frac{1}{s^8} + 22528 \times \frac{1}{s^9} + 0 \times \frac{1}{s^{10}} + 15360 \times \frac{1}{s^{11}} + 33792 \times \frac{1}{s^{12}} + 589824 \times \frac{1}{s^{13}} + 1703936 \times \frac{1}{s^{14}}$$

Now let m_i, for $i = 0,1,2, \ldots$ be the coefficient values of the above expansion

i.e, $m_0 = 31,\ m_1 = 0,\ m_2 = 288\ , m_3 = 128\ , m_4 = 1920\ , m_5 = 0\ , m_6 = 7616\ , m_7 = 22528\ , m_8 = 0\ , m_9 = 15360\ , m_{10} = 33792\ , m_{11} = 589824\ , m_{12} = 1703936$

Adjusting the value m_i „ for $i = 0,1,2, \ldots$ to mod 33 , we get the result values

31, 0,24,29,6,0,26,22,0,14,0,15,14

Let these value as

$$n_0 = 31,\ n_1 = 0,\ n_2 = 24\ , n_3 = 29\ , n_4 = 6\ , n_5 = 0\ , n_6 = 26, n_7 = 22\ , n_8 = 0\ , n_9 = 14\ , n_{10} = 0\ , n_{11} = 15\ , n_{12} = 14$$

To find key consider $n = m - 33 * key$

By using $n_i = m_i - 33 * k_i$ for $i = 0,1,2, \ldots$

We get the following key value

$$k_0 = 0,\ k_1 = 0,\ k_2 = 8\ , k_3 = 3\ , k_4 = 58\ , k_5 = 0\ , k_6 = 215, k_7 = 682\ , k_8 = 0\ , k_9 = 0\ , k_{10} = 1024\ , k_{11} = 17873\ , k_{12} = 51634$$

The resultant converted the message by using allotment

Table 3. **Converted Allocation in Example**

31	0	24	29	6	0	26	22	0	14	0	15	14
“	A	Y	?	G	A		W	A	O	A	P	O

Therefore the message converse

“AYEYARWADDY” in to “AY?GA WAOAPO

The sender publically sends the message and “ te^{2t}“., privately sends the key and Laplace expansion.

B. Decryption

The receiver the message“AY?GA WAOAPO.

The equivalent value are

Table 4 Backward Allocation in Example

“	A	Y	?	G	A		W	A	O	A	P	O
31	0	24	29	6	0	26	22	0	14	0	15	14

$$i.e\ n_0 = 31,\ n_1 = 0,\ n_2 = 24\ , n_3 = 29\ , n_4 = 6\ , n_5 = 0\ , n_6 = 26, n_7 = 22\ , n_8 = 0\ , n_9 = 14\ , n_{10} = 0\ , n_{11} = 15\ , n_{12} = 14$$

And the private key value are

$$k_0 = 0,\ k_1 = 0,\ k_2 = 8\ , k_3 = 3\ , k_4 = 58\ , k_5 = 0\ , k_6 = 215, k_7 = 682\ , k_8 = 0\ , k_9 = 0\ , k_{10} = 1024\ , k_{11} = 17873\ , k_{12} = 51634$$

To decrypt, consider $m_i = n_i + 33 * k_i$ for $i = 0,1,2, \ldots$

$$m_0 = 31,\ m_1 = 0,\ m_2 = 288\ , m_3 = 128\ , m_4 = 1920\ , m_5 = 0\ , m_6 = 7616\ , m_7 = 22528\ , m_8 = 0\ , m_9 = 15360\ , m_{10} = 33792\ , m_{11} = 589824\ , m_{12} = 1703936$$

$$\Longrightarrow \frac{1}{(s-a)^2} = \frac{31}{s^2} + 0 \times \frac{1}{s^3} + 288 \times \frac{1}{s^4} + 128 \times \frac{1}{s^5} + 1920 \times \frac{1}{s^6} + 0 \times \frac{1}{s^7} + 7616 \times \frac{1}{s^8} + 22528 \times \frac{1}{s^9} + 0 \times \frac{1}{s^{10}} + 15360 \times \frac{1}{s^{11}} + 33792 \times \frac{1}{s^{12}} + 589824 \times \frac{1}{s^{13}} + 1703936 \times \frac{1}{s^{14}}$$

Taking inverse Laplace transform

$$\mathcal{L}^{-1}\left[\frac{1}{(s-a)^2}\right] = \mathcal{L}^{-1}\left[\frac{31}{s^2} + 0 \times \frac{1}{s^3} + 288 \times \frac{1}{s^4} + 128 \times \frac{1}{s^5} + 1920 \times \frac{1}{s^6} + 0 \times \frac{1}{s^7} + 7616 \times \frac{1}{s^8} + 22528 \times \frac{1}{s^9} + 0 \times \frac{1}{s^{10}} + 15360 \times \frac{1}{s^{11}} + 33792 \times \frac{1}{s^{12}} + 589824 \times \frac{1}{s^{13}} + 1703936 \times \frac{1}{s^{14}}\right]$$

$$te^{2t} = \left[31\frac{t}{1!} + 0 \times \frac{t^2}{2!} + 288 \times \frac{t^3}{3!} + 128 \times \frac{t^4}{4!} + 1920 \times \frac{t^5}{5!} + 0 \times \frac{t^6}{6!} + 7616 \times \frac{t^7}{7!} + 22528 \times \frac{t^8}{8!} + 0 \times \frac{t^9}{9!} + 15360 \times \frac{t^{10}}{10!} + 33792 \times \frac{t^{11}}{11!} + 589824 \times \frac{t^{12}}{12!} + 1703936 \times \frac{t^{13}}{13!}\right]$$

$$e^{2t} = \left[31 + 0 \times \frac{t}{!} + 288 \times \frac{t^2}{3!} + 128 \times \frac{3}{4!} + 1920 \times \frac{4}{5!} + 0 \times \frac{t^5}{6!} + 7616 \times \frac{6}{7!} + 22528 \times \frac{t^7}{8!} + 0 \times \frac{8}{9!} + 15360 \times \frac{t^9}{10!} + 33792 \times \frac{t^{10}}{11!} + 589824 \times \frac{t^{11}}{12!} + 1703936 \times \frac{t^{12}}{13!}\right]$$

$$e^{2t} = 31 + 0 \times \frac{2t}{1!} + 24 \times \frac{2^2t^3}{2!} + 4 \times \frac{2^3t^4}{3!} + 24 \times \frac{2^4t^5}{4!} + 0 \times \frac{2^5t^6}{5!} + 17 \times \frac{2^6t^7}{6!} + 22 \times \frac{2^7t^8}{7!} + 0 \times \frac{2^8t^9}{8!} + 3 \times \frac{2^9t^{10}}{9!} + 3 \times \frac{2^{10}t^{11}}{10!} + 24 \times \frac{2^{11}t^{12}}{11!} + 32 \times \frac{2^{12}t^{13}}{12!}$$

The expansion (2) coefficient are

31, 0, 24, 4, 24, 0, 17, 22, 0,3,3,24,32

It is equivalent to

Table 4 Backward Converted Allocation in Example

31	0	24	4	24	0	17	22	0	3	3	24	32
“	A	Y	E	Y	A	R	W	A	D	D	Y	”

Therefore we get the message “AYEYARWADDY”.

It is obvious that the shorter the data length, the better the data security, and the longer the data length, the more vulnerable to the hacker’s attack. Other aspect of algorithm is key length it can be considered as advantage in some application or disadvantage in case of data length limited application.

V. Conclusion

With the advancement in development of information technology, lots of day to day transactions are performed with the use of electronic means, on the other hand, electronic data security is of real importance to protect data hacking and prevent cybercrimes. This research paper presents encryption and decryption of transmitted data in order that transaction is performed in secure way. In this paper, we use the long key, for example, key of 4096 bits, to break it by Bruce force attack, when faster super computers are used. In the proposed work we developed a new cryptographic scheme using Laplace transform and the key is the number multiples of mod n. Therefore it is very difficult for an eyedropper to trace the key by any attack. The similar results can be obtained by using Laplace transform of other suitable function. Hence extension of this work is possible. Moreover the entire document can encrypted by considering block cipher of small size. This development and relevant extension can be used in Electronic data security in areas such as internet transactions, mobile phone transactions, transmitting financial information, security of ATM cards, computer passwords.

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Application of Linear Programming in Wheat Noodles Production Selling Problem

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***Abstract*:** The purpose of this paper is to give the optimal profit of wheat noodles production selling problem in real life by using the graphical method, which is one of the linear programming (LP) methods. In the first part of this paper, the standard form, types of solutions and calculation steps of LP model are presented. In the second part, the wheat noodles production selling problem transformed into linear programming model and then the possible maximum profit of the wheat noodles production selling problem is given by using graphical method with the aid of Matlab codes.

***Keywords*:** Graphical, Linear, Matlab, Maximum, Production, Profit, Programming, Selling, Wheat noodles.

I. Introduction

The word linear programming (LP) is the most popular tool to solve the real life decision making problems. The keys of linear LP problems are all the mathematical functions in the problem must be linear functions and the word programming means for planning. A very important aspect of LPP is finding the optimal solution of resources such that desired result is maximized or minimized. For example, there would be a food processing plant wants to maximize its profits but it is limited in its production by the number of employees it has. Linear programming is a mathematical technique that solves certain real life problems of aforementioned kinds [3]. Nowadays most of the people all over the world consume wheat noodles widely and as a consequence, the food production plant produce noodles widely. Wheat noodles are the form of long, round or flat noodles which are made from wheat flour, water and salt, with the addition of eggs depending on the desired texture and taste of the noodles.

II. Preliminaries

A. Standard Form of LP Model

In general, the mathematical models of liner programming problems are as follow:

$$Z=c_1x_1 + c_2x_2 + \cdots + c_nx_n \qquad (1)$$

subject to the constraints,

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n &\le b_1 \\ a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n &\le b_2 \\ &\vdots \\ a_{m1}x_1 + a_{m2}x_2 + ... + a_{mn}x_n &\le b_m, \end{aligned} \qquad (2)$$

and $x_j \ge 0, \text{for } j = 1, 2, ..., n \text{ and } i = 1, 2, ..., m,$ where $a_{ij}, b_i \text{ and } c_j$ are given constraints and $m < n$, $x_1, x_2, ..., x_n$ are the decision variables [4]. The model also applies if the inequality symbols are >, < or ≥.

B. Some Definitions for Solution of LP Model

1) A *feasible solution* is a solution for which all the constraints are satisfied.
2) The *feasible region* is the collection of all feasible solutions.
3) An *optimal solution* is a feasible solution that has the most favorable value of the objective function.
4) A *corner-point* feasible solution is a solution that lies at a corner of the feasible region.

C. Graphical Method

Transform the inequalities (2) of the section II A to the equations, and then draw the lines. These lines are the boundaries between two half planes. To get the feasible region, select a point that is not on the line from one half planes. The origin (0, 0) is usually a best choice when it is not on the line. If (0, 0) lays on the line, select a point that is not on the line. Substitute the coordinates of the point for x and y in the inequality. If the selected point is satisfy the inequality, shade the half plane where the selected point lies. If the selected point does not satisfy the inequality, shade the half plane opposite of it. After getting the feasible region, do the following steps, [6], [8].

Step 1. Use each constraint in turn to sketch the boundary of the feasible region.

Step 2. Determine the corner points of the feasible region by solving pairs of linear equations, obtained from the constraints.

Step 3. Evaluate the objective function at each corner point.

Step 4. The maximum or minimum of the objective function at corner points yields the desired maximum or minimum.

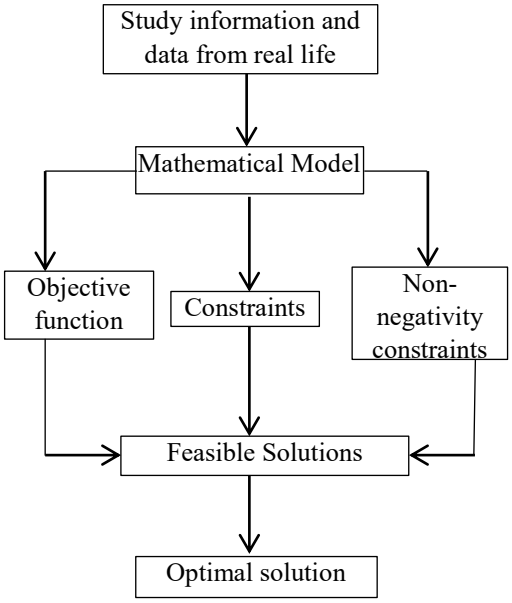

Figure 1. Calculation Process of LP Model

III. Finding The Optimal Profit of Wheat Noodles Production Selling Problem

In this section, wheat noodles production selling problem forms as linear programming problem and illustrated as follow:

Emerald Asia is a wheat noodles production plant and wants to produce two new types of wheat noodles , regular noodles (Brand X) and egg noodles (Brand Y).They grind their own wheat flour for both brands at a maximum rate 400 pounds per week. Brand A and Brand B require ½ pound ¼ pound flour per pound of dried noodles. They joined Golden Land Poultry Farms Group, and ordered 600 pounds of eggs per week. Brand A and Brand B require 1/3 pound and ½ pound of eggs per pound of dried noodles. Emerald Asia has 6 employees and working time is 40 hours per week each. Brand A and Brand B require 10 minutes and 15 minutes of labor respectively. They earn $3 profit for Brand A and $5 profit for Brand B per pound. Obviously that which is a maximization problem and the main aim is trying to maximize their sales. Sales means the total amount of money brought in by all of the products being sold. In this problem $3x + 5y$, where x and y represent the number of units sold of the regular noodles and egg noodles respectively. The second part is identifying the constraints of given data and observe that they are linear. The first limitation is flour, the plant grind the flour with a maximum rate 400 pounds per week, hence ½ x +¼ y ≤400. Similarly, constraint for eggs is, 1/3 x + ½ y ≤ 600 and the constraint for labor is, the plant has (6 labors)* (40 hours per week each)*(60 minutes) = 14400 minutes, 10 x + 15 y ≤ 14400. Finally, just only non-negative values of x and y make sense, giving with last two constraints, $x \geq 0$ and $y \geq 0$. Hence the mathematical linear programming model can be written as follow:

Maximize $Z = 3x + 5y$

Subject to $\frac{1}{2}x + \frac{1}{4}y \leq 400$

$\frac{1}{3}x + \frac{1}{2}y \leq 600$

$10x + 150y \leq 14400$

and $x \geq 0, y \geq 0.$

The problem has only two decision variables such as x and y. Hence, to get the optimal solution of this type of problem, graphical method is convenient and which is one of the linear programming techniques can be used.

By the graphical method, transform the above inequalities to equations as follow:

$$\frac{1}{2}x + \frac{1}{4}y = 400$$

$$\frac{1}{3}x + \frac{1}{2}y = 600$$

$$10x + 15y = 14400$$

Let $L_1 : y = 1600 - 2x$, $L_2 : y = 1200 - \frac{2}{3}x$,

and $L_3 : y = 960 - \frac{2}{3}x$. L_1, L_2 and L_3 pass through the points (0, 1600) and (800, 0), (0, 1200) and (1800, 0), (0,960) and (1440, 0) respectively. There are many methods to draw the graph of these three lines, in this paper, choosing Matlab [2]. By running the following codes in command window or with .m file, getting the Figure 2.

```
x =[0,800];
y =[1600,0];
plot(x,y)
x1=[0,1800];
```

```
y1=[1200,0];
hold on
plot(x1,y1)
x2=[0,1440];
y2=[960,0];
hold on
plot(x2,y2)
hold off
```

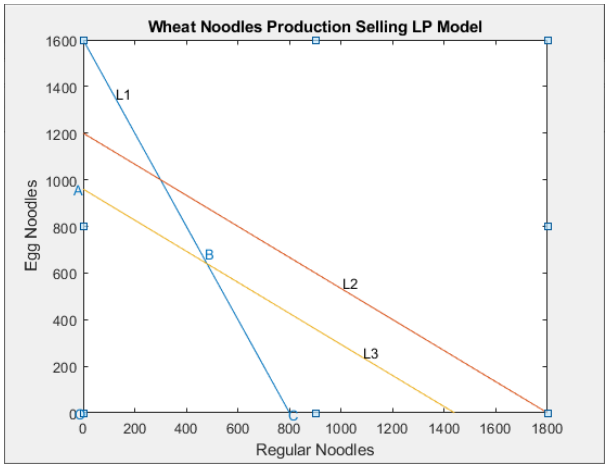

Figure 2. Regular Noodles Against Egg Noodles

Let B be the point of intersection of L_1 and L_3. The coordinates of point B (480,640) is getting by solving the equations of L_1 and L_3. The region bounded by the segments OA, AB, BC and CO is a feasible region.

At (0, 0), $Z = 3x + 5y = 0.$

At (480, 640), $Z = 3(480) + 5(640) = 4640.$

At C (800, 0), $Z = 3(800) + 0 = 2400.$

At A (0,960), $Z = 0 + 5(960) = 4800.$

Hence, Emerald Asia should be produced 480 pounds of regular noodles and 640 pounds of egg noodles to get the maximum profit $4640.

IV. Conclusion

This paper can support the person who interesting in wheat noodles marketing. The prices may be changing depend on the related ingredients for wheat noodles production. The optimal profit can get from corner points of feasible region. Hence, linear programming is an application of mathematics technique that was developed to solve the decision making problems in several different ways. This paper also shows out the very useful finding method of optimal solution for LPP. This paper can help management sciences, computer sciences, engineering fields and many other application fields and makes valued support to teaching pedagogies for faculty of computing.

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Building the Digital Circuits by Using Propositional Logic

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Abstract: The main aim of this paper is building the digital circuits manually. In the first part of in this paper, definitions of negation, conjunction, disjunction, exclusive or and digital circuits are presented. And then truth table with bit and types of gates such as inverter gate, OR gate and AND gate are illustrated. Finally, the objective of this paper, the digital circuits are built by propositional logic.

Keywords: Digital circuits, Logic, Logic circuits, OR /AND gate, Propositional, Statement, Truth tables.

I. Introduction

The word, propositional logic comes from the area of logic that deals with propositions. Nowadays Building the digital circuits are very useful in hardware, software technologies and electronic circuits. A proposition is a declarative sentence that is either true or false, but not both. For example, Naypyitaw is the capital of Myanmar, Kawthoung is the capital of Tanintharyi, 1+7=8 and 4+4 = 5 are the declarative sentences and What colour is it? , Take care, n+7 = 8 and x+y = z are not propositions which means opinions, interrogative and imperative are not propositions. The small letters p, q, r, … are represented as propositional variables.

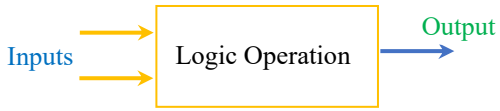

Figure 1. Basic Logic Gate for OR/ AND Gate

II. Some Basic Definitions

Table 1. Truth Table for True and False Propositions

Truth Value	Bit
T	1
F	0

A. Negation

Let p be a proposition. The negation of p is denoted by $\neg p$ (also denoted by $\overline{p}$) [1].

B. Conjunction

Let r and s be propositions. The conjunction of r and s, denoted by $r \wedge s$, is the proposition "r and s". The conjunction $r \wedge s$ is true when both r and s are true and is false otherwise [2].

C. Disjunction

Let s and t be propositions. The disjunction of s and t, denoted by $s \vee t$, is the proposition "s or t". The disjunction $s \vee t$ is false when both s and t are false and is true otherwise [2].

D. Exclusive Or

Let q and r be propositions. The exclusive or of q and r, denoted by $q \oplus r$, is the proposition that is true when exactly one of q and r is true and is false otherwise [2].

E. Digital Circuits

A digital circuit is a circuit which receives finite input signals $q_1,q_2,q_3,\ldots, q_n$ each a bit and produces finite number of output signals $r_1,r_2,r_3,\ldots, r_n$ each a bit.

F. Types of Gates

There are three basic circuits and called gates and these are the inverter (NOT gate), OR gate and AND gate.

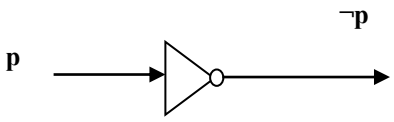

Figure 2. Inverter Gate

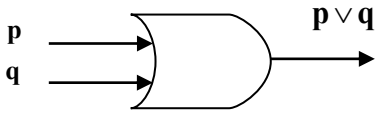

Figure 3. OR Gate

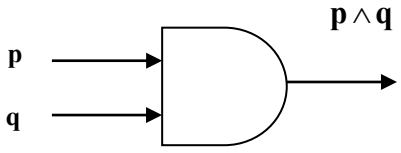

Figure 4. AND Gate

III. Building the Digital Gate

A. Illustration 1

The objectives of this illustration are constructing the truth table and building a digital circuit that produces the output $\neg(p \wedge q) \vee q$ when input bits p and q are given. First, construct a truth table of $p \wedge q$, $\neg(p \wedge q)$, $\neg(p \wedge q) \vee q$ as in Table 2. To build a digital circuit of $\neg(p \wedge q) \vee q$, contain two inputs p and q with AND gate and then use an inverter to produce $\neg(p \wedge q)$. Finally the desired circuit is getting by combining up with OR gate as shown in Figure 5.

Table 2. Truth Table for $\neg(p \wedge q) \vee q$

p	q	$p \wedge q$	$\neg(p \wedge q)$	$\neg(p \wedge q) \vee q$
0	0	0	1	1
0	1	0	1	1
1	0	0	1	1
1	1	1	0	1

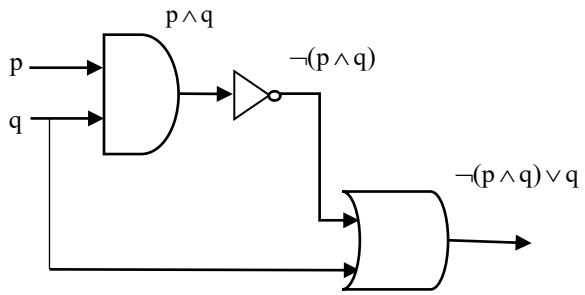

Figure 5. Digital Circuit of $\neg(p \wedge q) \vee q$

B. Illustration 2

The objectives of this illustration are constructing the truth table and building a digital circuit that produces the output $(p \vee q) \wedge (\neg p)$ when input bits p and q are given. First, construct a truth table of $p \vee q$, $\neg p$, $(p \vee q) \wedge (\neg p)$ as in Table 3. To build a digital circuit of $(p \vee q) \wedge (\neg p)$, contain two inputs p and q with OR gate and then use an inverter to produce $\neg p$. Finally the desired circuit is getting by combining up with AND gate as shown in Figure 6.

Table 3.Truth Table for $(p \vee q) \wedge (\neg p)$

p	q	$p \vee q$	$\neg p$	$(p \vee q) \wedge (\neg p)$
0	0	0	1	0
0	1	1	1	1
1	0	1	0	0
1	1	1	0	0

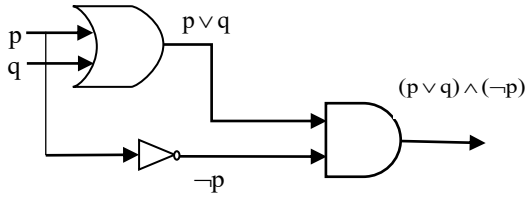

Figure 6. Digital Circuit of $(p \vee q) \wedge (\neg p)$

C. Illustration 3

The objectives of this illustration are constructing the truth table and building a digital circuit that produces the output $(\neg p \vee \neg q) \wedge \neg(\neg p)$ when input bits p and q are given. First, construct a truth table of $\neg p$, $\neg q$, $\neg(\neg p)$, $(\neg p \vee \neg q)$ and $(\neg p \vee \neg q) \wedge \neg(\neg p)$ as in Table 4. To build a digital circuit of $(\neg p \vee \neg q) \wedge \neg(\neg p)$, contain two inputs p and q with OR gate and then use an inverter to produce $\neg p$, $\neg q$, $\neg(\neg p)$. Finally the desired circuit is getting by combining up with AND gate as shown in Figure 7.

Table 4.Truth Table for $(\neg p \vee \neg q) \vee \neg(\neg p)$

p	q	$\neg p$	$\neg q$	$\neg(\neg p)$	$(\neg p \vee \neg q)$	$(\neg p \vee \neg q) \wedge (\neg(\neg p))$
0	0	1	1	0	1	0
0	1	1	0	0	1	0
1	0	0	1	1	1	1
1	1	0	0	1	0	0

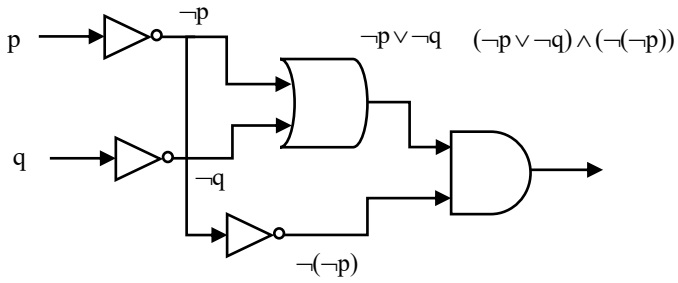

Figure 7. Digital Circuit of $(\neg p \vee \neg q) \wedge (\neg(\neg p))$

D. Illustration 4

The objectives of this illustration are constructing the truth table and building a digital circuit that produces the output $(p \vee \neg r) \wedge \neg q$ when input bits p, q and r are given. First, construct a truth table of $\neg q$, $\neg r$, $p \vee \neg r$, $(p \vee \neg r) \wedge \neg q$ in Table 5. To build a digital circuit of $(p \vee \neg r) \wedge \neg q$, contain three inputs p, q and r with use an inverter to produce $\neg q$, $\neg r$ and then with

OR gate. Finally the desired circuit is getting by combining up with AND gate as shown in Figure 8.

Table 5.Truth Table for $(p \vee \neg r) \wedge \neg q$

p	q	r	$\neg q$	$\neg r$	$p \vee \neg r$	$(p \vee \neg r) \wedge \neg q$
0	0	0	1	1	1	1
0	0	1	1	0	0	0
0	1	0	0	1	1	0
0	1	1	0	0	0	0
1	0	0	1	1	1	1
1	0	1	1	0	1	1
1	1	0	0	1	1	0
1	1	1	0	0	1	0

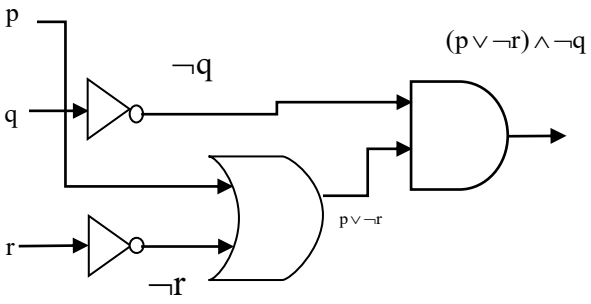

Figure 8. Digital Circuit of $(p \vee \neg r) \wedge \neg q$

E. Illustration 5

The objectives of this illustration are constructing the truth table and building a digital circuit that produces the output $(p \vee (q \wedge \neg r)) \wedge \neg s$ when input bits p, q, r and s are given. First, construct a truth table of $\neg r$, $\neg s$, $q \wedge \neg r$, $p \vee (q \wedge \neg r)$, $(p \vee (q \wedge \neg r)) \wedge \neg s$ as in Table 6. To build a digital circuit of $(p \vee (q \wedge \neg r)) \wedge \neg s$, contain four inputs p, q, r and s with use an inverter to produce $\neg r$, $\neg s$ and then use AND gate and OR gate. Finally the desired circuit is getting by combining up with AND gate as shown in Figure 9.

Table 6.Truth Table for $(p \vee (q \wedge \neg r)) \wedge \neg s$

p	q	r	s	$\neg r$	$\neg s$	$q \wedge (\neg r)$	$p \vee (q \wedge \neg r)$	$(p \vee (q \wedge \neg r)) \wedge \neg s$
0	0	0	0	1	1	0	0	0
0	0	0	1	1	0	0	0	0
0	0	1	0	0	1	0	0	0
0	0	1	1	0	0	0	0	0
0	1	0	0	1	1	1	1	1
0	1	0	1	1	0	1	1	0
0	1	1	0	0	1	0	0	0
0	1	1	1	0	0	0	0	0
1	0	0	0	1	1	0	1	1
1	0	0	1	1	0	0	1	0
1	0	1	0	0	1	0	1	1
1	0	1	1	0	0	0	1	0
1	1	0	0	1	1	1	1	1
1	1	0	1	1	0	1	1	0
1	1	1	0	0	1	0	1	1
1	1	1	1	0	0	0	1	0

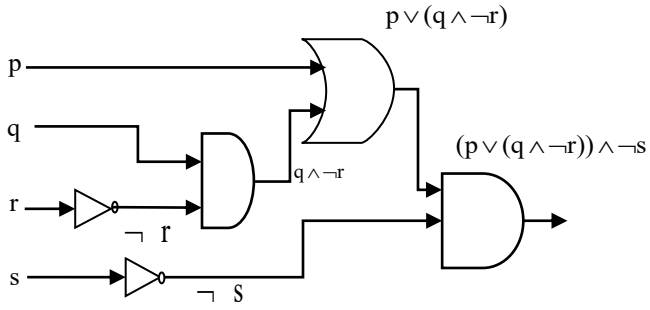

Figure 9. Digital Circuit of $(p \vee (q \wedge \neg r)) \wedge \neg s$

IV. Conclusion

The results of this paper is showing that if the usages of inverter gate, OR gate and AND gate are changing, the results of circuits are changing. In this paper, truth tables are presented to examine the operation of the basic logic gate. As in related works, all electronic projects would be nearly incomplete if it had no use of logic gates. Hence, this research paper can strongly help to all the basic learners of electronics and makes valued support to teaching pedagogies for faculty of computing.

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Practical Applications of Determinants in Real Life

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***Abstract*:** The purpose of this paper is to give how to find area between three places by using the rules of determinants. In the first part, the facts of determinants are introduced. And then the definitions of determinant, co-factor, scalar multiplication and area of the triangle are presented as preliminaries. Finally, the areas of cities triangle, universities triangle and Islands triangle in Tanintharyi Region are calculated by the rules of determinants.

***Keywords*:** determinants, practical, applications, calculation, preliminaries, areas, cities triangle, regions, Islands triangle, Tanintharyi Region**,** universities triangle

I. Introduction

A determinant is a function depending on n that associates a scalar, det(A), to every ever n×n matrix A. Determinants were originally introduced for solving linear system. Although impractical in computations, they have engineering applications in eigenvalue problems, differential equations, vector algebra and in other areas [3]. The fundamental geometric meaning of a determinant acts as the scale factor for area or volume when A is regarded as a linear transformation. Determinants are important in Calculus, where they enter the substitution rule for several variables. The determinant has a variety of applications and the value of the determinant can give the areas of triangles too.

II. Preliminaries

A. Determinant

The A determinant is an array of elements expressed in rows and columns. Thus,

$$|A| = \begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix}$$

is a determinant of the second order. The set of rows and columns is bracketed between vertical lines. Determinant is a scalar quantity. The second-order determinant is defined as

$$\begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix} = a_{11}a_{22} - a_{21}a_{12}.$$

B. Co-Factor

M_{ij}, minor of an element a_{ij} is obtained by omitting the row and the column containing the element a_{ij}, i.e., eliminate the row i^{th} and j^{th} column. Thus, in the determinant

$$A = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}.$$

The minor of the element a_{22} is obtained by eliminating the second row and the second column. Thus, minor of a_{22} is $\begin{vmatrix} a_{11} & a_{13} \\ a_{31} & a_{33} \end{vmatrix}$.Similarly, minor of a_{13} is $\begin{vmatrix} a_{21} & a_{22} \\ a_{31} & a_{32} \end{vmatrix}$, and the "co-factor", A_{ij} of an element a_{ij} is defined as $A_{ij}=(-1)^{i+j}M_{ij}$, where M_{ij} is "minor" of a_{ij}. Thus, if $i+j$ is even, then $A_{ij} = M_{ij}$ and if $i+j$ is odd, then $A_{ij} = -M_{ij}$.

C. Scalar Multiplication

The determinant is said to be multiplied by a constant k if each element in any row or column is multiplied by k. Thus, if

$$|A| = \begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix}$$

Then

$$k|A| = \begin{vmatrix} ka_{11} & a_{12} \\ ka_{21} & a_{22} \end{vmatrix} = ka_{11}a_{22} - ka_{21}a_{12}$$
$$= k(a_{11}a_{22} - a_{21}a_{12}).$$

D. Area of a Triangle

The area of a triangle with vertices (x_1, y_1), (x_2, y_2) and (x_3, y_3) is given by

$$\text{Area} = \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} \qquad (1)$$

where ± means the appropriate sign should be chosen to yield a positive value.

III. Practical Applications

A. Illustration 1

Tanintharyi Region is an administrative region of Myanmar covering the long narrow southern part of the country on the Kra Isthmus. Tanintharyi Region comprises ten townships spread over the three districts, such as, Dawei district, Kawthoung district, and Myeik district. Consider the following Cities triangle which is constructed by imagined lines assembling Myeik, which is a city in Tanintharyi Region, situated in the extreme south of the country Myanmar, Dawei, which is a city in south-eastern Myanmar, the capital of Tanintharyi Region and Kawthoung which is a town situated in the southernmost part of Myanmar, Tanintharyi Region. The objective of this illustration 1 is to calculate the area of the Cities Triangle of aforementioned three cities by using the rules of determinants. The coordinates given are estimate degrees in decimals of latitudes and longitudes.

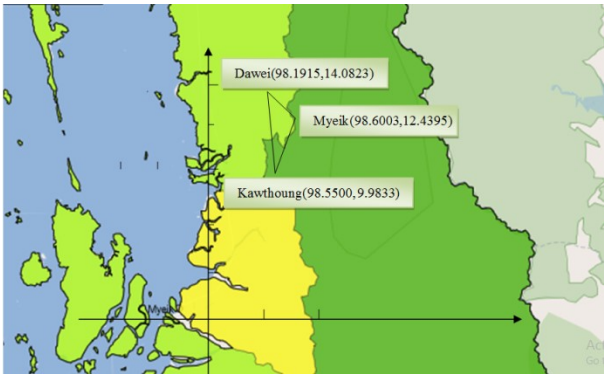

Figure 1. Cities Triangle of Dawei, Myeik and Kawthoung

The vertices of Cities triangle are Myeik (98.6003, 12.4395), Dawei (98.1915, 14.0823), and Kawthoung (98.5500, 9.9833) where the abscissa of Myeik (98.6003, 12.4395) is the estimate decimal degree of latitude of Myeik and the ordinate is the longitude. Let the area of the region between three cities be A_1.

$$A_1 = \pm\frac{1}{2}\begin{vmatrix} 98.6003 & 12.4395 & 1 \\ 98.1915 & 14.0823 & 1 \\ 98.5500 & 9.9833 & 1 \end{vmatrix}$$

$$= \pm\frac{1}{2}\left[98.6003\begin{vmatrix} 14.0823 & 1 \\ 9.9833 & 1 \end{vmatrix} - 12.4395\begin{vmatrix} 98.1915 & 1 \\ 98.5500 & 1 \end{vmatrix} + 1\begin{vmatrix} 98.1915 & 14.0823 \\ 98.5500 & 9.9833 \end{vmatrix}\right]$$

$$= \pm\frac{1}{2}\left[98.6003(14.0823 - 9.9833) - 12.4395(98.1915 - 98.5500) + 1(980.275202 - 1387.81066)\right]$$

$$= \pm\frac{1}{2}\left[404.16263 + 4.45956075 - 407.53546\right]$$

$$= \pm\frac{1}{2}\left[1.08673075\right]$$

$$= 0.54336538 \quad \text{square degree}$$

$$= 2586.96257 \quad \text{square miles}$$

The area of the Cities triangle is about 2586.96257 square miles.

B . Illustration 2

There are three universities in Myeik district, namely, Myeik University (in brief: MU), which has two faculties (Science and Arts) and 13 departments, located on University Avenue Road, Kalwin Ward, and Technological University (Myeik), (in brief: TU) situated on the side of the Yangon-Myeik road at the village of Kabin, in the township of Myeik and Computer University (Myeik), (in brief: UCS) is situated on Myeik-Tanintharyi highway road, Shwe-Du village, which is nine miles away from Myeik City. The objective of this illustration 2 is to calculate the area of the Universities Triangle of aforementioned three universities by using the rules of determinants. The coordinates given are estimate degrees in decimals of latitudes and longitudes. Let the area of the region between three universities be A_2.

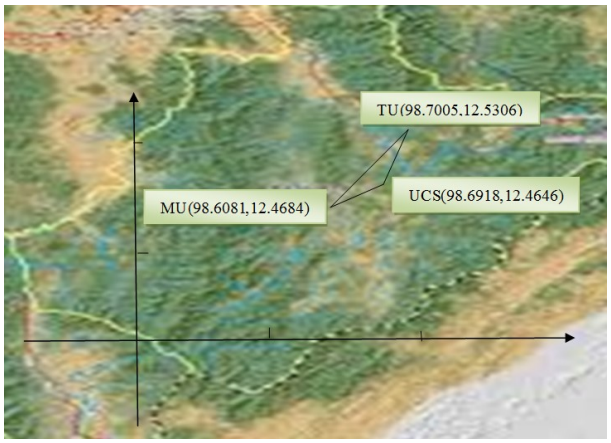

Figure 2. Universities Triangle of UCS, MU and TU

The vertices of Universities triangle are UCS (98.6918, 12.4646), MU(98.6081, 12.4684), and TU (98.7005, 12.5306) where the abscissa of Dawei

(98.1915, 14.0823) is the estimate decimal degree of latitude of Dawei and the ordinate is the longitude. Let the area of the region between three universities be A_2

$$A_2 = \pm\frac{1}{2}\begin{vmatrix} 98.6918 & 12.4646 & 1 \\ 98.6081 & 12.4684 & 1 \\ 98.7005 & 12.5306 & 1 \end{vmatrix}$$

$$= \pm\frac{1}{2}\left[98.6918\begin{vmatrix} 12.4684 & 1 \\ 12.5306 & 1 \end{vmatrix} - 12.4646\begin{vmatrix} 98.6081 & 1 \\ 98.7005 & 1 \end{vmatrix} + 1\begin{vmatrix} 98.6081 & 12.4684 \\ 98.7005 & 12.5306 \end{vmatrix}\right]$$

$$= \pm\frac{1}{2}\left[98.6918(12.4684 - 12.5306) - 12.4646(98.6081 - 98.7005) + (1235.61866 - 1230.63731)\right]$$

$$= \pm\frac{1}{2}\left[-6.13862996 + 1.15172904 + 4.98135\right]$$

$$= \pm\frac{1}{2}\left[-0.00555092\right]$$

$$= 0.00277546 \quad \text{square degree}$$

$$= 13.2139651 \quad \text{square miles}$$

Based on the assumption of a degree being 69 miles, a square degree would be 4761 square miles. That would give an area of 13.2139651 square miles. The area of the Universities triangle is about 13.2139651 square miles.

C. Illustration 3

There are so many beautiful islands in Tanintharyi Region, among them, the three islands; Marcus, Lampi and Nyaung Oo Phee are chosen to be finding the area between them. Marcus Island is the first island to become a popular destination in Myeik. It is a small but enchanting island with one long white-sanded beach. It is one of the most appreciated Islands of the archipelago as it allows for a full day of exciting activities and relaxation. Lampi Island also called Lanbi Kyun and Lambi Island is an island in the Mergui Archipelago, and known for 200 Moken people dead in a small island off Lanbi following the 2004 Indian Ocean earthquake and tsunami [6]. Nyaung Oo Phee Island is part of the Southern Mergui Archipelago and can be best reach from Kawthaung. Actually the island is named after one of the four famous warriors who won many wars for King Anawratha (Bagan Area). The objective of this illustration 3 is to calculate the area of the Islands Triangle of aforementioned three islands by using the rules of determinants. The coordinates given are estimate degrees in decimals of latitudes and longitudes. Let the area of the region between three universities be A_3.

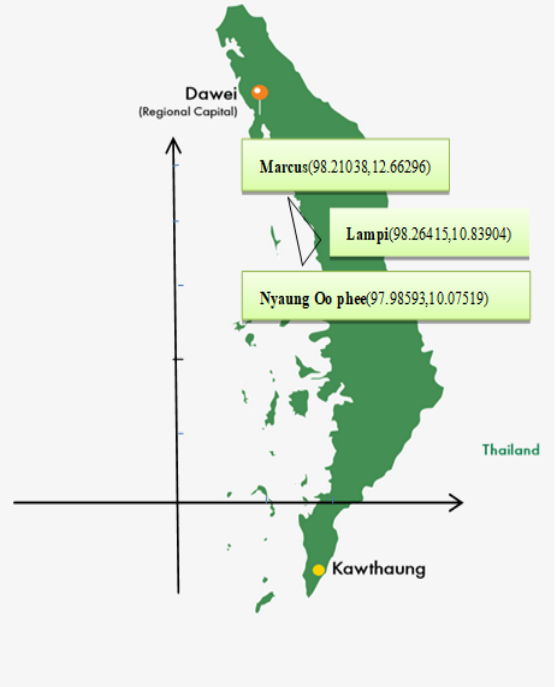

Figure 3. Islands Triangle of Marcus, Lampi and Nyaung Oo Phee

The vertices of the Islands triangle are Marcus (98.21038, 12.66296), Lampi (98.26415, 10.83904), and Nyaung Oo Phee (97.98953, 10.07519) where the abscissa of (98.21038, 12.66296) is the estimate decimal degree of latitude of Marcus and the ordinate is the longitude. Let the area of the region between three islands be A_3.

$$A_3 = \pm\frac{1}{2}\begin{vmatrix} 98.21038 & 12.66296 & 1 \\ 98.26415 & 10.83904 & 1 \\ 97.98593 & 10.07519 & 1 \end{vmatrix}$$

$$= \pm\frac{1}{2}\left[98.21038\begin{vmatrix} 10.83904 & 1 \\ 10.07519 & 1 \end{vmatrix} - 12.66296\begin{vmatrix} 98.26415 & 1 \\ 97.98593 & 1 \end{vmatrix} + 1\begin{vmatrix} 98.26415 & 10.83904 \\ 97.98593 & 10.07519 \end{vmatrix}\right]$$

$$= \pm\frac{1}{2}\left[75.01799 - 3.52309 - 72.04343\right]$$

$$= \pm\frac{1}{2}\left[-0.54853\right]$$

$$= 0.274265 \quad \text{square degree}$$

$$= 1305.775665 \quad \text{square miles}$$

Hence the area of the Islands triangle is about 1305.775665 square miles.

IV. Conclusion

In this paper, the areas of the most famous places are given and hence this paper can strongly support the travelling agencies. The applications of determinants either look fairly technical or deal with higher mathematical structures. This paper can also help the students who emphasizing to know the ways of calculation of the determinants for their practical fields. The reader may use the formula for finding the area of a triangle by setting up the coordinates as a 3×3 matrix and finding the absolute value of half the determinant. Based on the assumption of a degree being 69 miles, a square degree would be 4761 square miles. That would give an area of desired square miles.

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Optimal Solution in Numerical Integration by Different Methods

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Abstract: The numerical integration is the most popular way for obtaining the solution. Many different methods are applied to solve for numerical integration. This paper applied three different methods for a definite integral to get the approximation or smallest error value. An analysis of different methods provides much deeper insights into mathematical ideas and collection of data (approximations) can be extremely valuable. This paper is to focus the numerical results and determine or check out which method is the best to provide the result. Comparison of approximation values, Simpson's rule/method is more effective and accurate for solving a definite integration rather than the other methods. This paper aims at teaching how to calculate and compare at the issue of approximating a definite integral and seek to obtain better approximation and better method to generate a more accurate estimate for the optimal solution. This minimum value of approximation represents the best method for numerical integration.

Keywords**:** Numerical Integration, Numerical Analysis, Data-Comparison, Accuracy number, Accurate-result

I. Introduction

Calculus is used to improve the architecture not only of buildings but also of important infrastructures such as bridges. In electrical Engineering, Calculus (Integration) is used to determine the exact length of power cable needed to connect two substations, which are miles away from each other [1]. Numerical analysis is applied in the area of mathematics and computer science that creates, analyses, and implements algorithms for obtaining numerical solutions to problems involving continuous variables [3]. Such problems arise throughout the natural sciences, social sciences, engineering, medicine, and business. Advanced numerical methods are essential in making numerical weather prediction feasible. Therefore, the important of numerical integration plays a central role in real-world problems of engineering, mathematics, computer science, real-world projects and many other areas [4].

This paper applies on numeric methods for a definite integral. The main initial idea is to obtain approximations to the solutions of such definite integral in different methods. These approximations can be obtained from the formula/rule known as Rectangular Rule (Mid-point Method). While this rule is rather unstable and of little practical use, this paper focus on starting toward understanding more sophisticated method, namely, the Trapezoidal Rule which is more useful in practice. Then the Trapezoidal rule cannot provide more accurate approximation, this paper looks into the Simpson's Rule which is a weighted average that results in even more accurate approximation.

II. Evaluation Definite Integrals in Numerical Analysis (NA)

The important steps in NA are as follows:
1.Finding better approximation values.
2.Finding better approximation Method.
3.Generating a more accurate estimate to get the final answer. (Exact Value)

III. Experimental Results of Numerical Integration Using Graphs in Three Different Methods

This paper considers some numerical examples that will be performed by using graphs. The basic problem in numerical integration is to compute an approximate solution to a following definite integral to a given degree of accuracy [2].

$$J = \int_a^b f(x)dx$$

If $f(x)$ is a smooth function integrated over a small number of dimensions and the domain of integration is bounded, there are many methods for approximating the integral to the desired precision [5].

For the experiment in numerical analysis, this paper applies the following different approximation methods.

1.Rectangular Rule (Midpoint Rule)
2.Trapezoidal Rule, and
3.Simpson's Rule

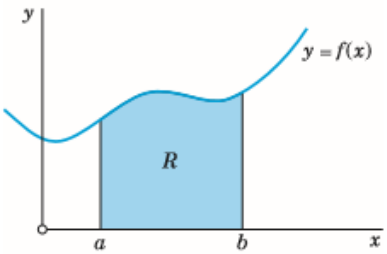

Figure 1. Geometric Interpretation of a Definite Integral

A. Rectangular Rule (Midpoint Rule)

Numeric integration methods are obtained by approximating the integrand f by functions that can easily be integrated. The rectangular rule (also called the midpoint rule) is the simplest method in mathematics used to compute an approximation of a definite integral [9]. The midpoint rule approximates the area between the graph of f(x) and the x-axis by summing the areas of rectangles with midpoints that are points on f(x) and the midpoint rule produces an estimate that is somewhat close to the actual value of the definite integral [6].

Divide the interval $[a, b]$ into n pieces; each piece has the same width h=$\frac{b-a}{n}$. Then the n rectangles in Figure 2 have the areas $f(x_1^*)h, \dots f(x_n^*)h$ and the rectangular rule is

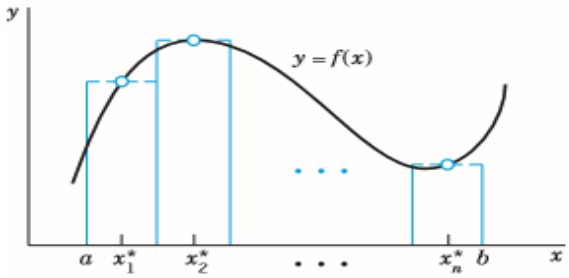

Figure 2. Rectangular Rule

$J = \int_a^b f(x)dx \approx h[f(x_1^*) + f(x_2^*) + \cdots + f(x_n^*)], \quad \left(h = \frac{b-a}{n}\right).$

(a). By Graphically for Rectangular Rule $J = \int_0^1 \frac{1}{1+x^2} dx$

Let us calculate by Rectangular Rule with n=10.

$$h = \frac{b-a}{n} = \frac{1-0}{10} = 0.1$$

Table 1. Computations for Rectangular Rule

j	x_j^*	$f(x_j^*) = \frac{1}{1+(x_j^*)^2}$
1	0.05	0.997506
2	0.15	0.977995
3	0.25	0.941176
4	0.35	0.890869
5	0.45	0.831601
6	0.55	0.767754
7	0.65	0.702988
8	0.75	0.640000
9	0.85	0.580552
10	0.95	0.525624

$$J = \int_a^b f(x)dx \approx h[f(x_1^*) + f(x_2^*) + \cdots + f(x_n^*)]$$

$$= \int_0^1 \frac{1}{1+x^2} dx \approx 0.1[0.997506 + 0.977995 + \cdots + 0.525624\ ]$$
$$= 0.7856065$$

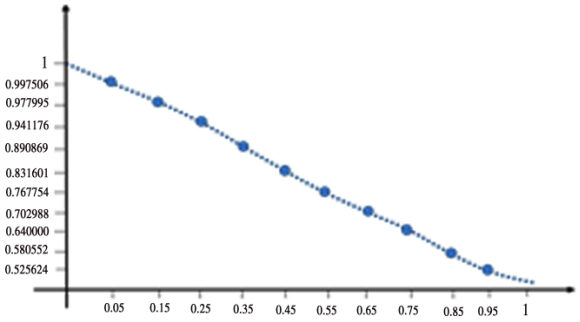

Figure 3. Graphical Solution for Rectangular Rule

1) Algorithm for Rectangular ($a, b, n, f_0^*, f_1^*, \dots, f_n^*$)

The algorithm computes the integral $J = \int_a^b f(x)dx$ from given values $f_j = f(x_j)$ at equidistant $x_0 = a, x_1 = x_0 + h, \dots, x_n = x_0 + nh$ where $h = \frac{b-a}{n}$ and in each subinterval approximate f by the constant $f(x_j^*)$ by the value of f at the midpoint x_j^* of the j^{th} subinterval.

INPUT: $a, b, n, f_0^*, f_1^*, \dots, f_n^*$

OUTPUT: Approximate value $\tilde{J}$ of J.

Compute Midpoint = $x_j^* = \frac{x_j + x_j + 1}{2}$

Set $f(x_j^*) = f_j^*$

Sum = $f_0^* + f_1^* + \cdots + f_n^*$

$h = \frac{b-a}{n}$

$\tilde{J}$=h[Sum].

OUTPUT $\tilde{J}$. Stop.

End RECTANDULAR.

B. Trapezoidal Rule

The Trapezoidal Rule is generally more accurate to determine the area under the graph by approximating it to that of a trapezoid and calculating its area. Then the area under the curve f between a and b is approximated by n trapezoids of areas [5].

$$J = \int_a^b f(x)dx \approx h\left[\frac{1}{2}f(a) + f(x_1) + f(x_2) + \cdots + f(x_{n-1}) + \frac{1}{2}f(b)\right]$$

$\frac{1}{2}[f(a) + f(x_1)]h, \ \frac{1}{2}[f(x_1) + f(x_2)]h, \dots, \frac{1}{2}[f(x_{n-1}) + f(b)]h$

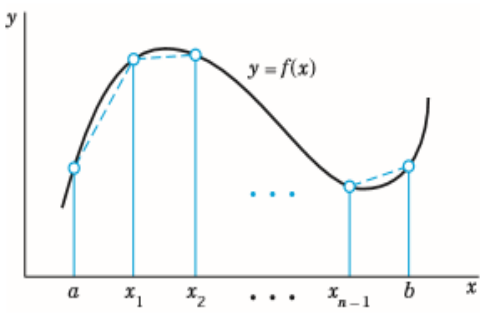

Figure 4. Trapezoidal Rule

(b) . By Graphically for Trapezoidal Rule

Let us calculate $J = \int_0^1 \frac{1}{1+x^2} dx$ by Trapezoidal Rule with n=10.

$$h = \frac{b-a}{n} = \frac{1-0}{10} = 0.1$$

Table 2. Computations for Trapezoidal Rule

j	x_j	$f(x_j) = \frac{1}{1+x_j^2}$
1	0.10	0.990099
2	0.20	0.961538
3	0.30	0.917431
4	0.40	0.862068
5	0.50	0.800000
6	0.60	0.735294
7	0.70	0.671141
8	0.80	0.609756
9	0.90	0.552486
	Sum	7.099813

$f(a) = f(0) = 1.000000$

$f(b) = f(1) = 0.5$

∴ Area is $J = \int_a^b f(x)dx \approx h\left[\frac{1}{2}f(a) + f(x_1) + f(x_2) + \cdots + f(x_{n-1}) + \frac{1}{2}f(b)\right]$

$= 0.1\left[\frac{1}{2}(1 + 0.5) + 7.099813\right]$

$= 0.7849813$

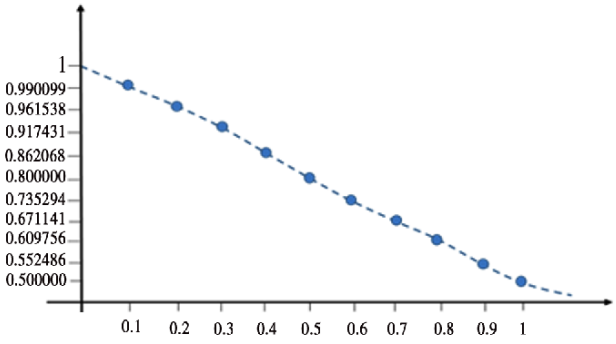

Figure 5. Graphical Solution for Trapezoidal Rule

1) Algorithm for Trapezoidal $(a, b, n, f_0, f_1, \ldots, f_n)$

This algorithm computes the integral $J = \int_a^b f(x)dx$ from given values $f_j = f(x_j)$ at equidistant $x_0 = a, x_1 = x_0 + h, \ldots, x_n = x_0 + nh$ and $h = \frac{b-a}{n}$.

INPUT: $a, b, n, f_0, f_1, \ldots, f_n$

OUTPUT: Approximate value $\tilde{J}$ of J.

Compute $S_0 = f_0 + f_n$

$S_1 = f_1 + f_2 + \cdots + f_{n-1}$

$h = \frac{b-a}{n}$

$\tilde{J} = h[\frac{1}{2}S_0 + S_1]$

OUTPUT $\tilde{J}$.Stop.

End TRAPEZOIDAL.

C. Simpson's Rule

Simpson's rule (Simpson's 1/3 rule) is a method for numerical approximation of definite integrals and parabolas are used to approximate each part of the curve [7]. We divide the area into n equal segments of width Δx. Simpson's rule actually gives exact results when approximating integrals of polynomials and approximates the area to that under a quadratic polynomial [8]. Piecewise quadratic approximation will lead to Simpson's rule, which is of great practical importance because it is sufficiently accurate for most problems, but still sufficiently simple [6].

To derive Simpson's rule, we divide the interval of integration $a \le x \le b$ into an *even number* of equal subintervals, say, into n=2m subintervals of length h=(b-a)/2m, with $x_0(=), x_1, \ldots, x_{2m-1}, x_{2m}(= b)$. We now take the first two subintervals and approximate f(x) in the interval $x_0 \le x \le x_2 = x_0 + 2h$

By the Lagrange polynomial $p_2(x)$ through $(x_0, f_0), (x_1, f_1), (x_2, f_2)$ where $f_j = f(x_j)$

$$p_2(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)} f_0 + \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)} f_1 + \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)} f_2$$

The denominators of the above equations are $2h^2, -h^2 and\ 2h^2$, respectively. Setting $s = \frac{x-x_1}{h}$, we have $x - x_1 = sh, x - x_0 = x - (x_1 - h) = (s+1)h$

$$x - x_2 = x - (x_1 + h) = (s-1)h$$

And we obtain

$$p_2(x) = \frac{1}{2}s(s-1)f_0 - (s+1)(s-1)f_1 + \frac{1}{2}(s+1)sf_2$$

$$\int_{x_0}^{x_2} f(x)dx \approx \int_{x_0}^{x_2} p_2(x)dx = h(\frac{1}{3}f_0 + \frac{4}{3}f_1 + \frac{1}{3}f_2)$$

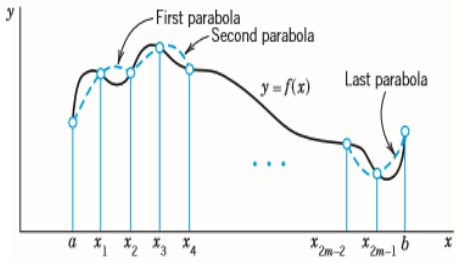

Figure 6. Simpson's Rule

A similar formula holds for next two subintervals from x_2 to x_4, and so on. By summing all these m formula we obtain Simpson's rule

$$\int_a^b f(x)dx \approx \frac{h}{3}(f_0 + 4f_1 + 2f_2 + 4f_3 + \cdots + 2f_{2m-2} + 4f_{2m-1} + f_{2m})$$

where $h = \frac{b-a}{2m}$ and $f_j = f(x_j)$.

(c). By Graphically for Simpson's $\int_0^1 \frac{1}{1+x^2}$Rule

Let us calculate by Simpson' Rule with n=10.

$$h = \frac{b-a}{n} = \frac{1-0}{10} = 0.1$$

Table 3. Computations for Simpson Rule

j	x_j	$f(x_j) = \frac{1}{1+x_j^2}$
1	0.10	0.990099
2	0.20	0.961538
3	0.30	0.917431
4	0.40	0.862068
5	0.50	0.800000
6	0.60	0.735294
7	0.70	0.671141
8	0.80	0.609756
9	0.90	0.552486
	Sum	7.099813

$f(a)$=$f(0) = f_0 =$ 1.000000

$f(b)$=$f(1) = f_{2m} = 0.5$

$$J = \int_a^b f(x)\,d \approx \frac{h}{3}(f_0 + 4f_1 + 2f_2 + 4f_3 + \cdots + 2f_{2m-2} + 4f_{2m-1} + f_{2m})$$

$$= \frac{h}{3}\{(f_a + f_b) + 4(f_1 + f_3 + \cdots + f_{2m-1}) + 2(f_2 + f_4 + \cdots + f_{2m-2})\}$$

$$= \frac{0.1}{3}\{1.5 + 4(3.931157) + 2(3.037901)\}$$

$$= 0.785398$$

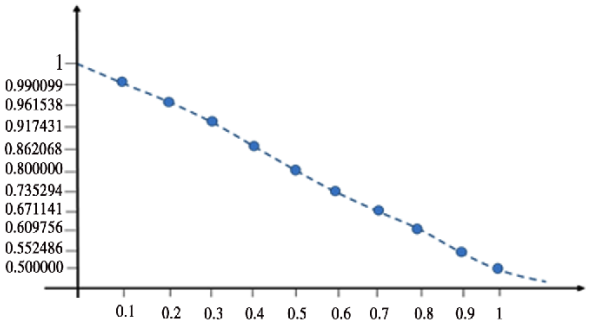

Figure 7. Graphical Solution for Simpson's Rule

1) Algorithm for Simpson $(a, b, n, f_0, f_1, \ldots, f_{2m})$

This algorithm computes the integral $J = \int_a^b f(x)dx$ from given values $f_j = f(x_j)$ at equidistant $x_0 = a, x_1 = x_0 + h, \ldots, x_{2m} = x_0 + 2mh$ and $h = \frac{b-a}{2m}$.

INPUT: $a, b, m, f_0, f_1, \ldots, f_{2m}$

OUTPUT: Approximate value $\tilde{J}$ of J.

Compute $S_0 = f_0 + f_{2m}$

$S_1 = f_1 + f_3 + \cdots + f_{2m-1}$

$S_2 = f_2 + f_4 + \cdots + f_{2m-2}$

$h = \frac{b-a}{2m}$

$\tilde{J} = \frac{h}{3}(S_0 + 4S_1 + 2S_2)$

OUTPUT $\tilde{J}$.Stop.

End SIMPSON.

For Exact Value

$J = \int_0^1 \frac{1}{1+x^2}dx$

$= [\tan^{-1} x]_0^1$

$= \tan^{-1} 1 - \tan^{-1} 0$

$= 0.785398$

IV. Consideration of Results in Different Methods

The comparison- figures and table for the best result are as follows:

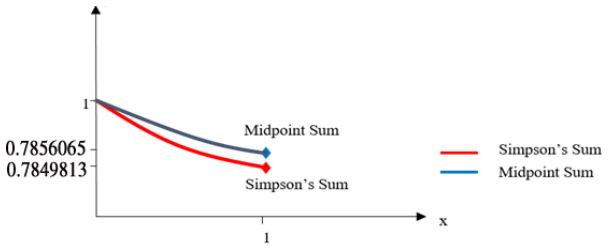

Figure 8. Comparison between Midpoint Rule and Simpson's Rule

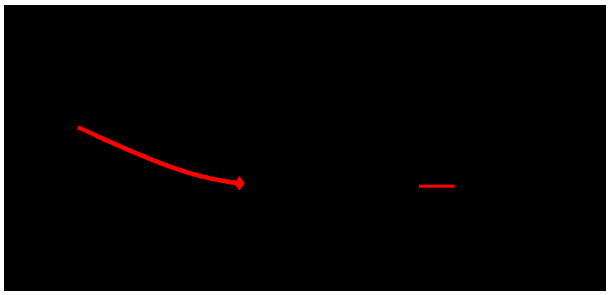

Figure 9. Comparison between Trapezoidal and Simpson's Rule

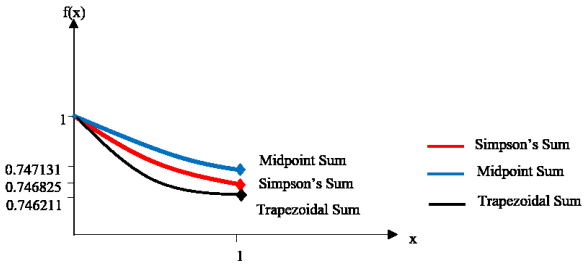

Figure 10. Comparison between Three Results from Three Different Rules/Methods

Table 4. Comparison between Exact Value and Numerical Results

Method	Exact Value	Numerical Result	Error
Rectangular	0.785398	0.785606	-0.000208
Trapezoidal	0.785398	0.784981	0.000417
Simpson	0.785398	0.785398	0

The above tables and figures show that the results cited for Simpson's Rule actually involve accurate answer for exact value than the other rules. In comparison, the result from Simpson's rule is much better than the Trapezoidal rule, whereas the number of operations is nearly the same in both cases. Collection the results for the three different rules are allowed to compare the relative effectiveness of each. This process is now focused on the priceless value of Simpson's rule which gives the best accuracy number to get the exact value. Therefore, it is conclude that of the three methods considered, Simpson's rule is the more effective than others, the best method.

V. Conclusion

The main objective of this paper is to formulate the best method by comparing different approximation values. This paper derives more accurate for a fixed number of subdivisions on the intervals. It is proved that Simpson's rule gives more accurate for exact value. Building on data/ approximation from the given integral and then comparing the results can look a better and more effective numerical rule for the definite integral.

This paper can promote teaching pedagogies for Faculty of Computational Members and help supports for the students who need to do their graduation thesis. So, it is proved how much the accurate rule is important in Numerical Integration in Engineering Mathematics and very useful in many other fields to calculate the required objective or the best technique. All students can be able to develop their problem-solving skills on numerical integration to solve verification problems in different methods by using simple graphs.

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Optimal Cultivation Plan Using Linear Programming Model

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***Abstract*:** The purpose of this paper is to find the optimal cultivation plan to devote how many acres for each crop at the study area. Satisfying some restrictions with the objective to maximize the total net return based on some constraints which are usable land, water allocation and acreage for each crop. In this paper, a Linear Programming model with the objective function and subject to the constraints which are constructed by using the crops data which are summer rice, monsoon rice, green gram(summer), green gram(monsoon), peanut(monsoon), peanut(winter) is used to find this optimal cultivation plan. The data presented in this paper are the case study conducted at Thu Kaung Te Area, located in Nyaung Oo township of dry zone of Myanmar. This area is doing electric water pumping irrigation project. This paper presents the optimal solution by using excel solver to solve this method. It also aims to help planning to promote agricultural production for the upcoming year.

***Keywords*:** Linear Programming model, maximize net return, optimal cultivation plan, excel solver.

I. Introduction

Myanmar is an agricultural country. Most of the people in the country work in agriculture which is an essential part in living life. Nowadays, various kinds of crops in this country are cultivated in a systematic manner to export a wide variety of crops to foreign countries, increasing the country's foreign exchange income. Irrigation is the application of controlled amounts of water to plants at needed intervals for the purpose of agricultural production. It is helpful to large extent to grow agricultural crops in dry areas during the periods of less than average rainfall. Effective irrigation will increase in agricultural production and productivity depends, to a large extent, on the availability of water [1].

Central Myanmar is a low rainfall area. However, since Thu Kaung Tal area is located on the east bank of the Ayeyarwaddy River, and also located in the area of the Government river project, irrigation system is used extensively in farmland under cultivation in all three climates instead of rainfall. This Region has (1052) acres of available irrigable land. The crops suit for this region include winter crops such as peanut and maize, summer and monsoon crops such as rice, green gram and sesame. To give a maximum profit for the farmers from that area, it is intended to use the best cropping pattern with linear programming for approximate calculation. Based on last year's crop and yield list, it is aimed to suggest optimal planning for the coming year.

Figure 1. Location Map of the Thu Kaung Te Area, Electric Water Pumping Irrigation Projects

II. Linear Programming Model

Linear programming is a mathematical technique used in Operation research to obtain an optimum solution. It deals with the problem of allocating finite limited resources among different competing activities in a best optimal way. Linear Programming is the analysis of problems in which objective is either to maximize the profit or to minimize the cost [5].

Solutions based on the feature and characteristics of the actual problem or situation can be generated by using Linear programming model. It can also be applied in many problems such as profit planning problem, transportation problem, diet problem, scheduling problem, agriculture problem and so on. In agriculture sector, this model can be used for crop rotation pattern, food crop, fertilizer minimization to improve farm economic and farm management. All the mathematical functions in this model are required to be linear functions but non-linear functions. Linear programming is formulated by an objective function and a set of constraints. The objectives and constraints of this model can be expressed in the set of decision variables and the form of linear relation [6]. In this study, limited resources are usable land, water allocation, acreage for each crop and our activity is aim to know how many acres are plant for each crop.

A. Standard Form of the Model and Other Forms

Interpretation for the general problem of allocating resources to activities,

Z be the value of overall measure of performance.

x_j be the level of activity j (for j _ 1, 2, . . . , n).

c_j be the increase in Z that would result from each unit increase in level of activity j.

b_j be the amount of resource i that is available for allocation to activities (for i _1, 2, . . . , m).

a_{ij} be the amount of resource i consumed by each unit of activity j.

Then in this model the problem can be express in terms of making decisions about the levels of the activities, so $x_1, x_2, \ldots . x_n$ are called the decision variables.

Standard form of the model;

objective function,

$$\text{Maximize } Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n \quad (1)$$

subject to the restrictions,

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \leq b_1 \quad (2)$$

$$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \leq b_2$$

$$\vdots \qquad\qquad \vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n \leq b_m \quad (3)$$

Other form of the model;

(i). Minimizing rather than maximizing the objective function:

$$\text{Minimize } Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n \quad (4)$$

(ii). Some functional constraints with a greater-than-or-equal-to inequality:

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \geq b_1 \quad (5)$$

for some values of i.

(iii). Some functional constraints in equation form:

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = b_1 \quad (6)$$

for some values of i.

(iv). Deleting the non-negativity constraints for some decision variables: x_j unrestricted in sign for some values of j[2].

B. Solution of the Model

Linear programming problems can be solved by graphical method which for two decision variables and simplex method which for more than two decision variables. An unknown quantity representing the decision variable is the solution. Two types of solution are feasible and infeasible solution. If the solution, it is satisfied all the constraints this solution is called feasible solution and if not called infeasible solution. A feasible solution that has the most favorable value of the objective function is called the optimal solution. The Excel Solver can quickly apply the simplex method to find an optimal solution for the model [2].

III. System Implementation

In this study, based on the choice of five different kinds of the cultivating crops data of the Thu Kaung Ti Area and applied it to build a linear programming model to determine the optimal cropping pattern. The variables are the area of each crop and the objective function is subject to the three constraints such as usable land, water allocation and acreage for each crop. The crops data (2018-2019) of the Thu Kaung Ti area are presented by Department of Agricultural (DOA) and given in the following table 1, 2 and 3.[Summer (S),Monsoon season (M), Winter(W)][3].

Table 1. Resource Data for the Thu Kaung Ti Area

	Max Quota (acres)	Water consumption (acre feet/ acre)	Net profit (kyats/ acre)
Rice(S)	97	8	196500
Rice(M)	290	8	198665
Green gram(S)	368	2	284300
Green gram(M)	65	2	101700
Peanut(M)	95	2	128000
Peanut(W)	90	2	64000

Total income = Yield (tin) × Market price of the produce (Ks/tin) (7)

Net Profit =Total Income –Total cost of cultivation (8) **[4]**

Table 2. Net Profit for Selected Crops

Crop	Yield (tin)	Selling prize (kyat/tin)	Net profit (kyat)
Summer rice	96	6000	196500
Monsoon rice	87.41	6500	198665
Green gram(summer)	14.81	30000	284300
Green gram(monsoon season)	10.24	30000	101700
Peanut(monsoon season)	38	13000	128000
Peanut(winter)	30	12000	64000

Table 3. Cost of Cultivation per Acre

Crop	Land prepa ration	Crop Manag- ement	Harve- sting &Thre- shing	Input(che- mical fertilizer, organic fertilizer, seed)
Rice (S)	73500	125000	50000	131000
Rice (M)	73500	115500	50000	130500
Green gram (S)	20500	40500	50000	49000
Green gram (M)	64000	48000	20000	73500
Peanut (M)	45000	55500	88000	177500
Peanut (W)	42500	38000	52500	163000

Table 4. Cost of Cultivation Process per Acre

Agronomic Practices	Rice(S)	Rice(M)	Green Gram(S)
1.Land Preparation			
Ploughing (animal &machine)	20000	10000	8000
Harrowing (animal &machine)	30000	30000	8000
Weeding	4500	4500	2000
Seed broadcasting	6500	6500	-
General cost	12500	12500	2500
total	73500	73500	20500
2.Crop management			
transplanting cost	65000	65000	40500
plant management cost	60000	50500	-
total	125000	115500	40500
3.Harvesting &Threshing	50000	50000	50000
4.Input			
Seed	15000	15000	16000
Water tax	9000	6000	3000
Organic fertilizer	25000	25000	20000
Chemical fertilizer	82000	84500	10000
total	131000	130500	49000

Table 5. Cost of Cultivation Process per Acre

Agronomic Practices	Green Gram(M)	Peanut(M)	Peanut(W)
1.Land Preparation			
Ploughing (animal &machine)	40000	20000	20000
Harrowing (animal &machine)	20000	20000	20000
Weeding	4000	-	-
Seed broadcasting	-	-	-
General cost	-	5000	2500
total	64000	45000	42500
2.Crop management			
transplanting cost	48000	13000	13000
plant management cost	-	42500	25000
total	48000	55500	38000
3.Harvesting &Threshing	20000	88000	52500
4.Input			
Seed	18000	120000	110000
Water tax	-	-	-
Organic fertilizer	15000	13500	25000
Chemical fertilizer	40500	44000	28000
total	73500	177500	163000

All the data in table 1, 2 and 3 was used to formulate the linear programming model.

A. Mathematical Formulation for the Optimal Cultivation in Thu Kaung Ti Area

According to the data from Department of Agricultural (DOA),

Let decision variables x_i be the acres to devote to summer rice, monsoon rice, green gram (summer), green gram (monsoon season), peanut (monsoon) and peanut(winter) respectively. The Objective is to maximize the total net return to the cultivators of agricultural crops. According to equations (1),(2),(3);

Z be the total net return.(thousands of kyat)

$$\text{Max } Z = 196.5\, x_1 + 198.665\, x_2 + 284.3\, x_3 + 101.7\, x_4 + 128\, x_5 + 64\, x_6 \quad (9)$$

Subject to the constraints are

For usable land,

$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 \leq 1052 \quad (10)$$

For water allocation,

$$8x_1 + 8x_2 + 2x_3 + 2x_4 + 2x_5 + 2x_6 \leq 4332 \quad (11)$$

For limit of acreage for each crop,

$$x_1 \leq 97,\ x_2 \leq 290,\ x_3 \leq 368,\ x_4 \leq 65,\ x_5 \leq 95,\ x_6 \leq 90$$

(12 to 17)

non-negativity constraint, $x_i \geq 0$ for i = 1,2,3,4,5,6

B. Using the Excel Solver to Solve the Model

Solver is a tool which uses the simplex method to find an optimal solution. The Solver tool is included in Microsoft Excel. Before using Solver, objective function and its value, each functional constraint and each decision variable need to be included on the spreadsheet. Start to run the Solver by choosing "Solver" in the Tools menu. The Solver dialogue box is appear. The value of the objective function is being specified in the "Target Cell". The "Changing Cells" are the cells containing the values of the decision variables.

step 1. Choose solver tool in the tools menu.

step 2. Type the value of the objective function in the "Target Cell" and the values of the decision variables in the "Changing Cells". Max also has been selected. Click "Add." Then "Add Constraint" appear.

step 3. All Constraints are specified in the "Add Constraint" box. Click on Add to bring up a new constraint dialogue box. Click OK. Then the Solver Option dialogue box appear.

step 4. Clicking on the Options button to specify the solving method, linear programming. Then click on Solve in the Solver dialogue box [2].

H16 =SUMPRODUCT(B16:G16,B17:G17)

	A	B	C	D	E	F	G	H	I	J
1										
2	Thu Kaung Te Electric Water Pumping Area									
3	Resources	Resource Usage per Unit of Activity						Total	sign	Available Acre
4		Activity								
5		Rice(S)	Rice(M)	Green Gram (S)	Green Gram (M)	Peanut (M)	Peanut (W)			
6										
7										
8	usable land	1	1	1	1	1	1	0	≤	1052
9	water allocation	8	8	2	2	2	2	0	≤	4332
10		1	0	0	0	0	0	0	≤	97
11		0	1	0	0	0	0	0	≤	290
12	pant for	0	0	1	0	0	0	0	≤	365
13	each crop	0	0	0	1	0	0	0	≤	65
14		0	0	0	0	1	0	0	≤	95
15		0		0	0	0	1	0	≤	90
16	Profit(Thousands of kyat)	1965	198.665	284.3	101.7	128	64	0		
17	Solution	0	0	0	0	0	0			

Figure 2. Excel Solver Spreadsheet

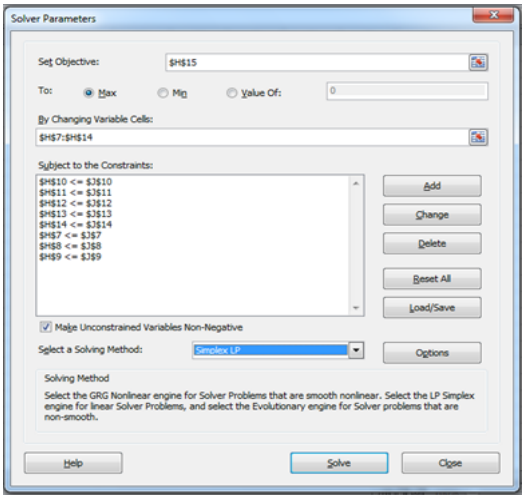

Figure 3. Solver Dialogue Box after Specifying the Entire Model in term of the Spreadsheet

IV. Optimum Solution

The optimum cultivation of crops result is obtained after solving the linear programming model by excel solver and express in Figure 4.

L16

	A	B	C	D	E	F	G	H	I	J
1	Thu Kaung Te Electric Water Pumping Area									
2	Resources	Resource Usage per Unit of Activity						Total	sign	Available Acre
3		Activity								
4		Rice(S)	Rice(M)	Green Gram (S)	Green Gram (M)	Peanut (M)	Peanut (W)			
5										
6										
7	usable land	1	1	1	1	1	1	1002	≤	1052
8	water allocation	8	8	2	2	2	2	4326	≤	4332
9		1	0	0	0	0	0	97	≤	97
10		0	1	0	0	0	0	290	≤	290
11	plant for	0	0	1	0	0	0	365	≤	365
12	each crop	0	0	0	1	0	0	65	≤	65
13		0	0	0	0	1	0	95	≤	95
14		0	0	0	0	0	1	90	≤	90
15	Profit(Thousands of kyat)	1965	198.665	284.3	101.7	128	64	376518		
16										
17	Solution	97	290	365	65	95	90			

Figure 4. Spreadsheet after Solving the Problem

From the result, the optimum solution for the firm is 97, 290, 365, 65, 95 and 90 with the acres to devote to summer rice, monsoon rice, green gram (summer), green gram (monsoon season), peanut (monsoon) and peanut(winter) respectively. The total net return is 376518 kyats.

V. Conclusion

The improvement of the region depends on Agriculture, especially depends on water and land resources. The provision of land and water for irrigation in right time and right quantity for various crops is the major role for the optimum agricultural production. Hence, the suitable planning and management process of water resources project and appropriate technology

are required. The present study makes effort to develop different crop planning strategies which increase productivity with maximum net benefits.

Compared to the reference data (2018-2019) from the Department of Agricultural (DOA) with the result data, it can be concluded that the farmers in this region should more plant monsoon rice, green gram (summer) to maximize their net return. The selection of optimum cropping system is a scientific and professional challenge. Therefore, it is believed that the Liner Programming model can be used to determine the optimal solutions for problems such as product mix Problem, blending Problem, transportation Problem and so on.

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Natural Science

A Gated Material Transfer Characteristic and Device Quality

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***Abstract*:** The aim of this work was the understanding of the mechanism that gave place to the improvement of the transfer characteristics of lead-based titanate TFT (Thin Film Transistor), in order to allow their application in one transistor of FeRAM (Ferroelectric Random Access Memories). The transfer characteristic graphs were parabolic variation nature. The m^{th} power of I_{DS} was evaluated and the values were not much difference for all thin film transistor cells. $(I_D)^{1/m}$ and V_{GS} characteristics were also analyzed for identifying the transconductance values. According to the results obtained, the fabricated cells were said to be n-channel E-mode one transistor of FeFET (Ferroelectric Field Effect Transistor).

***Keywords*:** PTA, Lead-based titanate, FeRAM, m^{th} power, Transfer character, Transconductance.

I. Introduction

The ferroelectric films have been studied for FeRAM (Ferroelectric Random Access Memories) application. Particularly, the FET (Field Effect Transistor) type memory has received great attention of a next generation memory. The field effect transistor type ferroelectric memory has been expected to enable capability of multi-application integrated circuit card and portable terminal unit. [1, 2]

II. Procedure of Experimental

The raw materials of PbO, TiO_2, and Al_2O_3 were chosen as starting materials. These powder materials were weighted and mixed to get the chemical formula $PbTi_{1-x}\ Al_{\ x}\ O_3$ (x= 0.10 mole %). Then, a few amount of acetone was added into the mixture and stirred with glass stirrer to be homogeneous. The primary ball-milling was carried out for 30 minutes. The homogeneous powder was sintered at 700ºC for 1 hour in O_2 atmosphere. The secondary ball-milling was performed to get crystalline powder. It was mixed with 2-methoxyethanol solvent to change into liquid phase and refluxed up to 100ºC for 30 minutes. After drying, it became precursor solution and ready to deposit onto desired substrate. [3, 4]

The p-type Si(100) orientations were chosen as starting substrates to get n-channel TFTs. They were cleaned with a dilute solution of HF:DIW (1:5), acetone and methyl alcohol to remove native contamination and dried at room temperature. SiO_2's were thermally deposited on all p-type Si(100) wafers. The middle zones of the insulating layers grown on Si wafers were covered with wax and their ends were etched with HF:DIW (1:3) to remove SiO_2 layers totally. To fabricate the source (S) and drain (D) regions, n-type phosphorus was deposited on these layers, annealed at 550ºC for 3 hours. To form the gate (G) region, the precursor solutions were spin-coated onto middle zones of the substrates while S and D regions were masked with wax. [5, 6]

To define the thin layers, the cells were heated at 500ºC, 550ºC, 600ºC, 650ºC, and 700ºC for 1 hour. Copper (Cu) electrodes were attached with S, G and D regions and back-side of the Si-wafer. In this paper was involved with the transfer characteristics of ferroelectric field effect transistor with PTA gated material. The schematic representation of preparation for PTA ferroelectric field effect transistor was shown in figure 1. [7]

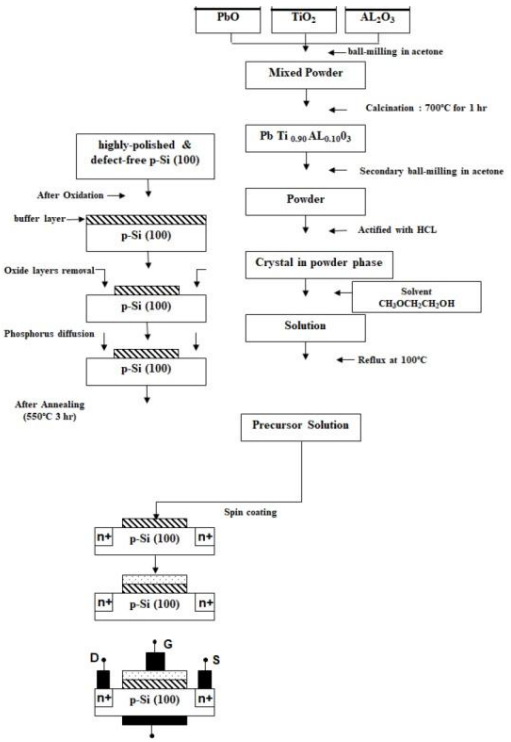

Figure 1. Block Diagram of Thin Film Transistor with PTA Gated Material

III. Results and Discussion

For the transfer characteristics, the drain to source current flow and gate to source voltage variation were measured at the saturation mode and shown in figure 2(a ~ e).

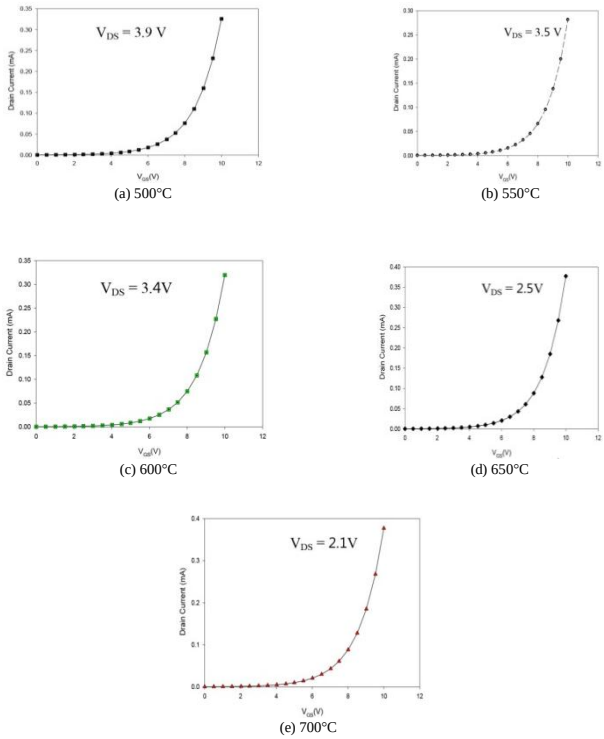

Figure 2(a ~ e). Transfer Characteristics of TFT at Different Temperatures

The drain current was exponentially enhanced with increasing gate to source voltage at the fixed drain voltage. At the low gate voltage region, I ~ V variation was formed and I ~ V^2 variation was caused at high gate voltage region. Threshold voltages were 5.5V, 5.3V, 5.2V, 5V and 4.5V for respective cells. The calculated m^{th} power values were 2.46, 2.31, 2.29, 2.12 and 2.34 for respective cells from the $I_D = k(V_{GS} - V_{TH})^m$. The V_{TH} and m^{th} power were listed in Table 1.

Table 1. V_{TH} and m^{th} Power of TFT at Different Temperatures

Process Temperatures (°C)	V_{TH} (V)	m^{th} power
500	5.5	2.46
550	5.3	2.31
600	5.2	2.29
650	5.0	2.12
700	4.5	2.34

Temperature dependence of V_{TH} and m^{th} power were also plotted at figure 3.

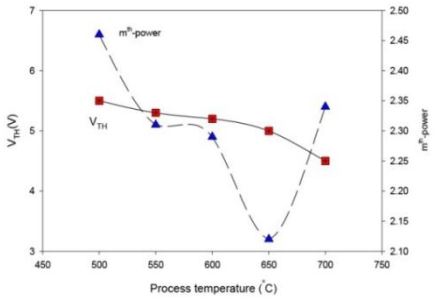

Figure 3. Temperatures Dependence of V_{TH} and m^{th} Power for PTA Gated TFT

To find the transconductance values of fabricated cell, $(I_D)^{1/m} \sim V_{GS}$ variation was studied and shown in figure 4(a ~ e). All variations were found to be linear relationship. The transconductance value g_m was obtained from the slope of linear graph ($g_m = \Delta I_{DS}/\Delta V_{GS}$). The calculated transconductance values were listed in Table 2. The dispersion of g_m with different process temperatures was shown in figure 5. To check the device quality, mobility (μ_n) was also observed at different process temperatures. The change in μ_n with different process temperatures was shown in figure 6. These values were collected in Table 3. The maximum current densities ($J_{D, max}$) were also observed 1.12 Acm^{-2}, 1.4 Acm^{-2}, 1.78 Acm^{-2}, 2.18 Acm^{-2} and 2.64 Acm^{-2} respectively. These values and threshold voltage (V_{TH}) were expressed with different temperature in Table 4.

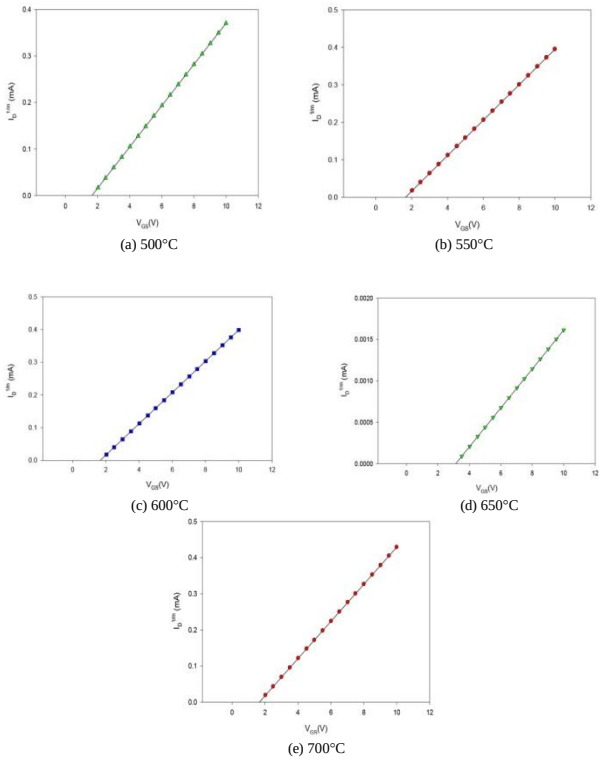

Figure 4(a~e). Transconductance Characteristic of TFT at Different Temperatures

Table 2. g_m of TFT at Different Temperatures

Process Temperatures (°C)	g_m (mA/V)	Standard Error
500	0.0444	0.0048
550	0.0473	0.0051
600	0.0478	0.0051
650	0.0002	0.0001
700	0.0514	0.0055

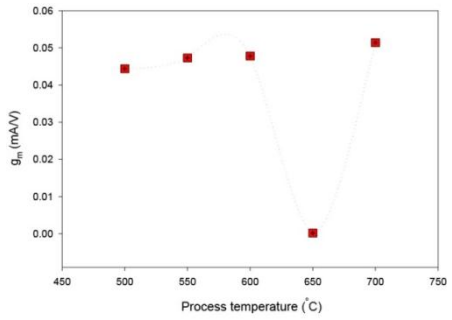

Figure 5. Temperatures and Transconductance Values for PTA Gated Material

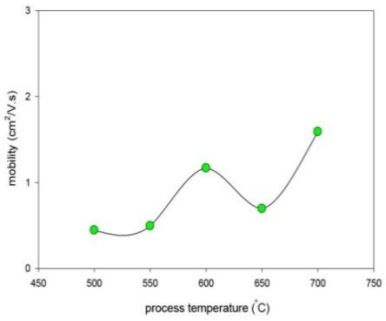

Figure 6. Change in Mobility with Different Temperatures

Table 3. Mobility(μ_n) at Different Temperatures

Samples	μ_n (cm^2/V-s)
PTA (500°C)	0.4449
PTA (550°C)	0.4939
PTA (600°C)	1.1676
PTA (650°C)	0.6948
PTA (700°C)	1.5900

Table 4. V_{TH} and $J_{D,\,max}$ at Different Temperatures

Samples	V_{TH} (V)	$J_{D,\,max}$ (A/cm^2)
PTA (500°C)	5.5	1.12
PTA (550°C)	5.3	1.40
PTA (600°C)	5.2	1.78
PTA (650°C)	5.0	2.18
PTA (700°C)	4.5	2.64

IV. Conclusion

The transfer characteristics of the *Al* modified $PbTiO_3$ thin film transistor were studied. Processing parameters were systematically observed in this study. The PTA epilayer were successfully deposited on n^+ introduced Si substrate using spin-casting method. As the transfer characteristics, the variation of $I_D \sim V_{GS}$ and $I_D \sim V_{GS}^2$ were caused at low and high gate voltage regions on transfer curve for all fabricated cells. According to the m^{th} power measurement, it was obvious that I_D was directly proportional to $(V_{GS})^{m=2}$ and revealed the parabolic nature of transfer curve. The g_m was obtained from $(I_D)^{1/m} \sim V_{GS}$ linear relationships and these values were accepted for ferroelectric field effect transistor field. Mobility of all fabricated thin film transistor were observed and found to be within the range of accepted values for one transistor of ferroelectric random access memories. The thin film transistor has the highest μ_n at 700ºC.

Acknowledgment

This paper was fully supported by Material Science Lab, Physics Department, University of Yangon.

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Zinc Oxide Ceramics Preparation and Structural Properties Doped Lithium

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***Abstract*:** The solid state sintered and rapid thermal annealed lithium (Li 1mol%, 2mol%, 3mol%, 4mol% and 5mol%) doped zinc oxide ceramics are presented. Li_2O and ZnO are used as starting materials. The zinc oxide ceramics with various lithium contents are prepared by solid state sintering method and rapid thermal process. The lithium doped zinc oxide are mixed in desired stoichiometric compositions and ground by agate mortar for 6 hours. After that, the mixtures are annealed at 500°C, 550°C, 600°C, 650°C and 700°C for 3 hours respectively. The X-ray diffraction (XRD) technique is used to determine the structural and phase formation of lithium doped ceramics. From the XRD analysis, temperature dependent of structural properties (such as lattice parameters, lattice micro strain, crystallite size) and covalent bond length are examined.

***Keywords*:** zinc oxide ceramics, Li, XRD technique, annealed temperature, structural properties.

I. Introduction

The zinc oxide has unique physical and chemical properties, like high chemical stability, high electrochemical coupling coefficient, broad range of radiation absorption and high photo stability is multifunctional material. In materials science, the zinc oxide is classified as a n-type semiconductor, whose covalence is on the boundary between ionic and covalent semiconductors [1, 2, 3]. A broad energy band, high bond energy and high thermal and mechanical stability at temperature make it attractive for potential use in electronics, optoelectronics and laser technology. The piezoelectric and pyro-electric properties of zinc oxide mean that it can be used as a sensor, converter, energy generator and photo-catalyst within hydrogen production [4, 5]. To realize the optoelectronic devices, an important issue is a fabrication of low resistance p-type zinc oxide with high hole concentration. Recently, p-type zinc oxide was reported to be achievable with lithium impurities, although p-type conduction is very sensitive to the growth conditions [6, 7]. In this study, solid state sintered and rapid thermal annealed lithium doped zinc oxide ceramics were reported. Processing parameters were reported. The processing parameters were systematically investigated and optimized. The XRD technique was used to study the structural properties and phase formation of the lithium doped zinc oxide ceramics [9, 10].

II. Experimental Procedure

The A-grade Li_2O and ZnO were used as starting materials in this study. The Li_2O and ZnO were mixed according to the equation Zn(1-x) and Li(x) O, where x = 0.01, 0.02, 0.03, 0.04 and 0.05 respectively. The mixture was grinded by the agate mortar for each 4 hours and heat treated at 600°C for each 3 hours.

All heat treatment schedules were rapid thermal annealing processes. After that, the XRD technique was carried to examine the structural properties and phase formation of ceramic samples. Ceramic samples were scanned from 10° to 70° in diffraction angle, 2θ with scanning speed of 0.01° per second.

The diffraction patterns were recorded at room temperature using CuKα (λ=1.5408°A) radiation and applied voltage and current were set to be 40 kV and 50 mA respectively. From the XRD analyses, the variations of dopant material concentrations with lattice parameters, crystallite sizes, lattice micro strains and bond lengths were examined.

III. Results and Discussion

The X-ray diffraction patterns of the zinc oxide ceramics with different lithium are doped shown in figure 1.

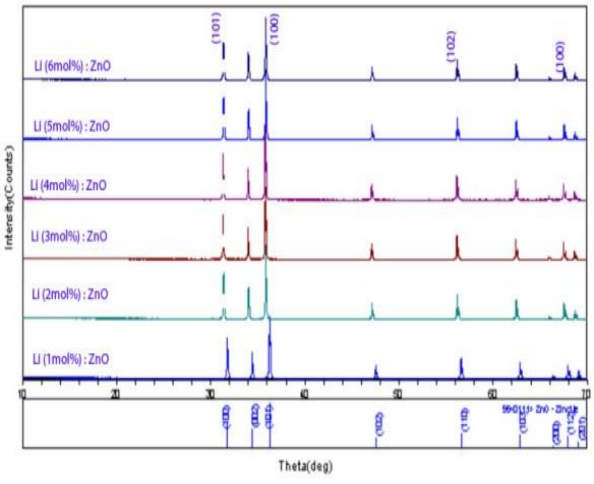

Figure 1. XRD Spectra of ZnO Ceramics with Different Li Doped

The peak search algorithm is used to determine the unknown peaks in this study. Only diffraction peaks corresponding to reference hexagonal wurtzite zinc oxide (99-0111 > JCPDS file) are studied. The single

phase polycrystalline zinc oxide structure with no external peaks is found. A shift of 101 peak maximum position is observed in all spectra. [13, 14]

In this case, doping concentration of Li is smaller than solubility limit of lithium in zinc oxide. Therefore lithium (with larger ionic radius 0.76°A) partially occupied into zinc (with ionic radius 0.74°A) site in host zinc oxide structure. Lattice parameters and lattice distortions are calculated and listed in table 1. The crystallize sizes and lattice micro strains are determined and listed in table 2.

Table 1. List of Lattice Parameters and Lattice Distortion

Molar concentration (%)	Lattice parameter "a" (°A)	Lattice parameter "c" (°A)	Lattice distortion
Li 1mol	3.2406	5.2124	1.6084
Li 2mol	3.2457	5.2078	1.6045
Li 3mol	3.2498	5.2009	1.6003
Li 4mol	3.2551	5.1956	1.5961
Li 5mol	3.2663	5.1876	1.5882

Table 2. List of Crystallite Size, Lattice Micro Strains and Bond Lengths

Molar concentration (%)	Crystallize size (nm)	Lattice micro strains	Bond length (°A)
Li 1mol	57.96	1.94×10^{-3}	1.9632
Li 2mol	76.57	1.47×10^{-3}	1.9665
Li 3mol	54.21	2.08×10^{-3}	1.9682
Li 4mol	52.17	2.16×10^{-3}	1.9705
Li 5mol	60.95	1.85×10^{-3}	1.9743

Then the covalent bond lengths between Zn and O for corresponding Li contents are computed, and also listed in table 2. The reported values of 'a' and 'c' of pure zinc oxide are 3.2498°A and 5.2009°A respectively. Bond length of zinc oxide structure is determined by using the following equations:

$$\text{Position parameter, } u = \frac{a^2}{3c^2} + 0.25 \qquad (1)$$

$$\text{Bond Length} = \sqrt{\frac{a^2}{3} + \left(\frac{1}{2} - u\right)^2 c^2} \qquad (2)$$

The reported value of bond length of pure zinc oxide is 1.9778°A. The figure 2 shows the dependence of dopant concentration on lattice parameter. Variation of dopant concentration with lattice distortion is shown in figure 3. There are no considerable changes in structural properties of lithium doped zinc oxide versus pure zinc oxide structures [11, 12]. The covalent bond lengths depend on many factors, such as bond strength, bond dissociation energy, electron affinities, sizes of atoms in the bond, differences in their electronegativity value and the overall structure of the molecule. In this study, the longer bond length has the lower the bond energy.

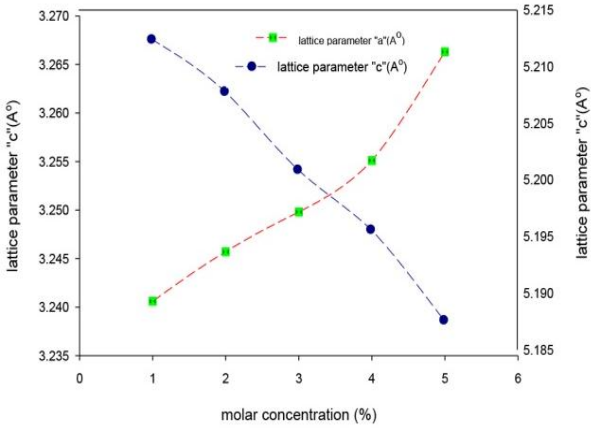

Figure 2. Dependence of Dopant Concentration with Lattice Parameters

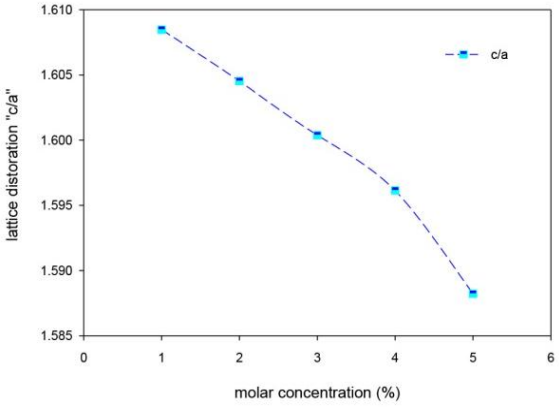

Figure 3. Variation of Dopant Concentration with Lattice Distortion

IV. Conclusion

The ferroelectric different lithium doped zinc oxide ceramic capacitor was prepared and structural properties were investigated in this paper. XRD analysis is the important of structural properties. From the XRD analysis, the small molar concentration of lithium was depended on the following: (i) the lattice parameter 'a' is small, (ii) the lattice parameter 'c' is large, (iii) the crystallize size is small, (iv) the micro strain is large, (v) the bond length is small, (vi) the lattice distortion is large. These results are quite acceptable and reliable. The lithium doped zinc oxide exhibits ferroelectric, piezoelectric and optoelectronic properties. Therefore, lithium doped zinc oxide is a suitable for memory device, piezoelectric transducer and optoelectronic device application.

Acknowledgment

This paper was fully supported by Material Science Lab, Department of Physics, University of Yangon.

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Determination of Water Quality of Some Water Samples in Kayin State in terms of WQIs

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Abstract: The present investigation is aimed at the development of water quality indices (WQIs) to assess water quality of rual area at Hpa-an district and Hpapun district, Kayin state in Southern part of Myanmar. Three water samples were collected from the study area. (6) kinds of various physico-chemical parameters such as pH, electrical conductivity (EC), hardness, turbidity, total dissolved solid (TDS), alkalinity and (7) sorts of elemental concentration like cadmium, lead, copper, zinc, potassium, sodium and calcium were analysed and computed WQIs for all water samples to determine the quality of water in this area. This study is the effort with respect to quality management of both surface water and ground water in two districts of Kayin State situated in Southern Myanmar. WQI was found to be 138.782 for sample-1 and 109.188 for sample-2 showing clearly that these two water samples are not good condition in accordance with the rating of water quality for drinking purpose but 27.014 for sample-3 is good for drinking.

***Keywords*:** Water Quality Indices (WQIs), physico chemical parameters, elemental concentration.

I. Introduction

Water plays vital role of various sectors of Earth's ecosystem. It is essential for the survival of living beings and is an excellent indicator of environmental change [6]. In its purest form, water is odorless, colorless and tasteless. The various sources of water pose the greatest risk to human health due to contamination of solid and human waste, effluents from chemical industries and dissolved gases.

Drinking water is obtained from a variety of sources like wells, rivers, lakes, reservoirs, ponds etc. Water pollutants mainly consist of heavy metals, micro-organisms, fertilizers and thousands of toxic organic compounds. The objective of this investigation is to discuss the suitability of water for the daily use of local people based on the physico-chemical data with reference to drinking water standards and computed WQI values. The goal of water quality index (WQI) is valuable and effective to interpret the whole water quality status into a single term that is very useful to meet the concerned issues. Water quality refers to different physico-chemical parameters for testing and analysis. To compute WQI values of three water samples in selected area, concentration of some metals and physico-chemical parameters were made experimental measurements in two laboratories at Yangon.

II. Material and Method

The workflow of the whole study was shown in Figure 1.

Figure 1. Step-by-step Procedures of Water Study

A. Condition of Study Area

To collect surface water sample, Donthami river at Hpa-an district and Yunsaline river at Hpapun district, Kayin State were chosen and then ground water sample was fetched from Denko petrol station in Hpa-an Township, Hpa-an district. All study areas are situated in Kayin State, Southern part of Myanmar. Sample 1 (HS-1) was collected from Donthami river near Donthami bridge with GPS coordinates of 16˚ 58' 51" N 97˚ 26' 31"E, sample-2 (HS-2) was fetched from Denko Petrol Station of 16˚ 52' 12" N 97˚ 39' 36"E and sample 3 (HS-3) was taken from Yunsaline river of 18˚ 03' 38" N 97˚ 26' 17"E. [4] The study area has temperate weather as it is located in the low latitude zone.

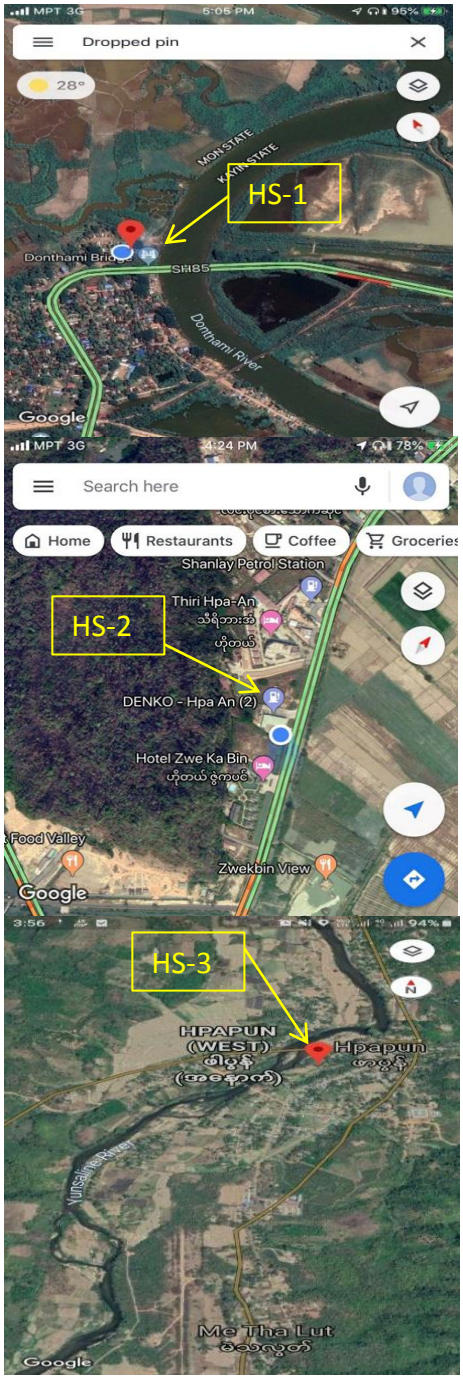

Figure 2. Map of Study Area [4]

B. Sampling and Sample Preparation

Water samples were collected from three locations in study area and then brought into laboratories for the measurement of various parameters to compute WQI values of both surface and ground water. Water samples were collected from each site to assess it for a period of December, 2019. All water samples were collected in the evening hour from 5:30 to 6:00 pm using dry and sterile plastic bottle using the standard procedures. The water of all rivers and drilled well are used for drinking, domestic usage and agriculture.

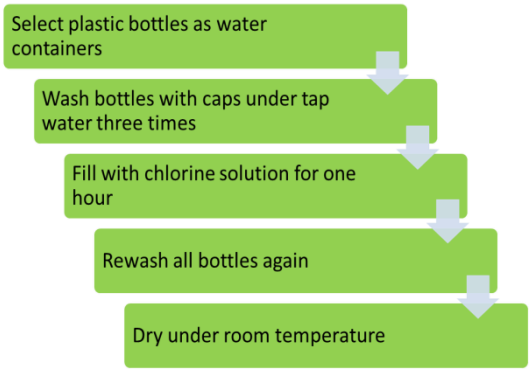

Figure 3. Sample Preparation Steps

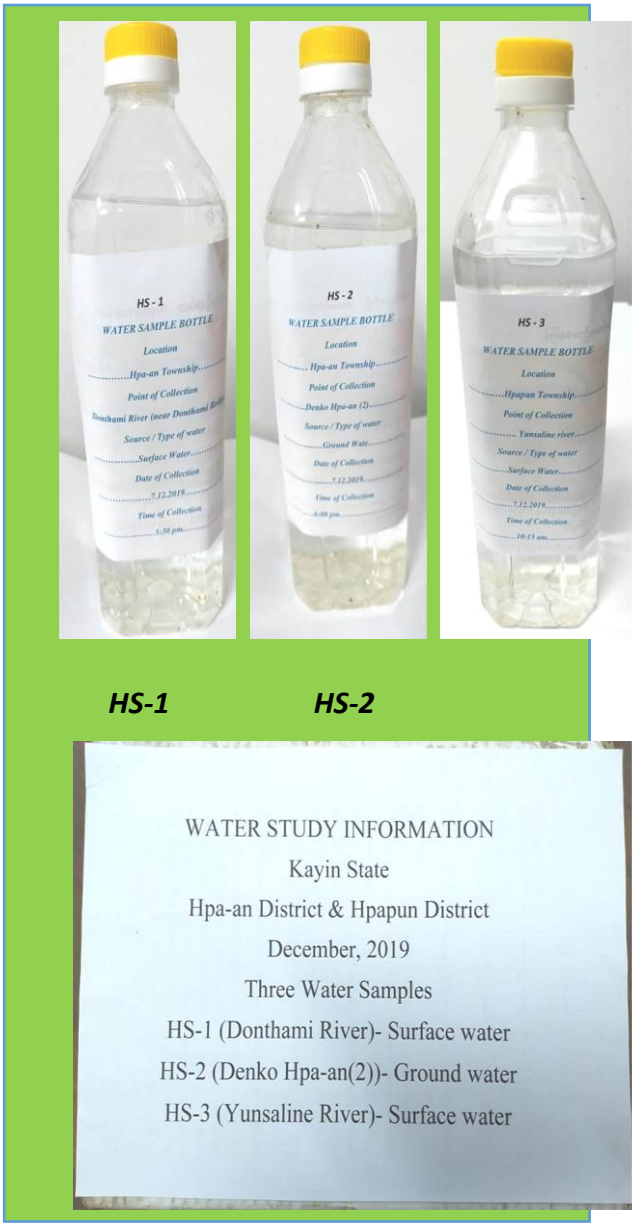

Figure 4. Sampling Procedures [7]

First of all, polyethylene plastic bottles were selected as sample bottles because some physico-chemical parameters, Cd, Pb, Cu, Zn, K Na and Ca were analyzed

for this study. Elemental concentration of mercury, some acid compounds and chlorine were not examined for this investigation, and thus glass bottles must not be used. Plastic bottle is economical, impact resistant, and provides a good moisture barrier for most applications. Moreover, it provides good protection at below freezing temperatures and also a strong barrier to most gases.[8] Polyethylene plastic bottles are simple to use and easy to be clean. But they must not be used to composite samples for determination of organic compounds. [9]

Before collecting water sample, plastic water bottles with caps were washed under the running water and filled with diluted chlorine water for one hour. And then, these bottles were slightly shaken and removed caps and made empty bottles. Water bottles and caps were rinsed under the flowing tap water until no foamed was seen. After that, three bottles including caps were rinsed with pure water. Finally, water sample bottles were dried at room temperature for a day. Before sampling, empty bottles were labeled with permanent marker not to rub off the written information. These dried bottles were packed with papers not to enter any effect including sunlight and brought to the area that is getting sample.

In getting sample water, water bubbles were not to be allowed during collecting water. After collecting water, bottles were screwed with caps immediately and tightly. Clean, dry and dark conditions must be needed throughout the transportation to the laboratory. Therefore, collected water sample bottles were put in a paper box, closed, and then labeled with sample information i.e. sample collection data as shown in figure (4). Finally, three sample water bottles were put to the University Research Centre, University of Yangon and ALARM Ecological Laboratory situated at Kamayut Township. The total time for sampling and transportation was during 24 hours to obtain correct and definite values for water parameters.

C. Sample Analysis

Heavy metals like cadmium, lead, copper and trace elements such as zinc, potassium, sodium and calcium concentrations were determined by atomic absorption spectrometry method (AAS) at University Research Centre, University of Yangon. Other parameters were analyzed at ALARM Ecological Laboratory situated in Kamayut Township, Yangon. Turbidity and hardness were analyzed by spectro direct method using Lovibond Spectro Direct. The measurement of pH and electrical conductivity (EC) were done by HANNA HI 98129, 98130 water proof pH tester and EC tester. Testing the TDS was made using TDS meter by electrode method. Turbidity parameter is tested by Spectro Direct method No 385. All the water quality parameters were analyzed according to standard methods for the examination of water and waste water in two laboratories, Yangon. Analyzed water parameters were distinguished into two parts namely heavy metals and physico-chemical parameters presented in Figure 5.

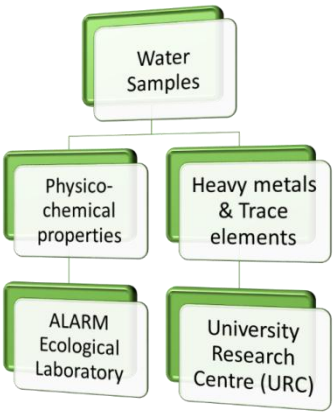

Figure 5. Procedures for Sample Analysis

D. Technology of Water Quality Index (WQI)

The index is among the most effective and efficient method to communicate the information on water quality trends to the policy makers and decision makers in water quality monitoring. WQI shows a useful representation of the overall quality of water for the healthy use of public. For the evaluation of WQI, various parameters namely pH, electrical conductivity (EC), hardness, turbidity, total dissolved solid (TDS), alkalinity, cadmium, lead, copper, zinc, potassium, sodium and calcium were analyzed to assess.

For computation of the values of water quality index, the following steps must be used. (Horton 1965).

1) First Step

In the first step, each of thirteen parameters has been computed as a weight (w_i) according to its relative equation used in the overall quality of water for drinking uses. [Mufid al-hadithi,2012]

$$W_i = \frac{Relative\ constant}{Standard\ values\ of\ i^{th}\ parameters}$$

2) Second Step

In the second step, the relative weight (W_i) is calculated using a weighted arithmetic method. [Brown et al., 1972, Horton, 1965][5]

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i}$$

In above equation, W_i is the relative weight, w_i is the weight of each parameter and "n" is numbers of measured parameters.

3) Third Step

In the third step, a quality rating scale (Q_i) for i^{th} water quality parameter was computed the following equation. [5]

$$Q_i = 100 \times [\frac{C_i}{S_i}]$$

In above equation, C_i is the concentration of each parameter in each water sample (measured data) and S_i

is the drinking water standards by WHO. In Table 2, the measured values of thirteen parameters for three water samples and standard permissible values according to WHO were described.

4) Fourth Step

Before calculating WQI values, the value of SI is first computed for each parameter to assess the quality of surface water in this region. To determine SI, the following equation was used.

$$SI_i = W_i \times Q_i$$

where, SI_i is sub index of i^{th} parameter and Q_i is the quality rating based on the concentration of i^{th} parameter.

Finally, calculation of WQI, a single number for all water quality, was made using a weighted arithmetic method in the following step.

$$WQI = \sum SI_i$$

Calculated water quality index of water samples is usually distinguished into five categories shown in table 1.

Table 1. Comparison of Water Quality Rating and WQI Values [5]

WQI value	Rate of Water Quality
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
Above 100	Unfit for Drinking Purpose

III. Result and Discussion

Table 2. Measured Values of Water Quality Parameters for Three Water Samples and Standard Permissible Values According to WHO [1][2][3]

Sr No	Parameters	(S_i)	HS-1 (river)	HS-2 (ground)	HS - 3(river)
1	pH	6.5-8.5	7.9	7.5	7.1
2	Electrical Conductivity	2500	300	400	43
3	Turbidity	5	<5	<5	<5
4	Hardness	200	80	160	100
5	Total Dissolved Solids	600	188	215	195
6	Alkalinity	120 (ICMR)	167	380	230
7	Cadmium	0.03	0.014	0.011	0.0027
8	Lead	0.01	0.914	1.278	1.05
9	Copper	2	0.044	0.037	1.581
10	Zinc	5	0.168	0.166	0.197
11	Potassium	100	ND	ND	0.9
12	Sodium	130	1.203	4.167	4.81
13	Calcium	100	44.97	52.05	55.02

The statistical analysis of water samples in study area was carried out to determine the water quality index. Standards of drinking water quality recommended by WHO which are universally accepted as the permissible values for the water-quality parameters are very important factors for all living things because the quality of water relates to the human health directly.

Table 2 gave the measured values of various selected physico-chemical parameters and concentration of some elements in collected water samples during December 2019. The values of pH, electrical conductivities (EC), turbidity, hardness and total dissolved solids (TDS) obtained from ALARM Ecological laboratory were valid within the standard values of WHO. However, the achieved values of alkalinity for all water samples were higher than the permissible limits of ICMR. For the experimental measurements of physico-chemical parameters for all water samples, methods and tester or instruments were described in sample analysis section. Among seven kinds of elemental concentration, content of lead (Pb) is greater than the permissible value set by WHO. In addition, the amounts of cadmium (Cd) for sample-1 and sample -2 were nearly closed to WHO standard. The concentrations of potassium for HS-1 and HS-2 were not detected. The rest of metals dissolved in sample water were within the allowed limits of WHO. Concentrations of (7) metals dissolved in sample water were measured using a high-performance PinAAcle™ 900H S/N PHCS16091301 atomic absorption spectrometer instrument in the laboratory of URC at University of Yangon.

Table 3. Computational Results of Water Quality Indices (WQIs) for Both Surface Water and Ground Water in Study Area.

Sr No	Parameters	HS-1 (river) $W_i Q_i$	HS-2 (ground) $W_i Q_i$	HS-3 (river) $W_i Q_i$
1	pH	0.0696	0.0386628	0.0174
2	Electrical Conductivity	0.000048	0.000064	0.00000688
3	Turbidity	-	-	-
4	Hardness	0.002	0.004	0.0025
5	Total Dissolved Solids	0.0006266	0.0007166	0.00065
6	Alkalinity	0.01113336	0.0253336	0.0153336
7	Cadmium	138.46	108.79	26.703
8	Lead	0.226215	0.316305	0.259875
9	Copper	0.000726	0.001188	0.0017391
10	Zinc	0.0066528	0.0065736	0.0078012
11	Potassium	-	-	0.000081
12	Sodium	0.0000703	0.00024396	0.0002812
13	Calcium	0.00445203	0.00515295	0.00544698
	WQIs	138.7815241	109.1882405	27.01411496

WQI for three sampling water from various locations has been calculated using the presented equation in above section (section-2.4) and then the suitability of drinking water quality is determined according to the rating of water quality shown in table-1. Studying the results of computed WQIs displayed in table-3, the value of water quality indices for HS-1 and HS-2 were larger than 100 and therefore they were unfit for drinking water according to table-1. Nevertheless, water quality index for sample-3 was 27.014 and thus the rate of water quality was good for drinking and domestic usage.

IV. Conclusion

The value of WQI for HS-1 was 138.782, for HS-2 was 109.188 and HS-3 was 27.014 computed by weighted arithmetic method as displayed in table-3. Therefore, the obtained results are the clear indication that the water in HS-1 and HS-2 are not suitable for both drinking purpose and domestic uses without treatment but also water in HS-3 is safe for drinking purpose. According to calculated WQIs presented in table-3, high concentration of cadmium makes larger values of WQI in HS-1&2. Although WQIs for HS-1&2 are very high, WQI for HS-3 is low because of the small value of cadmium content dissolved in it. After all, the obtained results from this investigation are essential requirement for the planner, decision makers, government agencies, and the residents who will have knowledge deals with water quality in this region during a certain period to understand complex water quality data very clearly.

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The Investigation of Radon Concentration and Exhalation Rates in Cigar and Cigarette Samples using Solid State Nuclear Track Detection Technique

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Abstract: The exposure of radioactive radiation for a long time period leads to pathological effects like the respiratory functional changes and the occurrence effects like the respiratory occurrence of lung cancer which was caused by alpha radiation. In the present work aimed to find out the radiation pollutant, especially alpha counting by using solid state nuclear track detection technique in five kind of fine powder and ash of cigarette and cigar samples in Myanmar. To detect the alpha, LR-115 Type II solid state nuclear track detector was used.

Keywords: alpha radiation, detector, cigarette

I. Introduction

Tobacco is a plant whose leaves are dried and processed into cigarettes, cigars, pipe tobacco, chewing tobacco and snuff. Tobacco can be smoked, chewed or sucked. Tobacco contains thousands of poisonous chemicals; probably the most dangerous is nicotine as well as radioactive elements contained. Cigarette is made of small pieces of tobacco leaves. Cigar is a tightly rolled bundle of dried and fermented tobacco which is ignited so that its smoke may be drawn into the smoker's mouth. When a person smokes a cigarette, cigar or pipe the nicotine and radioactive elements contained in the smoke enter the lungs and pass through cell lining into the bloodstream.

II. The Aim of Present Work

The aim of this research is to find out the radiation effect and alpha radiation effect due to radioactive material including in cigar and cigarettes samples using solid state nuclear track detection technique ("Can" technique).

A. Radioactive Radiation and Tobacco

The radioactive elements in tobacco are accumulated from the minerals in the soil, as with any plant, but are also captured on the sticky surface of the tobacco leaves in excess of what would be seen with plants not having this property. As radon decays, its electrically charged daughter products attach themselves to dust particles, which adhere to the sticky hairs on the underside of tobacco leaves. This leaves a deposited of radioactive polonium and lead on the leaves. Therefore radioactive element contents in tobacco are needed for human health problem due to tobacco consuming.

B. Radon

Radon is a radioactive gas that comes from the breakdown of naturally occurring uranium in soil and rock. Naturally occurring alpha radiation is ubiquitous in the environment, its primary source being radon gas. ^{222}Rn, a progeny of ^{238}U, is a colorless, odorless, but noble radium -226 ($T_{1/2}$ =4.51 billion yrs) comprises 4 ppm of the earth's crust. The problem of radon is an important global problem of radiation hygiene concerning the world population.

It is well known that exposure of population to high concentrations of radon and its daughters for a long period leads to pathological effects like the respiratory function changes and the occurrence of lung cancer. Radon is a potent carcinogen. Radon gas decays into minute radioactive particles which float in the air we breathe. These particles get trapped in the lungs where they undergo radioactive decay with a half-life of 22 years. The radiation damages the DNA of adjacent cells and causes lung cancer.

III. Sample Collection

The samples were personality collected from different shops in Yangon as shown in Table 1.

Table 1. Sample no with Different Sample Names

Sample No	Sample Name
T 1	Fine cigarette
T 2	Vegas cigarette
T 3	London cigarette
T 4	Freel cigarette
T 5	Shwe Nagar cigar

A. Experimental Detail for "Can" Technique

The known amounts (0.10kg) of the cigars and cigarettes samples (crushed, filtered through a sieve and oven dried) were placed in plastic cans shown figure-1. SSNTDs LR-115 Type II CN (1cm x 1cm) plastic detectors were fixed on the bottom of the lid of each can with tape such that, sensitive side of the detector faced the specimen. The cans were tightly closed from the top and sealed.

The diameter 10.1 cm, height 10.3 cm, volume 825cm^3.

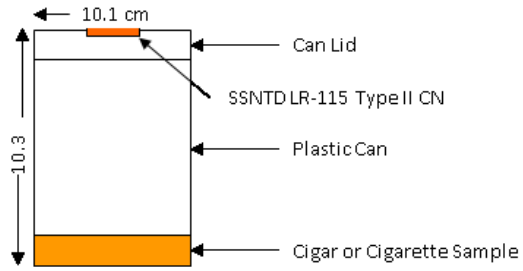

Figure1. Schematic Diagram of the Experimental Work of 'Can Technique'

B. Measurement Condition

Detector: (1 cm × 1cm) LR-115 Type II Cellulose Nitrate SSNTD
Measurement Technique: "Can" Technique
Samples : four cigarettes and one cigar samples
Exposure Time : 60 days
Microscope : Dp 12 Olympus Microscope with Digital Camera (× 400)
The equation used for exhalation rates are as follows:

$$E_X = \frac{\frac{CV\lambda}{M}}{T + \frac{1}{\lambda(e^{-\lambda T} - 1)}} \text{ (For mass exhalation rate)}$$

$$E_X = \frac{\frac{CV\lambda}{A}}{T + \frac{1}{\lambda(e^{-\lambda T} - 1)}} \text{ (For surface exhalation rate)}$$

where, C = integrated radon exposure ($Bqm^{-3}h$)
V = Volume of air in can (m^3)
T = Time of exposure (h)
λ = Decay constant for radon (h^{-1})
M = Mass of the sample (kg)
A = Area covered by the can or surface area of the sample (m^3)
The annual effective dose from radon was calculated following ICRP Publication (ICRP, 1993) where $1Bqm^{-3} = 0.0172\ m\ Svyr^{-1}$)

IV. Alpha Radiation

Alpha radiation was shown by Rutherford and Roylds to consist of helium nuclei which themselves consist of two protons and two neutrons. These four particles are bound together so tightly that the alpha particle behaves in many situations as if it is fundamental particle. Alpha particle has a mass of 4amu and carries two units of positive charge. Alpha radiation is not normally regarded as an external radiation hazard as it cannot penetrate the outer layers of the skin. A thin sheet of paper is usually sufficient to stop alpha particles and so they never present a shielding problem.

The alpha particle is a massive particle (by nuclear standards) and travels relatively slowly through matter. It thus has a high chance of interacting with atoms process (inelastic collisions with bound electrons) along its path and it may deviate from its path, and it gives up some of its energy during each of these interactions. As a consequence, alpha particles lose their energy very rapidly and travel only very short distance in dense media. The alpha particles can be deflected both by electric field and magnetic field. Alpha particles have most ionizing power than beta rays and gamma rays but the least penetrating power.

A. Alpha Track Detection using Solid State Nuclear Track Detection Technique

The technique of SSNTDs is based upon the damage created in an insulating solid along the path of a heavily ionizing particle such as an alpha particle and other ions. Solid state nuclear track etching methodology is still being one of the most widely used techniques in many applications. Track detectors are successfully performed in ^{222}Rn (radon) concentration measurements and determination of uranium.

V. Solid State Nuclear Track Detectors (SSNTDs)

Solid State Nuclear Track Detectors (SSNTDs) are dielectric materials or solid insulator such as mica, glass and synthetic plastics etc, which record and permanently store the trajectory of fast moving charged particles in the form of submicroscopic trails of continuous damage called "latent tracks". The kinds of SSNTDs are classified in three groups such as mineral crystals, glasses and plastics. Polycarbonate (Lexan, Makrafol, Milar), Cellulose Nitrate (Daicel, LR-115, CA-80-15) and CR-39 (allyldiglycol carbonate) are contained in plastics group. In this work, LR-115 detectors were used as track recording material.

A. The Structure of LR-115 Type II CN (Cellulose Nitrate) Detector

The plastic track detector LR-115 type II is a cellulose nitrate film manufactured by Kodak, France. The sensitive surface for alpha particle, red dyed, is 10µm thickness of cellulose nitrate and the base is 100µm polyester. Figure 2 shows the composition of LR-115 Type II CN detector.

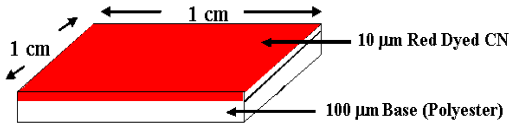

Figure 2. Structure of LR-115 Type II CN Detector

VI. Preparation of Etchant

2.5N NaOH solutions were prepared for etching irradiated LR-115 detectors. To obtain 2.5N solution, 10g of NaOH pellets (99% purity) were put into 100ml

measuring cylinder. Then distilled water was poured on the NaOH pellets in the measuring cylinder and stirred with a glass rod, until all NaOH pellets were dissolved. The distilled water was added to get 100ml solution.

A. Track Formation

At the end of the exposure time 60 days, SSNTD LR-115 Type II was taken from the can and was subjected to chemical etching process in 2.5 N NaOH solution at 60^{o} C for 45 minutes. The detector was rinsed and dried and the tracks produced by alpha particles were observed and counted under DP 12 Olympus optical microscope fitted with Digital Camera and a display system, PC. According to the observations of the different views of the screen of PC, alpha tracks were counted to reduce the statistical errors. In this work alpha tracks were counted for different fifty views.

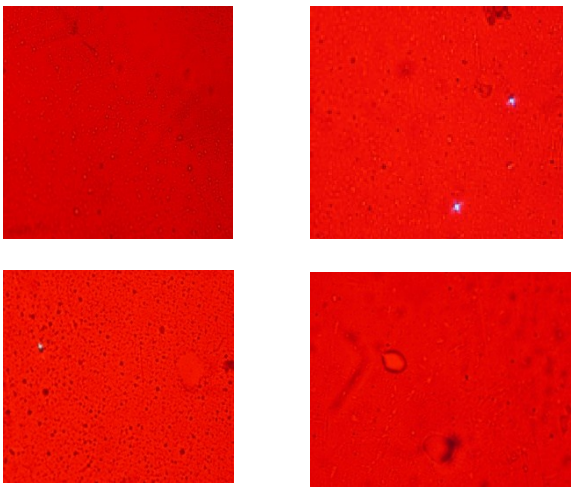

Figure 3. Microphotographs of Alpha Tracks in LR 115 Type II (Cellulose Nitrate) Detectors for Some Cigarettes and Cigar Samples Studied in the Present Work

B. Calculation of Alpha Track Density and Radon Concentration

The alpha track density in soil state nuclear track detector is the number of net alpha track per unit area.

$$\text{average track density} = \frac{\text{Number of net tracks}}{\text{Counted area} \times \text{Exposure days}}$$

From the values of alpha track density, the radon concentration can be calculated. The Environmental Assessment Division of BARC, calibration factor used was, 0.021 track cm^{-2} day^{-1} = 1 Bqm^{-3}. Then annual affective doses from cigar and cigarette samples were calculated using publication (ICRP, 1993), where 1 Bqm^{-3} = 0.072 mSvyr^{-1}.

The alpha radiation of fine powder and ashes of cigar and cigarette samples were mentioned in Table (2), (3) and the comparison of the alpha radiation of fine powder and ashes of cigar and cigarette samples was shown in Figure 4.

The results of the radon exhalation rates of fine powder and ashes of cigar and cigarette samples were mentioned in Table (4), (5) and the comparison of radon exhalation rates of fine powder and ashes of cigar and cigarette samples were also shown in Figure 5.

Table 2. Alpha Radiation of Fine Powder of Cigarette and Cigar Samples

Sr No	Sample Name	Radon Concentration (Bqm^{-3})	Annual Effective Dose (mSvyr^{-1})
1	Fine cigarette (T1)	94.88±4.47	1.60±0.08
2	Vegas cigarette (T2)	89.31±3.37	1.54±0.06
3	London cigarette (T3)	100.47±4.22	1.73±0.07
4	Freel cigarette (T4)	99.08±4.92	1.70±0.08
5	Shwe Nagar cigar (T5)	247.08±7.86	4.25±0.14

Table 3. Alpha Radiation of Ashes of Cigarette and Cigar Samples

Sr No	Sample Name	Radon Concentration (Bqm^{-3})	Annual Effective Dose (mSvyr^{-1})
1	Fine cigarette (T(a)1)	98.38±2.11	1.69±0.04
2	Vegas cigarette (T(a)2)	92.10±2.09	1.58±0.04
3	London cigarette (T(a)3)	111.63±2.55	1.92±0.04
4	Freel cigarette (T(a)4)	114.43±2.81	1.97±0.05
5	Shwe Nagar cigar (T(a)5)	253.27±4.32	4.36±0.07

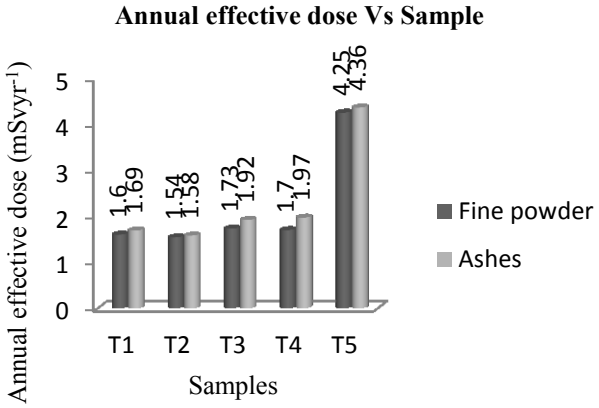

Figure 4. Comparison of Annual Effective Doses of Fine Powder and Ashes of Cigarette and Cigar Samples

Table 4. Radon Exhalation Rates for Fine Powder of Cigarette and Cigar Samples

Sr. No	Name of Sample	Mass Exhalation Rate (mBq kg^{-1} hr^{-1})	Surface Exhalation Rate (mBq m^{-2} hr^{-1})
1	Fine cigarette (T1)	4.68 ± 0.22	58.40 ± 2.75
2	Vegas cigarette (T2)	4.40 ± 0.18	54.97 ± 2.23
3	London cigarette (T3)	4.83 ± 0.20	60.31 ± 2.54
4	Freel cigarette (T4)	4.94 ± 0.25	61.73 ± 3.06
5	Shwe Nagar cigar (T5)	11.73 ± 0.37	146.44 ±4.66

Table 5. Radon Exhalation Rates for Ashes of Cigarette and Cigar Samples

Sr. No	Name of Sample	Mass Exhalation Rate (mBq kg^{-1} hr^{-1})	Surface Exhalation Rate (mBq m^{-2} hr^{-1})
1	Fine cigarette (T(a)1)	35.61 ± 0.76	71.01 ± 1.52
2	Vegas cigarette (T(a)2)	32.84 ±0.76	65.08 ±1.47
3	London cigarette (T(a)3)	46.36 ± 1.06	80.59± 1.84
4	Freel cigarette (T(a)4)	43.60 ± 1.07	84.34± 2.07
5	Shwe Nagar cigar (T(a)5)	48.89 ±0.83	173.20 ±2.95

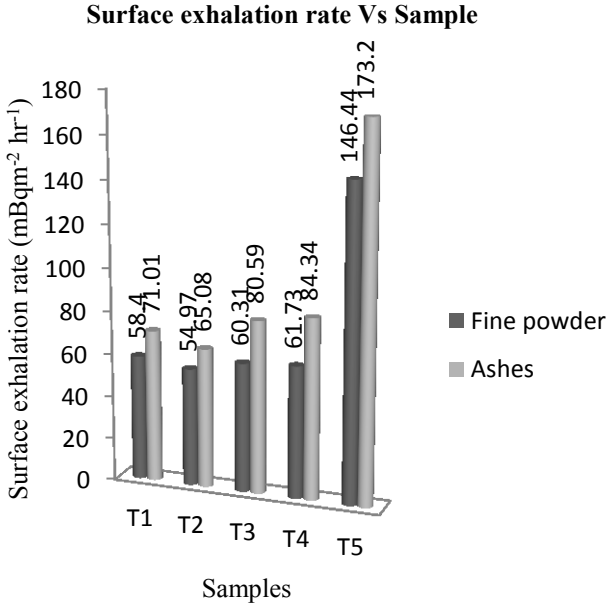

Figure 5. Comparison of Surface Exhalation Rates of Fine Powder and Ashes of Cigarette and Cigar Samples

VII. Result and Discussion

According to Table (2), the tracks of alpha radiation were observed obviously in all the fine powder of cigarette and cigar samples. In this research work, the maximum radon concentration 247.08 ± 7.86 Bqm^{-3} and maximum annual effective dose $4.25 \pm 0.14 mSvyr^{-1}$ were found in sample T5 Shwe Nagar cigar and the minimum radon concentration 89.31 ± 3.37 Bqm^{-3} and minimum annual effective dose $1.54 \pm 0.06 mSvyr^{-1}$ were found in sample T2 Vegas cigarette. According to the result Table (3), the tracks of alpha radiation were observed obviously in all the ash of cigarette and cigar samples. In this research work, the maximum radon concentration 253.27 ± 4.32 Bqm^{-3} and maximum annual effective dose $4.36 \pm 0.07 mSvyr^{-1}$ were found in sample T(a)5 Shwe Nagar cigar and the minimum radon concentration 92.10 ± 2.09 Bqm^{-3} and minimum annual effective dose $1.58 \pm 0.064 mSvyr^{-1}$ were found in sample T(a)2 Vegas Cigarette. Therefore, it was found that the radon concentration and annual effective dose of the ash samples were more than fine powder samples.

VIII. Conclusions

The research works have performed to find out the radiation effect (especially for radon) and

elemental analysis for fine powder condition and ash condition of some kind of cigarette and cigar samples. The comparison results and graphs were mentioned clearly. In solid state nuclear detection, it was found that solid state nuclear detectors are small in size, flexible, inexpensive, efficient and free from sophisticated electronics and dead time problems. The action level of annual effective dose is between 3-10 $mSvyr^{-1}$ according to the ICRP recommendation (1993). It was observed that annual effective dose of fine powder and ash of sample T5 Shwe Nagar Cigar was situated within the action level. Thus, it can be known that cigar is more harmful than the cigarette in annual effective dose.

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Optical Absorbance and Electrochemical Energy Levels of Natural Dye Sensitizer Extracted from *Rhinacanthus Nasutus* (Htaw-la-batt) Leaf for Dye Sensitized Solar Cell (DSSC)

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***Abstract*:** In this work the natural dye sensitizer was extracted from the *Rhinacanthus nasutus* leaf by using ethanol and methanol solvent for Dye-sensitized solar cells (DSSC). Methanol solvent found the better solvent than ethanol in this extraction process. The extracted dyes were analyzed by the Ultraviolet-Visible (UV-Vis) spectrophotometer, Fourier-Transform Infrared (FTIR) spectroscopy and Cyclic Voltammetry (CV). The UV-Vis result shows that the high absorption, wide absorption spectra and energy band gap 1.80 eV, at temperature 45°C and at high pH value 9.1. Functional groups of synthesized sample were identified by using FTIR, where the hydroxyl and carbonyl are found in this sample. Moreover, in the Cyclic Voltammetry analysis, the electrochemical energy levels of HOMO and that of LUMO of the *Rhinacanthus nasutus* leaf dyes were -5.95 eV and -4.15 eV respectively. The conditions of electron injection and regeneration were investigated by comparing the HOMO and LUMO energy level of dye molecules, the energy level of the semiconductor and the electrolyte for DSSC operation. The synthesized natural dyes have high prospect as photosensitizers in DSSC fabrication due to its wide absorption spectra and its chemical components existed within the pigments.

***Keywords*:** natural dye sensitizer, UV-Vis, FTIR, CV, temperature, pH

I. Introduction

The increasing demand of energy in the world led to increase consumption of fossil fuel but this is not balanced by the amount of its worldwide stock. By contrast, solar energy as one of renewable energy sources is abundant especially in tropical countries[4]. A solar cell is a photonic device that converts photons with specific wavelengths to electricity. Dye-sensitized solar cells (DSSCs) as the third generation solar cells devices have attract a lot of attention from researches as it is low cost and have potential for high photo conversion efficiency as reported by Gratzel group which have obtained efficiency up to 12% [6]. Generally, DSSCs comprise of four main parts such as large band gap and porous nanocrystalline semiconductor electrode, sensitizer, counter electrode, and electrolyte. Each part has its own importance in DSSC operation [8]. Photoactive electrode is made of porous nanocrystalline such as anatase titanium dioxide (TiO_2) deposited on Fluorine doped Tin Oxide (FTO) or Indium-doped Tin Oxide (ITO) conducting glass. FTO layer enables transport of photo-generated charge carriers to the electrode and it is also transparent so the light can penetrate into the solar cell. Dye is absorbed on TiO2 layer to complete the photoactive electrode. Counter electrode is also FTO glass, but it is deposited with platinum to increase the conductivity. The space between electrodes is fulfilled with electrolyte which is based on iodide and triiodide ions [5]. The choice of dye is an important parameter in the fabrication of DSSCs and a huge variety of dyes, both organic and inorganic, have been utilized as the light harvesting elements in DSSCs. Metal and other synthetic dyes are usually expensive and sometime toxic. Natural dyes are therefore an attractive alternative for the reason that they are less expensive, environmentally friendly and readily available. Natural dyes extracted from many plant sources have been used in DSSC with appreciable level of photocurrent and photo voltage characteristics. The main pigments responsible for light absorption in these dyes include anthocyanin, carotenoids, and chlorophylls. These pigments absorb in the visible and near-infrared region and also have anchoring functional groups that interact favorably with the surface of the semiconductor such as TiO_2, ZnO, SnO_2, and Nb_2O_5 [1]. The representative operating principle of dye-sensitized solar cells is shown schematically in Figure 1.[5]. Upon absorption of photons, dye molecules are excited from the highest occupied molecular orbitals (HOMOs) to the lowest unoccupied molecular orbital (LUMO) states. This process is represented by,

$S^0 + h\nu \rightarrow S^*$ (Excitation process),

Once an electron is injected into the conduction band of the wide bandgap semiconductor (eg.TiO_2) nanostructured film, the dye molecule (photosensitizer) becomes oxidized.

$S^* \rightarrow S^+ + e^-$ (TiO_2) (Electron injection process),

The injected electron is transported between semiconductor nanoparticles and then gets extracted to a load where the work done is delivered as an electrical energy.

e^- (TiO_2)+Electrode$\rightarrow$ TiO_2 + e^- (Electrode) + Energy (Energy generation),

Electrolyte containing I^-/I_3^- redox ions is used as an electron mediator between the wide bandgap semiconductor photoelectrode and the HOMO level of dye molecules.

$S^+ + e^- \rightarrow S^0 + I_3^-$ Redox regeneration (oxidation),

The I_3^- substitutes the internally donated electron with that from the external load and gets reduced back to I^- ion.

$2e^- + I_3^- \rightarrow 3I^-$ e^- Recapture reaction (reduction) [3].

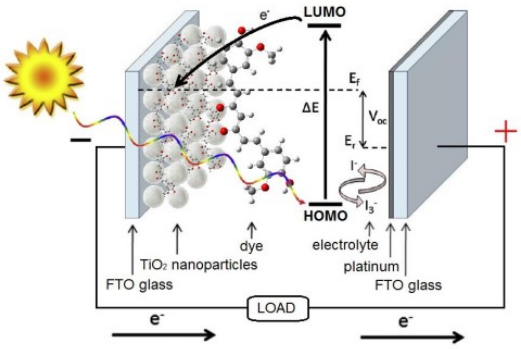

Figure 1. Schematic Structure and Principle of Operation of DSSC. [5]

Hence, the operating mechanism of dye-sensitized solar cell generates electricity without irreversible chemical changes in the cell. Dye molecules play a key role in producing electricity. They need to overcome small absorption of titanium dioxide by absorbing the photon and exciting the electron. Therefore, they are increasing the efficiency of solar cell. Thus, the greater absorption of the dye is, the solar cell will be more efficient [5]. The performance of DSSCs also depends on sensitizers that act as light harvesters in the mechanism. The best sensitizers must be capable of absorbing a wide range of visible light and producing electrons [6].

The present study investigates the optical absorbance of natural dye extracted from *Rhinacanthus nasutus* leaf, by varying solvent, temperature and pH values. Furthermore FTIR and the electrochemical energy levels of the synthesized dye were analyzed.

II. Materials and Methods

A. Materials

In this study, the used materials are methanol and ethanol for solvent, HNO_3 for pH variation. These materials were procured from market in Yangon. *Rhinacanthus nasutus* leaf were collected from Yangon University area.

B. Preparation of Natural Dye Sensitizer

In the preparation of natural dye sensitizer, the fresh and healthy *Rhinacanthus nasutus* leaf were thoroughly washed with distilled water to remove dust particles, and cut into small pieces at room temperature. About two 5g of leaves were weighed and transferred into each 150ml beakers containing 50ml ethanol and methanol separately. The dyes solutions were extracted by using a water bath at room temperature for 30 mins. The extracted solutions were filtered and analyzed optical absorption by UV-Vis spectrometer. The *Rhinacanthus nasutus* leaf, natural dye extracted in methanol and ethanol solvents in Figure 2. In UV-Vis spectra, the high absorption intensity was observed by using methanol solvent. Therefore the natural dye solution was extracted with methanol solvent by varying temperature and pH values for further studies.

(a) (b) (c)

Figure 2. (a) *Rhinacanthus Nasutus (Htaw-la-batt)* Leaf and Natural Dye Extracted in (b) Methanol (c) Ethanol Solvents

C. Characterization and Measurement

The absorption spectra of synthesized dyes were analyzed via ultraviolet–visible (UV–Vis) absorption spectroscopy (PerkinElmer: lambda 35) wavelength range 300- 700nm in Universities' Research Center (YU). The determination of optical band gap of synthesized dye is obtained by Tauc's equation,

$$\alpha h\nu = A\left(h\nu - E_g\right)^n$$

Where, A is a constant, hν is photon energy, E_g is the allowed energy gap, n = ½ for allowed direct transition and n = 2 for allowed indirect transition, α is the absorption coefficient. The Tauc's region is extrapolated to $(\alpha h\nu)^2$ vs $h\nu = 0$ to obtain the band gap *rhinacanthus* dye[9]. The requirement that natural dyes should meet presence of an anchoring group that can strongly attach to the mesoporous oxide layer[6]. Whereas, the functional group of chemical compounds can be studied from FTIR measurement which its represented by wavenumbers. The FTIR absorption spectra were recorded from 400 to 4000 cm^{-1}, Summit PRO in UATR mode using ZnSe crystal, 20 scans averaged per spectrum at Delta Science Co-ltd in Yangon. Cyclic voltammetry is used to identify level energy in organic dyes. The energy level consists of HOMO and LUMO energy. HOMO is an outer orbit that has a high molecular energy level that acts as an electron donor. When choosing organic dyes used for semiconductor dyes in DSSC, this is very important because to know the energy level HOMO, LUMO and bandgap obtained from the energy difference HOMO and LUMO[2]. These processes can be measured using cyclic voltammetry method by measuring the redox potentials E_{red} and E_{ox}. Ferrocence is used as a known

reference to calculate the energy of the HOMO and LUMO levels, including the ferrocene value of -4.4 eV. The energy levels were calculated using the following empirical Bredas *et all* equations:[7]

$$E(HOMO)=-e\ [E_{ox}^{onset}+4.4]V$$

$$E(LUMO)=-e\ [E_{red}^{onset}+4.4]V$$

$$E_g = E(LUMO) - E(HOMO)$$

The HOMO and LUMO levels of *Rhinacanthus nasutus* dye were determined via cyclic voltammetry (CV) using a potentiostat (Digi-Ivy, DY2000) complete with cell stand and data processor, in Universities' Research Center (YU). The three-electrode system is composed of Glassy Carbon Electrode (GCE) as the working electrode, an Ag/AgCl as the reference electrode, and a platinum wire as a counter electrode, using 1mM silver salt solution in aqueous (0.1M) KNO3 medium.

III. Result and Discussion

A. Ultraviolet-Visible (UV-Vis) Absorption Spectra Analysis

1) UV-Vis Absorption Spectra in Different Solvent

The UV-Vis absorption spectra of natural dye solution extracted from *Rhinacanthus nasutus* leaf using ethanol and methanol shown in Figure 3. The maximum absorption wavelength spectra of *Rhinacanthus nasutus* dye in both solvents are (λ_{max} 430 nm and 660 nm) which indicate a large amount of chlorophyll-A can be found inside the leaf which helps in photosynthesis processes and to reflect green colors from the surface of leaf.

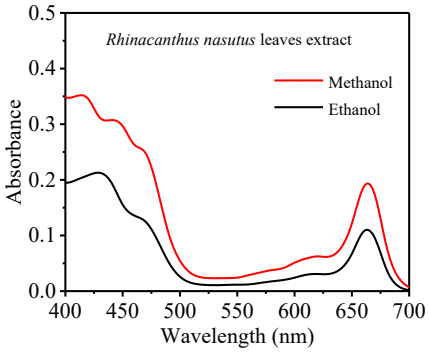

Figure 3. UV-Vis Absorption Spectra of *Rhinacanthus Nasutus* Leaf Extract in Methanol and Ethanol

The absorption intensity of dye samples using extract in methanol was higher than in ethanol. This is due to the concentration of dyes more soluble methanol than ethanol solvent. Therefore the *Rhinacanthus nasutus* leaf dyes were extracted with only methanol solvent. The studies were continuing by varying effect of temperature and pH values.

2) UV-Vis Absorption Spectra in Different Temperature

The absorption intensity of *Rhinacanthus nasutus* leaf dyes extract in methanol was analyzed by varying at 30°C, 45°C and 60°C. The absorption spectra obtained for extracted dye shown in Figure 4. The higher absorption intensities were observed with increasing in temperature, which indicates that more solubility of dye molecules in the solvent at higher temperature. The absorption intensity were varied and invariant wavelength when different in temperature.

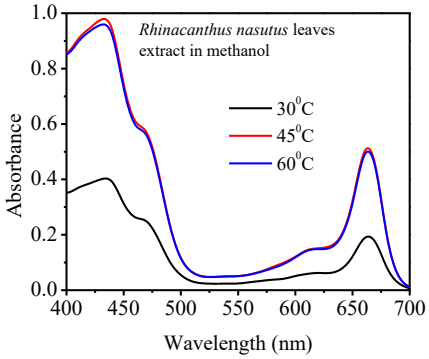

Figure 4. UV-Vis Absorption Spectra of *Rhinacanthus Nasutus* Leaf Extract at Temperature 30°C, 45°C and 60°C in Methanol

3) UV-Vis Absorption Spectra in Different pH Values

Another study was undergoing in varying different pH values at 6.2, 7.1, 8.3 and 9.1 at room temperature using methanol in Figure 5.

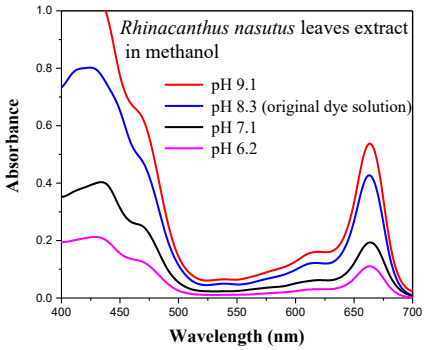

Figure 5. UV-Vis Absorption Spectra of *Rhinacanthus Nasutus* Leaf Extract varying pH Values in Methanol at Room Temperature

The pH value of original synthesized dye is 8.3, which is in acid condition. The absorption intensities in the UV-Vis spectra, they decreased at the lower levels of pH value and increase in the acid medium.

According to the above results, the *Rhinacanthus nasutus* dye was extracted at the optimum conditions by using methanol solvent, at temperature 45°C and high pH value 9.1 to get the best sensitizer for higher absorption intensity. The final absorption spectrum for the synthesized dye is presented in Figure 6. The synthesized dye mainly contain chlorophyll-A due to its absorb bands (430 nm) and (660 nm) spectral ranges. Whereas the UV-Vis graph provides the synthesized dyes of absorbance, position of maximum absorbance λ_{max} and the longest absorption wavelength λ_{onset}. The energy band gap (1.801 eV) of extracted dye was observed by using Tauc's equation shown in Figure 7. The optical properties of synthesized dye sample are expressed in Table 1.

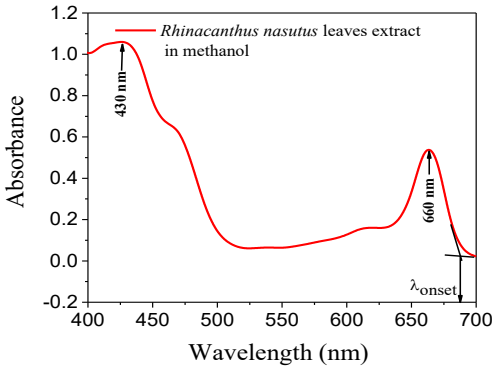

Figure 6. UV-Vis Absorption Spectrum of *Rhinacanthus Nasutus* Leaf Extract at pH Value 9.1, Temperature 45°C in Methanol

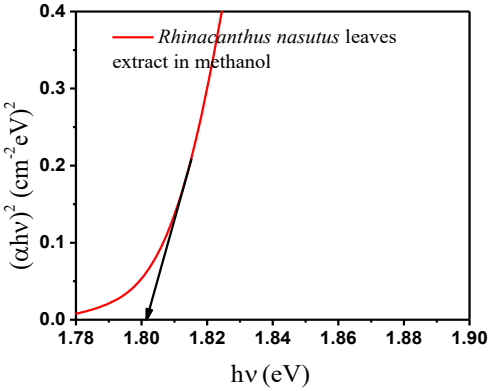

Figure 7. Energy Bandgap of *Rhinacanthus Nasutus* Leaf Extract

Table 1. Optical Properties of Synthesized Dyes Sample

Dyes sample	Pigment	λ_{max} (nm)	λ_{onset} (nm)	E_g (eV)
Rhinacanthus nasutus dye	Chlorophyll A	430 and 660	690	1.801

B. Fourier-Transform Infrared (FTIR) Spectroscopy Analysis

The functional group of dye structure must own several carbonyl (C=O) or hydroxyl (−OH) groups to enable dye molecule chelating to the Ti (IV) sites on the TiO_2 surface [3]. The analysis of the functional groups of the sensitizers was conducted using FTIR spectroscopy, with KBr as the reference background. Figure 8. shows the analysis result of FTIR spectrum on *Rhinacanthus nasutus* leaf dyes extract. A strong and broad band at 3375 cm^{-1} shows that the existent of O-H with a H-bonded in hydroxyl group. Carbonyl functional group of C=O bond is represented at the strong peak of 1622cm^{-1}. The FTIR result show that these natural dyes consist of functional groups of chlorophyll molecule which could help to form bonds with porous nanocrystalline semiconductor as photoanode of DSSC.

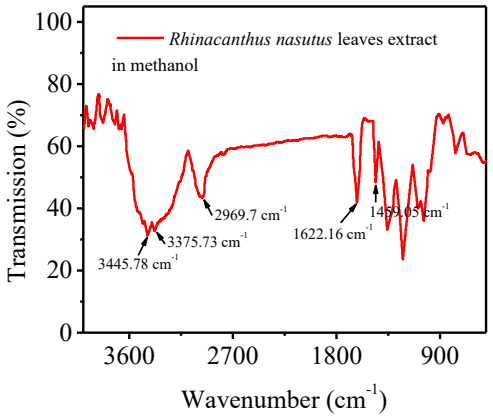

Figure 8. FTIR Spectrum of *Rhinacanthus Nasutus* Leaf Dye

C. Electrochemical Energy Levels Analysis

The DSSC operation, the energy levels of HOMO and LUMO cannot be estimated only from the dye but also must be adjusted according to the energy levels of the semiconductor and the electrolyte. Cyclic voltammetry is used to investigate the energy levels in organic dyes. The energy levels consists of HOMO and LUMO energy [2]. The conduction band (CB) of TiO_2 was reported to locate around -4 to -4.3 eV. Ooyama and Harima reported that the desire difference of LUMO level of sensitizer and CB of TiO_2 should be more than 0.2 eV. The HOMO level of sensitizer must be more negative than the redox potential with respect to the vacuum level in the range of 0.2–0.3 eV. From the previous study, the redox potential of I_3^-/I- redox couple was reported to locate in the range of -4.6 to -5 eV [6].

The Electrochemical behavior of Natural Dye Extracted from *Rhinacanthus nasutus* Leaf was studied by carrying out cyclic voltammetry in the potential range +0.1 V to -0.1V vs Ag/ AgCl in a repetitive scanning mode at a scan rate of 20mVs^{-1}. Figure 9.

shows the record of cyclic voltammograms of 1mM silver salt solution in aqueous (0.1M) KNO3 medium.

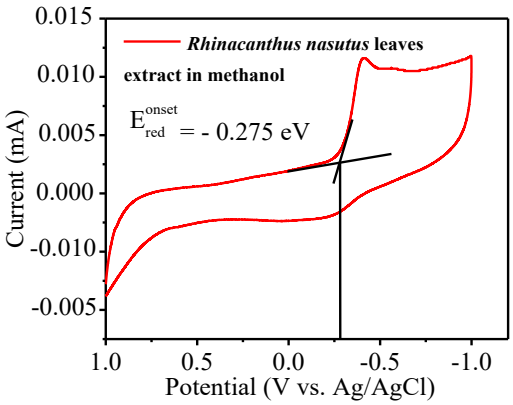

Figure 9. Cyclic Voltammetry Test of Dye Extracted from *Rhinacanthus Nasutus* Leaf

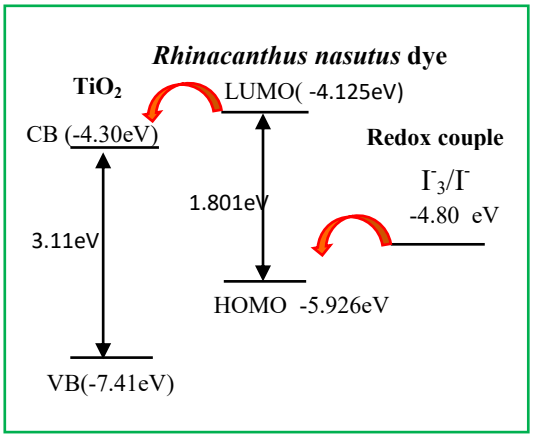

Figure 10. Schematic Diagram for the Energy Levels of TiO_2, HOMO, LUMO of the Investigated Dye Sensitizers and Electrolyte

The Figure 10 is the schematic diagram for the relation between of the electrochemical energy levels of synthesized dye and conduction band of TiO_2 and redox potential of electrolyte. In this work HOMO energy for The *Rhinacanthus nasutus* dye is -5.926 eV, energy LUMO -4.125 eV and bandgap energy 1.801 eV. The results show, the LUMO energy is more higher than the HOMO energy and low energy band gap therefore the electron in dye molecule from the HOMO energy more easily jump to the LUMO energy. The minimum gap from the LUMO level to conduction band of TiO_2 is 0.175eV, this condition provide the efficient electron injection from the LUMO of dye to TiO_2 layer conduction band. The HOMO level of sensitizer also more negative than the redox potential about 1.126 eV. It shows that the good dye regeneration from electrolyte to the HOMO level of dye sensitizer, and hence these investigated conditions lead to the good performance of DSSC device.

IV. Conclusion

In the current study, the natural dye was successfully extracted from *Rhinacanthus nasutus* leaf by using methanol solvent to use as sensitizer for DSSC. In UV-Vis analysis, the optimum conditions for the higher absorbance and low energy band gap with methanol solvent were observed at temperature 45°C, and high pH value 9.1. The effect of higher absorbance was due to the more soluble concentration of dye at above conditions. The UV-Vis results show that the influence of chlorophyll-A at the maximum absorbance at λ_{max} 430nm and 660nm. As in FTIR analysis results, prove the presence of two anchoring groups with TiO_2 such as carbonyl (C=O) and hydroxyl group (O-H) in the *Rhinacanthus nasutus* dye. Furthermore, the efficient conditions of electron injection and regeneration process of synthesized dye molecules in DSSC were observed from the cyclic voltammetry (CV) analysis. The investigated results show, this synthesized dye can be used as a sensitizer in the DSSC fabrication.

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The Study of Heavy Toxic Metal Concentration and Risk Assessment of Some Vegetables

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Abstract: The objective of this research work is to study the contamination of heavy metal in a vegetable. The analysis of elemental concentration in vegetables was measured by the EDXRF method. In this research work, vegetable samples have been collected from the Shwebo market, Shwebo Township, Sagaing Region has been performed. From the EDXRF method, the elemental concentrations of heavy toxic metal such as As, Cr, Cd, Ni, and Pb are contained in samples. The daily intake of some heavy elements in all vegetable samples and health risk index is also calculated. The daily intake of metal (DIM) values for chromium is 13.6 mg/kg. The lowest value of daily intake of metal (DIM) values for arsenic is 0.153 mg/kg. It can be seen that the order of the daily intakes of metal (DIM) values for some heavy elements was Cr > Cd > Pb> Ni > As. According to the study, the health risk index of heavy toxic metals such as As, Cr, Cd, Ni, and Pb is less than 1. So, it can be concluded that people do not harm their health by eating vegetables.

Keywords: heavy metal, vegetable, contamination, daily intake, health risk.

I. Introduction

Vegetables are important edible crops and are an essential part of the human diet. They are rich in nutrients required for human health and are an important source of carbohydrates, vitamins, minerals, and fibers [1]. Heavy metals can be readily taken up by vegetable roots and can be accumulated at high levels in the edible parts of vegetables, even heavy metal in the soil at low levels. In many countries and regions, vegetables are exposed to heavy metals by various means, thus vegetable consumption can cause adverse health effects [1, 5].

In many countries and regions, vegetables are exposed to heavy metals by various means, thus vegetable consumption can cause adverse health effects. In Huludao City, China, the ranges of Pb and Cd concentrations in vegetables are 0.003–0.624 mg/kg and 0.003–0.195 mg/kg (fresh weight), respectively, and the maximum concentrations of Pb and Cd all exceed the recommended values (GB 2762-2005). Hu et al. reported that 16%, 26%, and 0.56% of market vegetables in Hong Kong were contaminated by Pb, Cd, and Cr, respectively. Rahman et al. reported that some Australian and Bangladeshi vegetables contained Cd concentrations higher than the Australian standard maximum limit (0.1 mg/kg). Therefore, vegetable consumption is considered to be one of the major sources of heavy metal intake for humans, and elevated levels of heavy metal in edible parts of vegetables can affect human health. Vegetables can absorb metals from the soil as well as from deposits on the parts of the vegetables exposed to the air from polluted environments [1, 2, 3].

In the present work, the six samples of vegetables have been collected from the Shwebo market. These vegetable samples were analyzed by using the SPECTRO XEPOS system. Measurements for all vegetable samples have been done in the Nuclear Physics Laboratory, Department of Physics, and Mandalay University. The results were analyzed (i) the heavy toxic metal concentration in vegetable (ii) to evaluate the metals using different metal assessment indices such as daily intake of metals (DIM) and health risk index (HRI) in vegetables from Shwebo market, Shwebo, Sagaing Region.

II. Materials and Methods

A. Sample Collection

In the present work, the six samples of vegetables have been collected from the Shwebo market. The collected vegetable samples are onion, garlic, ginger, tomato, potato, and watercress. The vegetable species used in the experiment were shown in Table 1. The vegetable species used in the experiment was shown in Figure 1.

Table 1. Vegetable Species Used in the Experiment

Sample Code	Sample Name	Myanmar Name	Botanical Name
S-1	Onion	ကြက်သွန်နီ	*Allium cepa*
S-2	Garlic	ကြက်သွန်ဖြူ	*Allium sativum*
S-3	Ginger	ဂျင်း	*Zingiber officinale*
S-4	Tomato	ခရမ်းချဉ်သီး	*Solanum lyycopersicum*
S-5	Potato	အာလူး	*Solanum tuberosum*
S-6	Watercress	ကန်စွန်းရွက်	*Luziola*

Figure 1. Vegetable Species Used in the Experiment

B. Sample Preparation for XRF Method

In this research work, there are six vegetable samples are collected from the Shwebo market, Shwebo Township. The vegetable samples were then cleaned using pure water to remove any contaminants, such as pesticides, fertilizers, dust, and mud. The edible parts of the vegetables were separated from the plants and dried at room temperature until the weight of the sample remained constant. The vegetable was dried, ground to a fine powder by using an agate mortar and pestle, and passed through a 325-mesh sieve, then kept in clean polyethylene containers before analysis. After getting very fine powder; the sample was weighed nearly 5g. So the powdered samples were prepared as pellets. After pelletizing, the pressed pellet was weighed again. Finally, each pellet sample was placed in a small plastic bag. On the outside of each bag, weight and sample names were marked.

C. Experimental Procedure for XRF Method

In this research work, the elemental concentration of vegetable samples was analyzed by using the SPECTRO XEPOS system. All the prepared pellets were put into the sample changer. Sample identification and changer number were carefully recorded. All of the pellet samples were analyzed 300 sec for each filter. The elemental concentrations contained in vegetable samples were determined by the fundamental parameter method. The measurement set-up for SPECTRO XEPOS Spectrometer is shown in Figure 2.

Figure 2. Experimental Set-up for SPECTRO XEPOS EDXRF System

D. Calculation of Daily Intake of Metals (DIM)

This is determined by the following equation

$$DIM = C_{metal} \times C_{factor} \times D_{food\ intake} / B_{average\ weight} \quad (1)$$

Where

C_{metal} = heavy metals conc. in plants (mg/kg)

C_{factor} = conversion factor

$D_{food\ intake}$ = daily intake of vegetables.

The conversion factor of 0.085 is to convert fresh vegetable weight to dry weight.

E. Calculation of Health Risk Index (HRI)

The health risk index is defined as the ratio of daily intake of metal to the reference dose. The following formula is used for the calculation of HRI.

$$HRI = DIM / R_fD \quad (2)$$

If the value of HRI is less than 1 then the exposed population is said to be safe. If the value of HRI is greater than 1 indicates that there is a potential risk associated with that metal [3. 4, 9].

III. Results

From the EDXRF method, the heavy toxic elements such as arsenic (As), chromium (Cr), cadmium (Cd), nickel (Ni) and lead (Pb) were found in the vegetable samples.

The elemental concentrations of some toxic heavy metals were presented in Table 2.

The statistical data on the elemental concentrations of some toxic heavy metals were shown in Table 3.

The daily intakes of metal (DIM) of some toxic heavy metals for these measured samples are shown in Table 4.

The health risk indexes (HRI) of some toxic heavy metals for these measured samples are shown in Table 5.

Table 2. Elemental Concentrations of Some Toxic Heavy Metals

Sample Name	Elemental Concentration (mg/kg)				
	As	Cr	Cd	Ni	Pb
Onion	0.7	8.0	0.8	0.4	1
Garlic	0.5	6.4	0.6	0.8	1
Ginger	0.9	8.6	2	0.5	1.9
Tomato	0.5	6.6	1	0.4	1
Potato	0.4	5.1	2	0.5	0.1
Water Cress	0.6	7.2	0.4	0.3	0.4
Safe Limit	**7**	**50**	**1.5**	**4**	**10**

Table 3. Statistical Data on the Elemental Concentrations of Some Toxic Heavy Metals

	Elemental Concentration (mg/kg)				
	As	Cr	Cd	Ni	Pb
Mean	0.58	6.98	1.02	0.67	0.82
Median	0.5	7.2	0.8	0.5	1
Std Dev	0.16	0.67	0.69	0.52	0.59
Min	0.4	5.1	0.4	0.3	0.1
Max	0.9	8.0	2	1.8	1.9
Sum	4.1	41.9	7.2	4.7	5.8

Table 4. Daily Intakes of Metal (DIM) of Some Toxic Heavy Metals

Sample Name	Daily Intakes of Metal (DIM) (µg/kg)				
	As	Cr	Cd	Ni	Pb
Onion	0.12	13.6	0.13	0.06	0.17
Garlic	0.08	1.08	0.10	0.13	0.17
Ginger	0.15	1.46	0.34	0.08	0.323
Tomato	0.08	1.12	0.17	0.06	0.17
Potato	0.07	0.86	0.34	0.08	0.017
Water Cress	0.10	1.224	0.06	0.051	0.068
Mean	0.09	2.94	0.17	0.11	0.140
Std.Dev	0.02	4.7025	0.11	0.08	0.101
Min	0.06	0.867	0.06	0.051	0.017
Max	0.15	13.6	0.34	0.306	0.323
Ref: Dose	**0.3**	**5**	**1**	**20**	**600**

Table 5. Health Risk Indexes (HRI) of Some Toxic Heavy Metals

Sample Name	Health Risk Index (HRI)				
	As	Cr	Cd	Ni	Pb
Onion	0.396	2.72	0.13	0.0034	0.0002
Garlic	0.283	0.217	0.10	0.0068	0.0002
Ginger	0.51	0.292	0.34	0.0042	0.0005
Tomato	0.283	0.224	0.17	0.0034	0.0002
Potato	0.226	0.173	0.34	0.0045	2.8E-5
Water Cress	0.34	0.244	0.06	0.0025	0.0001
Mean	0.331	0.588	0.17	0.0057	0.0002
Std.Dev	0.09	0.94	0.11	0.004	0.0001
Min	0.226	0.173	0.06	0.0025	0.0000
Max	0.51	2.72	0.34	0.0153	0.0005
Safe Limit	**< 1**	**< 1**	**< 1**	**< 1**	**< 1**

IV. Discussion

From Table 2, the concentration of arsenic (As) is range from 0.4 mg/kg to 0.9 mg/kg. The safe limit for the concentration of arsenic (As) in the vegetable is 7 mg/kg. The mean concentration was 0.58 ± 0.16 mg/kg. These results obtained are within the safe limit for vegetables.

The concentration of chromium (Cr) is range from 5.1 mg/kg to 8.6 mg/kg. The safe limit for the concentration of chromium (Cr) in the vegetable is 50 mg/kg. The mean concentration was 6.98 ± 0.67 mg/kg. These results obtained are within the safe limit for vegetables.

The concentration of cadmium (Cd) is range from 0.4 mg/kg to 2 mg/kg. The safe limit for the concentration of cadmium (Cd) in the vegetable is 1.5 mg/kg. The mean concentration was 1.02 ± 0. 69 mg/kg. These results obtained are within the safe limit for vegetables.

The concentration of nickel (Ni) is range from 0.3 mg/kg to 0.8 mg/kg. The safe limit for the concentration of nickel (Ni) in the vegetable is 4 mg/kg. The mean concentration was 0.67± 0.52 mg/kg. These results obtained are within the safe limit for vegetables.

The concentration of lead (Pb) is range from 0.1 mg/kg to 1.9 mg/kg. The safe limit for the concentration of lead (Pb) in the vegetable is 10 mg/kg. The mean concentration was 0.82 ± 0.59 mg/kg. These results obtained are within the safe limit for vegetables. The concentrations of heavy metals in all vegetable samples were within the safe limit suggested by the Food and Agriculture Organization and World Health Organization (FAO/WHO, 2001).

The daily intakes of metal (DIM) values for some heavy metals have been calculated based on the 110g, 120g, and 130 g per person per day (assuming a value for each person). From these three DIM values, the mean DIM value was obtained. According to Table 3, the chromium has the highest DIM value in all samples by the consumption of vegetables. Among them, the arsenic has the lowest DIM value in all samples by the consumption of vegetables.

The daily intake of metal (DIM) values for chromium is 13.6 mg/kg. The lowest value of daily intake of metal (DIM) values for arsenic is 0.153 mg/kg. It can be seen that the order of the daily intakes of metal (DIM) values for some heavy elements was Cr > Cd > Pb> Ni > As. The comparison graph of daily intakes of metal for each sample is shown in Figure 3.

The health risk assessment associated with heavy metal (As, Cd, Cu, Ni, and Pb) in locally grown vegetables estimated and risk index has been calculated. The health risk index was found below one in all varieties of vegetables, and As, Cr, Cd, Ni, and Pb were not found to cause any risk to the people by consuming vegetables. The comparison graph of health risk index (HRI) in each sample is shown in Figure 4.

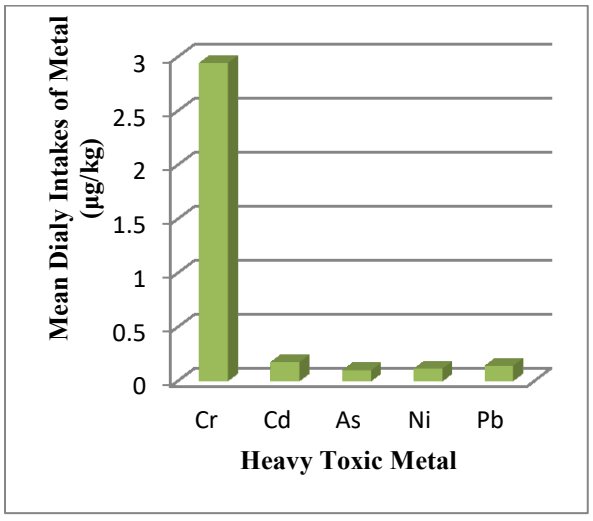

Figure 3. Comparison Graph of Daily Intakes of Metal for each Sample

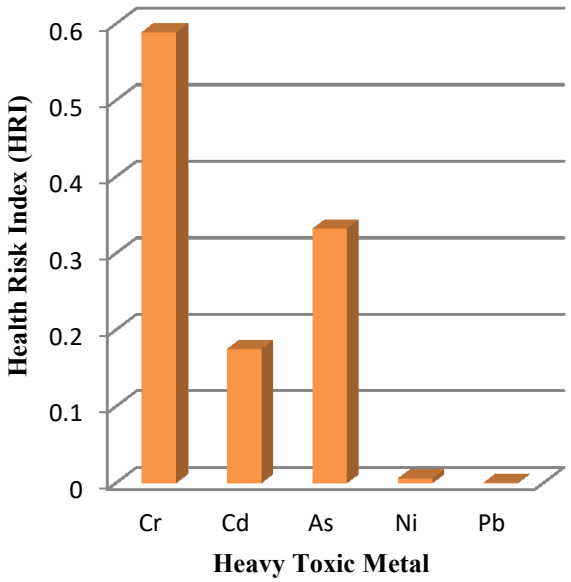

Figure 4. Comparison Graph of Health Risk Index (HRI) in each Sample

V. Conclusion

The elemental concentrations of heavy metals such as As, Cr, Cd, Ni, and Pb are contained in samples. These metals are caused by the use of fertilizers, the use of pesticides, soil types, burning of fuels and other conditions, such as industrial wastes and the method of chemicals used.

The ingestion of some vegetables containing heavy metals is one of the pathways in which these elements enter the human body. Once entered, the heavy metals are deposited in bone and fat tissues, overlapping noble minerals. The slowly released into the body, the heavy metals can cause diseases.

The value of the intake of heavy metals in human diets was also calculated to estimate the risk to human health. All sampled vegetables presented average concentrations are lower than the permissible limits. In the present study, the daily ingestion of heavy metals was below the oral dose of reference, therefore, consumption of these vegetables can be considered safe and without risk to human health.

Acknowledgments

The authors are would like to express my deepest appreciation to Dr. Aung Khin Myint, Rector, Dr. Su Su Win, Pro-rector, Kyaukse University for their kind permission, and encouragement in writing this paper. We are also sincerely grateful to Prof. Dr. Cherry Than, Head of Department of Physics, and, Prof. Dr. Nwet Nwet Aye, Department of Physics, Kyaukse University, for their encouragement.

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Chemistry

Study on the Colour Fastness Properties and Desorption of Natural Dye Extracted from Madama Bark (*Ceriops Tagal* (Perr.) C.B.Rob.) on Cotton Cloth

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***Abstract*:** The purpose of this study is to investigate the adsorption, colour fastness properties and nature of reddish brown natural dye extracted from Madama bark (*Ceriops tagal* (Perr.) C.B.Rob.) on cotton cloth. The prepared natural dye was characterized by FT IR and UV- visible analysis. The six dye sample solutions (S_1, S_2, S_3, S_4, S_5 and S_6) were prepared by natural dye powder (without mordant), inorganic mordant (alum) bio mordant (cow dung) and other inorganic mordants (alum, copper II sulphate, potassium dichromate and ferrous sulphate) respectively. Sorption properties of natural dye solution (S_1) were determined at different temperatures (40, 60 and 80) °C to select the more effective dyeing temperature. The colour density of dyeing cotton cloths dyeing with six different dye solutions were determined by Reflection Transmission Color Densitometer. From the results, S_2 showed low color density than other five dyeing cotton cloth. Depending on the type of mordants, such as alum, cow dung, copper II sulphate, potassium dichromate and ferrous sulphate, colour fastness of the dyeing cotton cloth were studied. The values of colour fastness and the visual colour of S_3 (cow dung) and S_4 (copper II sulphate) were nearly the same. So, S_3 (natural mordant or biomordant) can be used as instead of S_4 (chemical mordant). The prepared reddish brown natural dye can also be associated with the benefits of reducing health hazards, lowering toxicity levels and avoiding allergic reactions. Therefore, the present research is efficient and effective for dyeing industry.

***Keywords*:** natural dye; natural mordant; colour fastness

I. Introduction

Natural dyes are known for their use in coloring of food substrate, leather as well as natural protein fibers like wool, silk and cotton as major areas of application since pre-historic times. The use of natural dyes for textiles industries has essentially been evolved from many years ago [6]. However, the use of natural dyes was replaced by synthetic dyes slowly because synthetic dyes generally have superior fastness dyeing properties, the colors are more diverse, not easily fading, easy to produce, and the cost is cheaper than natural dyes. Natural dyes can be obtained from plants, animal, and rocks that presence in our environment. Natural dyes are non-allergenic, non-toxic and easily degraded so it does not cause environmental pollution. The colors of natural dyes are soothing to eyes, earthly, warm, and high appealing. Therefore, to obtain newer shades with acceptable color fastness behavior and reproducible color yield, appropriate scientific techniques or procedures need to be derived from scientific studies on dyeing methods, dyeing process variables, dyeing kinetics and compatibility of selective natural dyes [1].

Ceriops tagal (Perr.) C.B.Rob. (family Rhizophoraceae) is a small tree with short buttresses and knee-like breathing roots. The tree is formerly a commercial source of tannins and dyes. *Ceriops tagal* is a rich source of biologically active compounds like triterpenoids, diterpenoids, tannins and polysaccharides [4]. *Ceriops tagal* bark dye is the one of the various plant dyes. They are widely used to their low cost, excellent colour range, good light fastness and ease of application to the material. This natural dye is water soluble and possesses good affinity for fibers [7].

Figure 1. *Ceriops tagal* (Perr.) C.B.Rob. (Madama)

Figure 2. Bark of *Ceriops tagal*

The bark of *C. tagal* has been used for the treatment of infected wounds in Thailand, and obstetric and hemorrhagic conditions in the Philippines [2]. The species is also used to treat sores, haemorrhages and malignant ulcers and malaria in China. An extraction of the bark is used in obstetrical and hemorrhage cases.

Tannin is produced from the bark. Dye is obtained from the wood and bark, and used in the 'batik' industry in Malaysia and Indonesia. The wood is heavy, very hard and very strong; does not check badly but shrinks excessively. Easy to split and work. Asians may use the astringent bark or the old calyx with their betel quid [3].

II. Materials and Methods

A. Collection and Preparation of Sample

The bark of *Ceriops tagal* (Madama) was collected from Dedaye Township, Ayeyarwady Region. After collection, the scientific name of Madama was identified by authorized botanist at Botany Department, Yangon University. The sample was washed with tap water to remove impurities and then air-dried under shade to prevent some reaction of sunlight with organic constituents of sample. The dried sample was separately cut into pieces and ground in a grinding machine. The powdered sample was separately stored in the air-tight container.

B. Extraction of Madama Bark Dye Powder

In the procedure of dye extraction, 5 g of powder sample (madama bark) was boiled with 2000 mL of distilled water at 90 °C for 2 hours and then pre dye solution was obtained. This dye solution was heated at 80 °C until dried pasty dye, which was powdered and sieved with 90 µm aperture size. The dye powder sample was separately stored in the air-tight container so that the sample was free from getting molds to prevent moisture, as well as other contaminations and was ready to be used for the experimental works.

C. Preparation of Cow Dung Ash Mordant

Dried cow dung powder 30 g was heated in furnace at 400 °C for 2 hours. Then cow dung ash 15 g was obtained.

D. Methods

Extracted dye from madama bark was used as adsorbate and cotton cloth was used as adsorbent. Extracted natural dye was characterized by FTIR and UV visible spectrometry. Cotton dyeing was carried out by these dyes in the absence and presence of mordants. Sorption properties of six different dye solutions were studied according to the contact time and different temperatures for S_1.

III. Results and Discussion

A. FT IR Analysis

The FT IR spectra of natural dye extracted from *Ceriops tagal* (Perr.) C.B.Rob. was shown in Figure 3. Absorption band at about 3400 cm^{-1} indicate OH stretching of Madama bark dye, while C-H stretching was observed at 2900 cm^{-1}. The absorption peaks at 1612 cm^{-1} are characteristic of the C=C stretching vibration. The broad band at 1111 cm^{-1} in natural dye are caused by phenolic OH bending respectively [5].

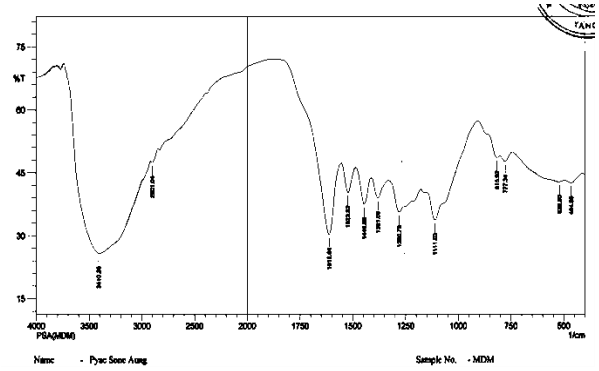

Figure 3. FT IR Spectrum of Natural Dye Extracted from *Ceriops tagal* Bark

B. UV Analysis

UV-visible spectrum of natural dye extracted from Madama bark was described in Figure 4. The maximum wavelength (λ_{max}) values were found to be 224, 240, 280 and 475 nm.

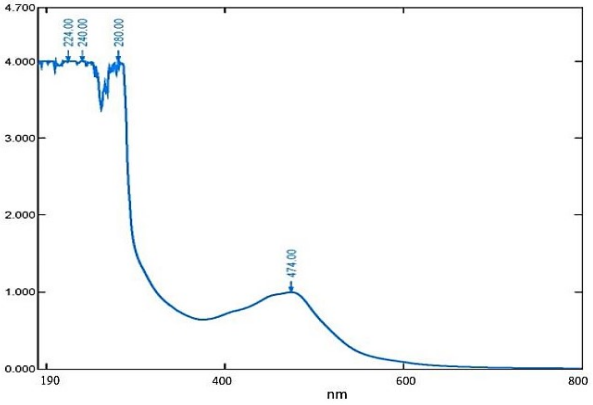

Figure. 4. UV-visible Spectrum of Natural Dye Extracted from *Ceriops tagal* (Perr.) C.B.Rob.

C. Effect of Temperature on Reddish Brown Natural Dye (S_1) on Cotton Cloth

The adsorption properties of S_1 was studied at different temperatures (40 °C, 60 °C and 80 °C). The adsorption properties of natural dye increases with increase in temperature is said to be endothermic process. It was found that S_1 undergo endothermic process, its suitable dyeing temperature was 80 °C.

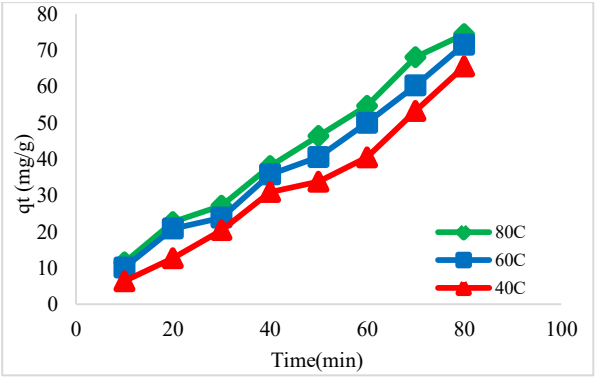

Figure 5. Effect of Dyeing Temperature on the Reddish Brown Natural Dye (S_1) on Cotton Cloth

D. Effect of Contact Time for Six Dye Solutions Dyeing on Cotton Cloth at 80 °C

Figure 6 shows the amount of dye on cotton cloth with different dye solutions (S_1, S_2, S_3, S_4, S_5 and S_6) with respect to contact time at 80 °C. It was found that maximum sorption capacities were reached at contact time 80 minutes.

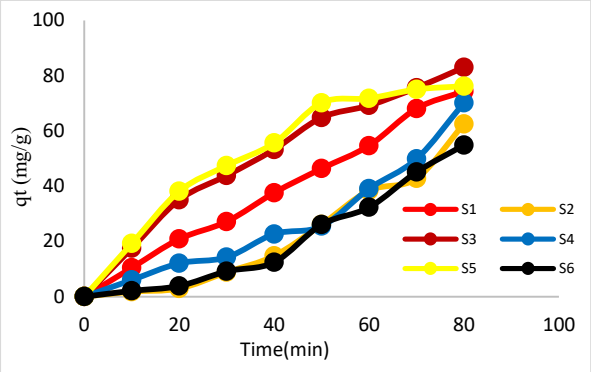

Figure 6. Effect of Contact Time on Dyeing of Cotton Cloth with Various Dye Solutions at 80 °C

E. Colour Fastness Properties of Six Dye Solutions on Cotton Cloth

The colour density on the cotton cloth was increased significantly by using mordant. Colour fastness of cotton cloth samples were determined using pre mordanting, simultaneous mordanting and post mordanting with 2 % dye concentration and 80 minutes dyeing time because those conditions resulted in the highest colour strength for cotton cloth. The colour density for six dyeing cotton cloth before and after colour fastness testing were compared in Figures 7, 8, 9 and 10.

Poor substantivity and fastness properties are often found in natural dyes for cotton cloth and can be improved if the cotton cloth was first treated with a solution containing mordant, such as a salt of alum, iron, copper or chromium. Metallic mordants improve the fixation and fastness properties of dyes lacking substantivity for cotton cloth.

The sample S_2 (natural dye with alum mordant) was seen the lowest colour density. The sample S_6 (using $FeSO_4$ mordant) was the highest colour density. The sample S_3 (natural mordant using cow dung) and S_4 (using $CuSO_4$) were nearly equal colour density. Therefore, natural mordant (cow dung) can be used instead of $CuSO_4$ for madama bark dye solution. In this research, the effects of natural mordant (cow dung) and chemical mordants were studied for dyeing process. It was found that alum was the good appearance and $K_2Cr_2O_7$ was good colour fastness [8].

Figure 7. Colour of Cotton Cloth Dyeing with Six Dye Sample Solutions (i) Pre Mordanting (ii) Simultaneous Mordanting (iii) Post Mordanting

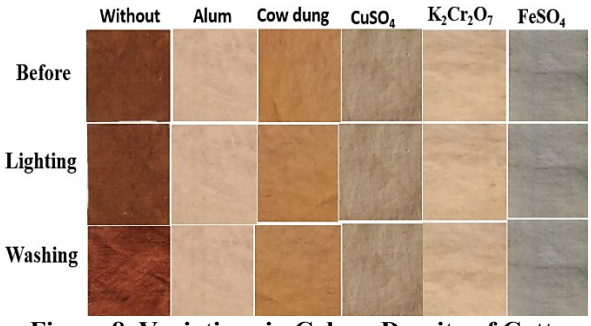

Figure 8. Variations in Colour Density of Cotton Cloths after Fastness Test (Pre Mordanting)

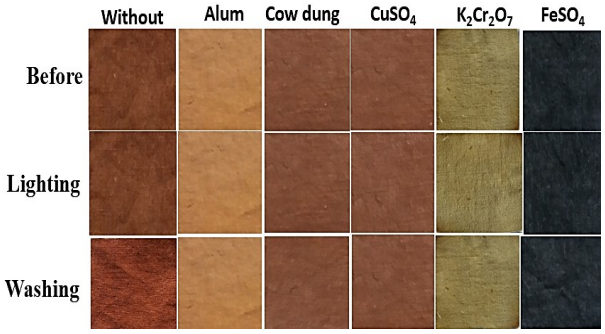

Figure 9. Variation in Colour of Cotton Cloths after Fastness Test (Simultaneous Mordantig)

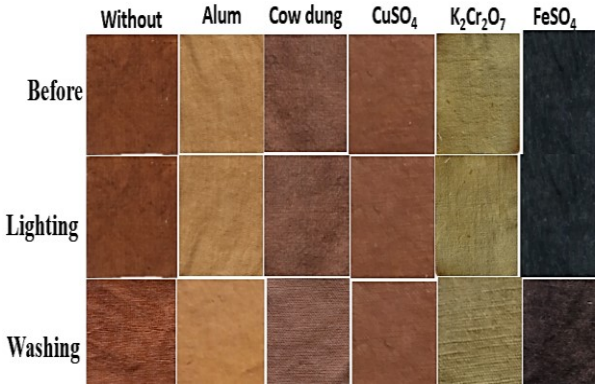

Figure 10. Variation in Colour of Cotton Cloths after Fastness Test (Post Mordanting)

F. Effect of Desorption

Six dyeing cotton cloths were washed with 1 % weight by volume detergent solutions. It was found

that desorption of colour from six dyeing cotton cloth became decrease 30 minutes. Among them, desorption of S_5 was lowest and S_1 was highest. Figure 11 showed the desorption properties of six dyeing cotton cloth.

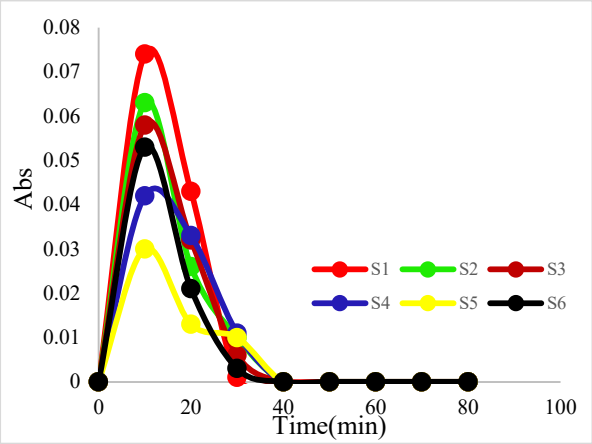

Figure 11. Comparison of Desorption Properties of Six Dye Solutions from Dyed Cotton Cloth (λ_{max}475 nm)

IV. Conclusion

A systematic approach for extracting, characterizing and improving the properties of dye is very important to minimize the cost investment for yield maximization and dye purity. This study focused on color fastness properties (pre mordanting, simultaneous mordanting and post mordanting) and desorption properties of natural dye. From the results, it can be found that, according to the types of mordant used, colour of dyeing cotton cloths can be seen different colours. Among six dye solutions, S_2 (alum or common mordant), S_3 (cow dung or biomordant) and S_5 ($K_2Cr_2O_7$ or inorganic mordant) can be chosen for home-made dyeing process.

Thus, this research will pave the way for more discoveries of new types of natural dyes which could be manufactured through systematic and well-structured experiment.

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The authors would like to thank to Professors and Head, Dr. Daw Ni Ni Than, Department of Chemistry, University of Yangon, for her kind suggestions during this research work. The authors also wish to grateful thanks to University Research Journal, University of Computer Studies (Myeik). The author also gratefully acknowledge the support and help of the Universities' Research Centre (URC) for FT IR measurement.

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Kinetic of Dyeing Cotton Cloth with Natural Dye Extracted from Mango Bark (*Mangiferaindica*L.)

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***Abstract*:** The present study of the natural dye extracted from Mango bark (*Mangiferaindica* L.) on cotton cloth with thermodynamic and kinetic nature. In this research work, the two dye sample solutions (S_1 and S_2) were prepared by natural dye and natural mordant (banana petaloid). The temperature effect on adsorption of prepared samples on cotton cloth was determined. According to pseudo first and second order models, the kinetic nature was conducted. The adsorption kinetic for two samples (S_1 and S_2) was more accurately represented by a pseudo second order model. The activation energy of S_1 and S_2 were also found to be 26.27 and 18.71 kJ mol^{-1}. And then the ΔH^{θ} and ΔS^{θ} values were (-46.23 and -33.26) kJ mol^{-1} and (-0.166 and -0.167) kJ mol^{-1} K^{-1}. The values of ΔG^{θ} were positive and less than +84 $kJmol^{-1}$. Also the values of ΔH^{θ}, ΔS^{θ}, ΔG^{θ} and E_a all observed that the sorption of S_1 and S_2 on cotton cloth was exothermic and non-spontaneous physi sorption process.

***Keywords*:** natural dye, natural mordant, adsorption, kinetic, thermodynamic

I. Introduction

Mango bark as one of the parts of plants in natural dyes due to increased awareness of the environmental and health hazards associated with the synthesis, processing and use of synthetic dyes.

Natural dyes have been used extensively in colouring of food substrate, leather. Cotton is an abundant natural fibre which consists of practically pure cellulose [1]. The use of non-allergic, non-toxic and eco-friendly natural dyes on textiles have become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes [2].

A. Mangiferaindica L. (Mango)

Mangifera is genus of flowering trees in the Anacardiaceae family. Mango trees require tropical and warm, subtropical areas with temperatures ranging from 20 to 30 ˚C [3]. Bark is usually dark grey-brown to black, rather smooth, superficially cracked or inconspicuously fissured, rather thick pieces [4].

Figure 1. *Mangiferaindica* L. (Mango)

II. Materials and Methods

A. Extraction of Natural Dye from Mango Bark

The bark of Mango Bark (*Mangiferaindica*L.) was collected from Yangon University campus. After collection, the scientific name of Mango was identified by authorized botanist at Botany Department, Yangon University. The sample was washed with tap water to remove impurities and then air-dried under shade to prevent some reaction of sunlight with organic constituents of sample. The dried sample was separately cut into pieces and ground in a grinding machine. In the procedure of dye extraction, 5 g of powder sample (mango bark) was boiled with 2000 mL of distilled water at 90 °C for 2 hours and then pre dye solution was obtained. This dye solution was heated at 80 °C until dried pasty dye, which was powdered and sieved with 90 μm aperture size. The dye powder sample was separately stored in the air-tight container so that the sample was free from getting molds to prevent moisture, as well as other contaminations and was ready to be used for the experimental works.

B. Preparation of Two Dye Samples (S_1 and S_2)

S_1 was prepared 100 mL of distilled water and 0.5 g mango bark dye powder. S_2 was prepared by the mixture 0.05 g of banana petaloid and 0.5 g of mango bark dye powder.

C. Methods

Extracted natural dye from Mango bark was used as adsorbate and cotton cloth was used as adsorbent. Cotton dyeing was carried out by two samples (S_1 and S_2). Sorption properties of two different dye samples were studied according to different temperatures.

III. Results and Discussion

A. Effect Temperature on Brown Natural Dye (S_1 and S_2) Dyeing on Cotton Cloth

Adsorption properties S_1 and S_2 were examined at 40, 60 and 80 °C, respectively. Figure 2(a) and 2(b) were shown in the adsorption properties of S_1 and S_2 dyeing on cotton cloth at that temperatures. It was found that S_1 undergoes exothermic process, its suitable dyeing temperature was 60 °C. Similarly, the uptake of S_2 sample was increased with decreasing temperature at the same adsorption time.

The resultant data were calculated by $q_e = \frac{C_o - C_e}{1g} \times 1$ L

C_o = initial concentration, C_e = equilibrium concentration, q_e= the amount of dye adsorbed per gram of cotton cloth (mg/g cotton) at equilibrium.

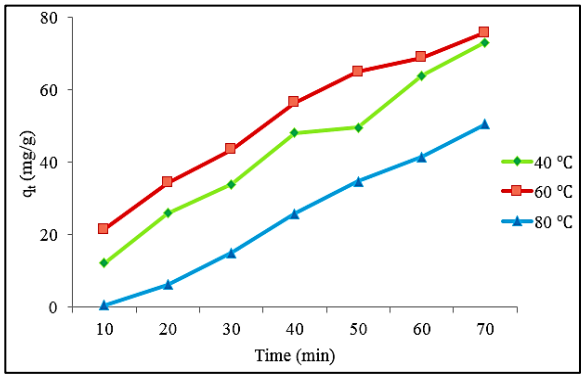

Figure 2. (a) Temperature Effect on the S_1 and Cotton Cloth

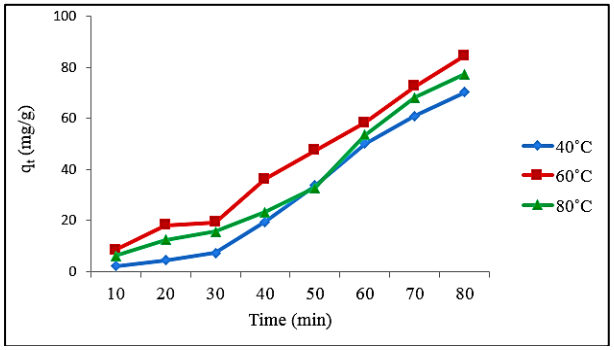

Figure 2. (b) Effect of Dyeing Temperature on the Banana Petaloidmordan (S_2) and Cotton Cloth

B. Kinetics Analysis

The pseudo first order and second order kinetics models of S_1, and S_2 on cotton cloth were determined by the Lagergern equation as follows [5]:

$$\frac{dq_t}{dt} = k_1 (q_e - q_t) \quad \ldots\ldots\ldots\ldots (1)$$

$$\ln (q_e - q_t) = \ln q_e - k_1 t \quad \ldots\ldots\ldots\ldots (2)$$

where, k_1 is the rate constant of pseudo first adsorption (s^{-1}), and q_e and q_t are the amount of dye adsorbed per gram of cotton cloth (mg/g cotton) at equilibrium and at a time, t.

Figure 3 (a) and 3(b) shows The k_1 and q_e were calculated from the slope and intercept. The pseudo second order kinetic model can be expressed based on adsorption equilibrium capacity as follows:

$$\frac{dq_t}{dt} = k_2 (q_e - q_t)^2 \quad \ldots\ldots\ldots (3)$$

$$\frac{1}{(q_e - q_t)} = \frac{1}{q_e} + k_2 t \quad \ldots\ldots\ldots (4)$$

(or)

$$\frac{t}{q_t} = \frac{1}{k_t q_e^2} + \frac{1}{q_e} t \quad \ldots\ldots\ldots (5)$$

$$h_i = k_2 q_e^2 \quad \ldots\ldots\ldots (6)$$

where, k_2 is the rate constant for pseudo second order adsorption, h_i is the initial dye adsorption rate (mg / g min)[6].

The results of pseudo second order kinetics are showed in figure 3(a) and (b) using the plot of (t/q_t) versus t . As seen in figures it was found that the adsorption on cotton cloth are not likely to be a first order reaction due to the resulting correlation coefficient .

The pseudo second order kinetic model was used Eq (5) and plot of (t/q_t) against t for the adsorption of dye on cotton cloth are given in Figure 4 (a) and (b). The slopes and intercepts of these plots were used to calculate the adsorption capacity ($q_{e,\ cal}$) and the rate constant (k_2). As seen in figures, the correlation coefficient values for pseudo second order rate equation $\frac{dq_t}{dt} = k_2 (q_e - q_t)^2$ was found to be higher than the pseudo-first-order rate equation .

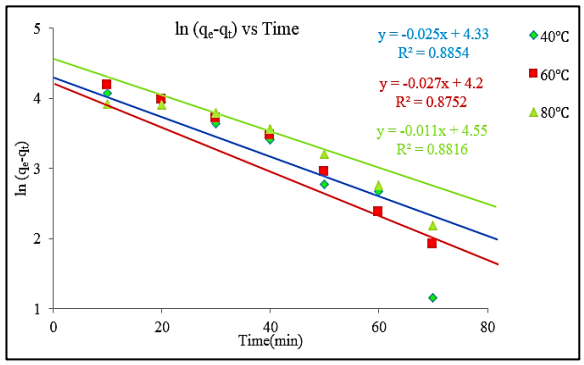

Figure 3. (a) Pseudo First Order Plot for S_1 on Cotton Cloth at Different Temperatures

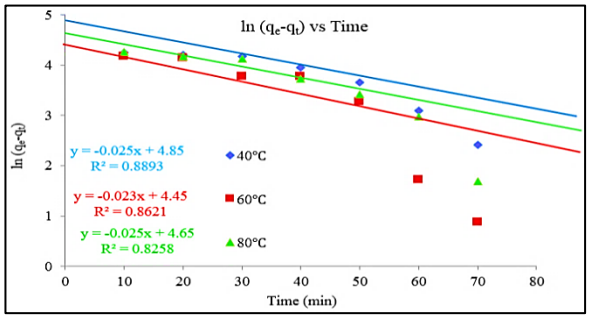

Figure 3. (b) Pseudo First Order Plot for S_2 on Cotton Cloth at Different Temperatures

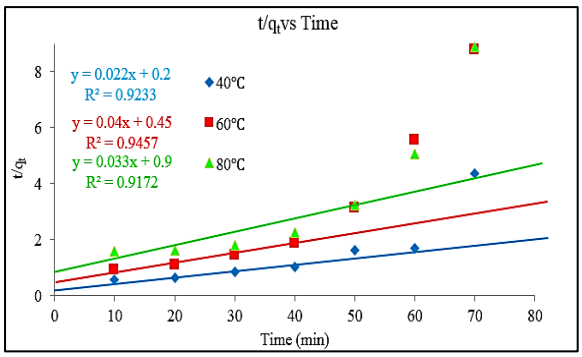

Figure 4. (a) Pseudo Second Order Plot S_1 on Cotton Cloth at Different Temperatures

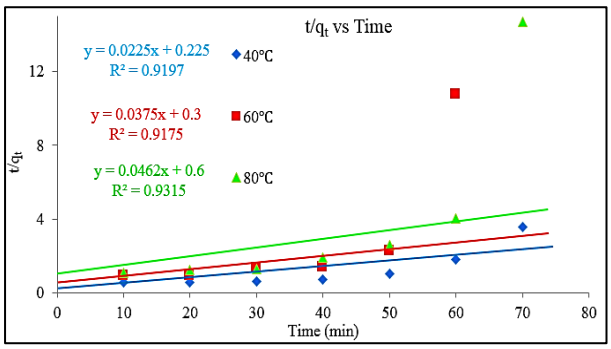

Figure 4. (b) Pseudo Second Order Plot for S_2 on Cotton Cloth at Different Temperatures

C. Activation Parameters

The S_1 and S_2 were determined the activation energy (E_a), enthalpy ($\Delta H^{\#}$), entropy (ΔS^{θ}) and the free energy (ΔG^{θ}) of using equation (7), (8) and (9) as follows:

$$\ln k_2 = \ln A - \frac{E_a}{RT} \quad \ldots\ldots\ldots (7)$$

$$\ln\left(\frac{k_2}{T}\right) = \ln\frac{k_b}{h} + \frac{\Delta S^{\#}}{R} - \frac{\Delta H^{\#}}{RT} \quad \ldots\ldots\ldots (8)$$

$$\Delta G^{\theta} = \Delta H^{\theta} - T\Delta S^{\theta} \quad \ldots\ldots\ldots (9)$$

where, E_a, R and A refer to the Arrhenius activation energy, the gas constant and the Arrhenius factor , k_b and h refer to Boltzmann's constant (1.38×10^{-23}) and Plank's constant (6.626×10^{-34}) respectively [7,8].

Figure 5(a) and (b) shows the Arrhenius plot of ln k_2 against 1/T for the adsorption of dye S_1, and S_2 on cotton cloth. Figure 6(a) and (b) showed that the ΔH^{θ} and ΔS^{θ} were calculated from the slope and intercept plot of ln (k/T) versus 1/T.

The calculated values are listed in Table 1. Therefore, the values of ΔH^{θ}, ΔG^{θ} and E_a all observe that S_1 and S_2 on cotton cloth by aphysic sorption process.

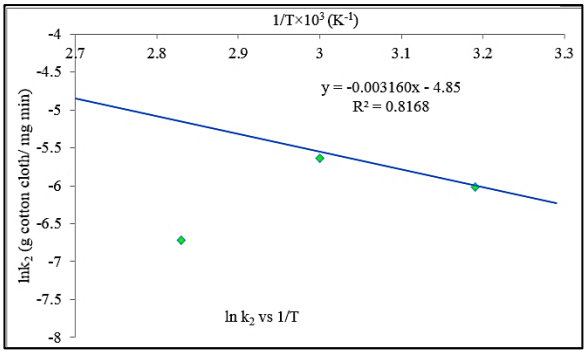

Figure 5. (a) Arrhenius Plot for the Sorption of S_1 Dyeing on Cotton Cloth

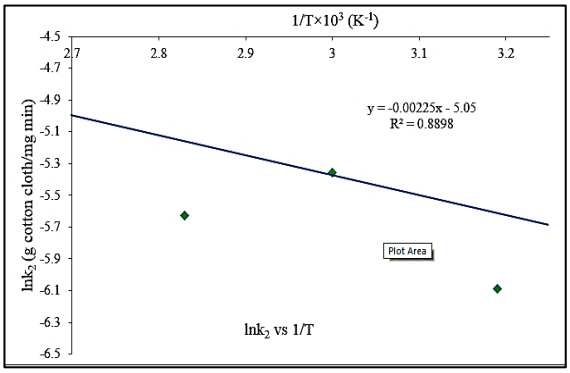

Figure 5. (b) Arrhenius Plot for the Sorption of S_2 Dyeing on Cotton Cloth

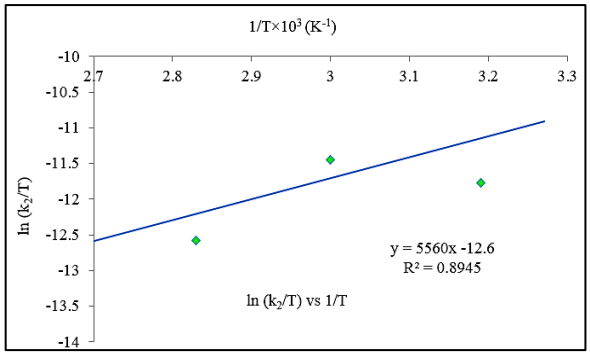

Figure 6. (a) Eyring Plot for the Sorption of S_1 Dyeing on Cotton Cloth

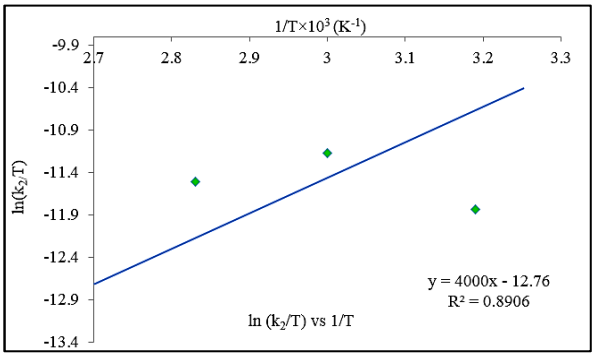

Figure 6. (b) Eyring Plot for the Sorption of S_2 Dyeing on Cotton Cloth

Table 1. Activation Parameters for Sorption of S_1 and S_2 Dyeing on Cotton Cloth

Dye	Temp (°C)	k_2	E_a (kJ mol^{-1})	R^2 (Eyring)	$\Delta H^{\#}$ (kJ/mol)	$\Delta S^{\#}$ (J mol^{-1} K^{-1})	$\Delta G^{\#}$ (kJ/mol)	R^2 (Arrhenius)
	40	0.0024					+5.63	
S_1	60	0.0036	26.27	0.8945	-46.23	-0.166	+8.72	0.8168
	80	0.0012					+12.36	
	40	0.0023					+19.01	
S_2	60	0.0047	18.71	0.8906	-33.26	-0.167	+22.35	0.8898
	80	0.0036					+25.69	

D. Application of Brown Natural Dye Extracted from Mango Bark

In Myanmar, natural dyes can be extracted from trees and other materials. People have been using these types of materials for cloth and in decorations because of their glorious naturals. Figure 7 shows that S_1 (natural mango bark dye) and S_2 (banana petaloid or natural mordant) can be applied in home-made dyeing process.

(a) **(b)**

Figure 7. Application of Brown Natural Dye Extracted from Mango Bark for Home-made Dyeing Process Using (a) S_1 (Natural Dye), (b) S_2 (Banana Petaloid or Natural Mordant)

IV. Conclusion

In this research investigated the dyeing process for adsorption capacities at 40, 60 and 80 ˚C. Banana petaloid was waste of the bud but it can be used as chemical mordant for this dyeing process. According to the results, the kinetics studies of dyeing process can be showed by pseudo second order model as a correlation coefficient values. The rate of adsorption (h_i) of S_1 and S_2 dyeing on cotton cloth decreased at increasing dyeing temperature which indicated exothermic process. The activation energy for S_1 and S_2 were found to be 26.27 and 18.71 kJ mol^{-1}. Also the values of ΔH^{θ} and ΔS^{θ} were (-46.23 and -33.26) kJ mol^{-1} and (-0.166 and -0.167) kJ mol^{-1} K^{-1}. The values of ΔG^{θ} were positive and less than +84 kJmol^{-1}. The sorption of S_1 and S_2 on cotton cloth was exothermic, non-spontaneous and physisorption process due to the values of ΔH^{θ}, ΔS^{θ}, ΔG^{θ} and E_a. It is hoped that the finding from the present study may contribute to the extracted natural dye from bark of plant and also was non-toxic and cost effective for the eco-system.

Acknowledgement

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Extraction of Anthocyanins as a Natural Food Colourant from Dragon Fruit Skin and Determination of Some Physical Properties

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***Abstract*:** Today consumers are increasingly associating natural food colorants to health benefits. The preliminary phytochemical tests of the skins of dragon fruit were performed. The mineral contents of the skins of dragon fruit were determined by using EDXRF Spectroscopy. Anthocyanins were extracted by using distilled water and 2% citric acid solution. Some qualitative tests for anthocyanins were carried out by standard method. Total anthocyanin content in each extract was determined by pH differential method. The total anthocyanin pigment (95.05 mg/100 g and pH 3.4) of 2% citric acid extract was higher than that of watery extract (78.02 mg/100 g and pH 5.7). Anthocyanin extract was encapsulated, using the mixture of gum arabic and maltodextrin by microwave-assisted drying at 1000w. Tween-80 was used as emulsifying agent. Some physicochemical properties of encapsulated powder were determined by reported method. The stability of color of juice prepared with encapsulated anthocyanin powder was evaluated under different temperatures.

***Keywords*:** Anthocyanins, dragon fruit, pH differential method, encapsulated powder, gum arabic**.**

I. Introduction

Natural dyes have been used for centuries to color food. These dyes are produced from plant and animal sources. Natural food colors offer additional health benefits of biologically active compounds like vitamins, minerals, flavonoids, chlorophyll, and other cancer fighting antioxidants. But natural colorants are generally more sensitive to light, temperature, pH and redox agents [5].

Plant pigments include a variety of different compounds, including anthocyanins, carotenoids and chlorophylls. They can be classified into two groups, lipid-soluble and water-soluble. The most common water-soluble pigments are anthocyanins that are present in a large number of vegetable products, and are responsible for a wide range of colors from colorless to purple. Anthocyanins are the most varied in composition and in color.

The different types of anthocyanins depend on the number of hydroxyl groups, sugars, aliphatic groups and aromatic acids attached to the basic structure of anthocyanins. The particular color of each anthocyanin depends on the number and orientation of the hydroxyl and methoxyl groups in the molecule. The dragon fruit is an exotic fruit world-wide, as it is known in many countries, which creates a potential for diversifying by making different types of food products with high nutritional value. The skins of the dragon fruit can be an important source of natural colorants, as restrictions on the use of synthetic food colorants have led to a rising interest in the use of anthocyanins and flavonoids as food colorants, as well as for pharmaceuticals products and cosmetics [6].

Encapsulation is a technique that is used for protection, stabilization and slow release of core materials. There are several techniques and wall materials that are available for encapsulation of natural food colorants to overcome their instability, solubility and handling problems [4].

The hypothesis of this research is that the encapsulated anthocyanin powder should give an increase its stability and possibilities for the use of coloring. In this research work, anthocyanin was extracted from the skins of dragon fruit using distilled water and 2% citric acid solution and then encapsulated with a mixture of gum arabic, maltodextrin and Tween-80. The stability of this encapsulated pigment under different storage conditions is good and use as food colorant.

II. Materials and Methods

A. Sample Collection

The dragon fruits were obtained from local market in Mandalay Township. The dragon fruits were selected and washed with water. They were peeled manually. The encapsulating agents were: Maltodextrin (DE 4-17), gum arabic and Tween-80 (Atlas Chemical centre and Able Hospital Equipment & General Trading). All reagents were analytical grade.

B. Phytochemical Investigation

Phytochemical investigation on dragon fruit skins were carried out according to the reported methods [3].

C. Determination of Mineral Contents

Elemental composition in the skins of dragon fruit was measured at Department of Chemistry, Monywa University by using Energy Dispersive X-ray Fluorescence Spectrometer (EDXRF).

D. Preparation of the Anthocyanin Extracts from Dragon Fruit Skins

Extraction of anthocyanin pigments from dragon fruit skins were carried out according to the procedure described by Spanga *et al*., 2003. The extracting solvents were: distilled water and 2% citric acid solution. Dragon fruit skins (100 g wet weight) were ground into fine particle using blender, into which 250 mL of solvent was added. Continuous stirring was given for about 20 min at 28°C. The solution was filtered by using muslin to obtain anthocyanin. The same procedure was followed to extract until become colorless and then the final volume (1000 mL) was obtained. The extracts were kept in refrigerator until further analysis [2].

E. Determination of Total Monomeric Anthocyanins

Before the determination of anthocyanins content, maximum absorption of anthocyanins extract was detected by UV-VIS spectrophotometer. The results are shown in Figures 3 and 4. Total anthocyanin content was determined using the spectrophotometric pH-differential method using two buffer systems: potassium chloride buffer, pH 1.0 (0.025 mol/L) (125 mL of 0.2 mol/L KCl and 375 mL of 0.2 mol/L HCl) and sodium acetate buffer, pH 4.5 (0.4 mol/L) (400 mL of 1 mol/L sodium acetate, 240 mL of 1 mol/L HCl and 360 mL of water). The absorbance was measured at 520 and 700 nm with distilled water as blank using a UV–VIS spectrophotometer (Spectro UV 2550). The absorbance (A) difference between the pH 1.0 and pH 4.5 samples was calculated [8].

Absorbance (A) = (A520nm pH1.0 – A700nm pH1.0)
- (A 520nm pH4.5 – A700nm pH4.5)

The total anthocyanin content was calculated as cyanidin-3-glucoside according to the following equation:

$$\text{Total anthocyanin content} = \frac{A \times MW \times DF \times 10^3}{\varepsilon l}$$

Where, MW (molecular weight) = 449.2 $gmol^{-1}$ for cyanidin-3-glucoside; DF = the dilution factor;

l = path length; A = Absorbance; ε =Molar absorptivity

F. Choice of Solvent for Extraction of Anthocyanin

In order to know the best solvent for extraction of anthocyanins, the yield percent of both extracts were compared. For stability of anthocyanin extracts, they were placed in sunlight and noted.

G. Qualitative Tests for Detection of Anthocyanins in 2% Citric Acid Extract

The presence of anthocyanins in dragon fruit skins extracts was tested by using three common reagents: (i) sulphuric acid (ii) Ferric chloride and (iii) dilute hydrochloric acid [1].

H. Application of Anthocyanin Solutions Extracted from the Dragon Fruit Skins

About 3 g of jelly powder was added to 100 mL of 2 % citric acid or water extracted solution and heated at 70°C and stirred for about 10 minutes to reach the desired condition. After that it was transferred into steel bowl and allowed to cool in water bath. It is shown in Figure (7, a). About 100 g of rice with 200 mL of 2 % citric acid extracted solution were added in a rice cooker and it was cooked. It was then transferred to a plate. It is shown in Figure (7, b). About 50 g of sago seeds was added to 100 mL of 2 % citric acid extracted anthocyanin solution and stirred constantly at 70°C. After it reached to the desired condition, it was cooled and transferred to a steel bowl. It was shown in Figure (7, c).

I. Preparation of Encapsulated Anthocyanins Powder

1) Preparation of Gum Arabic Solution: Gum Arabic (24g food grade) was dissolved slowly in 30mL of distilled water at 30°C and after complete dispersion the final volume was make up to 60mL by adding distilled water. It was kept under ambient condition for 12 hour to improve the film forming and emulsification properties. The prepared 40 per cent gum arabic solution was filtered using muslin cloth to remove the foreign materials if any, and use for further experiments.

2) Preparation of Maltodextrin Solution Maltodextrin (DE-10, 24g) was dissolved slowly in 30mL of distilled water at 60°C by continuously stirring and after complete dispersion, the final volume was made up to 60mL by adding distilled water. The prepared 40 per cent maltodextrin solution was filtered using muslin cloth to remove the foreign materials if any, and used for the experiments.

3) Preparation of Encapsulation: Anthocyanins extract (180 mL) was added to the mixture (120 mL) of 40 per cent gum arabic solution and 40 per cent maltodextrin solution obtaining total volume of 300 mL.This immiscible mixture was emulsified at 1000 rpm for 10 min by using magnetic stirrer until the anthocyanins dispersed completely. Two drops of Tween-80 was added to aid the emulsification process. The anthocyanin emulsion was concentrated in low pressure rotatory evaporation at 70°C. The concentrated solution was transferred to crucible and placed in a microwave domestic oven. It was treated for up to 10 minutes at microwave power intensities (1000W). It was ground into powder and immediately placed in brown bottle and stored in refrigerator [7].

J. Determination of Some Physical Properties of Encapsulated Powder

Some physical properties such as pH, moisture content and solubility in water were determined by reported method.

1) pH The pH of samples (1 % solution) was measured by using pH meter.

2) Moisture Content: The samples were accurately weighed (1 g, W_0) and dried by loss on drying measurement (W_1). The temperature of drying was 105 °C. The weights of the sample before and after drying were calculated for the moisture contents. All samples were performed in triplicate. The moisture content was determined as the percentage of moisture in the powder using the following equation.

$$\text{Moisture content\%} = \frac{W_0 - W_1}{W_0} \times 100$$

3) Solubility: One gram of sample was dispensed into 20 mL of distilled water while taking care to break up any lumps using a glass rod. After 30 min of stirring, centrifuged for 10 min. The supernatant was then decanted and the weight of its solid content determined after it had been evaporated to a constant weight. The Water Solubility Index (WSI) was then calculated as:

$$\text{WSI} = \frac{\text{Wt: of dissolved solids in supernatant}}{\text{Wt: of dry powder sample}}$$

K. Determination of Color Stability of Solution Prepared with Encapsulated Anthocyanin Powder

The color stability of solution prepared with encapsulated anthocyanin powder was evaluated under different temperatures. (4ºC, room temperature and sunlight conditions).

III. Results and Discussion

A. Preliminary Phytochemical Tests for Dragon Fruit Skins

According to the phytochemical examinations alkaloids, flavonoids, carbohydrates, phenolic compounds, glycosides, saponins, tannins, steroids, terpenes and reducing sugars were found to be present in the sample whereas resin was absent. Among these phytochemicals, flavonoids play an important role in food colorant.

B. Determination of Mineral Contents in the Skins of Dragon Fruit

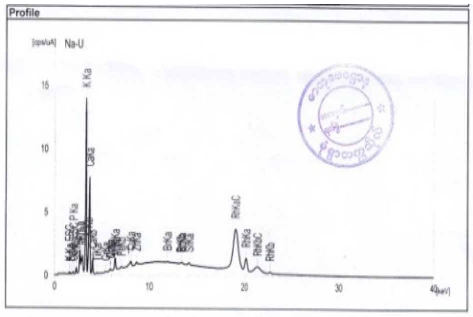
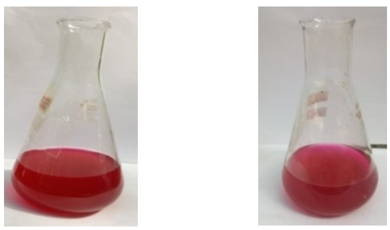


Figure 1. Elemental Aanalysis of the Skins of Dragon Fruit

According to the EDXRF results, potassium are higher than the other minerals in the skins of dragon fruit. Mineral are inorganic substances, present in all body tissue and fluids. Their presence is required to maintain certain physical and chemical processes which are essential to life. For humans, potassium is an essential macro mineral nutrient. Potassium is one of the important mineral in the body and it is necessary for the heart, kidneys and other organs to work properly. High potassium diet helps to reduce blood pressure and it helps regulate fluid balance, muscle contractions and nerve impulse.

C. Extraction of Anthocyanin Pigments from Dragon Fruit Skins

Distilled water and 2% citric acid solution were used as solvents for extraction of anthocyanins. Material to solvent ratio was 1:10 w/v. The pH values of watery anthocyanins extract (red), and 2% citric acid anthocyanin extract (purple red) were found to be 5.6 and 3.4 respectively as shown in Figure 2.



(a) Watery Extract (b) 2% Citric Acid Extract

Figure 2. Extract of Anthocyanin

D. Determination of Total Anthocyanins Pigment

Before determination of total anthocyanins pigment in both extracts, maximum absorption of both anthocyanins extracts was determined by UV-Visible Spectro-photometer. The spectra of anthocyanins extracts are presented in Figure 3 and Figure 4.

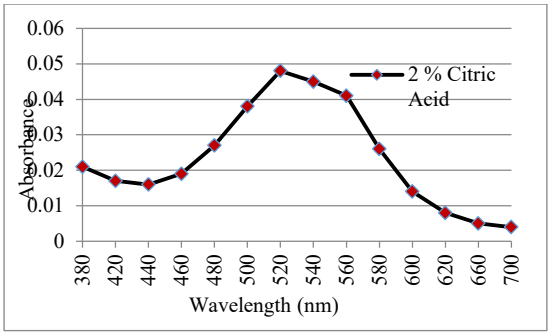


Figure 3. Absorption Spectrum of Anthocyanin Extract in Citric Acid

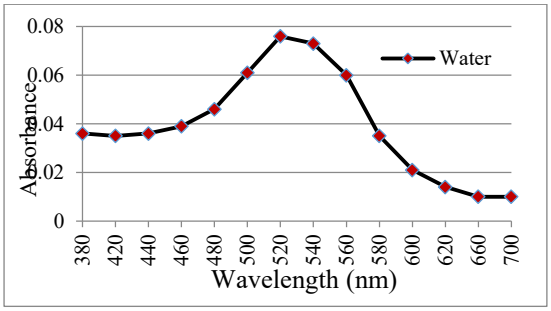


Figure 4. Absorption Spectrum of Anthocyanin Extract in Water

According to the spectra, maximum absorption was found to be 520 nm for 2 % citric acid extracts and water. So, its value was used for the calculation of anthocyanins content in pH differential method.

E. Choice of Solvent for Extraction of Anthocyanins

Table 1 shows the extraction efficiency of anthocyanin affected by the type of solvents. The yield pigments of 2% citric acid solution was higher than that of water. At low pH value, anthocyanin yield was the highest and stability.

Table 1. Extraction Efficiency of Anthocyanins Affected by the Type of Solvents

No.	Extraction Solvent	pH	Yield pigments (mg/100g)
1	2% citric acid	3.4	95.05
2	Water	5.6	78.02

* Based on wet weight

In order to know the stability of anthocyanin pigments of water and 2% citric acid extracts, they were left in sunlight. The changes of color are shown in Figure 5. After three days, watery extract was changed the color to darken purple but 2% citric acid extracts color was little changed. Therefore 2% citric acid solution was chosen as a solvent for the extraction of anthocyanins.

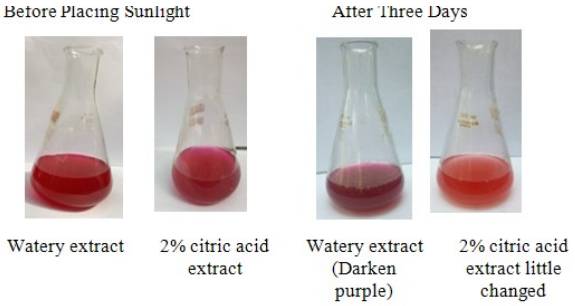
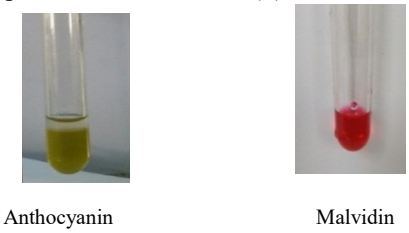


Figure 5. Changes of Color in Sunlight for Both Extracts after Three Days

F. Qualitative Tests for Anthocyanins in 2% Citric Acid Extract

According to the tests, pelargonidin, cyanidin and malvidin were found to be present in the extract.

(i) Sulphuric Acid Test (ii) Ferric Chlorid



(iii) Dilute Hydrochloric Acid Test

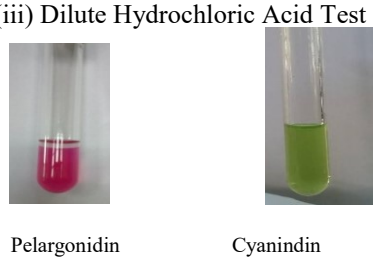
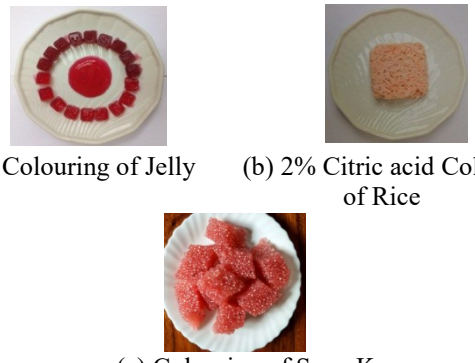


Figure 6. Qualitative Tests for Anthocyanins

G. Application of Anthocyanin Solutions Extracted from the Skins of Dragon Fruit

Water extract and 2 % citric acid extract were utilized in coloring of foods. It was found that water extract gives deep red color and the 2 % citric acid extract gives reddish pink color depending on their different pH values.



(a) Colouring of Jelly (b) 2% Citric acid Colouring of Rice

(c) Colouring of Sago Kyo

Figure 7. Application of Anthocyanin Solutions on Foods

H. Encapsulation of 2% Citric Acid Anthocyanin Powder

To increase the stability of anthocyanins and protect from light, high temperature, pH and oxidation, encapsulation was carried out. In this research, anthocyanins pigment of 2%citric acid solution extract for core material, a mixture of gum arabic and maltodextrin for wall materials and Tween-80 as emulsifier were used. The core to wall materials ratio was 3:2 (v/v). The encapsulated powder (38.2g) was obtained. It was stored in brown bottle.

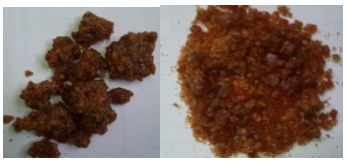


Figure 8. Yellow Color Encapsulated Anthocyanins Powder

I. Some Physical Properties of Anthocyanin Powder

Table 2. Some Physical Properties of Encapsulated Powder

No.	Parameters	Results
1	pH	3.2
2	Moisture (%)	6
3	Solubility in water (%)	94

The visual color changes of model samples in various storage conditions for 14 days period are shown in Figure (9, 10, 11).

1st Day 7th Day 14th Day

Figure 9. Color Changes of The Sample in The Refrigerator

1st Day 7th Day 14th Day

Figure 10. Color Changes of the Sample in the Room

1st Day 7th Day 14th Day

Figure 11. Color Changes of the Sample under Sunlight

It was observed that an increase in the storage temperature from refrigerator and room to sunlight led to change in the characteristic color (yellow) of anthocyanins and a darkening to pale yellow was noted. They are started to spoil at the start of the 3rd day and ferment at sunlight. Therefore, they should be stored inside the refrigerator.

IV. Conclusion

In this research work, the anthocyanins present in the skins of dragon fruit were collected from local market, Mandalay Region. Among the phytochemicals, flavonoids play an important role in food colorant. According to the EDXRF result, the skins of dragon fruit do not contain any toxic metal. An attempt has been made to extract the anthocyanins as natural food colorant from dragon fruit skins using 2% citric acid solution and to prepare encapsulated powder and to be applied in coloring of food. The yield of anthocyanins expressed as cyanidin-3-glucoside was found to be (95.05 mg/100g) in dragon fruit skin extract. By encapsulation of anthocyanin extract using mixture of gum arabic and maltodextrin and emulsifier Tween - 80, encapsulated powder (38.2 g) was obtained.

The color stability of encapsulated powder solution was determined under different temperatures (4ºC and room temperature and sun light conditions). The result from this study showed that storage at 4 ºC in the absence of light was the best condition. Therefore the storage temperature and light conditions are very important for coloring of natural food colorant.

This research could be very important from an economic point of view, because the skins of dragon fruit can be used for food dye applications. The skin, which is now treated as a waste product, would be useful as a source of anthocyanin colorants, helping to lower costs in the production of natural food colorants.

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Synthesis and Characterization of Hydroxyapatite from *Terebra Dislocata*

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***Abstract*:** This research work deals with synthesis and characterization of hydroxyapatite (HAp) powder by hydrothermal method from *Terebra dislocate* sea shells. The characterization of the synthesized HAp was performed by using EDXRF, FT IR, SEM, TEM, XRD and TG-DTA. EDXRF spectrum of the synthesized hydroxyapatite revealed the presence of Ca and P. FT IR spectroscopic measurement was performed to identify calcine *Terebra dislocata* and synthesized HAp powders. In FT IR analysis, the formation of hydroxyapatite is evident according to the characteristi peaksofthe PO_4^{3-} tetrahedral(566.16,962.82,1032.74 and 1088.29cm^{-1}), the hydroxyl(629.84 and 3642.20cm^{-1}) and carbonate(874.75,1421.00,1416.48cm^{-1}) .The CO_3^{2-} bands at 1421.00 and 1416.48 cm^{-1} indicate the presence of carbonated hydroxylapatite. In SEM analysis, the *Terebra dislocata* showed a rough and disordered surface with low porosity grains. Although the structure change after 1000 ºC calcination process, the image was showing smooth and more uniform surface. SEM image of HAp powders has the shape and size of particle that is almost uniform with narrow size distribution. From XRD analysis of HAp, it was found that the sharp peak of diffractogram confirmed that the product was well crystallized. The peak intensities in the XRD pattern of HAp were found at (hkl) indices of (300) and (202) at 2θ~ 33ºand 35º that attributed to HAp. The crystallites size for synthesized HAp from *Terebra dislocate* was found at 26.88 nm. The structure and morphology of the synthesized HAp was further confirmed by TEM image. The micrograph revealed that synthesized HAp has the spherical shape, or closed to spherical shape, dark contrast area and uniformly dispersed throughout the image.

Keywords: EDXRF, FT-IR, SEM, TEM, XRD, TG-DTA

I. Introduction

Hydroxyapatite (HAp) has been widely used as a biocompatible ceramic in biomedical engineering applications in the past few decades. Hydroxyapatite (HAp) [$Ca(PO_4)_6(OH)_2$] is the main mineral constituent of human bone, and also an outstanding bone substitute because of it's osteoconductive properties. The increasing interest in HAp is due to it's similar chemical composition to that of the inorganic component of natural bone. HAp ceramics can be manufactured from natural materials, via calcinations, from various hard tissues such as human bovine, sheep, chicken, fish and other general dental structures such as teeth. HAp was also prepared from natural calcite/aragonite structures such as corals, sea shells, land snail shells, cuttle fish bone and egg shells with various methods [5]. Hydroxyapatites produced biologically are much more complicated, they are not stoichiometric, have an atomic ratio Ca/P <1.67 and does not contain only ions and radicals of the HAp but also traces of CO_3^{2-} , Mg, Na, F^- and Cl^-. These amounts vary according at the specific type of tissue, which is related to the properties and bioactivity of it [3].

Hydroxyapatite can be synthesized via numerous production routes, using various different reactants. Many synthetic methods were used for the production of HAp such as precipitation, solid-state reaction, sol-gel and hydrothermal reaction. Basically, two starting materials are used as calcium source and phosphate source. The reactions shown below (eq 1, eq 2 and eq 3) are reported in literature. Natural material like coral, nacre, natural gypsum, egg shell, animal bone have considered as biowaste which are rich in calcium in the form of carbonate and oxide. An attempt to synthesize HAp using these materials as calcium source was widely studied [8].

$$10CaCO_3+6(NH_4)_2HPO_4+2H_2O\rightarrow Ca_{10}(PO_4)_6(OH)_2+6(NH_4)_2CO+4CO_3 \quad (1)$$

$$CaCO_3 + 3Ca(PO_4)_2 + H_2O \rightarrow Ca_{10}(PO_4)_6(OH)_2 + CO_2 \quad (2)$$

The hydroxyapatites were used in areas of orthopedics and orthodontics, where they have to replace, partially or totally, part of bone tissue. Another important application is as coating metallic prostheses, which is done to give at the tissues a better suited and recognizable surface, given their characteristic and biocompatibility. Due to the reduced of both stability and bioactivity of HAp, a large number of applications have being developed in the field of maxillofacial surgery [4]. Although due to their reduced mechanical properties is primarily used in coatings for dental prostheses and metal plates, for the reconstruction of some cranial bones.

In the case of porous ceramics made of hydroxyapatite, implants are surrounded by connective tissue and osteoid, developing a network structure accompanied by some degree of collapse around the ceramic, unless Osseointegration takes place at the implant site. One of the most important aspects in the application of these materials is the interaction that may

exist at the interface with living tissues, both in terms of toxicity, such as dissolution and the active roles that promote the formation of new bone.[4] The stoichiometry of HAp plays an important role in the mechanical properties; obtaining better results when the Ca/P ratio is between 1.60 and 1.67. For this reason, become of vital importance the control of morphology and microstructure during the synthesis process of HAp, as well as the control of manufacture process of parts or objects with mechanical properties suitable for biomedical applications [1]. HAp also has the advantage of absorbability and high binding affinity with a variety of molecules; it had been used in various drug delivery systems and used as the carrier for protein. In addition, HAp is also used in chromatography, in water treatment and protein purification [8].

The natural species of sea origin, such as corals and sea shells, consist of calcium carbonate (aragonite structure) as well [2]. These sea shells are just laid to waste and are abundantly available in nature. Therefore they are expected to use as calcium source for hydroxyapatite production. In this study *Terebra dislocata,* have been selected as the calcium source for preparation of HAp. *Terebradislocata*sea shells are shown in Figure 1.

Figure 1.*Terebradislocata* from Chaung Thar Beach

The genus of this species is *dislocata*, scientific name is *Terebra dislocata*, and common name is tiger cowry. The shape of this species is dextral and its length is up to 15 cm (6 in). The colour is slender augers or screws [6].

II. Materials and Methods

A. Sample Collection

In this study, waste sea shells *(T. dislocata)* were used as a source of calcium. The *T. dislocate* were collected from Chaung Thar Beach, Pathein Township, Ayeyarwady Region. The taxonomist of the department of Zoology, Yangon University, Zoologically identified and authenticated the sea shells [7]. The image of *T. dislocata* is shown in Figure 1.

B. Sample Preparation

The collected *T. dislocate* sea shells were cleaned by brushing their outer surface to remove dirty adhered. The shells were crushed into small pieces and then washed with distilled water. The shells were dried on oven at 100°C for 24 hours. After drying, the shells were grained into powder by an agate mortor and weighed accurately. The characteristics of *T. dislocate* was examined by EDXRF, FT IR and XRD. The microstructure was observed by SEM micrograph.

C. Calcination of Terebra dislocata Powder

The sample powders were sieved with 100 μm film sieve. The samples were placed in a furnace. The temperature of furnace was set at 1000 °C and period of heating time at 5 hours. After cooling, the calcinated samples were collected and weighed accurately to calculate the yield percent of hydroxyapatite. The calcined samples were examined by EDXRF, FT IR, and SEM. The prepared calcined *Terebradislocata*is shown in Figure 2 (a).

$$CaCO_3 + \text{Heat} \longrightarrow CaO + CO_2 \quad (3)$$

D.Synthesis of Hydroxyapatite from Calcined Sample

Hydroxyapatite was synthesized by hydrothermal method from calcined sample and diammonium hydrogen phosphate.

The calcined powder was obtained from the calcinations process of *T. dislocata* for 5 hours at temperature of 1000 °C. 30 mL of saturated $(NH_4)_2HPO_4$ was added slowly to 5 g of calcined shells powder. Then a small amount of high concentrated NH_4OH was added to adjust the pH into 10-11. The prepared suspension mixture was heated and stirred at 90 °C. After stirring well, the mixture paste was obtained and placed in a stainless steel vessel. The vessel was then sealed and placed on the oven. Hydrothermal reaction was performed in sealed vessel. The temperature of oven was set at 200 °C and periods of heating time at 4 hours. After cooling, the synthesized hydroxyapatite was collected and characterized by EDXRF, FT IR, SEM, TEM AND TG-DTA. Synthesized hydroxyapatite from calcined *T. dislocate* is shown in Figure2 (b).

III. Results and Discussion

In the study, hydroxyapatites were prepared from hydrothermal process by using *T. dislocata* and diammonium hydrogen phosphate as starting materials. The yield percent obtained of hydroxyapatite from *Terebradislocata* is 70 % of weight based on shell powder. Images of calcined *T. dislocate* powder and synthesized HAp powders are show in Figures 2. (a) and (b).

(a) (b)

Figure 2. Images of (a) Calcined *T. dislocata* Powder (b) Synthesized HAp Powder

A. Characterization of Hydroxyapatite

Hydroxyapatite powder has been synthesized from *T. dislocate* raw materials and diammonium hydrogen phosphate. The synthesized HAp was characterized by using modern techniques; EDXRF, FT IR, SEM, TEM, XRD and TG-DTA.

B. EDXRF Analysis

Elemental abundances of synthesized hydroxyapatite have been also determined by EDXRF analysis. From the results, the *T. dislocate* powder were composed of Ca as the main metal and small amount of Sr, Si, K, Fe, Cr and Cu. Among them Ca content was found that 98.186 % and small amount of Sr 0.630 %, Si 0.572 %, K 0.296 %, Fe 0.216 %, Cr 0.056 % and Cu 0.022 % were also found. The content of elements present in synthesized HAp were Ca, P, Sr, Fe, K, Cr and Cu.Ca content was 90.511%, followed by P content was 8.325 %. Trace amount of Sr 0.528 %, Fe 0.281 %, K 0.258 %, Cr 0.082 % and Cu 0.015 % were also observed.

C. FT IR Analysis

There are many aquatic organisms such as *T. dislocata* which consists of exoskeleton which is made by biomineralization of calcium carbonate ($CaCO_3$). FT IR spectroscopy was performed to identify the chemical bond existing in *T. dislocata,* calcined *T. dislocate* and synthesized HAp. The FT IR spectrum of *T. dislocata* powder showed the carbonate ion characteristic peaks at 712.32 cm^{-1}, 857.46 cm^{-1}, 1082.39 cm^{-1} and 1446.50 cm^{-1}. The band at 1784.617 cm^{-1} corresponds to the CO_3^{2-} groups of the carbonate ion. In FT IR spectrum of calcined sea shells, the presence of CaO was indicated by IR absorption at 550 cm^{-1}. The characteristic peaks at the CO_3^{2-}group at 1447 $cm^{-1}$and 855.52 cm^{-1} were lost in the FT IR spectrum of calcined sea shells. After hydrothermal treatment, the formation of HAp is evident according to the characteristic peaks of the PO_4^{3-} tetrahedral (566.16, 962.82, 1032.74 and 1088.29cm^{-1}), the hydroxyl (629.84 and 3642.20cm^{-1} and carbonate (874.75, 1421.00 and 1466.48 cm^{-1}). The CO_3^{2-}bands at 1421.00 and 1416.48 cm^{-1} indicate the presence of carbonated hydroxyapatite. The observed FT IR data were consistent with literature values [2].

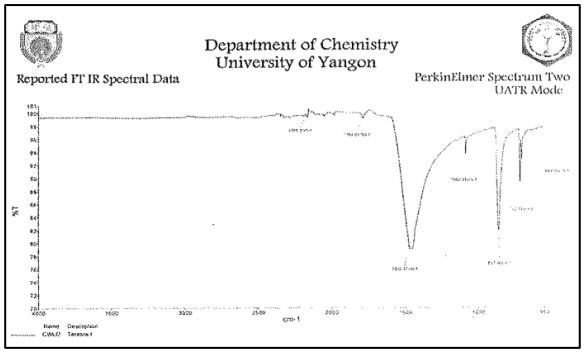

Figure 3. FT IR Spectrum of *Terebra dislocata* Powder

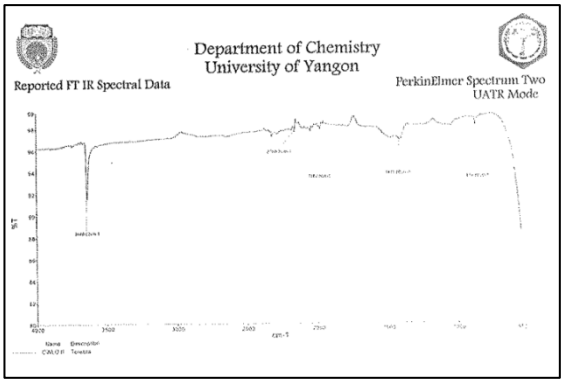

Figure 4. FT IR Spectrum of Calcined *Terebra. dislocata* Powder

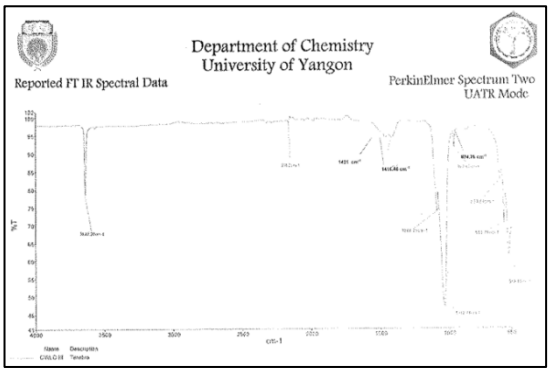

Figure 5. FT IR Spectrum of Synthesized HAp Powder

D. SEM analysis

The changes in the *T. dislocata* structure before and after calcinations are observed by SEM analysis. Figure 6(a) shows the *T. dislocata* structure of before calcinations process. In SEM, the *T. dislocata* powder showed a rough and disordered surface with low porosity grains. Although the structure changed after 1000 °C calcinations process, the image was showing smoother and more uniform surface as shown in Figure 6(b). The surface of calcined *T. dislocata* powder showed clusters of tidy and porous grain.

Furthermore, the surface morphology of synthesized samples was revealed by SEM analysis. The SEM image of HAp powders has the shape and size of particle that is almost uniform with narrow grain size.

The uniform grain size with a narrow size distribution was corresponding to the crystallinity improvement of the HAp powder. SEM micrograph of synthesized HAp is shown in Figure 6 (c).

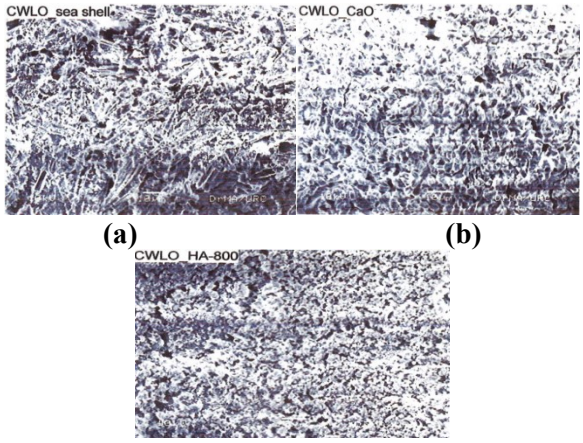

Figure 6. SEM Micrographs (a) *Terebra. dislocata* Powder (b) Calcined *Terebra. dislocata* Powder (c) Synthesized HAp Powder

E. TEM Analysis

The morphology of the synthesized hydroxyapatite were confirmed by TEM image as shown in Figure 7. The micrograph revealed that synthesized HAp contain spherical shape in length varying from 39-55 nm and width varying from 25-55 nm. The average particle size of synthesized HAp was found at 78 nm by using Broken Symmetry Software.

From TEM image, the HAp was visible as dark contrast area and seen uniformly dispersed throughout the image. The micrograph revealed that synthesized HAp was shown the morphology as spherical or close to spherical in shape.

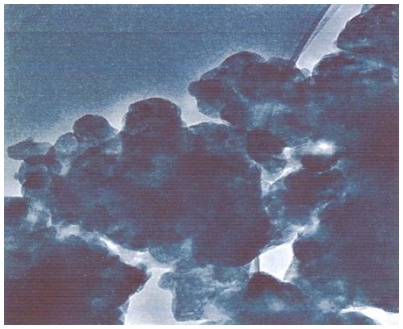

Figure 7. TEM Micrograph of Synthesized HAp Powder

F. XRD Analysis

The XRD analysis was performed by using the X-ray diffractometer. The XRD patterns of *T. dislocata* powder, calcined *T. dislocata* powder and synthesized HAP powder are shown in Figure 8 and Figure 9. All collected data were recorded in 20 range of 10-70º. The X-ray analysis was used to analyze the present phases, the degree of crystallinity of HAp and its size of crystallites.

The XRD pattern of *T. dislocata* powder, that exhibited the characteristics peaks of aragonite at 2θ values of 25° and 50° respectively, which correlate with (hkl) indices of (111), (221) and (122), respectively. These were the strongest peaks observed in the X-ray diffraction patterns of the analyzed samples. All the reflections can be attributed to the pure aragonite phase of calcium.

The crystallite sizes of calcium carbonate were calculated by Scherrer equation Tiny Tools Software and the crystallite size of *T. dislocata* powder was found at 58.36 nm.The structure and crystallite size of the synthesized hydroxyapatite has been analyzed by X-ray analysis. The sharp peaks of the diffractogram in Figures confirmed that product was well crystallized. The XRD pattern indicated that hydroxyapatite was formed in this sample. The secondary CaO phase was observed at (hkl) indices of (111), (200), (222) and (213) in this figure. The peak intensities in the XRD patterns of HAp were found at (hid) indices of (202), (211) and (300) at 2θ~33° and 35° that attributed to HAp.The crystallite size for HAp powder according to Scherrer formula showed crystallite size of 26.88 nm.

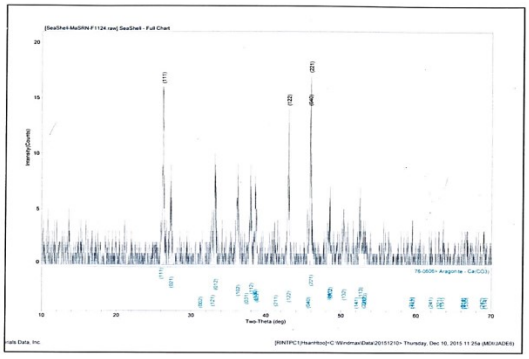

Figure 8. XRD Diffractogram of *Terebradislocata* Powder

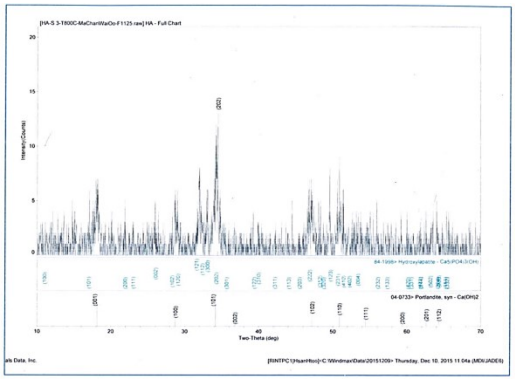

Figure 9. XRD Diffractogram of Synthesized HAp Powder

G. TG-DTA analysis

The TGA of the HAp nano-powder was carried out between 38.26 ºC to 601.69 ºC in nitrogen at flow rate 50 mL/min the decomposition behavior of HAp is shown in Figure 10. TGA thermogram showed no

significant weight loss from starting up to 20 min. After 20 min, TGA curve was showing a small decrease in weight may be due to the decomposition reaction of a minor amount of $Ca(OH)_2$. The percent weight loss of nanocomposite content was calculated from the residual weight in TGA curve. The total degradation loss of HAp in TGA curve was found at 17.65 % during thermal analysis that showed the thermal stability of synthesized HAp from the *T. dislocata.* Corresponding with weight loss, a strong endothermic peak due to decomposition of trace amount of $Ca(OH)_2$ was observed at 413.62 °C in the DTA curve. The TG-DTA curve of HAp is shown in Figure 10.

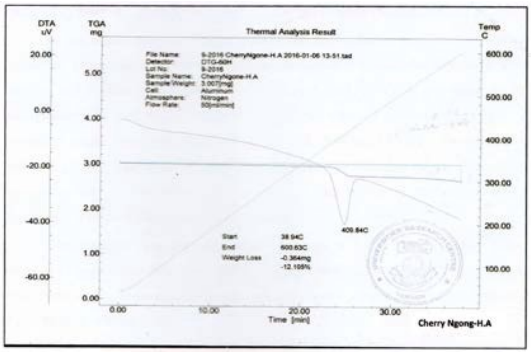

Figure 10. TG-TDA Thermogram of Synthesized HAp Powder

IV. Conclusion

From the synthesization and characterization of hydroxyapatite from *T. dislocata,* the following inferences have been deduced. The present study revealed that hydroxyapatite powder can be synthesized by hydrothermal method using *T. dislocata.* FT IR analysis indicated that all absorptions bands are typical characteristic of hydroxyapatite phase. In FT IR analysis, the formation of hydroxyapatite is evident according to the characteristic peaks of the PO_4^{3-}tetrahedral (566.16, 962.82, 1032.74 and 1088.29 cm^{-1}), the hydroxyl (629.84 and 3642.20 cm^{-1}) and carbonate (874.75, 1421.00 and 1416.48 cm^{-1}).In SEM analysis, the *T. dislocata* powder showed a rough and disordered surface with low porosity grains. Although the structure changes after 1000 °C calcinations process, the image was showing smooth and more uniform surface. SEM image of HAp powders has the shape and size of particle that is almost uniform with narrow grain size distribution. The uniform grain size with narrow size distribution was corresponding to the crystalinity improvement of HAp powders. From XRD analysis of HAp, it was found that the sharp peak of diffractogram confirmed that the product was well crystallized. The peak intensities in the XRD pattern of HAp were found at (hkl) indices of (300) and (202) at 2θ~ 33º and 35º that attributed to HAp. The crystallites sizes for synthesized HAp from *T. dislocata* were 26.88 nm. The structure and morphology of the synthesized HAp was confirmed by TEM image. The micrograph revealed that synthesized HAp has the spherical shape or closed to spherical shape, dark contrast area and uniform dispersed throughout the image. The average crystallite size of synthesized HAp also revealed at 26.88 nm. The total weight loss was 17.65 % during TG-DTA analysis that showed the thermal stability of synthesized HAp from *T. dislocata.* Hydroxyapatite (HAp) powder with particles having nano size was successfully prepared via hydrothermal procedure using *T. dislocata* powder and diammonium hydrogen phosphate as the precursor.

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Characterization and Physicochemical Properties of EM Compost and *Trichoderma* Inoculated Compost Fertilizers

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***Abstract*:** In this research work, various kinds of compost fertilizers were prepared from organic waste materials such as cow dung, rice straw, water hyacinth and rice bran by open heap layering method. Cow dung, rice straw, water hyacinth and rice bran were collected from Kyune Taw Quarter, Mogaung Township, Kachin State. Four different types of compost fertilizers were type 1(control untreated with EM and *Trichoderma*), type 2 (EM), type 3 (*Trichoderma*) and type 4 (EM and *Trichoderma*). Some physicochemical properties and nutrients of the waste materials and their related compost fertilizers were determined by modern and conventional methods. Highest concentration of N (1.77%) and P (0.10%) and K (2.20%) were found in *Trichoderma* compost fertilizer. During composting process, changes of some physicochemical properties and germination percent were also determined. The fertilization activities of different compost fertilizers were used for Mustard plant growth study. The highest yield of Mustard plant (318.67 kg/ha) was found when using EM compost fertilizer (treatment 2).

***Keywords*:** effective microorganism (EM), *Trichoderma* (Yezin Isolate), composting process, open heap layering, compost fertilizers**.**

I. Introduction

Composting is naturally occurring waste recycling process for the reuse of essential nutrients present in organic materials which produced a stabilized and sanitized form of organic matter such as compost [3].

The quality and acceptability of many organic wastes, from both on-farm and off– farm sources, can be greatly enhanced through composting (Aker, 2010). Such materials included animal manure, green manure, crop residues, wood ashes, tree leaves, weed from canals, wild grasses, urban sewage and street refuse. Many of these materials were composted to destroy weed seeds and potential human and plant pathogens; to enhance their nutrient availability; and to facilitate their storage, transport, and application to land [6].

Trichoderma are known as saprophytic mycoparasites which have been effectively cultured on agricultural waste products (Harman, 2004). EM Bokashi (EM fermented organic matter) prepared by fermenting organic matter such as rice straw. Beneficial microorganisms are known to be bio – control agents and / or growth promoters. Microorganisms in EM improve crop health and yield by increasing photosynthesis, producing bioactive substances such hormones and enzymes, accelerating decomposition of organic materials and controlling soil-boune diseases (Hussaing *et al*., 2002). The present paper aims to find the physicochemical properties and nutrients of EM compost and *Trichoderma* inoculated compost fertilizers.

II. Materials and Methods

A. Sample Collection and Preparation

Cow dung, rice straw, rice bran and water hyacinth were collected from Kyune Taw Quarter, Mogaung Township in Kachin State. *Trichoderma* (Yezin Isolate) was provided by Plant Pathology Research Section, Department of Agricultural Research (Yezin), Naypyitaw. Effective Microorganisms (EM) was provided by Kachin State Agricultural Department.

B. Preparation of Different Compost Fertilizers using Trichoderma and EM by Open Heap Layering Method

This research was done in sericulture farm, Kachin State Agriculture Department.All materials such as cow dung, rice straw, water hyacinth and rice bran (3: 4 : 3 : 2) and water (10 L) were used in composting process for preparation of fertilizer by open heap layering method. Pile size of box used in composting was 4.5´x 3´x 3´. Rice straw (first layer) is heaped in composting pile. Cow dung manure (second layer) is put on top of the straw layers. On top of the layer, one or two handfuls of the activator was broadcast and sprinkled of water on compost heap. This procedure is repeated until the pile is full.

In *Trichoderma* compost fertilizer, firstly compost fungus activator *Trichoderma* substrate is mixed with rice bran. Rice straw (first layer) is heaped in composting pile. Cow dung manure (second layer) is put on top of the straw layers. On top of the layer, one or two handfuls of the activator was broadcast and sprinkled of water on compost heap. The same procedure is used in EM compost fertilizer.

C. Methods

Some physicochemical properties and nutrients of all materials and compost fertilizers such as moisture, bulk density, pH, organic carbon, total N, P, K, Ca and Mg were determined. Measurement of pH was carried out by a pH meter (Digital pH Meter), moisture content was determined by oven drying method, bulk density was

determined by tapping box and organic carbon content was determined by Walkey and Black method. Nitrogen content was determined by Kjeldahl's method. Phosphorous content was determined by UV-Visible Spectrophotometric technique and potassium content was determined by Flame photometric technique. Ca, Mg and some micronutrients were determined by atomic absorption spectrophotometer. In the analytical procedures of the experiments, recommended methods and techniques were applied [2] [5]. Some part of this research work was done in the Water Utilization Research Section, Department of Agricultural Research, Yezin.

D. Application of EM Compost and Trichoderma Compost Fertilizer

The Mustard seeds were placed in provided portion of soil. After two weeks, the plants were transferred to earthen pots. The pot experiment was conducted in Sericulture Farm, Agriculture Department, Myitkyina Township in Kachin State. The experiment was laid out in Randomized Complete Block (RCB) design with four treatments and five replications. The treatment used in this experiment was.

Treatment 1 (T1) = Control

Treatment 2 (T2) = EM Compost

Treatment 3 (T3) = *Trichoderma* Compost

Treatment 4 (T4) = EM+ *Trichoderma* compost

Each treatment (200 g/plant) is used for Mustard plant cultivation. Earthen pots (28 cm diameter × 32 cm height) were filled with 9 kg. Randomized Complete Block (RCB) design of mustard is shown in Figure 3.

III. Results and Discussion

A. Some Physicochemical Properties and Nutrients of Raw Materials

Table 1 represents moisture, bulk density, pH and organic carbon of raw materials. Rice bran has higher organic carbon (53.05%) than that of cow dung, rice straw and water hyacinth. It indicated that the pH values of cow dung and water hyacinth are nearly neutral.

The nutrient contents of the raw materials (cow dung, rice straw, water hyacinth and rice bran) are presented in Table 2. Cow dung contains 2.03 % of N, 0.09 % of P, 0.19 % of K. Rice straw contains 0.74 % of N, 0.02 % of P, 1.09 % of K. Water hyacinth contains 0.51% of N, 0.06 % of P, 0.36 % of K. Rice bran also contains 0.53 % of N, 3.43 % of P, 1.58 % of K.

Table 1. Some Physicochemical Properties of Raw Materials

Properties	Cow Dung	Rice Straw	Water Hyacinth	Rice Bran
Moisture(%)	7.62	8.59	37.86	12.29
Bulk Density(g/mL)	0.85	0.17	0.13	0.38
pH	6.48	8.44	6.49	5.51
Organic Carbon(%)	9.77	46.82	49.59	53.05

Table 2. Nutrients of Raw Materials

Macro and Micronutrients	Cow Dung	Rice Straw	Water Hyacinth	Rice Bran
Total N (%)	2.03	0.74	0.51	0.53
Total P (%)	0.09	0.02	0.06	3.43
Total K (%)	0.19	1.09	0.36	1.58
Total Ca (%)	0.17	0.41	0.32	1.20
Total Mg (%)	0.08	0.48	0.12	0.68
Fe (ppm)	0.66	Nil	0.14	152.30
Mn (ppm)	78	900	100	117.00
Cu (ppm)	Nil	Nil	Nil	14.46
Zn (ppm)	1500	600	900	73.32

B. Aspects of Compost Fertilizer

The composting procedure used in this study was patterned from the recommened procedure [4] for composting and only varies with the gradual addition of green biomass during composting. Compost activator *Trichoderma* and EM were added to the mixture to speed up the decomposition process. A compost pile must be of sufficient size to prevent rapid dissipation of heat and moisture, yet small enough to allow good air circulation in aerobic composting process. The shape of the pile helps to control its moisture content. In the case of composting, the highest temperature 35°C was observed only at 18-20 days and descreased to 27 °C at 75 -80 days. The microbes are happiest between 43 – 66 °C . If the microbes get too hot , to cold , or they run out of nutrients or air, they will stop to do their job [8].

In the case of compost fertilizer , the moisture percent ranged from 50 % to 100 %. All living creatures, composting microbes need adequate moisture to survive and the ideal moisture content is 50 to 60 % [12].

In the case of compost fertilizer, the pH values ranged from 6.5 to 8.0. The maximum pH value 8.0 was observed only between 40 – 42 days. Typical range for pH was 6.8 – 7.3. However, these ranges can be substanially different depending on the kinds of feed stock used. The predominant use of compost is to mix it with soil to form a good growing medium for plants . The pH value of the composting is important, since applying compost to the soil can alter the soil pH which in turn can affect the availability of nutrients to the plant [11].

(a) Control

(b) EM Compost

(c) *Trichoderma* Compost

(d) EM+*Trichoderma* Compost

(e) Heap Compost

Figure 1. Preparation of Compost Fertilizers by Open Heap Layering Method

C. Germination Percent in Compost Fertilizers

Germination percent was evaluated during composting for maturity and stability of compost. Germination % of compost was detected at 40 days and 80 days interval. A germination percent 80 – 85 % indicated the absence of phytotoxicity in compost. Germination of water cress seed germination was recorded after compost fertilizer on peteridish and data were presented in Figure 3 and Table 3.

D. General Comments for Rapid Composting

Initially, the colour of organic matters seems to be brown and turns into black at the end of composting process. The compost was crumbly, loose, and humus – like. Control (untreated with EM and *Trichoderma*) of the composting process were recorded after composting 90 days. After 70 days, the height of EM compost fertilizer was stable. EM and *Trichoderma* compost fertilizer of the composting process were recorded after composting 75 days. The good quality of *Trichoderma* compost fertilizer was obtained after composting 80 days.

Table 3. Germination Test for Compost Fertilizers

Days	Germination (%) of Compost Fertilizers			
	Control	EM Compost	*Trichoderma* Compost	EM+ *Trichoderma* Compost
40	45	50	50	50
80	80	83	82	84

40 Days

80 Days

Figure 2. Seed Germination Test for Compost Maturity (40, 80 Days)

E. Physicochemical Properties and Nutrients of Compost Fertilizers

The physicochemical properties and nutrients of compost fertilizers after composting were analyzed and the results are shown in Table 4. The physicochemical characteristics of *Trichoderma* compost fertilizer were higher moisture content (4.09%), higher bulk density (0.54), higher pH value as control (7.93) and higher organic carbon (24.88%). Organic carbon plays a very important and sometimes spectacular role in the maintenance and improvement of soil properties. Regarding the C/N ratio, it ranged from 13.43:1 to 14.26:1 for different compost types. Maintaining C:N ratio after composting is also important to determine the value of finished compost as soil amendment for crops. The final C:N ratio of 15 to 20 will be expected the value of more than 20 might have a negative impact and will damage the crop and seed germination. These results are in agreement with the results ranged from 15:1 to 20:1 is ideal for ready to use compost [10].

The nutrient contents of the compost fertilizer were described in Table 5. The contents of N, P, K are essential to maintain and sustain the soil fertility. In the present work, the potassium contents were higher than that of calcium and magnesium in compost fertilizers. So, the sufficient amount of N, P, K and macro and micronutrients were present in compost fertilizers.

Table 4. Physicochemical Properties of Compost Fertilizers

Properties	Cont-rol	EM Comp-ost Fertilizers	*Trichoderma* Compost Fertilizers	EM+ *Trichoderma* Compost Fertilizers
Moisture (%)	3.88	3.62	4.09	3.74
Bulk Density (g/mL)	0.53	0.54	0.54	0.54
pH	7.93	7.52	7.34	7.61
Organic Carbon (%)	22.57	24.42	24.88	24.24
C/N ratio	13.43	14.03	14.06	14.26

Table 5. Macro and Micronutrients in Compost Fertilizers

Macro and Micronutrients	Control	EM Compost Fertilizer	*Tricho-derma* Compost Fertilizer	EM+ *Trichoderma* Compost Fertilizer
Total N(%)	1.68	1.74	1.77	1.70
Total P (%)	0.06	0.09	0.10	0.08
Total K(%)	2.07	2.18	2.20	2.16
TotalCa(%)	1.10	1.03	1.01	0.87
Total Mg (%)	0.37	0.44	0.50	0.53
Fe (ppm)	11.00	12.30	9.40	13.90
Mn (ppm)	1.85	1.61	1.63	1.63
Cu (ppm)	339.90	313.80	309.90	282.90
Zn(ppm)	31.30	27.80	26.90	30.90

F. Effect of EM Compost and Trichoderma Compost Fertilizer on Mustard

The fertilization activities of all compost fertilizers from T1 to T4 were also determined by growing Mustard plant within 54 days. The growth of plants was shown in Figure 4 and 5. The highest plant height, number of leaves and leaf width were recorded in T2 for Mustard and the lowest was in control. The results are shown in Table 6 to 9. From these results, it was observed that highest total yield of EM compost fertilizer for Mustard plant.

Figure 3. View of Pot Experiment for Mustard

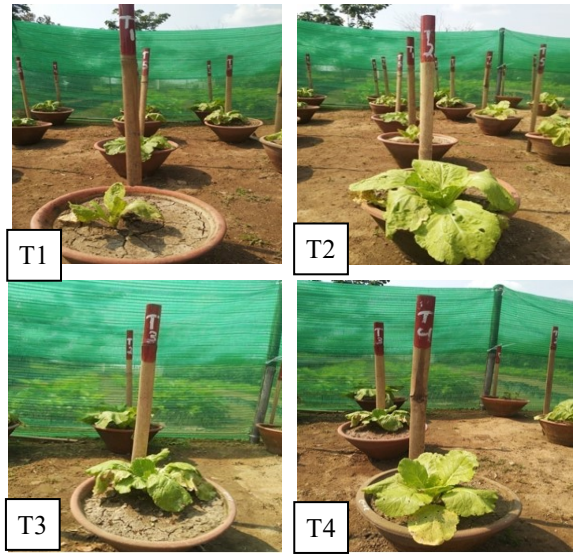

Figure 4. Vegetative Stage of Mustard

Figure 5. Maturity Stage of Mustard (Harvesting Time)

Table 6. Plant Height (cm) of Mustard at Different Days after Sowing

Treatment	19 Days	26 Days	33 Days	40 Days	47 Days	54 Days
T1	7.88	10.03	11.85	13.64	14.70	17.35
T2	8.88	10.88	21.80	23.00	24.88	31.00
T3	8.13	10.13	15.75	18.15	19.43	22.63
T4	9.25	11.28	16.75	25.88	26.00	24.63

Table 7. Number of Leaves Mustard at Different Days after Sowing

Treatment	19 Days	26 Days	33 Days	40 Days	47 Days	54 Days
T1	3	4	5	7	8	11
T2	3	4	9	10	14	19
T3	3	4	7	9	12	16
T4	3	4	7	10	13	15

Table 8. Leaf Width (cm) of Mustard at Different Days After Sowing

Treatment	19 Days	26 Days	33 Days	40 Days	47 Days	54 Days
T1	2.38	4.38	5.38	5.98	6.43	8.38
T2	3.55	5.55	12.18	12.60	14.45	16.75
T3	12.63	4.68	8.30	10.88	12.65	15.83
T4	2.75	5.05	8.48	12.88	12.65	15.83

Table 9. Comparative Total Yield of Mustard

Treatment	Yield Mustard	
	g/plant	kg/ha
T1	17.25	76.05
T2	72.28	318.67
T3	49.13	216.61
T4	45.75	201.71

IV. Conclusion

In this study, physicochemical properties of prepared compost fertilizers were found to suit for plant growth. Control is not consisted microorganism in long time compost fertilizer than the other EM compost fertilizer, *Trichoderma* compost fertilizer and EM+ *Trichodrma* compost fertilizer. Effective microorganism (EM) is rapidly compost fertilizer than *Trichoderma* compost fertilizer. *Trichoderma* is slowly compost fertilizer than effective microorganism (EM) compost fertilizer. And then, EM and *Trichoderma* is medium of EM compost fertilizer and *Trichoderma* compost fertilizer. With using compost fertilizers, a low input system can be carried out, and it can be supported to achieve outcomes for agricultural sector.

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Extraction and Biochemical Characterization of Peroxidase from Spinach

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***Abstract*:** Peroxidase (PODs, E.C.1.11.1.7) catalyzes the oxidation of H_2O_2 and guaiacol forming the product tetraguaiacol and water. In this research, partially purified peroxidase enzyme was isolated from spinach leaves by ammonium sulphate precipitation (20 % - 70 %) method. Peroxidase activity was determined by spectrophotometric method using guaiacol as substrate at 470 nm. Protein content was determined by Biuret method using Bovine Serum Albumin (BSA) as standard at 550 nm. Specific activities and degree of purification were determined in each purification steps. Peroxidase was purified 3.36 fold over crude extract. Specific activity of peroxidase in crude extract was 0.2009 µmol min^{-1} mg^{-1} and increased to 0.6759 µmol min^{-1} mg^{-1} after 70 % ammonium sulphate precipitation. The optimum pH of the peroxidase-catalyzed reaction was determined by using different pH values (5-8) and the maximum peroxidase activity was found at 6.0. The optimum temperature of the peroxidase-catalyzed reaction was conducted at different temperatures in the range of (10 ℃ - 60 ℃) and the highest peroxidase activity was observed at 40 ℃. The K_m and V_{max} values of peroxidase were found to be 5.98 mM and 51.02 M min^{-1} respectively, from Lineweaver-Burk plot.

***Keywords*:** peroxidase, spinach leaves, guaiacol, ammonium sulphate precipitation method

I. Introduction

Peroxidase [E.C.1.11.1.7] is a ubiquitous enzyme which belongs to the oxidoreductase class of enzyme and generally catalyzes a reaction between H_2O_2 as electron acceptor and many kinds of substrate by means of O_2 liberation from H_2O_2 and extensively distributed among higher plants, animal and microorganisms [8]. They catalyze the reduction of peroxidase but also oxidase a variety of organic and inorganic compounds (Figure 1). Commercially available peroxidase is widely employed for removal of phenols and amines from industrial waste water, bleaching of industrial dyestuffs, lignin degradation, fuel and chemical production from wood pulp and in various organic syntheses. Peroxidase act on the removal of hydrogen atom most usually from the alcohol groups, which are combined with hydrogen peroxide in order to form molecules of water and oxidized phenolic compounds, acting as detoxifying enzymes and as a cell wall crossing linked enzyme during wounding stress [4].

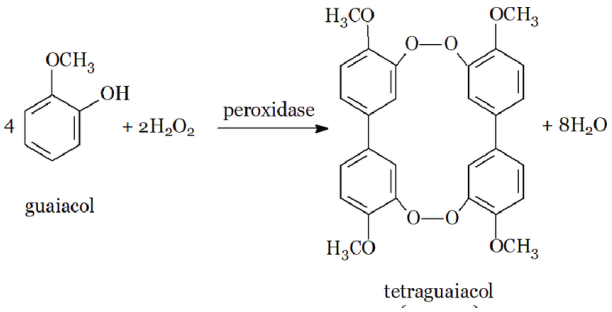

Figure 1. Enzymatic Conversion of Guaiacol to Tetraguaiacol in the Presence of Hydrogen Peroxide

II. Materials and Methods

A. Plant Materials

Spinach samples were purchased from local shop, Yangon Region (Figure 2).

Figure 2. Spinach Leaves

B. Chemicals

Ammonium sulphate from British Drug House was used. Bovine Serum Albumin (BSA) was purchased from Sigma Aldrich, England. All other chemicals were used of analytical reagent grade. In all investigations, the recommended standard methods and techniques involving both conventional and modern methods were provided.

C. Procedure

1) Sample Preparation and Extraction of Peroxidase from Spinach Leaves

The fresh leaves of spinach were washed with tap water, chopped and mixed with phosphate buffer pH 7.0 solution. It was stirred in ice for 2 h and filtered. Solid ammonium sulphate was slowly added to this extract to obtain (20-70) % saturation and stirred for 2 h in ice. After standing overnight, the precipitated protein containing peroxidase enzyme was collected by centrifugation for 30 min.

2) Determination and Characterization of Peroxidase Activity from Spinach Leaves

For enzyme assay the peroxidase activity of spinach leaves was determined with the spectrophotometric method at 470 nm using guaiacol as a substrate in the presence of hydrogen peroxide. Protein content was determined by Biuret method using Bovine Serum Albumin (BSA) as standard at 550 nm. Specific activity was calculated by using enzyme activity and protein content. Enzyme concentration, effect of pH, temperature and reaction time were determined by spectrophotometric method. The enzyme kinetic parameters of K_m and V_{max} of peroxidase-catalyzed reaction were determined by spectrophotometric method.

III. Results and Discussion

A. Determination of Peroxidase Activity, Protein Content and Specific Activity of Spinach Leaves

Enzyme activity was tested using Guaiacol as substrate where the effect of peroxidase enzyme on guaiacol in the presence of hydrogen peroxide was tested [3]. Spectrophotometric method of analysis was used at a wavelength of 470 nm to quantify the activity on the basis of the production of coloured complex due to the action of the enzyme. One unit of peroxidase was defined as the amount of enzyme that caused the formation of 1 mM of tetraguaiacol per minute.

The protein content was determined by Biuret method and it was observed to be 377.865 mg mL^{-1} (Table 1 and 2). Specific enzyme activity is the number of enzyme units per mL divided by the concentration of protein in mg/mL. The specific activity was calculated to be 0.6759 μmol min^{-1} mg^{-1}. After 70 % ammonium sulphate precipitation, peroxidase was purified to 3.36 fold over crude extract.

Table 1. Enzyme Activity and Protein Content of the Enzyme Solution

Fraction	Enzyme Activity (μmol min^{-1} mL^{-1})	Protein Content (mg/mL)
Crude	81.2538	404.342
After Purification with 20 % $NH_4(SO_4)_2$	208.182	383.448
After purification with 70 % $NH_4(SO_4)_2$	255.405	377.865

Table 2. Specific Activity of the Enzyme Solution

Fraction	Specific Activity (μmol min^{-1} mg^{-1})	Degree of Purity (fold)
Crude	0.2009	1
After purification with 20 % $NH_4(SO_4)_2$	0.5429	2.70
After purification with 70 % $NH_4(SO_4)_2$	0.6759	3.36

B. Calibration Curve for Protein Determination by Biuret Method

In this work, bovine serum albumin (BSA) was used as a standard protein [5]. The different absorbance values were obtained for various standard protein solutions by using a UV-visible spectrometer. It was found that the nature of the plot of absorbance at 550 nm *vs.* concentration of protein (mg mL^{-1}) (Table 3 and Figure 3), was a straight line passing through the origin showing that Beer's Law was obeyed.

Table 3. Relationship between Absorbance and Concentration of Bovine Serum Albumin (BSA) Solutions

No.	Protein Concentration (mg mL^{-1})	Absorbance at 550 nm
1	2.0	0.147
2	4.0	0.283
3	6.0	0.405
4	8.0	0.524
5	10.0	0.630

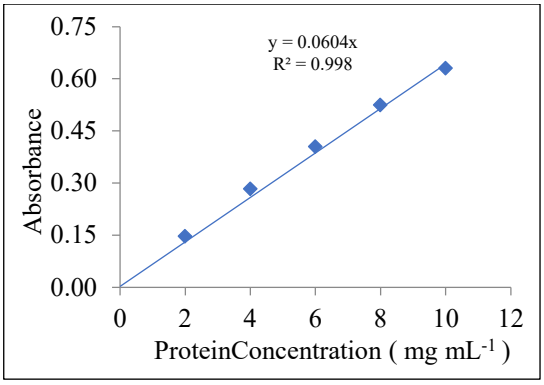

Figure 3. Plot of Calibration Curve for Standard Protein Solution

C. Effect of Enzyme Concentration on Peroxidase-catalyzed Reaction

The activity of an enzyme was determined by the enzyme concentration [7]. As the enzyme concentration increases the rate of reaction increases linearly, because there are more enzyme molecules available to catalyze reaction. Substrates mixed with different concentration of enzyme and then observe the absorbance at 470 nm. Oxidized guaiacol (yellowish-brown color) absorbs at 470 nm (Figure 4). The enzyme activity was found to have a linear relationship with different enzyme concentration ranging between 4.76 to 23.76 mg/mL of enzyme (Table 4 and Figure 5).

(a) (b) (c) (d) (e) (f)

Figure 4. (a) 20 mM guaiacol and 22 mM H_2O_2 Solution Without Enzyme Solution (Control) at Room Temperature
(b-f) 20 mM Guaiacol and 22 mM H_2O_2 Solution with Enzyme Solution

Table 4. Relationship between Absorbance and Enzyme Concentration

No.	Enzyme concentration (mg/mL)	Absorbance
1	4.76	0.117
2	9.51	0.239
3	14.26	0.353
4	19.01	0.472
5	23.76	0.585

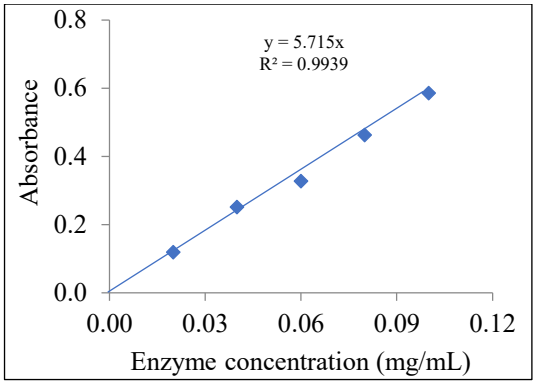

Figure 5. Plot of Absorbance as a Function of Enzyme Concentration

D. Optimum pH of Peroxidase Activity

At an optimum pH, an enzyme's activity is highest. At pH above and below optimum pH, the activity of the enzyme is reduced and reaction rates are slower [1]. In this work, different buffers of pH values 5.0 to 8.0 were used to determine the activity of the prepared peroxidase sample. The nature of the activity *vs.* pH curve of the enzyme (Table 5 and Figure 6) was obviously found to be unsymmetrical and the optimum pH was obtained at pH 6.0 with guaiacol as substrate.

Table 5. Relationship between Peroxidase Activity and pH of Buffer Solution

Buffer	pH	Peroxidase activity (μmol min^{-1} mL^{-1})
1	5.0	3.306
2	5.5	3.767
3	6.0	4.908
4	6.5	4.301
5	7.0	4.052
6	7.5	3.188
7	8.0	2.357

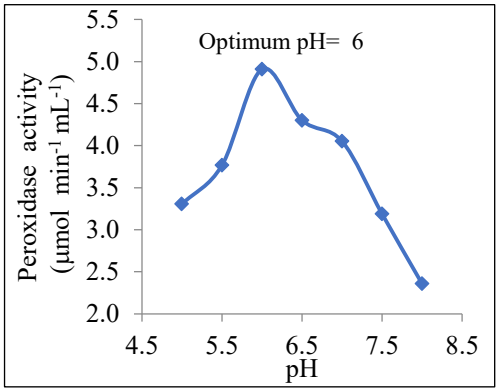

Figure 6. Plot of Peroxidase Activity as a Function of pH of the Solutions

E. Optimum Temperature of Peroxidase Activity

In this study, the effect of the temperature on the peroxidase activity was investigated in the temperature range between 10 to 60 ºC with 10 ºC intervals. The optimum temperature for peroxidase was found to be 40 ºC in phosphate buffer pH 6.0 (Table 6 and Figure 7).

Table 6. Relationship between Peroxidase Activity and Temperature of the Solution at pH 6.0

No.	Temperature (°C)	Peroxidase Activity (µmol min^{-1} mL^{-1})
1	10	1.972
2	20	3.163
3	30	4.723
4	40	5.319
5	50	4.069
6	60	2.534

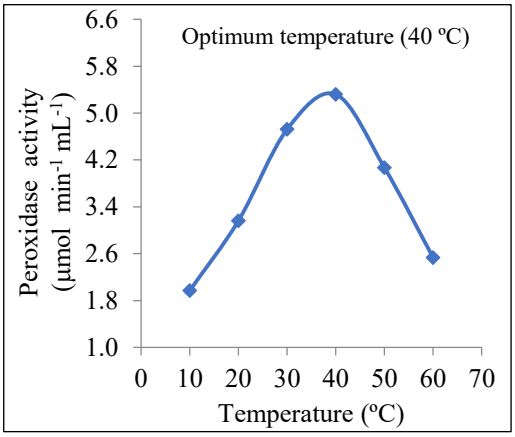

Figure 7. Plot of Peroxidase Activity as a Function of Temperature of the Solutions at pH 6.0

F. Effect of Reaction Time on Peroxidase-catalyzed Reaction

Reaction time is also a major factor in the determination of enzyme activity [2]. Among other conditions which regulate the rate of enzyme reaction, reaction time is an important factor in the determination of enzyme activity. In this work, the action of the peroxidase on guaiacol substrate was studied in sodium-phosphate buffer 6.0. The amounts of tetraguaiacol liberated during the various times of 1, 2, 5, 8, 11, 14 and 17 min were determined (Table 7 and Figure 8).

Table 7. Relationship between Reaction Time and Velocity of Peroxidase-catalyzed Reaction

No	Reaction Time (min)	Concentration (mM)	Velocity (mM min^{-1})
1	1	24.830	25.592
2	2	46.186	23.051
3	5	99.240	8.107
4	8	81.017	3.503
5	11	89.831	2.938
6	14	97.881	2.683
7	17	104.153	2.091

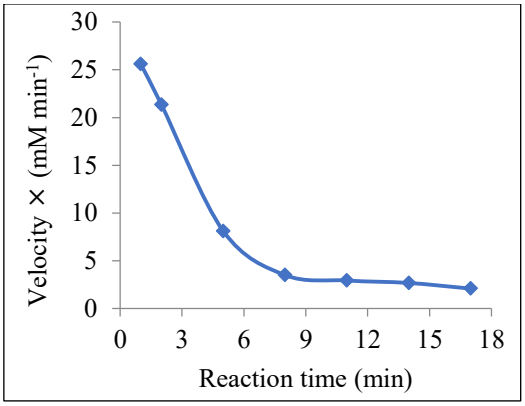

Figure 8. Plot of Velocity of Peroxidase-catalyzed Reaction as a Function of Reaction Time

G. Effect of Substrate Concentration on Peroxidase-catalyzed Reaction

The rate of any enzyme-catalyzed process depends upon the concentration of the enzyme and its substrate [6]. The relationship between the initial rate, the substrate concentration [S], and maximum velocity V_{max} of an enzyme is obtained by using the Michaelis-Menten equation. In this study, statistical methods were used for obtained V_{max} and K_m from experimental results. The K_m and V_{max} values of peroxidase were found to be 5.98 mM and 51.02 M min^{-1} respectively, from Lineweaver-Burk plot (Table 8 and Figure 9).

Table 8. Relationship between Substrate Concentration and Velocity of Peroxidase-catalyzed Reaction

No.	[S] (mM)	1/[S] (mM)	V (M min^{-1})	$1/V \times 10^{-1}$ (M min^{-1})
1	5	0.200	28.051	0.3565
2	10	0.100	42.797	0.2337
3	15	0.067	49.915	0.2003
4	20	0.050	53.729	0.1861
5	25	0.040	55.763	0.1793
6	30	0.033	57.203	0.1748
7	35	0.029	57.797	0.1730
8	40	0.025	58.898	0.1698

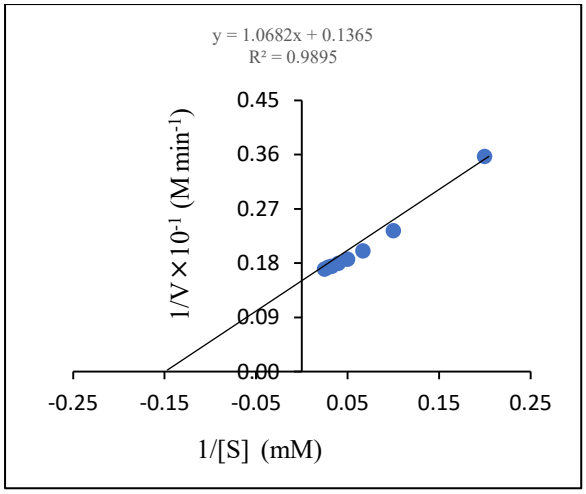

Figure 9. Lineweaver-Burk Plot of 1/V *vs.* 1/[S] Used for Graphic Evaluation V_{max} and K_m for Crude Peroxidase

IV. Conclusion

In this research, partially purified peroxidase enzyme was isolated from matured spinach leaves by ammonium sulphate precipitation (70 %) method. Peroxidase was purified 3.36 fold over crude extract. Specific activity of peroxidase in crude extract was 0.6759 µmol min^{-1} mg^{-1} after 70 % ammonium sulphate precipitation. The peroxidase activity was found to have a linear relationship with different enzyme concentrations. The optimum pH of peroxidase was found to be 6.0 in phosphate buffer and optimum temperature was found to be 40 °C. Reaction time of 2 min was chosen for initial velocity measured in enzyme kinetic. The K_m and V_{max} values of peroxidase were found to be 5.98 mM and 51.02 M min^{-1} respectively, from Lineweaver-Burk plot.

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Abstract: Listening comprehension is well-known to play a very important role in foreign language teaching. Listening skill is regarded as it has been a great responsibility for both teachers and students and it is trying to enhance communicative competence. Many of the activities of the contemporary society are based on information that is available through multimedia. The use of multimedia technology in listening instruction is an excellent and technical way to enhance our chances of achieving the goal of language pedagogy. According to it, this study discovered difficulties in listening to most technological university students. This study mainly focuses on the Third Year Electronics Engineering students who are from Technological University (Myeik). Their problems in listening skills were found out with the help of the questionnaires. The effective ways of using multimedia listening activities in practice are determined by students' questionnaires. The purpose of this research is to define the terms listening and understanding listening, reviewing parts of listening, the role of teachers in listening comprehension and their role in the use of multimedia technology for the development of students' listening skills.

Keywords: listening skills, multimedia, third-year electronics engineering students, the role of teachers, and questionnaire

I. Introduction

Language is a set of skills; listening, speaking, reading, and writing. Of these four skills, the listening skill is the first to develop. Listening skill was regarded as a prior condition for oral learning in language teaching, which was of great concern to language teachers. For those language teachers, who think that learning a foreign language is rather comparable to acquiring a mother tongue, listening is a key tool for creating learners' understanding of the language and gaining absorption. Taking everything into consideration, language learning is a matter of input and output process, Krashen (1981) [1] formulated this idea. According to what is being said, listening ability covers most of the content and is an important agent for participation in the learning process. The output depends a lot on the input. Listening ability is also important for output. In this way, the listening skill can be regarded as an important matter in oral production with the help of building a communication background. A wide range of multimedia media technologies enable effective language teaching and learning. Multimedia is the mixture of the variety of content forms. It includes the arrangement of text, audio, still images, animation, video, or interdependent content forms. It is usually recorded and played, replayed, or accessed by information content processing devices such as computerized and electronic devices, and language labs, and it becomes part of a live performance. Arranging these combined media is a threat to materials developers. The technologies that are integrated effectively into language learning describes as a threat to language teaching professionals. The purpose of this paper is to provide students with the opportunity to listening and speaking and speak with the help of technology and to analyze how to achieve effective multimedia communication skills. These applications are successfully used in reading, writing, listening and speaking practices, both language teachers and students all over the world. With the progress on the Internet, multimedia has been transformed to increase the conceivability that every person around the world can integrate a large amount of information.

II. What is Listening?

According to (Morley, 1971) [2]. Rost, M. (1993) [3], Listening is a kind of discrimination, slecting and remembering necessary information, and oral grammar. Aural Grammar Selecting the required information; This includes the connection between the meaning of listening and listening to it as an active mental capacity. It is an essential part of understanding the world around us and helping us to succeed in communication. Pourhossein Gilakjani and Sabouri, N.B. (2016) [4] showed that listening includes thinking, and listening to the learners' feelings and goals. It includes active participation, and it requires effort and training. As with the opinions of interlocutors, filling in gaps in what one learns with the knowledge of a single language, and integrated all complementary all come into play.

A. The Comprehension of Listening

There are many different meanings of the term "listening comprehension". It is a kind of different process for understanding a spoken language.

These include knowing the sounds of speech and understanding the meaning of each word. Hamouda (2013) [5], describes that the comprehension of listening refers to understanding what the listener hears. The listener can hear sounds over and over again without really understanding, but he / she is capable of repeating the sound despite of real understanding. Until recently, listening comprehension activities in foreign language and the target language classrooms were restricted in the test of listening comprehension test. The background is that if students successfully learn a subject, they must automatically determine the structure and vocabulary of the textbooks they have created.

B. Constitutions of Listening Comprehension

Listening comprehension is divided into four constitutions. The very first is the ability to distinguish between all sounds, voice qualities, and intonation patterns in the target language and to recognize among them and the comparable utterances with the native language. The second is the awareness of the whole message that are produced from the speaker. According to Rivers (1981) [6], that message is based on understanding semantic meaning. Only when the meaning is not understood, then it can move from a sound understanding of syntax knowledge. The third is the ability to hold it in memory until it is finished. Teachers should learn as much of the language as they can to develop students' memory. This means most classes should be done in the language of the lesson. The pace of presentation and the level of difficulty of the content should be adjusted with the students. Significant is the progress plan. The fourth is to find the meaning that is essential for the transportation of parts. Listeners should use more energy to understand unknown content. They have to go up because of their lack of background. The last step is to use examples to confirm or deny previous expectations. The samples accept that their listeners' expectations match their expectations, (Kaspar, 1984) [7].

III. Listening Activities: The Roles of Teachers

According to Harmer (1991) [8] and Machackova (2009) [9], there are some roles for teachers. The teachers act as instructors and helps their students to develop ideas. They should help their students towards guess the missing information. Once teachers complete the entire lesson. What do students have to say? When to speak, the teachers are responsible for determining what language they should speak. The teachers determine what the students should do at the listening stage. The teachers should explain what their students want to do. Clear instructions and helpful feedback should be provided to them. The teacher must prepare a listening lesson and guide their students. They motivate their students and provide suggestions for students' activities. They should support the students in every stage of the listening activities. The teachers give their students the necessary advice and helps them solve problems, especially unfamiliar vocabulary or grammar. The teachers evaluate their students and provides needed feedback on their performance. They should evaluate the student's grade.

IV. Multimedia Technologies for Listening

An outstanding unit of traditional believes concerning with the role of listening in language learning is the language lab. The principle for language labs is connected to the mental apprehension that listening practice with audiotape individually assists to strengthen a learner's ability to understand and speak the foreign language. Technology is thought to enhance the language learning process. The development of Computer Assisted Language Learning (CALL) is not the same as the great interest for audiotape-based technology. The second language materials that the learners can control and use in their practices individually can support assessments to each effort. In general, however, looking forward to an event for CALL, and especially multimedia, are increasing. So, the impact of multimedia on the language acquirement process is becoming an important matter. Through carefully consideration and selecting authentic multimedia, the genuine resources of multimedia exhibit the image of a huge improvement in the field of replicating real-life events. On the other hand, the target language might be presented more familiar contexts. Another important topic is the selection of good teaching aids that are related to teaching listening through multimedia.

V. Methodology

This research mainly focuses on the audio-lingual method. This method is based on the theory of behaviour. Language is taught through useful vocabulary and dialogues with common communication structures. This method helps the students learn and develop listening and speaking skills quite efficiently. In order to achieve the aim to develop listening skills in Third Year Electronic Engineering (EC) Students, it was based on methodology and practice of collecting and researching material. The role of practical materials is to carry out questionnaires of the students' observations towards listening skills for the target students; identifying learning thorough activities in developing listening skills and to find effective ways in improving listening of third-year students in Electronics Engineering.

Listening and note-taking are important skills that students have the ability to develop them. It will have the challenges to become a better listener and more efficient at recording what the learner hears. The aim of taking lecturer notes is to put ideas of speaker on paper in a way that the students can quickly know the topic of the lecture, the main ideas, and some details that support the main idea. It can also help to improve new vocabularies, and structures of sentences.

This study is 40 Third-Year students from Electronics Engineering. They range from 18-20 years of age. The teacher used questionnaires in this study because it helps to create groups for the research, and it is also the easiest ways to collect data in no longer period of time. Furthermore, the important thing is related to teaching listening through multimedia is becoming the selection of teaching aids. The questionnaires are based on the listening section Module 1, lesson 3 from Brue Print Textbook for Pre-advance level. The topic is "Dangerous Job". The teacher first introduces about the topic and makes groups of 5 students in each. Then, the teacher lets them to take notes on their paper and discuss the given topic. While they are discussing, the teacher walks around the students and pay attention to them. After that, the teacher opens the audio files for three time. In the first time, the students are asked to close their eyes and listen to the audio carefully. Then, they listen again and have to answer the given exercises in the next two times. The teacher finds out that the students have found difficulties in listening skills as they all have not completed all the exercises even though they have listened three times. So, from above listening activities, data from the questionnaires are sorted out and analyze statically and demonstrate in the pie chart.

A. Outcomes

In this research, the teacher arranged questionnaires for Third Year Electronics Communication Students. There are four choices in each question. The analysis and explanations of the questionnaire are exhibited in figure 1-2.

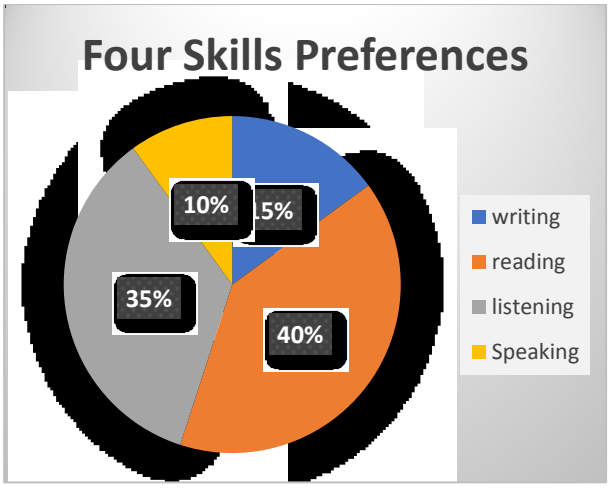

Figure 1. Analysis for the First Question (What skill do you like more?)

1) Figure

This analysis shows that (15%) of students like to write, while (40%) of students prefer reading. On the other hand, almost (35%) of students prefer listening and (10%) like speaking skills.

These answers of students for the given question show a positive attitude of students to reading and listening skills. They would like to improve their skills in reading and listening.

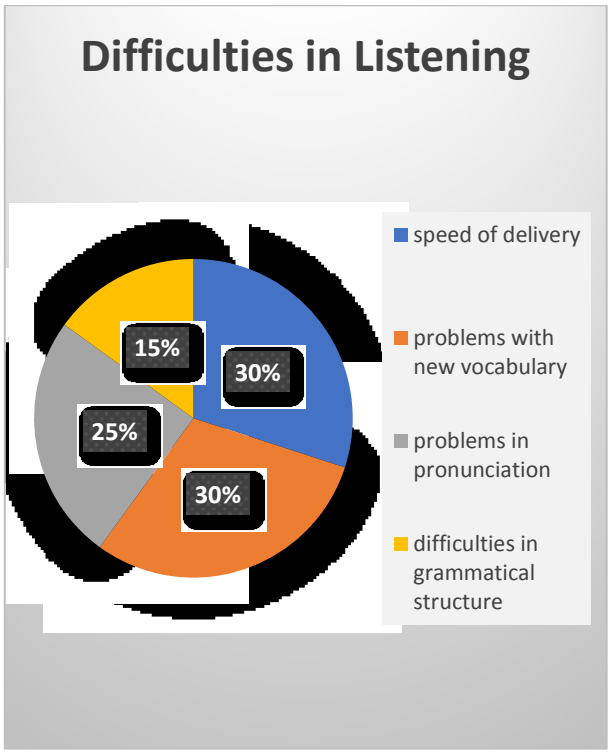

Figure 2. Analysis for the Second Question (What is the difficulty face while listening?)

2) Figure

This analysis shows that (30%) of students have found difficulties in speed of delivery during listening and speaking, (30%) face problems with misinterpretation of new vocabulary and expressions, (25%) of students think that they have problems in pronunciation of English words, while (15%) of students have difficulties in forming sentences by using correct grammatical structure.

For third-year electronics students, role-plays can give students real life situations, experiences, and opportunities, and help them often to deal with common utterances. In addition, role-playing helps students to perform together as a group, and to understand each other.

VI. Potential Benefits of Multimedia in Listening Activities

As for Third Year Electronics Engineering Students, acting out together helps students manage with their real-life situations, driving them to think basically, and use of the common utterances.

The concept of the traditional classroom practice and bringing a number of potential advantages for the development of one's listening competency are involved in the field of multimedia-supported listening activities to the target language. The Internet is an ideal place to practice the language, which allows us to use images and sound sources at the same time by using the right software. It is possible that the integration of voice and images into real-world communications situations. The Internet can be useful in learning environment only when the sources are properly selected. Listening to the instructions of the trainers, facilitators, and teachers who indeed learned themselves, searched the platforms their own, or find a really helpful Web page are the best way to find good websites and great approaches to listening activities. For example, Facebook, Messenger and Viber applications have millions of users worldwide. Learners take good advantages by practicing or developing listening and speaking skills from using the social medias. Social medias always design newer opportunities for the any destinations of users. This software can also pass on video calls or calls at the same time when the users speak to each other. So, these features raise the level of intercommunications to the learners from these practices.

Internet, television and radio can be used to enhance students' listening comprehension skills are another substitute way. However, YouTube.com is emerging as a new phenomenon. This is a website where videos can be watched, uploaded, or if the creators allow, we can download videos that is gaining popularity todays. Television, Video Radio News & Events Documentary Music, and just one click of any video that goes beyond the imagination of the video and people.

What the learners shouldn't miss a good web site is BBC Learning English as it has always been seen as an authentic source of "right" form of English courses for all levels of learners who want to practice or improve their target language, it is really helpful for English Language Teaching. The BBC is aware of its educational role, and the book are written with sound, videos and more. Thanks to the advance of the Internet, BBC has set up an English Learning Page, the best site of ever. The site gives countless numbers of approaches to the learners about the useful materials, methods, development and how to work effectively with the target language. The platform is kept at http://www.bbc.co.uk/worldservice/learningenglish/.
The BBC is looking for learners who are interested in podcasts, games, quizzes, video and voice recordings. There are many activities based on listening skills. In addition, the songs are very useful for developing students' listening skills. Music can be integrated into every aspect of life and the learners can also incorporate music and songs into language learning in order to change or enhance emotions and feelings.

A. Disadvantages of Utilizing Multimedia Technology

All the more of the improvements of application of multimedia technology to English communication teaching has to improve teaching effectiveness and university students' overall competencies, there are many other issues existing in practical teaching. It is fortunate that a lot of teachers are active in multimedia technology application but they are not well qualified enough to handle it confidently. In listening class, they are standing by the computer, and students are fixing their attention only on the screen, and as a result, there is no eye contact between teachers and students. To this extant, it should be noted that the enlightenment of students' thinking competence might be the main objective in teaching and of using multimedia technology and then it should not become involved in the students' time for exploring questions, thinking, and analyzing.

VII. Conclusion

It is extremely difficult for technology to support the development of foreign-language listening capabilities for multimedia. There is a logical match of system characteristics such as Internet applications, audio, video, and the goal of listening skills development in a second or English language as a good useful platform for the development of listening practice. It is crucial that consideration of the roles of teachers carefully and combination of the input tools and patterns of interaction are ranged by the software developers that

inspire students' manipulation. Technology has certainly provided teachers and learners with a variety of materials and communication possibilities to enhance their language learning and teaching. Both of the teachers and students need to make ready to adapt the profitable new technology platforms and appropriate methods for a successful integration with the use of multimedia technology and create a good blended classroom. The important thing is that before the class, teachers should prepare with professional skills, which include methodology, technical skills and the requirements can move on to implementation of the Internet in language classrooms. They need to have more knowledgeable and enthusiastic as they should be a good motivator for their students. Otherwise, no achievable gets to the students in their listening skills. Learners can get benefit from technology-based activities that are provided by their teachers and these activities must be relevant to their needs and interest.

This study addresses in surveying listening in Third Year Electronics Communication Students from Technological University (Myeik). Based upon the questionnaires, this study has classified the well-organized of learning activities in expanding listening skills on the given multimedia listening activities.

To cap it all, this study is of the opinion to be practical for operating in different groups. It is hoped that the English teachers can benefit new concepts and plentiful approaches to improve listening skills from this study.

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Investigation of Students' Listening Comprehension via Pre-Listening Test

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***Abstract*:** Listening is an imperious language skill developed in second language learning. Despite its importance, the feeble skills of EFL students experiencing different types of deafness. The main purpose of this study is to investigate the impact of pre-listening activities on student understanding of IELTS listening comprehension. Based on this aim, forty students from the University of Computer Studies (Mandalay) were selected for the study to take part in a listening test. Participants were randomly divided into two groups: an experimental group and a control group, each group consisting of 20 members. The experimental group contacted and accepted the IELTS test listening advice, the other groups were untreated, but all underwent a hearing test. Expressed quantitative data analysis by comparing the IELTS test and the average scores of the two groups. The results of this work show that students who take part in the listening activities do better in the test and can answer correctly. Moreover, the students become motivated to English Language Learning.

***Keywords*:** pre-listening, IELTS listening test, listening comprehension, students, teachers role**.**

I. Introduction

From kindergarten to high school students, English is a must-have foreign language in Myanmar. However, students use English but only focus on reading and writing. Most students lack the ability to speak and listen. Granted, they are good readers, but they have a lot of problems understanding their pronunciation and listening.

The main purpose of this study was to investigate the impact of pre-listening activities on the listening comprehension of EFL students in Myanmar. Listening is especially difficult for those who study English in a second language (EFL) classroom. Students at the Computer Research University in Mandalay, Myanmar, do not have sufficient background knowledge of English vocabulary and must perform a pre-listening activity prior to the IELTS test. Pre-listening activities improve students' vocabulary knowledge (input) and simplify listening comprehension of IELTS. In addition, pre-listening activities can be used to increase student input and improve listening comprehension. The listening comprehension process provides beneficial intuitions in teaching listening. Students can have difficulty understanding their listening comprehension. This can also provide teachers with an effective opportunity to change their listening strategies. By developing listening comprehension, students will be able to learn languages successfully and reinforce easy-to-understand input. For this reason, this article focuses on improving student listening comprehension.

Additionally, as the IELTS training book is a compulsory English subject course book for IT students in Myanmar in order to develop the four skills such as reading, writing, speaking, and listening, the students are trained and practiced by using effective activities to answer well. This study will give them a lot of benefits concerned with IELTS listening tests. The effects of this paper showed that using pre-listening actions improved their listening understanding.

II. Literature Review

Krashen (1982) pointed out that listening is paramount in language learning. Furthermore, this is a very complex solution activity (Byrnis, 1984), where the listener interacts with the speaker and uses knowledge and background information to build meaning. Learners will become familiar with their listening abilities once they understand the factors that affect their listening skills. This awareness helps those strategies and helps learners improve their listening comprehension. In other words, these strategies are useful to learners because they offer the components needed to improve listening comprehension.

Understanding listening requires a more focused and faster understanding. When listening, you need to pay special attention to many factors. Hedge (2000) pointed out that modern society likes to change from print media to sound and its members. Therefore, the meaning of listening cannot be ignored. He emphasized that listening is very important in an English classroom.

A. Listening Comprehension Problem

According to Vishwanath Bite (2013), listening is not easy and there are many obstacles to effective listening. Listening is not a natural skill. People are not born as good listeners. It was developed through practice and training. Therefore, lack of listening training is an important obstacle. In addition to the obstacles mentioned above, Nobuko Nagata (2004) also

provides reasons to prevent effective listening learning.

- First, the listener has no control over the playback speed. Many English learners believe that the biggest difficulty in listening is that the listener does not understand as fast as the speaker.
- Second, listeners cannot always repeat words. This is a serious problem in the learning environment.
- Third, other people may encounter unknown messages. This can cause others to stop thinking and consequently pass through some of the audio.
- Fourth, there is a newsletter that the hand cannot track the signal that the speaker is moving from one point to another.
- Fifth, the audience may lack contextual knowledge. Sharing knowledge and a common background facilitates communication. Even if the audience can understand the superficial meaning of the text, it can be very difficult to understand the full meaning of a paragraph if they are not familiar with the context.
- Sixth, listeners may find it difficult to focus on the text. Even the shortest attention in listening comprehension can seriously undermine understanding. It's easier to focus if the topic of the listening passage is interesting, but you may get tired of listening lessons because you spend a lot of effort in understanding the meaning even if you are interested.

B. Schematic Knowledge for Listening Comprehension

Listening course teachers remember that it is more important to activate a student's stored knowledge structure (scheme) in order to deepen their understanding and create new graphs than to convey new knowledge of the language system. Must be kept. There are relatively few empirical studies on possible relationships between model building and comprehension of listening comprehension, and helping listeners cope with auditory learning disabilities. Rost (1991) pointed out that listeners have many sources of information, which makes listening easier. In other words, listening comprehension is influenced by personal thinking information. Therefore, knowledge of graphics is clearly useful for understanding listening and requires activation of the associated graphic illustration (Carrel, 1988).

In addition, O'malley and Chamot (1989) pointed out: "Listening comprehension is a positive and conscious process. In this process, the audience constructs meaning by using contextual information and hints of existing knowledge, while relying on multiple strategies to satisfy Mission requirements.

Long (1980) expressed this view in the same view. “Understanding is based on the learner's ability to use existing knowledge. Understanding is a positive process in which individuals focus on selected aspects of auditory input and form meaning from paragraphs. , Correlate audible sounds with existing knowledge, therefore proper text processing is required to activate the schema and promote effective understanding.

Mansor, Noraien (2017) emphasized the need to study how background knowledge affects the second language auditory comprehension.

C. Teachers’ Role on Listening Activities

Teachers have the primary responsibility in the classroom and can create a friendly atmosphere for their students and play a major role. Harmer (1991) and Macháčková (2009) state that teachers have eight major roles:

- Teacher as Organizer: In this role, the teacher must explain what the student wants to do, give clear instructions, and offer useful feedback. Teachers also prepare listening lessons and provide learners with clear guidance.
- The teacher is the administrator. The teacher is in charge of the entire course. The teacher is responsible for deciding what the student will do when to speak, and which language to use. The teacher also decides what the student should do during the listening phase.
- Teacher as an Evaluator: Teachers test students and give feedback on their grades. They should evaluate the level of their students.
- A Teacher as a Resource: In this role, teachers provide students with the settings they need, especially to help them solve unknown problems or problems.
- Teachers as mentors: Teachers act as coaches and resources to help their learners develop ideas. Teachers assist learners at every stage and should help them predict missing information.
- Teacher as an Inspector: Teachers observe course activity and assess learner performance. They appreciate the benefits of listening activities.
- A Teacher as a Prompter Teachers encourage students to suggest learner activities. At each stage of the listening activity, the teacher needs to support the student for success.
- A Teacher as a Participant: Teachers must participate in listening activities and be aware of their role in these activities. They can improve the atmosphere of the classroom. They participate in pre-listening and post-listening activities such as discussions and role-playing.

III. What is IELTS?

IELTS (International English Test System) is popular all over the world, and English as a second language user proves its ability. It helps learners reach educational, professional, or life goals. Academic IELTS is required for admission to universities and colleges, but general training IELTS is used for career and immigration purposes.

The reading and writing part of the test has two different modules, such as academic training and general training, but the listening and speaking tests for the two modules are the same. As part of the IELTS test, listening tests are designed to understand key ideas and certain factual information, track the progress of certain discussions, and improve the speaker's ability to determine perspective, attitude, and purpose. It has been. It consists of four parts, each containing 10 questions. As the test progresses, these questions become increasingly difficult. The first part is the dialogue between the two speakers and the second part is the monologue. The last two sections relate to educational or training environments. The third part is a dialogue of up to four people and the fourth part is soliloquy. Each question has a score, for a total of 40 questions.

IV. Method and Data Collection

In this study, 40 students from the University of Computer Studies (Mandalay) were selected as study participants and divided into two groups (experimental group and control group) of 20 students each. In this study, students had to answer 10 questions. In this paper, both group used the same IELTS test .The listening test which was used in the text was a conversation between a man and woman .Experimental group and control group were divided to reveal which of these groups are more useful for students in improving listening comprehension.

One group received actual auditory input, accepted actual auditory input (experimental group), and another received simplified auditory material (control group).Analysis of the two sets of quantitative data and comparison of the average scores show that the students participating in the pre-listening activity(experimental group) performed better in the listening test than control group .Analyze results and display in the table (1) and (2).The comparison of two scores before and after treatment of the action is analyzed and displayed in table (3)and (4) .

A. Treatment for the Experimental Group

The guidance for this study includes pre-listening activities using a variety of situational awareness activities designed to teach students grammatical perspectives and background knowledge of listening tests that students must answer. These activities are conducted to generate interest, build self-confidence, activate their current knowledge, and thereby promote their understanding.

In addition, after the guidance of the experimental group, several activities took place and the students came to understand the IELTS test. Initially, the teacher's activity in the classroom was to identify keywords that would help students summarize and easily understand their listening tasks. But before that, the teacher talked about the subject of the listening task and asked some questions to stimulate the background knowledge of the students.

Students are then invited to share their knowledge of the topic and infer their meaning from the context. If the student does not make the right guess, the teacher will influence the meaning. If there is a new grammatical structure, we will also explain it. The teacher activities above helped students better answer the IELTS test. Helps you review what you learned in the previous stages, and teachers provide feedback when needed.

B. Treatment for Control Group

In the control group, all the conditions are the same, except in this group, the participants only received lectures and post-listening guidance, and answered the IELTS test with the teacher's explanation without any other skills or emphasis on specific forms.

V. Findings and Discussion

To achieve its goal, the study addressed two main research questions. Research question: Do experimental group used pre-listening activities have an influence? What are the students 'perspective and benefits about pre- listening test.

According to the quantitative data, the students in the experimental group were given pre-listening activities like discussion of the background knowledge to the topic, prediction about the answers and the use of different context-awareness activities before they listened to the test. It was found that their average score was 9.55 in Table 1. The comparison of two scores (before and after treatment) for the experimental group is as shown in Figure 1.

Table 1. **Experimental Group**

Students	Experimental	Mean	Median	Standard Deviation
1	10	9.55	10	0.69
2	10	9.55	10	0.69
3	10	9.55	10	0.69
4	10	9.55	10	0.69
5	10	9.55	10	0.69

6	10	9.55	10	0.69
7	10	9.55	10	0.69
8	10	9.55	10	0.69
9	10	9.55	10	0.69
10	10	9.55	10	0.69
11	10	9.55	10	0.69
12	10	9.55	10	0.69
13	10	9.55	10	0.69
14	9	9.55	10	0.69
15	9	9.55	10	0.69
16	9	9.55	10	0.69
17	9	9.55	10	0.69
18	9	9.55	10	0.69
19	8	9.55	10	0.69
20	8	9.55	10	0.69

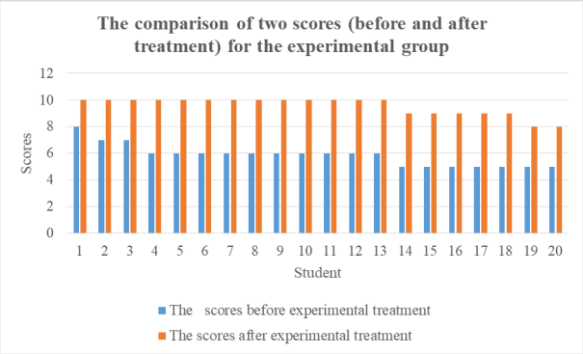

Figure 1. Comparison of Two Scores (before and after treatment) for the Experimental Group

In the control group, the students' average score was 5.8 as shown in Table 2. The comparison of two scores (before and after treatment) for the control group is as shown in Figure 2.

According to the students, pre-listening activities are helpful to guess the answer but also useful to improve their listening comprehension. Based on the research, we found that the students in experimental group can answer well and got benefits. The students agree that using pre- listening activities is very useful for them to enhance their listening skills.

Table 2. Control Group

Students	Control	Mean	Median	Standard Deviation
1	8	5.8	6	1.15
2	7	5.8	6	1.15
3	7	5.8	6	1.15
4	7	5.8	6	1.15
5	7	5.8	6	1.15
6	7	5.8	6	1.15
7	6	5.8	6	1.15
8	6	5.8	6	1.15
9	6	5.8	6	1.15
10	6	5.8	6	1.15
11	6	5.8	6	1.15
12	6	5.8	6	1.15
13	5	5.8	6	1.15
14	5	5.8	6	1.15
15	5	5.8	6	1.15
16	5	5.8	6	1.15
17	5	5.8	6	1.15
18	4	5.8	6	1.15
19	4	5.8	6	1.15
20	4	5.8	6	1.15

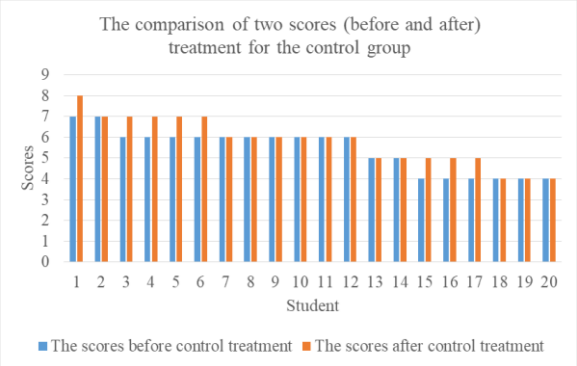

Figure 2. Comparison of Two Scores (before and after treatment) for the Control Group

The comparison of these two groups as shown in Figure 3.

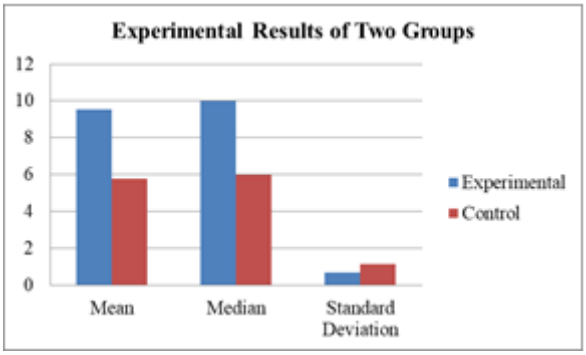

Figure 3. Comparison for Experimental Group and Control Group

Standard deviation is directly related to accuracy. If the data spread is small, then the mean is more accurate. Small standard deviation results in better predictions. In Figure-3, it is seen that standard deviations are low so there is a low possibility of having errors in the statistical predictions.

VI. Conclusion

The purpose of this study is to assist students in adjusting their second language listening brains using pre-listening techniques, thereby improving their listening comprehension of IELTS. Students need to understand the purpose of listening to the message and understand how to establish a connection with the listening phase. Moreover, in real life, it is strange for people to listen to something without having background knowledge of what they are going to speak.

Therefore, the pre-listening activity affects the learner's second language acquisition. Students who received guidance on listening activities performed much better in the IELTS test. This guidance shows that students can be effectively guided to understand new words. The findings of this study support the assertion that pre-listening activities may promote hearing understanding and accelerate achievement.

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Developing the Writing Skill of the Computer Science Students by Using Effective Motivating Strategies

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***Abstract*:** This research paper aims to develop the writing skill of the computer science students by using effective motivating strategies. According to curriculum, computer science students have to learn English language four skills through their academic years. Among them, the most important skill the students need to learn is writing skill as writing helps the students to pass their examination and continue to learn or perform well in their academic and occupational fields. To develop the computer science students' writing skill, appropriate approaches and effective teaching techniques are required. And then, effective motivating strategies are also required as writing receives the least attention and it is a difficult and tiring activity for some students. It includes data analysis of the second year computer science students studying at the University of Computer Studies, Myeik and findings are also pointed out. So, it is hoped that this research paper will be helpful for the English Language teachers who want to develop their students' writing skill.

***Keywords*:** academic, computer science, examination, language, writing

I. Introduction

Writing is a process of using symbols to communicate thoughts and ideas in a readable form. Writing is a way of representing the language in a visual or touching way. Writing skill is the output of listening, speaking and reading, and it is the second manifestation of language.

It is one of the most important skills for learning a new language. It requires proper handling of the script to write the correct sentences and paragraphs.

It is a form of communication that allows students to put their feelings and ideas on paper, to organize their knowledge and beliefs into convincing arguments, and to convey meaning through well–constructed text.

It is an activity which involves the writer in the process of formulating ideas, then testing and confirming them. Writing is such a skill which keeps us active as we communicative with one another and transmit our culture, ideas and thoughts from one generation to another. It provides opportunities to access feelings and thoughts in a positive way.

This research paper is concerned with developing the writing skill of the computer science students by using effective motivating strategies. Therefore, this research paper provides appropriate approaches to teaching writing, techniques for teaching writing and effective teaching strategies for motivating students. Not only that, the importance of motivation and the simple activities used in data analysis are also highlighted in it.

II. The Importance of Motivation

Motivation is essential for most areas of learning because it is essential to success. Without prompting, the learner will fail to make the necessary effort to succeed.On the other hand, due to enough motivation, learners can overcome some difficulties that come out of in their short–term and long–term goals.

Motivation is a key factor for explaining the success or failure of a difficult task. And, it is also the most important factors in determining the level of success that everyone will achieve. It is one of the most important reasons that motivates learners to go forward. It is acquired throughout the entire goal process.

Motivation comes from the mutual effect of both mindfulness and awareness.It provides learners with an aim and direction to follow. Motivation teaches learning to be a purposeful, continuous practice and to achieve a high level of success.

III. Approaches to Teaching Writing

There are various approaches to the teaching of writing. In particular, product approach and process approach are common approaches to writing.

A. Product Approach

The first approach to the teaching of writing which has been known as traditional approach, is product approach.

The product approach to writing usually involves the presentation of a model text, which is analysed and then forms the basis of a task that leads to the writing of an exactly similar or a parallel text.

Robinson (1991) summarises the method in the following way:

Model Text → Comprehension/Analysis/Manipulation → New Input→ Parallel Text

In addition, this approach starts with pre-written activities, primarily by choosing from a perspective. It is viewed as an actual writing and editing.

It is a process of planning or writing. The process continues through the editing process and the final draft. The writing provided by the students is the last and most important piece of work. It is their best work that doesn't require revision.

The feedback and correction made on the texts by the teachers would not make any difference at this stage. Since the focus of this approach is on the final, the coherent, error-free text, it is also known as the product oriented approach.

B. Process Approach

The second approach of teaching writing that has been dominant over the recent years, is a process approach.

The process approach has emphasised the idea of writing as problem-solving, with a focus on thinking and process. It is most closely associated with the work of how to identify the rhetorical problem, plan a solution or series of solutions to the problem and finally reach an appropriate conclusion.

The process stage involves translating the plan into paragraphs and sentences, reviewing the first draft and then revising the text to produce a number of subsequent drafts. In the actual teaching, the skills of editing and review are taught through peer review and group work, and the whole emphasis is on moving students on from over-concern with sentence-level accuracy.

The first stage in the process approach is the thinking stage, which follows the sequence below:

Generate Ideas → Select Ideas → Group the Ideas → Order the Ideas

Robinson (1991) characterises the subsequent writing stages in the following way:

Writing Task→ $Draft_1$ → Feedback→ Revision → Input → $Draft_2$ → Feedback→ Revision → $Draft_3$

In this process, the authors usually edit and edit them from the very beginning until they have finished the final draft. Writers go step by step in an informal way. The text is then re-evaluated under this approach, not as a final and default product, but as part of a complex process.

The traditional approach (product approach) is given response once and the feedback in multiple drafts approaches. The purpose is to build students' confidence and slowly get the best writing. The process approach considers individual authors and readers.

IV. Techniques for Teaching Writing

There are three common techniques for teaching writing. They are controlled writing, guided writing and free-writing.

A. Controlled Writing

Writing is sometimes used as a production mode for learning, reinforcing, or testing grammatical concepts. This intense writing is usually controlled, controlled and organized. These are written exercises. This type of writing does not allow the author's creativity much.

A typical form of controlled writing is to present a paragraph that requires students to change the structure provided. Thus, for example, they may be asked to change past tense verbs into the past. In such a case, students may need to change the other instructions in the text.

Another way of controlling writing is to kill. Here a paragraph is usually read at a regular rate; usually two or three times; then the teacher asks the students to rewrite the paragraph to the best possible way to re-read the reading. In one of the many variations, the teacher reads the text and then puts the key words in the text as markers on the paper for students.

B. Guided Writing

Guided writing is the most effective way to get students into independent writing. It is a teaching strategy that can be used to expand and develop the writing of freelance writing. This includes a teacher who leads a group of students in their efforts to create individualized text; responding to students' efforts; and students' thinking during the process.

Additionally, the author must study what level of writing development is and how writing will be challenged will be extended to the next level of development; it explains how to give specific lessons that will help them achieve their unmatched goals. And it includes ideas on mindfulness and teaching; the whole class, organizing and managing classroom principles for peer groups or teacher-led subgroups.

Guided writing is useful for a variety of teaching situations. It is designed to engage students, audiences, and students as they structure their writing. It allows students to spell, and write. It can encourage students to edit and edit their writing.

C. Free Writing

Freewriting is one of the main purposes of the development of ideas. It attempts to overcome the problem of the author's "blocking". This is sometimes called speedwriting or quickwriting. Its main feature, the speed feature, is to focus on the subject rather than the form.

The main focus is to reduce the idea to as much paper as possible. At a later stage, the quality can be transferred from the quantity to the selection and restructuring process. Freewriting is a follow-up to a brain exploit that can be done as a class or as an individual.

An important aspect of freewriting is that students write without being concerned about spelling, punctuation, or grammar. Of course, this element of writing is important, but students' concerns about them can sometimes restrain the free flow of their ideas. Since free writing helps students get started with student work, it is often used as a starting point to explore student ideas.

V. Effective Teaching Strategies for Motivating Students

In almost every class, there may be students who do not want to stay in class, to follow the class rules or to pay attention when the teacher is teaching. Teacher can face this kind of unmotivated students in their classes. To deal with the unmotivated students, teachers need to create positive learning environment. And, they need to have effective teaching techniques and strategies. And then, teachers need to find out ways of influencing and motivating the students.

A. Be Accessible

Teacher may be an influencing person in the class. Teacher may be enthusiastic the subject he or she is teaching. If teacher is teaching the respective subject with enthusiasms, the students may also be enthusiastic on the subject the teacher is teaching. Teacher needs to be interested in and enthusiastic when she deals with the problematic students or the unmotivated students. When the students feel that teacher takes care of them, they will start to take care, too. Teacher may be an approachable and accessible person for the students. If the teacher is approachable and accessible person, students will come and discuss their difficulties and problems and ask for suggestions from their friendly and respectful teacher. Not only that, teacher may be an ideal person in the class and for the students. If teacher is an idol for most of the students, they may duplicate their teacher's positive behaviours and mannerisms.

B. Be Communicative

The most effective ways of motivating students are praising and rewarding. Teacher needs to give praise to the students for actively participating in the classroom activities or successfully completing their assignments. To communicate well with the students, teacher needs to build a good relationship with the students. If teacher has positive relationship with students, they will actively participate in group discussions about the respective subjects and classroom activities that the teacher asks to do. Teacher needs to give positive feedback or responses on students' writing tasks and other classroom activities. When students feel that the teacher pays attention to them and to their work, they will pay attention and respect to the teacher as well.

C. Be Challenging

To be charming and attractive class, teacher needs to prepare the lessons carefully. As well, teacher also needs to prepare the materials to be fun and exciting. Teacher always needs to find out ways of motivating students to be successful learners. Teacher needs to choose the lessons, classwork and class assignments that are suitable for their students' levels and their capabilities. Teacher needs to use different instructions and directions for different students because students' needs, lacks and wants are different from each other and their concentration and confidence may also differ. When students feel bored or they cannot concentrate on their classwork, teacher needs to grab their attention by stimulating music, art and video or by doing interesting activities. By using effective technology teacher can motivate the students to be active and the class to be alive.

VI. Sample Activities

The activities that show below are the sample activities and they are used for data analysis of the second year computer science students studying at the University of Computer Studies, Myeik. These activities are simple and effective activities for teaching and practising writing skill.

Activity-I

Describe a present you bought which gave someone a lot of pleasure.

You should say:

- what the present was
- who it was for
- why you chose it

and explain why the person who received it was so pleased.

Activity-II

Answer the following questions.

1. Do you like flowers? Which one do you like most?
2. Do you like to have flowers in your home?
   (Why/ Why not?)
3. On what occasions would you give someone flowers? Why?
4. Where would you go to buy flowers? Why?
5. Are flowers important in your culture?
   (Why/ Why not?)

Activity-III
Answer the following questions.
1. Do you enjoy dancing? (Why/ Why not?)
2. Which instrument do you like listening to most? Why?
3. Do you like watching television? (Why/ Why not?)
4. Which television channel do you usually watch? Why?
5. Do you think most programmes on television are good? (Why/ Why not?)

Activity-IV
Answer the following questions.
1. When do people give gifts or presents in your country?
2. When did you last receive a gift? What it was?
3. Which type of gift or present do you want to get and why?
4. Do you enjoy looking for gifts for people? (Why/ Why not?)
5. Do you ever take a gift when you visit someone's home? (Why/ Why not?)

Activity-V
Describe a town you have visited.
You should say:
-where the town is
-why you visited this town
-what you did there
and explain how you feel about visiting this town.

Activity-VI
Describe a beautiful place you have visited in your country. You should say:
-where the place is
-when you visited it
-who you went with
-what you did there
and explain why you think the place is so beautiful.

Activity-VII
Describe someone who you like in your family.
You should say:
-who is he/she
-how the person is related to you
-what this person looks like
-what kind of person he/she is
and explain why you like this person.

Activity-VIII
Describe a party that you particularly remember.
You should say:
-what the party is
- why the party was held
-who attended and what happened
and explain what made it memorable.

Activity-IX
Describe a memorable day in your life in about 150 words.

Activity-X
Describe your favourite house in about 150 words.

VII. Data Analysis

During the three months period of the current academic year, a research study was conducted to the second year computer science class at the University of Computer studies, Myeik. This study was conducted to find out the students' participation and their writing skill developing conditions when developing the students' writing skill by using effective motivating strategies. There are fifty-seven students in the second year computer science class and they all are the target students of this research study. The study was started at (19.12.2019) and ended in (28.2.2020). It was performed as practice teaching and practice writing program and it has been carried out once a week, but, sometimes, twice a week.

Actually, before starting the practice teaching and practice writing program, questionnaires were firstly provided to the computer science students to know the computer science students' views and perceptions on writing skill, their needs and wants, and their weak points and strong points for developing their writing skill. The following table illustrates the result of the students' feedback on the questionnaire.

Table 1. **Students' Feedback on Questionnaire**

No	Question	Yes %	No %
1	Do you think writing is an important skill in your academic and occupational fields?	90%	10%
2	Do you want to improve your English writing skill?	90%	10%
3	Are you interested in doing writing activities?	70%	30%
4	Do you think writing is a difficult and tiring activity?	80%	20%
5	Are you fond of doing writing activities individually?	55%	45%
6	Are you fond of doing writing activities as groupwork?	78%	22%
7	Do you want to do writing practices in class regularly?	73%	27%
8	Do you want to do writing practices as assignment?	45%	55%

The tables below show the results of the students' participation and the students' writing skill developing conditions by performing practice teaching and practice writing program during this study period.

Table 2. **Students' Participation Condition**

No.	Activity	Organisa-tion	Total partici-pants	partici-pants (%)
1	Describing a present	individual	50 sts	88%
2	Answering the short questions	group	50 sts	88%
3	Answering the short questions	group	51 sts	90%
4	Answering the short questions	group	55 sts	97%
5	Describing a town	group	55 sts	97%
6	Describing a beautiful place	group	55 sts	97%
7	Describing someone	group	55 sts	97%
8	Describing a party	group	55 sts	97%
9	Describing a memorable day	individual	55 sts	97%
10	Describing a favoruite house	individual	55 sts	97%

*sts - students

*grps - groups

Table 3. **Students' Writing Skill Developing Condition**

Acti-vity no.	Total Organ isatio n	Given marks	Getting marks (%)			
			9 Ms	8 Ms	7 Ms	6 Ms
1	50 sts	10	-	20%	40%	40%
2	11 grps	10	46%	27%	27%	-
3	14 grps	10	50%	29%	21%	-
4	14 grps	10	71%	29%	-	-
5	18 grps	10	-	39%	33%	28%
6	18 grps	10	-	56%	33%	11%
7	14 grps	10	-	50%	43%	7%
8	14 grps	10	-	64%	36%	-
9	55 sts	10	-	22%	29%	49%
10	55 sts	10	-	26%	49%	25%

*sts - students

*grps - groups

*Ms -marks

VIII. Findings

According to data collection by the questionnaires, it is known that 90% of students want to improve their English writing skill and they accept writing is an important skill in their academic and occupational fields. 78% of students are fond of doing groupwork activities. And, 73% of students want to do writing practices in class regularly. However, only 70% of students are interested in doing writing activities. And then, 80% of students think that writing is a difficult and tiring activity.

According to practice teaching and practice writing program, it is found that the percentage of participants is 88% when doing activity 1 and the percentage is the same as the activity 1 when doing activity 2. However, when doing activity 3, the percentage becomes 90%. Moreover, the percentage of participants also increases 97% when doing activity 4. And then, the percentages of participants constantly remain 97%; especially, when doing activity 5, activity 6, activity 7, activity 8, activity 9 and activity 10.

Not only that, it can be seen that the students' writing skill have been developed by using effective motivating strategies. When doing activity 1, fifty students participated in it. This activity was performed as individual activity. In this activity, 20% of students get 8 marks, 40% of students get 7 marks and 40% of students get 6 marks respectively. Activity 2 was also performed as groupwork activity. There are eleven groups in this activity and 46% of groups get 9 marks, 27% of groups get 8 marks and 27% of groups get 7 marks. Activity 3 is a groupwork activity. When doing activity 3, there are fourteen groups. Among them, 50% of groups get 9 marks, 29% of groups get 8 marks and 21% of groups get 7 marks. The next activity includes fourteen groups and 71% of groups get 9 marks and 29% of groups get 8 marks.

Moreover, it is seen that although the number of participants and groups are the same position in activity 5 and activity 6, their results are different; in activity 5, 39% of groups get 8 marks, 33% of groups get 7 marks and 28% of groups get 6 marks, and in activity 6, 56% of groups get 8 marks, 33% of groups get 7 marks and 11% of groups get 6 marks. And then, in activity 7and activity 8, the numbers of participants are the same as activity 5 and 6, however, in these activities, the

numbers of groups are decreased from 18 groups to 14 groups. So, in activity 7, 50% of groups get 8 marks, 43% of groups get 7 marks and 7% of groups get 6 marks. However, in activity 8, the percentages also increased; 64% of groups get 8 marks and 36% of groups get 7 marks. The final two activities were carried out as individual activities. Although in this two activities the number of participants are the same, it is found that the results are also different; in activity 9, 22% students get 8 marks, 29% of students get 7 marks and 49% of students get 6 marks, and in activity 10, 26% of students get 8marks, 49% of students get 7 marks and 25% of students get 6 marks respectively.

By comparing the results of the students' feedback on the questionnaire and the results of practice teaching and practice writing program after implementing effective motivating strategies, it is also found that before participating in the writing activities implementing effective motivating strategies, the students' interest rate on writing activities is only 70%, however, while participating in the writing activities implementing the effective motiving strategies and guided writing technique, the students' interest and participation rates increase 97%. Although most students think writing is a difficult and tiring activity for them, after participating in the writing activities implementing effective motiving strategies and guided writing technique, they feel excited and they have self-confident for doing other writing activities. Before participating in the writing activities, most students express that they are fond of doing writing activities as groupwork, however, when doing both groupwork activities and individal activities, the students actively participated in both of them. And then, most students say they want to do writing practices in class regularly, however, when sometimes giving them the writing assignment, they do well it.

And then, it is also found that by doing groupwork activities the students broaden their cooperation and negotiation skills, and by doing individual activities the students develop their autonomy and promote the skills of self-reliance and investigation over teacher-dependence.

IX. Suggestions

When developing the writing skill of the computer science students, English Language teachers need to understand the facts: in all areas of language learning, writing requires a great deal of commitment and motivation on the part of the students. If students are uncertain the purposes of writing, they will rapidly become demotivated and unwilling to invest much time and energy in it. And, if they favour a more creative approach, they may well become demotivated if they are asked to perform endless controlled, guided writing tasks. And then, the students will not be impressed if their attempts on writing activities come back covered with red ink.

Besides, the teachers need to follow the facts: teachers should offer guidance in helping students to take part in the creative process of writing, however, must not impose teachers' own thoughts on students' writing. And, instead of appropriating students' texts, teachers should provide useful feedback that respects the students' values and beliefs.

X. Conclusion

This paper aims to develop the computer science students' writing skill by using effective motivating strategies. To develop the computer science students' writing skill, English language teachers need to have appropriate approaches and effective techniques. And, they may also have effective motivating strategies and charming and attractive activities. This paper provides English language teachers appropriate approaches and effective techniques for teaching writing. And then, effective motivating strategies and sample activities are also provided. The activities that describe in this paper are not only useful for data analysis but also effective for teaching and practising the writing skill.

Moreover, this paper proves that by combining effective motivating strategies, the effectiveness of guided writing, and charming and attractive writing activities can develop computer science students' writing skill. Not only that, it is believed that this paper can change the perception in the minds of many students that writing is a difficult and tiring activity.

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ဇော်နောင်၏ နှလုံးသားမာတိကာကဗျာများမှ ဘာသာစကားသွေဖည်မှု

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စာတမ်းအကျဉ်း

ဤစာတမ်းသည် ကဗျာဆရာ ဇော်နောင်၏ "နှလုံးသား မာတိကာ ကဗျာများ" မှ ဘာသာစကား သွေဖည်မှုကို လေ့လာ တင်ပြထားသော စာတမ်း ဖြစ်ပါသည်။ ရည်ရွယ်ချက်မှာ မြန်မာကဗျာများရှိ စာပေ မျက်နှာစာ အတွင်း စာဆို့အခွင့်ထူးဖြင့် ဘာသာစကား ပုံသဏ္ဌာန် အမျိုးမျိုး ဖန်တီး ရေးဖွဲ့ထားပုံတို့ကို ဖော်ထုတ်လိုခြင်း ဖြစ်ပါသည်။ ထိုသို့ ဖော်ထုတ်လေ့လာရာတွင် ဇော်နောင်၏ "နှလုံးသား မာတိကာ ကဗျာများ (၁၉၇၃-၂၀၁၇)" ကို အလေ့လာခံဖြင့် ထား၍ ယင်းကဗျာ အတွင်းရှိ သွေဖည်ခြင်း သဘောတရားများကို ရေးဟန်ပညာ နယ်ပယ်မှ ချဉ်းကပ် လေ့လာသွားပါမည်။ ထို့သို့ လေ့လာရာတွင် စကားသံ၊ စကားလုံး၊ ဝေါဟာရ၊ ဝါကျ၊ အနက်အဓိပ္ပာယ်၊ အရေးပုံသဏ္ဌာန်၊ စာပုဒ်၊ ဒေသိယ၊ အသုံးကွဲ၊ သမိုင်းခေတ် စသည့် သွေဖည်ခြင်းများကို စိစစ် ဖော်ထုတ်သွားပါမည်။ ဤသို့ လေ့လာရသောကြောင့် စာဆို၏ အတွေးအမြင်၊ ခံစားမှု၊ စေတနာနှင့် ရေးဟန်သွင်ပြင် လက္ခဏာ စသည့်တို့ကို သိမြင်နိုင်သော အကျိုးကျေးဇူးများ ရနိုင်မည်ဖြစ်ပါသည်။

သော့ချက်ဝေါဟာရများ - သွေဖည်ခြင်း၊ စကားသံ၊ စကားလုံး၊ ဝါကျ

နိဒါန်း

ခေတ်အဆက်ဆက် အားကောင်းခဲ့သော မြန်မာကဗျာသည် မြန်မာ စာပေလောကတွင် ပုံသဏ္ဌာန် အမျိုးမျိုးဖြင့် ရပ်တည်နေပါသည်။ မြန်မာ ကဗျာဆရာတို့သည် မိမိ ကဗျာကို ကဗျာကောင်း တစ်ပုဒ် ဖြစ်လာစေရန် အားထုတ် ကြိုးပမ်းရာ၌ အသံကို တန်ဆာဆင်ရုံ သာမက အနက် ကိုလည်း တန်ဆာဆင်တတ်ကြပါသည်။ ဤသည်မှာ စာဆို ၏ အခွင့်ထူးပင် ဖြစ်သည်၊ ထို အခွင့်ထူးများကြောင့် ရသမြောက်သော ကဗျာများကို ဖန်တီးရေးဖွဲ့ နိုင်ရန် အတွက် သွေဖည် အသုံးပြုလာကြသည်။ ဤသို့လျှင် သွေဖည်သော အသုံးများသည် တွေ့ရှိးတွေ့စဉ် နှင့် မတူဘဲ ကဗျာ မျက်နှာစာတွင် ထင်းခနဲ ပေါ်လွင်နေပြီး ဆန်းသစ်နေသည် ကို တွေ့မြင်ရပါသည်။ ထို့ကြောင့် ကဗျာ သွေဖည်မှု၏ ပုံသဏ္ဌာန် အမျိုးမျိုးကို ဇော်နောင်၏ နှလုံးသား မာတိကာ ကဗျာများအား အခြေခံ၍ လေ့လာ တင်ပြသွားပါမည်။

၁။ ကဗျာဆရာဇော်နောင်၏ အတ္ထုပ္ပတ္တိ

ကဗျာဆရာ ဇော်နောင်ကို အဘ ဦးလှအောင်၊ အမိ ဒေါ်သန်းရီတို့မှ ၁၉၄၅ ခုနှစ်တွင် ဖွားမြင်ခဲ့သည်။ ၁၉၅၉ ခုနှစ်မှ စတင်၍ ယင်း ကာလထုတ် စာစောင်များ၊ ဂျာနယ်များနှင့် သတင်းစာတို့တွင် ကလောင်သွေးခဲ့သည်။ ၁၉၆၄ ခုနှစ်၌ ကဗျာ စင်မြင့်ပေါ် ရောက်ရှိပြီး မြဝတီ၊ ငွေတာရီ၊ သွေးသောက်တို့တွင် ပါဝင် ရေးသားခဲ့သည်။ ၁၉၇၂ ခုနှစ်တွင် မိုးဝေမဂ္ဂဇင်းမှ စတင်၍ ကဗျာများ ပြန်လည် ရေးသားခဲ့ပါသည်။ The Light of English Magazine တွင် ကဗျာ ယဉ်ကျေးမှု ခေါင်းစဉ်ဖြင့် ကဗျာခံစားမှု ဆောင်းပါးများ လစဉ် ရေးသားခဲ့သည်။ ၂၀၁၃ ခုနှစ် မှ စတင်၍ စံတော်ချိန် သတင်းစာတွင် ကဗျာနှင့် ဆောင်းပါးများ ရေးသားခဲ့သည်။ ယခု လက်ရှိ မြန်မာတိုင်းမ် သတင်းစာတွင် ကဗျာ နှင့် ဆောင်းပါးများ ဆက်လက် ရေးသားလျက်ရှိပါသည်။

၂။ ကဗျာ၏သဘောသဘာဝ

မြန်မာ စာပေလောကတွင် ကဗျာသည် အစောဆုံး ပေါ်ပေါက်ခဲ့သော အနုပညာလက်ရာ တစ်ခု ဖြစ်သည်။ ကဗျာ ဟူသော ဝေါဟာရသည် မြန်မာစကား စစ်စစ် မဟုတ်ပါ။ သက္ကတ ဘာသာစကားဖြစ်သော "**ကာဗျ၊ ကးဗျ**" တို့မှ ဆင်းသက်လာခြင်း ဖြစ်သည် ဟု ပညာရှင်တို့က ဆိုပါသည်။

မင်းသုဝဏ်က - ကဗျာ နှင့်ပတ်သက်၍ -

“ကဗျာဟာ ရေပွက်ပမာ တစ်သက်လျာ ဆိုတဲ့ ပေါ်ပင်စာမျိုး မဟုတ်ဘူး၊ ကဗျာကောင်းလျှင် အသားတက်ပြီး အနှစ်ကောင်းတဲ့ ကျွန်းပင်လိုပဲ။”[၄] ဟူ၍ ကဗျာ၏ သဘောကို ပြဆိုခဲ့သည်။

မြန်မာအဘိဓာန်၌ ကဗျာကို -

“စည်းမျဉ်းများ နှင့်အညီ စာလုံး၊ စာပိုဒ် အရေအတွက် ကာရန် အချိတ်အဆက်၊ အသံနေအသံထား စသည်ဖြင့် စီကုံးဖွဲ့နွဲ့ထားသောအဖွဲ့အနွဲ့” [၅] ဟူ၍ ဖွင့်ဆိုထားပါသည်။

ကဗျာဆရာ မောင်စိမ်းနောင်က -

“ကဗျာကောင်း တစ်ပုဒ်သည် ကြည်နူးမှုမှ ကြာလေကြာလေ အစပြု၍ အသိတရား တစ်ခုမှာ အဆုံးသတ်သည်”[၃] ဟူ၍ ကဗျာ၏ သဘောတရားကို ဖွင့်ဟခဲ့ပါသည်။

ဆရာ ဇော်နောင်က - **“ကဗျာ ဆိုတာ စိတ်ခံစားမှုနဲ့ စိတ်ကူးဉာဏ်ကွန့်မြူးမှုကနေပေါက်ဖွားလာတဲ့အနုပညာပါ။ ကဗျာဟာ ကဗျာဆရာရဲ့ နှလုံးသားမာတိကာတစ်ခုပါပဲ”**[၂] ဟူ၍ ခံစားဖွင့်ဆိုခဲ့ပါသည်။

ထို့ကြောင့် ကဗျာသည် စိတ်ကူးယဉ် သက်သက် မဟုတ်။ လူက ဖန်တီးထားသည့် အတွက် လူနှင့်အတူ ပျော်လိုက်၊ ရွှင်လိုက်၊ မြူးလိုက်၊ တက်ကြွလိုက်၊ ရင်နာလိုက်၊ ကြေကွဲလိုက်နှင့် တစ်သားတည်း ဖြစ်နေသော စိတ်ကူး ပန်း တစ်ပွင့်သာ ဖြစ်ပါသည်။

၃။ ကဗျာသွေဖည်မှု၏ သဘောသဘာဝ

စာပေကို ဖန်တီးရာတွင် ဘာသာစကားသည် စာပေ ဖြစ်စဉ် ကို မြင်သာ ပေါ်လွင်စေသည့် လက္ခဏာ တစ်ခု ဖြစ်သည်။ ကဗျာတစ်ပုဒ်ကို ဖန်တီးရေးဖွဲ့ရာ၌ ကဗျာ တွင် ပါဝင်သော ဘာသာစကား၏ လုပ်ငန်း တာဝန်များသည် စာဖတ်သူအား လတ်ဆတ်သော လှုံ့ဆော်မှု၊ ဆန်းသစ်သော အာရုံခံစားမှုနှင့် အတွေးအမြင် စိတ်ကူးအသိကို ပေးစွမ်းနိုင်စွမ်း ရှိရပါမည်။ ထိုသို့ ပေးစွမ်းရန်အတွက် ကဗျာဖန်တီးသူ တို့သည် ဘာသာ စကားကို အသုံးပြုရာ၌ ပုံမှန်သုံးနေကျ ရေးရိုးရေးစဉ် ဘာသာစကားများကို အသုံးမပြုကြဘဲ၊ ဘာသာစကား၏ စည်းကမ်း စံသတ်မှတ်ချက်များကို မသုံးဘဲ သွေဖည်၍သုံးစွဲလာတတ်သည်။ ထို သွေဖည်သော အသုံးများသည် ပုံမှန် အသုံးများ ထဲမှ ကဗျာ ရှေ့မျက်နှာစာသို့ ထိုးထွက်ပြီး ဘာသာစကား ကို ထင်ရှား ကြွတက်လာအောင် ပြုလုပ်နိုင်စွမ်းရှိသည်။

မြန်မာ အဘိဓာန် အနက်တွင် **“သွေဖည်သည်ကို ရှောင်လွဲသည်၊ ဆန့်ကျင်သည်”**[၅] ဟူ၍ ဖွင့်ဆိုထားပါ သည်။

ရေးဟန်ပညာရှင်ကေတီဝေးလ်စ်က-

“ထင်ရှားပြခြင်းတွင် အဓိကအားဖြင့် သွေဖည်ခြင်းနှင့် ထပ်ကျော့ခြင်း”[၆] နှစ်နည်း ရှိပါသည် ဟူ၍ ဖော်ပြ ထားပါသည်။

ကဗျာ ဖန်တီးသူသည် ကဗျာတစ်ပုဒ် သက်ဝင် ပီပြင် လာအောင် ကဗျာ၏ စည်းမျဉ်း တင်းကျပ်မှုကို ဘာသာ စကား နှင့် လျစ်လျူရှုခွင့်ရှိသည်။ ဤသည်မှာ **“စာဆို အခွင့်ထူး” (Poetic License)** ဟူ၍ ဆိုပါသည်။ ထို့ကြောင့် မိမိ ကဗျာ သစ်လွင် လန်းဆန်းပြီး ထင်းခနဲ ပေါ်လွင်စေရန်၊ ဆိုလိုချင်သော အကြောင်းအချက်ကို ထိမိ စေရန် အတွက် အခွင့်ထူးများကို အသုံးပြုကာ သွေဖည်ရေးဖွဲ့လာခဲ့ကြပါသည်။ ထို အကြောင်းရပ် ကြောင့် ကဗျာတွင် ဘာသာစကား ၏ သွေဖည်ခြင်း သဘောကို လေ့လာနိုင်ပြီး ကဗျာ ဖန်တီးသူ၏ ဘာသာစကား အတတ်ပညာ၊ နှလုံးသားခံစားမှု တို့ကို သိရှိနိုင်မည်ဟု ယုံကြည်ရပါသည်။

၄။ ဇော်နောင်၏ နှလုံးသား မာတိကာကဗျာများမှ ဘာသာစကား သွေဖည်မှု

ဇော်နောင်၏နှလုံးသားမာတိကာ ကဗျာစာအုပ် တွင် ကဗျာ ပုဒ်ရေပေါင်း (၁၅၀) ပါဝင်ပါသည်။ တချို့ ကဗျာများ၌ ကာရန် စံနစ် ဖွဲ့ထုံး စည်းကမ်းများကို တိတိကျကျ လိုက်နာခဲ့သည်။ တချို့ ကဗျာများတွင် ကာရန် စနစ်၊ ဖွဲ့ထုံးစည်းကမ်းတို့ကို သွေဖည်၍ လွတ်လပ်စွာ ဘာသာစကားကို သုံးထားခြင်းများ ရှိသည်။ ထိုသို့ ရေးသား သုံးစွဲထားသော်လည်း ကဗျာ အာနိသင် ယုတ်လျော့မှု မရှိဘဲ စာဖတ်သူအား နှစ်သက်မှု ပေးစွမ်းနိုင်ကြောင်း လေ့လာ တွေ့ရှိရပါသည်။

မောင်ခင်မင်(ခနဖြူ) က ရေးဟန်ပညာနိဒါန်းတွင် -

“စာပေရေးဖွဲ့ရာ၌ အထူးသဖြင့် ကဗျာအရေးအဖွဲ့ တွင် ရှေ့မျက်နှာစာသို့ ထုတ်ပြမှုဆိုင်ရာ နည်းနာ များကို အသုံးပြုလေ့ရှိသည်။ ရှေ့မျက်နှာစာသို့ ထုတ်ပြနည်း နှစ်မျိုးရှိသည်။ တစ်မျိုးမှာ ဘာသာစကား ၏ စည်းကမ်းများ၊ စံများကို သွေဖည်ချိုးဖောက်၍ သုံးသည့်နည်း ဖြစ်သည်။ ထို နည်းနာကို စံသွေခြင်းဟု ခေါ်သည်။ နောက်တစ်မျိုးမှာ လိုအပ်သည်ထက် ပို၍ စည်းကမ်း နှင့်ညီအောင် စံကိုက်အောင် ပုံစံတူများကို

အကြိမ် ထပ်ကာထပ်ကာ သုံးသည့်နည်း ဖြစ်သည်။ ထို နည်းနာများကို ထပ်ကျော့ခြင်း ဟု”[၁]ဖွင့်ဆိုပြခဲ့ပါသည်။

ထို့ကြောင့် ကဗျာဆရာ ဇော်နောင်၏ ကဗျာ အတွင်းသားရှိ ဘာသာစကား သွေဖည်မှု အသုံးများကို ရေးဟန် ပညာ၏ သွေဖည်ခြင်း (၁၀)မျိုးဖြင့် ခွဲခြားခြင်း ချဉ်းကပ် လေ့လာသွားပါမည်။

၄၊ ၁။ စကားသံသွေဖည်ခြင်း

ကဗျာတွင် ပြောသူ၏ စကားသံသည် သူရေးဖွဲ့ထား သော အကြောင်းအရာ အပေါ်၌ ထားရှိသည့် သဘောထားကို ဖော်ညွှန်းနေပေသည်။ “စကားသံ အစိတ်အပိုင်း များတွင် စာဆိုအခွင့် အရ လိုအပ်သလို အသံဖျောက်သုံးခြင်း၊ ထပ်တိုး သုံးခြင်း၊ ကာရန် ကိုက်အောင် သရသံပြောင်းခြင်း၊ စကား တစ်လုံး၏ ရှေ့နောက် ဗျည်းသရသံများ နေရာ လဲလှယ် သုံးခြင်း စသည့် သွေဖည်သုံးသော နည်းနာများ ဖြစ်သည်။”[၁]

ရှေးဦးစွာ အသံဖျောက်၍ သုံးရာ၌ **ကောင်းကင်မိခင်** ကဗျာတွင် - နွေရာသီရောက်၍ ပန်းကလေးများ ရေငတ် နေရကြောင်း ကောင်းကင်မိခင်မှ မိုးရွာပေး၍ ကူညီ ကယ်တင်စေလိုကြောင်းကို - “သင့်ကလေးတွေ အသက် ရှူ(ရှည်)ဖို့၊ မိုးနို့ရေ(ရည်)ချိုချိုအေးကို **ကျွေးပါမဆိုင်း”** (စာ-၁၅) ဟူ၍ ရေးဖွဲ့ထားသည်။ ဤတွင် တိုက်ကျွေး ဟူသော အသုံးမှ အစ စကားသံ **“တိုက်”** ကို ချေဖျောက်ကာ **“ကျွေး”** ဟူ၍ သိမြင်လွယ် သော စကားလုံးဖြင့် စာဆိုအခွင့်ထူး အရ ဖန်တီးဖွဲ့ဆိုထား သည့်အတွက် အဓိပ္ပာယ်ကို လိုရာသို့ ရှင်းရှင်းလင်းလင်း ရောက်စေနိုင်သည်ကို တွေ့ရသည်။

ချိုးကလေးဖွဲ့တဲ့ ကဗျာတွင်- “အများတကာ ဘဝင်လန်းစေဖို့၊ မနားရှာ တမင် မှန်းမှန်းပြီး၊ စကားကဗျာ **အစဉ်ကမ်းရော့သလား”** (စာ-၁၃) ဟူ၍ ကဗျာကို လက်ဆင့်ကမ်း သယ်ဆောင်လာသည့် အဓိပ္ပာယ်ကို ဖော်ကျူး ရာ၌ **“လက်ဆင့်”** ဟူသော အစ စကားသံတွဲကို ဖျောက်၍ **“ကမ်း”** ဟု ရေးဖွဲ့ထားသည်။ ဤတွင် ကာရန်ယူလိုသော အသံနှင့် ကိုက်အောင် အစသံကို ဖျောက်သုံးခြင်းသည် စာဆို၏ ဆန္ဒကို ပြတ်သား ရှင်းလင်းစွာ သိမြင်စေသည်။

ထို့ပြင် “အမည်မဲ့ပန်းများ”ကဗျာတွင် - မြန်မာစာပေ လောကရှိ လှပသော ကဗျာများ၊ သမိုင်းတွင်သော ကဗျာ အချို့ကို ဖန်တီးခဲ့သော အမည်မသိ စာဆိုများ ရှိနေပါကြောင်း၊ ၎င်းတို့ ဖန်တီးခဲ့သော ကဗျာ၏ စွမ်းပကား အာနိသင်သည် စာဖတ်သူ၏ နှလုံးသားဝယ် အမြဲ မမေ့နိုင်ဘဲ ရှိနေပါကြောင်း၊ ထို ကဗျာစာဆို တို့ကို မမေ့နိုင်ဘဲ အမြဲပင် မှန်းဆ၍ လေးစား ဦးညွတ် မိပါကြောင်းကို “သဇင်ခက်ကယ် အစုံ၊ ရွှေလက်ရယ် **ကြာပဒုမ်**နဲ့၊ အာရုံစိတ်ကူး...”(စာ-၁၄၃) ဟူ၍ ဂုဏ်တင် ဖွဲ့ဆို ထားသည်။ ဤတွင် စာဆိုသည် မိမိ ဆိုလိုချင်သော အကြောင်းအရာ ထင်သာစေရန် အတွက် ရှေ့ ပဒရှိ “စုံ” ဟူသော အသံ ကာရန်နှင့် ကိုက်ညီအောင် **“ကြာပဒုမ်”** ဟု သုံးခဲ့သည်။ “ပဒုမ္မာ” ဟူသော စကားလုံးကို **“ပဒုမ်”** ဟူ၍ အဆုံးစကားသံ ဖျောက်ပြီး သွေဖည်သုံးထားခြင်း ဖြစ်ပါသည်။ ထို့ကြောင့် စာဆို ပေးချင်သော အကြောင်း အချင်းအရာ သည် ပို၍ ပေါ်လွင် ထင်ရှား လာပြီး ကဗျာရွတ်ဆိုရာတွင် အသံအရှိန်ကို အားဖြည့်ပေးကာ သာယာပြေပြစ်အောင်လည်းအထောက်ကူပြု နေပါသည်။

၄၊ ၂။ စကားလုံးဖွဲ့ပုံ သွေဖည်ခြင်း

“စကားတစ်လုံးဖြစ်အောင် ထို စကားလုံးထက် ပို၍ သေးငယ်သော အစိတ်အပိုင်းများကို ပေါင်းစပ် ဖွဲ့စည်းရာတွင် သုံးနေကျ ဖွဲ့စည်းပုံကို သွေဖည်ပြီး ဖွဲ့စည်းခြင်း ဖြစ်သည်။ (တစ်နည်း) ကဗျာ၏ ကာရန်အသံတို့နှင့် ကိုက်ညီအောင် စကားလုံး အစိတ် အပိုင်းများကို နေရာပြောင်းခြင်း နှစ်ပိုင်း ခွဲစိတ်၍ မရသော စကားလုံး တစ်လုံးကို နှစ်ပိုင်းခွဲ ပစ်ခြင်းတို့ ဖြစ်သည်။”[၁]

တောင်ပို့ဘုရားကဗျာတွင် - **“ခြပုန်းတောင်ပို့၊ ရွှေ ရွှေပို့၍ မောက်မို့ကြီးထွား”**(စာ-၂၀) ဟူ၍ လည်းကောင်း၊ မေဒေးမုန့်တိုင်း ကဗျာတွင် **“မစာကိုယ်ချင်း၊ ဖိနှိပ်ညှင်းသလား လည်စင်းမခံနိုင်ဘူးဟေ့”** (စာ-၃၀) ဟူ၍ လည်းကောင်း၊ **“မေဒေးမုန့်တိုင်း၊ အရွှေလှိုင်းလျှင်”** ဟူ၍ လည်းကောင်း၊ ခြေတစ်လှမ်းဟာ ကုဋေ တစ်သန်းတန်တယ် ရတုကဗျာ တွင် - **“ရွယ်ရည်ရာ ထိုစခန်းဆီသို့၊ အရောက်လှမ်းမှာ သည်ခြေလှမ်းပါပဲ”** (စာ-၆၁) ဟူ၍ လည်းကောင်း၊ တောင်ပေါ်စခန်းက နောင်တော်ရှမ်း ကဗျာတွင် - **“ကဗျာမြေမှာ သဟာဆွေ တစ်သင်းရယ်နဲ့ ဆရာအနေ ရှင်းကာအပြုံးမပျက်”** (စာ-၁၀၄) ဟူ၍ လည်းကောင်း၊ ညနေဆည်းဆာကဗျာတွင် - **“ဘဝဆည်းဆာ ရှုခင်းသာလော၊ ပမာနေလုံး၊ သူ့အပြုံးဖြင့်”** (စာ-၁၃၁) ဟူ၍ လည်းကောင်း၊ စကားလုံး အစိတ်အပိုင်းများ ကို ရှေ့နောက် နေရာပြောင်း၍ ရေးဖွဲ့ထားပါသည်။ ဤတွင် **“မို့မောက်” “ရည်ရွယ်”** ဟူသော စကားလုံးတို့သည် နှစ်ပိုင်း ခွဲစိတ်၍ မရသော စကားလုံး များဖြစ်သည်။ သို့သော် ကာရန်၊ အသံ တို့နှင့် ကိုက်ညီအောင် **“မောက်မို့၊ ရွယ်ရည်”** ဟူ၍ ခွဲစိတ်၍

မရသော စကားလုံး များကို နှစ်ပိုင်း ခွဲပစ်ခြင်းဖြင့် သွေဖည် သုံးနှုန်းထားပါသည်။

ထို့ပြင် **ကိုယ်ချင်းမစာ** ကို - **မစာကိုယ်ချင်း၊ လှိုင်းအရွှေ့** ကို - **အရွှေ့လှိုင်း၊ ဆွေသဟာ**ကို - **သဟာဆွေ၊ နေလုံးပမာ** ကို - **ပမာနေလုံး"** ဟူ၍ မူလ စကားလုံးတို့ကို ကဗျာ၏ ကာရန်၊ အသုံးတို့နှင့် ကိုက်ညီအောင် စကားလုံး အစိတ်အပိုင်းများကို ရှေ့နောက် နေရာပြောင်း၍ သွေဖည် သုံးထားသည်ကို တွေ့ရသည်။ စာဖတ်သူတို့ မြင်သာ စေရန်နှင့် ဆိုလိုချင်သော အဓိပ္ပာယ်ကို ထင်သာစေရန် ရေးသားနိုင်စွမ်းရှိပါသည်။

၄၊ ၃။ ဝေါဟာရသွေဖည်ခြင်း

"စကားလုံး အသစ်ထွင်ခြင်း၊ စကားလုံး အမျိုးအစား ဝါစင်္ဂပြောင်း ၍ သုံးခြင်းတို့ဖြင့် သုံးနေကျ ဘောင်ကို ချဲ့၍ သုံးနှုန်းခြင်း တို့ကို ဝေါဟာရ သွေဖည်ခြင်း ဟုခေါ်ပါသည်။"[၁] သာဓက - နွေပြန်ချိန် ကဗျာတွင် - လောက ကမ္ဘာမြေ၌ နွေ၊ မိုး၊ ဆောင်း ရာသီ သုံးပါးသည် တစ်လှည့်စီ ကမ္ဘာမြေကို ကောင်းကျိုးများ ဆောင်ရွက် ပေးပြီး နွေရာသီမှာ မိမိ တာဝန် ကုန်ဆုံးသွား၍ ပြန်ရမည် ဖြစ်ကြောင်းကို **"ငမိုးက လည်း ၊ အမှေ့ကို ရေချိုး သန့်စင်ပေးဖို့ရာ၊ ရောက်လာပါပြီ အမေ၊" "မိဆောင်းကိုလည်း၊ ကောင်းစွာမွန်စွာ လိမ်လိမ် မာမာနေဖို့၊ အစ်ကိုကြီး နွေရယ်၊ မှာခဲ့တယ်လို့ ပြောပြလိုက်ပါ အမေရယ်"** ဟူ၍ ဖော်ညွှန်းရေး ဖွဲ့ထားပါသည်။ မိုးရာသီ၊ ဆောင်းရာသီ၊ နွေရာသီ ဟူသော သက်မဲ့ ဝေါဟာရများကို သက်ရှိ အဖြစ် တင်စားပြီး **"ငမိုး၊ မိဆောင်း၊ အစ်ကိုကြီးနွေ"** ဟူ၍ မြန်မာ အမည်နာမည် အဖြစ် တီထွင် သုံးလိုက်ခြင်း ဖြစ်သည်။ ဤတွင် မြန်မာလအစဉသည် တန်ခူး၊ ကဆုန် ဖြစ်သည့်အတွက် နွေသည် အဦးဆုံး ကာလ နှင့် အားကြီးရာ ကြီးမြတ်ရာ သဘောကိုယူ၍ ဆွေမျိုးစပ် ဝေါဟာရ ဖြင့် တင်စားကာ **"အစ်ကိုကြီးနွေ"** ဟု သုံးခြင်းဖြစ်သည်။ မိုးကို ပုဂံခေတ် အမည်ရှေ့တပ်သော **"ငမိုး"** ကို ယူ၍ **"ငမိုး"** ဟု ပြောင်းသုံးခြင်းသည် လည်း ငယ်ရွယ်ခြင်း၊ ရင်းနှီးခြင်းစသည့် သဘော များသက်ဝင် လာပါသည်။ **"ဆောင်း"** ဆိုသည်မှာ နူးညံ့ သိမ်မွေ့ပြီး အေးမြမှု သဘောဆောင်ကာ နှစ်သက်မှု ကို ပေးစွမ်းနိုင်သည့် အတွက် မြန်မာ မိန်းကလေးတို့ကို ခေါ်ဝေါ် သော **"မိ"** ဆိုသည့် အမည်နာမ ဖြင့် တွဲစပ်၍ **"မိဆောင်း"** ဟု တင်စား သုံးခြင်းသည် တစ်မူ ထူးခြားပြီး သုံးရိုးသုံးစဉ် မဟုတ်ဘဲ ဝေါဟာရ သွေဖည်နေပြီး ဆန်းသစ်နေပါသည်။

နန်းကျခြင်းကဗျာတွင် - "စံပယ်မှတဲ့၊ မိန့်မှာခဲ့ငြား၊ **မဖုရားကား၊** စိတ်ထားပြောင်းကာ၊ ရင်မှာချိတ်ဆွဲ" (စာ-၈၅) ဟူ၍ ဖွဲ့ဆိုရာတွင် မိမိချစ်ခင်ရသော သူကို စံပယ် ပန်းလေး ပန်ရန် နှေ့စဉ် ဈေးထဲမှ ဝယ်လာပြီး လက်ဆောင် အဖြစ်ပေးခဲ့သည်။ သို့သော် မိမိတန်ဖိုးထား ရသောသူက ဦးခေါင်းၭ ပန်းမကိုင့်ကို ပန်ဆင်ကာ မိမိပေးသောစံပယ်ပန်း ကိုနေ့တိုင်း လက်ခံရုံမျှသာ လက်ခံခဲ့သည်။ တစ်နေ့တွင် စိတ်ထား ပြောင်းကာ ရင်မှာချိတ်ဆွဲထားသည်ကို တွေ့ရသောအခါ ရင်ထဲတွင် ခံစားရလွန်း၍ နာကျဉ်ခံခက်စွာ နှလုံးသားတွင် မိဖုရားဟု သတ်မှတ် ထားရာမှ **"မဖုရား"** ဟု အမည်နာမ အဖြစ် သုံးနေကျဘောင် ကို ချဲ့၍ ပြောဟန်ဘက် သို့ တိမ်းညွတ်ကာ သွေဖည်လိုက်ခြင်း ဖြစ်သည်။ ထို အသုံး ကြောင့် ပြောသူ၏ ရင်တွင်း ခံစားချက် ထိခိုက်သွားပုံကို ထင်သာမြင်သာစေပါသည်။ ရိုးရိုးနှင့် ထိမိပြီး ဂယက် အနက် ပေါ်လွင်စေသောအသုံးပင်ဖြစ်သည်။ ထို့ကြောင့် စကားသံ၊ စကားလုံး ဝေါဟာရ သွေဖည်ခြင်းတို့သည် စာဆို၏ အခွင့်ထူး ဖြစ်သည့်အတွက် နှစ်သက်သူ၊ မနှစ်သက်သူ ရှိစေကာမူ အသက်ဝင်နေသည်မှာ အမှန်ပင် ဖြစ်ပါသည်။

၄၊ ၄။ ဝါကျဖွဲ့ပုံသွေဖည်ခြင်း

ကဗျာတွင် ဝါကျသည် ရှိစမြဲ။ **"ထိုဝါကျတွင် ဖန်တီးသူက ရေးဖွဲ့ ပုံစည်းကမ်းကို သွေဖည်ကာ ဝါကျထဲက ပုဒ်များကို ထားနေကျ မဟုတ်သော နေရာသို့ ပြောင်းရွှေ့ဖွဲ့ခြင်းမျိုး ဖြစ်သည်။"**[၁] ဟူ၍ ဆိုထားပါသည်။

မြန်မာ ဝါကျဖွဲ့ထုံးတွင် ကြိယာကို အဆုံးမှာထား၍ နာမ်အထူးပြုပုဒ်ကို နာမ်ရှေ့၊ ကြိယာအထူးပြုပုဒ်ကို ကြိယာ ရှေ့က ထားရသည်။ သို့သော် စာဆိုတို့သည် ကာရန်၊ အသံ တို့ကို ငဲ့၍ သွေဖည်ပြီး ပုဒ်များကို နေရာပြောင်းသုံးခြင်းမျိုး ဖြစ်သည်။ သာဓက -

ပန်းသည် ကဗျာတွင် - **"ပန်းရောင်းရင်း အိပ်ပျော်၊ ပလက်ဖောင်းပေါ်က ကလေး နှစ်ယောက်"** (စာ-၂၁) တွင် ဝယ်မယ့်သူကို မျှော်နေသော ပလက်ဖောင်း ပေါ်က ကလေး နှစ်ယောက်သည် ပန်းရောင်းရင်း အိပ်ပျော်နေကြသည် ဟု အဓိပ္ပာယ်ရသည်။ ဤတွင် ကြိယာကို ကတ္တား၏ နောက်မှ ထားသည့် စည်းကမ်း ကို သွေဖည်၍ **အိပ်ပျော်** (ကြိယာ) ကို **ကလေး နှစ်ယောက်**(ကတ္တား) ၏ ရှေ့မှာထားသည် ကို တွေ့ရပါ သည်။

ငြိမ်းချမ်းရေး မော်ကွန်းထိုးကြစို့ ကဗျာတွင် - "ဒုက္ခထောင်သောင်း၊ လူသေအလောင်းနှင့် **ချောင်းဖြစ်မျက်ရေ**" (စာ-၃၆) ဟူ၍ ပြည်တွင်းစစ်များကြောင့် ငြိမ်းချမ်းရေးသည် အလွန် ဝေးကွာနေပြီး အပြစ်မဲ့ ပြည်သူအချို့ လည်း ဒုက္ခရောက်ကာ မျက်ရေချောင်းစီးနေရသည် ဟု အဓိပ္ပာယ်ရပါသည်။ ဤတွင် ကြိယာကို နောက်က ထားရမည့် စည်းကမ်းကို သွေဖည်၍ **ချောင်းဖြစ်** (ကြိယာ) ကို **မျက်ရည်** (ကတ္တား) ၏ ရှေ့မှာ ထားပြီးဖွဲ့ဆိုခဲ့သည်။ စာဆိုသည် စစ်ကို လည်း မုန်းတီးပြီး စစ်ပွဲများကို အနီးကပ် ခံစားနေရသည့် ပြည်သူတို့၏ စိတ်ထဲရှိ ခံစားချက်ကို သူကိုယ်တိုင် ခံစားရဘိ သကဲ့သို့ ရင်ဘတ်အင်္ဂါးပြု၍ ဖွဲ့ပြထားသည်။

ငါချစ်တဲ့ နံနက်ခင်းကဗျာတွင် - "အလှဖုံဖုံ၊ မည်မျှစုံစေ၊ **မခုန်ငဲ့ရင်၊ မမင်ငဲ့စိတ်၊ မဖိတ်သဒ္ဒါ၊** စိတ်မပါချေ" **(စာ-၁၃၉)** ဟူ၍ စာဆိုက နံနက်ခင်း အလှကို လောကသဘာဝ အလှဆုံးဟု သတ်မှတ်ပါကြောင်း၊ "ည" သည် လှပါသည် ဟု အများသူငါ တင်စား ပြောခဲ့လျှင်လည်း ငါ၏ စိတ်သည် "ည" အချိန်ကို မညွတ်နူးခဲ့ပါကြောင်း မနှစ်သက်သော ခံစားမှုကို ဖော်ပြ ထားပါသည်။ ဤတွင် ကြိယာကို ကတ္တား၏ နောက်က ထားရမည့် စည်းကမ်းကို သွေဖည်၍ **မခုန်၊ မမင်၊ မဖိတ်** အငြင်းပြကြိယာများကို **ငဲ့ရင်၊ ငဲ့စိတ်၊ သဒ္ဒါ** စသည့် ကတ္တား များ၏ ရှေ့တွင် ထားရှိသည့်အပြင် ပုဒ်များ ကို ဟန်ချက်ညီ အပြိုင် ဖွဲ့ဆိုထားသည့် အတွက် **"ည" အချိန်** ကာလ အပေါ် ထားရှိသော စာဆိုခံစားမှု မုန်းစိတ်မှာ ပြင်းထန်လှကြောင်းကို တွေ့မြင်ရပါသည်။

၄၊ ၅။ အနက်အဓိပ္ပာယ်သွေဖည်ခြင်း

"လောကထုံးစံ နှင့်အညီ ကောက်ယူရသော အနက် အဓိပ္ပာယ် စနစ်နှင့် မညီညွတ်ဘဲ သွေဖည်သုံးပုံများကို ကဗျာတွင် အများဆုံး တွေ့ရသည်။ ရူပကအလင်္ကာ၊ အတိသယဝုတ္တိ အလင်္ကာ အစရှိသည့် အလင်္ကာ အဖွဲ့များသည် အနက် အဓိပ္ပာယ် သွေဖည်သော အဖွဲ့များ ဖြစ်သည်"[၁] ဟူ၍ ဖွင့်ဆိုထားပါသည်။

ဦချင်းသစ် ကဗျာတွင် - **"လောဘ၊ ဒေါသ မောဟ တွေပွား၊ အတ္တဝတ်ရုံကြီး တဖားဖား" (စာ-၆၆)** ဟူ၍ လောကရှိ လူသားတို့သည် ရလာသော ဘဝအချိန်တိုတို အတွင်း လောဘ၊ ဒေါသ၊ မောဟများက ပရဟိတစိတ်ကို သတ်၍ အတ္တစိတ်ကို ရှင်သန် ဦးစားပေးနေကြပုံ ကို ထင်ရှားအောင် **"အတ္တဝတ်ရုံကြီး"** ဟူသော ရူပက အလင်္ကာ ဖြင့် ဖွဲ့ဆိုပြထားသည်။ အမှန်တကယ် ပြဿနိုင်စွမ်း မရှိသည့် ဒြပ်မဲ့ အတ္တစိတ်ကို ထင်းကနဲ မြင်သာအောင် ဒြပ်ရှိ ဝတ်ရုံကြီး ဖြင့် ခိုင်းနှိုင်း ဖွဲ့ထား သည့်အတွက် အနက် အဓိပ္ပာယ် သွေဖည်နေသည် မှာ ဆန်းသစ်လှပါသည်။

သတ္တဗေဒ အစည်းအဝေးကြီး၏ ကြေညာချက် ကဗျာတွင် - တောတွင်းနေ တောသတ္တဝါ တို့သည် လူသားများ၏ နှိပ်စက် အန္တရာယ်ပေးမှု ကြောင့် ဒုက္ခရောက်ရကြောင်း နှင့် ခြင်္သေ့မင်းကြီး က ခေါင်းဆောင်၍ အစည်းအဝေးခေါ်ကာ လူသားတွေကို ကန့်ကွက် ရွှတ်ချကြောင်း ကို **"ဒီ အစည်းအဝေးကြီးမှာ၊ တက်ရောက်လာတဲ့၊ သတ္တဝါ အားလုံးက၊ လူသားတွေ ရိုင်းပျမှုကို၊ ဒေါသတကြီး ဆွေးနွေးကြတယ်" (စာ-၆၉)** ဟူ၍ ဖွဲ့ဆိုပြခဲ့သည်။ တိရစ္ဆာန်တို့မည်သည် အသိဉာဏ် မရှိသည့်အတွက် လူသားတို့ ကဲ့သို့ မလုပ်ဆောင်နိုင်ပေ။ သို့သော် ကဗျာဆရာက လူသားတို့ ၏ ကမ္ဘာ မြေပေါ်နှင့် သတ္တဝါတို့ အပေါ် ညှင်းပန်း နှိပ်စက်မှုကို တရားသဖြင့် သိလာအောင် လူသား တို့သာ ဆောင်ရွက်တတ်သော အစည်းအဝေး ဆွေးနွေးပွဲကို သတ္တဝါ အားလုံးက အစည်းအဝေး ကျင်းပပြီး ဆွေးနွေးနေပုံ၊ ဒေါသတရားကို နားမလည် သော်လည်း ညာတာစိတ် မရှိသည့် လူသားများကို ခံပြင်းနေပုံ၊ စသည်ဖြင့် ဆန့်ကျင်သွေဖည်၍ အနက်အဓိပ္ပာယ် ကို ပို၍ ထင်ရှားစေခဲ့သည်။

နီမောင့်ကဗျာတွင် - **"နီမောင့်ကဗျာ၊ နီမောင့်စာကို၊ ကဗျာဆန်သည် မော်ဒန်ချစ်တဲ့၊ ခေတ်ပြိုင်ရေးသား၊ ရေးဖော်များလည်း အားကျဖွယ် မရှိ။ ရပ်သံရွာသံ လူထုဆန်တဲ့၊ ဟိတ်ဟန် မရှိ။ ကဗျာချစ်သူ၊ မြတ်ပြည်သူ ကား ဂုဏ်ယူ တွတ်တွတ်၊ အစဉ် ရွှတ်ဖတ်၊ နတ်ပြည်ကပင် ကြားလိမ့်မည်" (စာ-၈၈)** ဟူ၍ စာဆိုက မိမိဖန်တီးထားသော ကဗျာတို့သည် ခေတ်ပြိုင် ကဗျာ ဖြစ်သော်လည်း အားကျစရာ မရှိလှပါ ကြောင်း၊ ရိုးသားသည့် ဟန် သာ ရှိပါကြောင်း၊ မိမိကိုယ်ကို ပထမ နှိမ့်ချ တိုးလျှိုး ပြောဆိုနေရာမှ မိမိ ကဗျာကို ချစ်သော သူ၊ မြင့်မြတ်သော ပြည်သူတို့ကား ဂုဏ်ယူဖွယ် အမြဖတ်ကြား သဖြင့် နတ်ပြည် ကပင် ကြားရ လိမ့်မည်ဟု နောက်ဆုံး ဘဝင်မြင့်ဖွယ် ဂုဏ်ယူ ဝမ်းမြောက်ဖွယ် ကြွေးကြော် သုံးနှုန်းခြင်းသည် အနက် အဓိပ္ပာယ် ရှေ့နောက် ဆန့်ကျင်နေသော သွေဖည်မှု တစ်ခုပင် ဖြစ်ပါသည်။

၄၊ ၆။ အရေးပုံသဏ္ဌာန်သွေဖည်ခြင်း

"စာရေးရာတွင် ရှေးရိုးရာ အစဉ်အလာ အတိုင်း မဟုတ်ဘဲ စာလုံးများကို အကြီးအသေး ရောရေးခြင်း၊ မဖြတ်ရမည့် စကားလုံးများကို ဖြတ်၍ ရေးခြင်း၊ ကဗျာ ရေးရာတွင် အကြောင်း အရာနှင့် ညီညွတ်အောင် ဖန်တီး၍ တြိဂံပုံဖော်ခြင်း။ တစ်လုံး၊ နှစ်လုံး၊ သုံးလုံးစီ တိုးသွားခြင်း။ စကားလုံးများကိုသေးသေးကလေး ရေးပြီး တစ်ချို့ နေရာမှာ အကြီးကြီး ရေးခြင်း။ စသည့် နည်းများသည် အရေး ပုံသဏ္ဌာန် ပုံမှန် မဟုတ်သော သွေဖည်မှုပင်ဖြစ်ပါသည်။"[၁] ဟူ၍ ဆိုထားပါသည်။

အရေးပုံသဏ္ဌာန်သည် စာဆို၏ စိတ်ကူးယဉ် ဖန်တီးမှု တစ်ခုပင်ဖြစ်သည်။ ကဗျာဆရာတို့သည် မိမိတို့ ရေးသားဖန်တီးသော ကဗျာ အတွင်းသား ရှိ စိတ်ပိုင်း ဆိုင်ရာ အသိကို ရုပ်ပိုင်းဆိုင်ရာ အမြင် နှင့် ရောက်အောင် ပို့ဆောင်သည့် အရေးအသား ပုံစံမျိုးပင် ဖြစ်သည်။ သာဓက အားဖြင့် - ချဉ်ဖတ်ကဗျာတွင် -

ချဉ်ဖတ်

ချဉ်ဖတ်

အမြင်ကတ် သပေါ့လေ။

အင်း ... ခံတွင်းပျက်မှ

လာဖွင့်ကြပေါ့

ရပါတယ် ...

ရပါတယ်...။ (စာ-၂၅) ဟူ၍ လောက သဘာဝ တရားအရ လူတို့သည် အစားအသောက်တို့၏ အနံ့ မကောင်းမှုကို မခံစားနိုင်သော်လည်း မြန်မာတို့၏ ရိုးရာ အစားအစာဖြစ်သော ချဉ်ဖတ်ကိုမူ အစားအသောက် ပျက် သည့်အချိန် တို့စရာ အဖြစ် နှစ်သက် မြိန်ယှက်စွာ စားတတ်ကြသည်။ ထို ကဗျာလေး၏ အနက်သည် အနက်ရိုး သာမက စာဖတ်ပရိသတ် ၏ အတွေး ခံစားချက် ပေါ်မူတည်၍ ဂယက် အနက်များ လည်း ရှိနေပါသည်။ ဤ သဘာဝတရားကို မီးမောင်းထိုးပြ ကာ ကဗျာ အရေး ပုံသဏ္ဌာန်တွင် စကားလုံး များကို နှစ်လုံး မှ သုံးလုံး တိုးသွားပြီး အပြော ပုံသဏ္ဌာန်ဖြင့် သွေဖည်၍ ရေးသားထားသည်ကို တွေ့ရသည်။

ထို့ပြင် **"ငလျင်ကို စေ့ငုခြင်း"** ကဗျာတွင် ကမ္ဘာ မြေကြီးပေါ်တွင် နေထိုင်နေကြသော လူသားတို့၏ သစ္စာ တရားပျက်မှုကြောင့် ကမ္ဘာမြေကြီး စိတ်ပျက်နေရပုံကို -

ငလျင်...

ငလျင်...

အရင်တုန်းကလည်း လှုပ်ဖူးသပ၊

ဒါပေမယ့် ဒီလို မကြာခဏမဟုတ်

အခုမှ မကြာခဏ ဘာ့ကြောင့်လှုပ်

ကျွန်ုပ်တွေးကြည့် ...

"ငလျင်လှုပ်" သတဲ့

ဗရုတ်သုက္ခ ကမ္ဘာရွာ

မြေကမ္ဘာ အမြင်ကပ်သလော။ (စာ-၇၁)

ငလျင်တည်းဟူသော အန္တရာယ်ကျရောက်မှု လှုပ်ရှားနေပုံ ကို ကဗျာပုံသဏ္ဌာန်ဖြင့် ရေးဖွဲ့ထားသည့် အတွက် အမြင် အသိမှ ခံစားမှု အသိသို့လည်းကောင်း၊ အနက်အဓိပ္ပာယ် အသိမှရုပ်ပုံသဏ္ဌာန်အသိသို့လည်းကောင်း၊ ရောက်သွား အောင် ငလျင်လှုပ်နေသည့် ပုံစံ၊ မတည်ငြိမ်သော အရေးအသားဖြင့် သွေဖည် ရေးဖွဲ့ထားပါသည်။

၄၊၇။ စာပုဒ်အတွင်းသွေဖည်ခြင်း

"စာတစ်ပိုဒ်အစတွင် နိဒါန်းချီ၍ အဆုံးတွင် နိဂုံးချုပ် ရသည်မှာ ပုံမှန်သဘောပင် ဖြစ်သည်။ ပုံမှန်သဘောတွင် သွေဖည်ကာ စာကို နိဒါန်းဖြင့် မစဘဲ အလယ်က ဖောက် ပြီး စခြင်း၊ နိဂုံးဖြင့် အဆုံးမသတ်ဘဲ တစ်ဝက်ဖြင့်ရပ်ထား ခြင်း တို့သည် စံသွေသော လက္ခဏာများဖြစ်သည်။"[၁] ဟူ၍ ဆိုထားပါသည်။

ထိုကဲ့သို့သော သွေဖည်မှု အရေးအသား ကို မော်ဒန်ကဗျာ၊ ခေတ်ကဗျာ၊ ကာရန်မဲ့ ကဗျာများတွင် အများအားဖြင့် တွေ့ရတတ်သည်။ "မရှိသူ"ကဗျာတွင်-

"မတည်ကတိ မရှိအရှက်။

အရှက် မရှိ၊

မရှိ သိက္ခာ။

သိက္ခာ မရှိ၊

မရှိ တန်ဖိုး။

တန်ဖိုး မရှိ၊

မရှိ အယုံအကြည်။

အယုံအကြည် မရှိ၊ မရှိ ... မရှိ... မရှိ...။ (စာ-၁၈၉)

ဟူ၍ ကဗျာစာပုဒ်ကို အဆုံးမသတ်ဘဲ ရပ်ထားသည်။ ပဲ့တင်ထပ်သည့် ဘာသာစကား အသုံးအနှုန်းနှင့်

ဖွဲ့ဆိုထားသည်။ ရေးရိုးရေးစဉ် ပုံစံကို သွေဖည်ထားခြင်း ဖြစ်သည့်အပြင်၊ ရှေ့စာကြောင်း၏ အဆုံးစကားလုံးကို နောက် စာကြောင်း၏ အစ စကားလုံး အဖြစ် လှေကားထစ် သဏ္ဌာန်ရေးဖွဲ့ထားသည်။ ထို့အပြင် ကဗျာမှာ အဆုံးမသတ်ထားသည့် အတွက် စာဖတ် ပရိသတ်၏ အတွေးအမြင်များကို ဆက်၍ ရှင်သန် စေသော ရေးဟန်အဖွဲ့လည်း ဖြစ်သည်။

အမေကဗျာတွင် - **"နွေအခါ ယပ်တောင်၊ ကတ္တီပါ စောင်ပေါ့ ဆောင်း။ ဝဿန်ခါ မိုးတွေသည်းတော့ ထီးကြီး တစ်ချောင်း။"** (စာ-၁၄) ဟူ၍ ကဗျာကိုနိဒါန်းဖြင့် မစဘဲ အလယ်မှဖောက်ပြီး သွေဖည်၍ ရေးထားခြင်း ဖြစ်သည်။ ထိုကဗျာ၏ အဓိပ္ပာယ်မှာ မိခင်(အမေ)တို့ မည်သည် အနန္တ ဂိုဏ်းဝင် ကျေးဇူးရှင်တစ်ပါး ဖြစ်ရုံမျှမက ပဋိသန္ဓေတည်စမှ ကြီးပြင်းသည်အထိ ဂရုစိုက်ပြုစုခဲ့သူ၊ လမ်းညွှန်ပျိုးထောင် ပေးနိုင်သူ အခက်အခဲများကို ရင်ဆိုင် ဖန်တီးနိုင်စွမ်းရှိသူ၊ ဒုက္ခသုခတို့ကို ရင်စည်းခံသူ၊ နွေးထွေး ကြင်နာဖေးမနိုင်သူ၊ ဖြစ်ကြောင်းကို သွယ်ဝိုက်သော နည်းဖြင့် ဖွဲ့ဆိုထားသည်။ ထိုသို့ ဖွဲ့ဆိုရာတွင် အခက်အခဲကြုံတွေ့မှုများကို မြင်သာသော နွေ၊ မိုး၊ ဆောင်း ဟူသည့် ရာသီသင်္ကေတတို့ဖြင့် လည်းကောင်း၊ ထို အခက်အခဲများကို ရှိသမျှ အင်အားလေးနှင့် အချိန်အခါ မရွေး ဖြေရှင်းပေးနိုင်သည့် မိခင်၏စွမ်းပကားကို**"ယပ်တောင်၊ ကတ္တီပါစောင်၊ ထီး"** စသည်ဖြင့် မြင်သာသော သင်္ကေတများနှင့်ဖန်တီး ရေးဖွဲ့ထားပြီး အစနှင့်အဆုံး မပါဘဲ အလယ်ဖောက်ပြီး စံသွေကာ ရေးဖွဲ့ထားခြင်း ဖြစ်သည်။ ထို့ကြောင့် အနက် အဓိပ္ပာယ်နှင့် ကဗျာ ပုံသဏ္ဌာန်တို့သည် ရိုးဂုဏ်နှင့် ဆန်းသစ်နေသည်ဟု ဆိုချင်ပါ သည်။

၄၊ ၈။ ဒေသိယသုံးသွေဖည်ခြင်း။

"နေရာဒေသ လူမှုအဆင့် အရ ဖြစ်စေ၊ အသံထွက်သဒ္ဒါ၊ ဝေါဟာရအသုံးအနှုန်းတို့ ကွဲပြားသော ဒေသိယစကား များကို စာရေးသူတို့က မိမိတို့၏ ဝတ္ထု၊ ကဗျာစသည့် စာထဲတွင် ယူသုံးလေ့ရှိကြသည်။ စာရေးသူ အရင်းခံအသုံးပြုသည့်စကားသွင်ပြင်နှင့် ထင်ထင်ရှားရှား အသွင်ကွဲသော သွေဖည်မှုမျိုးဖြစ်သည်" [၁]

ကဗျာဆရာတို့သည် ကဗျာကာရန် နှင့်အညီ ချောမွေ့ပြေပြစ်အောင် သတိမမူမိဘဲ တမင် ရည်ရွယ်၍ ဖြစ်စေ တခါတရံ ဒေသအင်္ဂေအသက် ထင်ဟပ်နေသော စကားလုံး များကို အလျဉ်းသင့်သလို ထည့်သွင်းရေးဖွဲ့ တတ်ကြသည်။ "စကားနောက်တရားပါ၏၊ **ဘွာခတ်** သော်လည်း အချည်းနှီး" (စာ-၂၂)၊ "အသားညှပ် **တစ်ယှက်၊** ယိုသုတ်က **တစ်ယှက်၊** အိုဗာတင်းလေး ဖျော်ပါ ကွယ်" (စာ-၄၃)၊ "နှင်တိုင်းမပြေး၊ နောက်ကျန်ဝေးခဲ့၊ **ဖင့်နှေး** စိုးကြောက်" (စာ-၆၃)၊ **"သို့ကလို** တာဝန်ကျေခဲ့သမို့" (စာ-၁၀၅)၊ "ခပ်ပြုံးပြုံး အေးဆေးဆေး၊ အကုန် **လွေး**ပစ်လိုက်ပါရော" **(စာ-၁၄၂)** ဟူ၍ ကျေးလက် ဒေသ လေသံ ပါနေသော လူမှုဒေသိယ အသုံးများ၊ အသွင်ကွဲ စကားများကို အကွက်ကျကျ သုံးနှုန်း ထားပါသည်။ ပုံမှန်အသုံးများနှင့် သွေဖည်နေ သော်လည်း ဒေသိယအသုံးများကြောင့် ပြောသူ၏ ဒေသ အင်္ဂေအသက် လူမှုဝန်းကျင် အင်္ဂေအသက်များ ထင်ဟပ် နေပြီး ထူးခြားနေပါသည်။

၄၊ ၉။ အသုံးကွဲစကားသွေဖည်ခြင်း

ဘာသာစကားတွင် နေရာဌာနအလိုက် အသုံးများ တွင်ကျယ်လျက်ရှိသည်။ အသုံးကွဲစကားနှင့် ပတ်သက်၍ **"စစ်သုံး၊ ဥပဒေသုံး၊ လယ်ယာသုံး၊ ကွန်ပျူတာသုံး စသည်ဖြင့် လုပ်ငန်း အလိုက် ကွဲသော အသုံးကွဲ စကားများ၊ စာသုံး၊ အပြောသုံး၊ လုပ်ငန်းခွင်သုံး၊ ဗန်းစကား အသုံး စသည်ဖြင့် ဆက်သွယ်မှု အလိုက် ကွဲသော အသုံးကွဲစကားများကို စာဆို၊ အခွင့်ထူး အရ တမင်ထည့်သုံးခြင်းဖြင့် စာ၏ အာနိသင်ထက်မြက်အောင် ဖန်တီးလေ့ရှိသည်"** [၁] ဟူ၍ ဖွင့်ဆိုခဲ့သည်။

ကဗျာဆရာတို့သည် ကဗျာကောင်း တစ်ပုဒ် ဖြစ်မြောက် လာစေရန် အားထုတ်ရာ၌ အသံကို သာမက အနက်အဓိပ္ပာယ် ကိုလည်း တန်ဆာဆင်ရန် ကြိုးပမ်းကြ သည်။ ထိုသို့ အနက် တန်ဆာဆင် ရာတွင် မြန်မာစကားကို အစားထိုး၍ မရသည့် အတွက်ကြောင့် ဖြစ်စေ၊ တမင်ရည်ရွယ်၍ ဖြစ်စေ၊ ကာရန်ကိုင့်ရခြင်း၊ အတွက်ဖြစ်စေ၊ အသုံးကွဲ စကားများကို သုံးစွဲလေ့ ရှိတတ်ကြသည်။

ဇူလိုင်ရောက်လျှင် ကဗျာတွင် - **"ဂျူလိုင်ရောက် တိုင်း၊ "တောက်" အလီလီ ခေါက်မိသည်၊ ဖြေဆည် မရ ပါတကား"** (စာ-၁၆)၊ မာတ်ပုံကဗျာတွင်- **"မျက်လုံးဟာ ကင်မရာ၊ အချစ်ဟာ ဖလင်ပြား"** (စာ-၁၈)

ရေခဲတုံးကဗျာတွင် - **"ဘရန်ဒီခွက်ထဲ တချို့ ဝီစကီခွက်ထဲတသိုက်၊ ရှန်ပိန်ခွက်ထဲတစ်ဖွဲ့"** (စာ-၂၆)

အန်ကယ်ဆောင်း ကဗျာတွင် - **"လောင်းကုတ်၊ ဘောင်းဘီရှည် အစုတ်၊ ဦးထုပ် အဟောင်း၊ တုတ်ကောက် ကြီး တစ်ချောင်းနဲ့၊ သြော်... "အန်ကယ်ဆောင်း" ကိုး"** (စာ-၄၅)၊ စသည်ဖြင့် မြန်မာ ဘာသာစကားထဲတွင်

အင်္ဂလိပ် (မွေးစား စကားလုံး) များ ထည့်သွင်း သုံးနှုန်းထားခြင်းသည် ကဗျာ ဆရာ၏ စိတ်အာရုံမှာ အနုအရွအလှအပကို ဦးစားပေး မဖွဲ့ ဖွင့်ဟပြချင်သော စေတနာ အကြောင်းအရာသည် ထင်ရှား ပြတ်သား နေသည့် သဘောဖြစ်ပြီး စာဖတ်သူကိုလည်း ထင်ရှားသိမြင်စေချင်သည့် သဘောပင် ဖြစ်သည်။

တစ်ဖန် သတ္တဗေဒအစည်းအဝေးကြီး၏ ကြေညာ ချက်ကဗျာတွင်- **“အဲ့ဒါကြောင့်.. သတ္တဝါအပေါင်းက သတ္တဗေဒ၊ သမဂ္ဂကနေ၊ မနုဿ လူသားတွေကို၊ ထုတ်ပယ် ကြောင်း ကြေညာ မောင်းခတ် လိုက်သတဲ့၊ ကဲ ကောင်းရော ...ကောင်းရော...” (စာ-၄၀)** ဟူ၍ တိရစ္ဆာန်တို့နှင့် မလိုက်ဖက်သော စာကြီးပေကြီးသုံး စကားများဖြင့် တမင် ထည့်သုံးကာ အသိဉာဏ်ရှိသော လောကလူသား တို့၏ စိတ်ဓာတ် ညံ့ဖျင်း မှုနှင့် ရက်စက်မှုကို အသိဉာဏ်မရှိသော ၊ ကြမ်းတမ်းသော တိရစ္ဆာန်တို့ကပင် ရှုံ့ချပါကြောင်း၊ လှောင်သံ ပြောင်သံ သရော်သံ ပေါ်အောင် ဖွဲ့ထားပါသည်။

သတင်းသမားကဗျာတွင် - **“သတင်းသမား ဆိုတာ အပြင်းစား ဖိုက်တာ” (စာ-၇၈)** ဟူ၍ ကဗျာ အကြောင်းအရာ နှင့် လိုက်ဖက်အောင် **“ဖိုက်တာ”** ဟူသော ခေတ်ကာလသုံး ဗန်းစကားကို တမင် သွေဖည်ပြီး သုံးကာ ကဗျာ ရည်ရွယ်ချက်ကို ထိရောက်အောင် ပို့ဆောင်နိုင်ရန် ကြိုးစားပြန်သည်။ ထို အသုံးအနှုန်းများ ကြောင့် ခေတ်ကာလတွင် မှန်ကန်သော သတင်းသမားတို့၏ ကိုယ်အမူအရာ၊ စိတ်အမူအရာကို မြင်ယောင်လာစေရုံမျှမက ပြောသူ၏ ဂုဏ်ယူသံကိုပါ ကြားယောင်လာစေနိုင်သည့် အသုံးကွဲ သွေဖည်မှုပင် ဖြစ်သည်။

၄၊၁၀။ သမိုင်းခေတ်သွေဖည်ခြင်း

ယခုခေတ် ရေးသော ကဗျာ၊ ဝတ္ထု စသည့် စာပေများတွင် တစ်ခေတ်မှ တစ်ခေတ်သို့ ပြောင်းလဲလာသည့် ဘာသာ စကား၏ သဘာဝကို အာရုံမပြုဘဲ ရှေးသုံးနှင့် ခေတ်သုံးကို အတူတူ ဟု မှတ်ယူ၍ လည်းကောင်း၊ တမင် အသက် ပြန်သွင်းခြင်း မျိုးဖြင့် လည်းကောင်း ခွဲခြားရန် မလွယ်ကူ သော်လည်း ရှင်ပြုံးဖွယ် ဖြစ်အောင် သွေဖည်၍ ရေးသား လာနေကြသည်ကို တွေ့ရပါသည်။

ဇူလိုင် ရောက်လျှင်ကဗျာတွင်- **“ သည် အဖြစ်မျိုး ကြမ္မာညှိုး၊ ရုပ်ဆိုးထုပ္ပတ် အရိုင်းဇာတ်” (စာ-၁၆)။** တောင်ပို့ဘုရားကဗျာတွင် - **“သို့တိုးကား၊ ယိုးမှား လက်အုပ်၊ ပုဆစ်တုတ်ကာ၊ကျွန်ုပ်ဦးညွတ်ရအံ့လော” (စာ၂၀)။** နန်းကျခြင်းကဗျာတွင် - **“သပြာဖိုးထိုက်၊ ပန်းမကိုင်ထိုက်၊ ထိုးစိုက်ပန်ဆင်ခဲ့ပြီကော” (စာ၈၅)။** ဂျမ်းဆရာအတွက် လွမ်းကဗျာတွင် - **“ဩော်... အညာမန်းကနက်၊ တမာတန်း ဘက် ဆီက၊ ကဗျာ အစွမ်းထက်လှတဲ့...(စာ-၉၉)** ဟူ၍ **“ထုပ္ပတ်၊ သို့တိုးကား၊ ယိုးမှား၊ သပြာ၊ မကိုင်ထိုက်”** စသည်ဖြင့် ယခုခေတ်နှင့် အလှမ်းကွာနေသော ရှေးခေတ် စကားလုံး အသုံးနှုန်းများကို သုံး၍ သွေဖည်ရေးဖွဲ့ထား ပါသည်။ ရှေးသုံးစကားများကို ယခုခေတ်တွင် တမင်သုံးကာ အသက်ပြန်သွင်းခြင်းမျိုးလည်း ဖြစ်နိုင်သည်။ မည်သို့ပင်ဖြစ်စေ သမိုင်းခေတ် သွေဖည် ရေးဖွဲ့မှုကြောင့် ကဗျာ အာနိသင်သည် ပို၍ ပုံပေါ်လာရပါသည်။ တနည်း အားဖြင့် ဘာသာစကားကို ကြွတက်လာအောင် ပြုခြင်းပင် ဖြစ်သည်။

ခြုံငုံသုံးသပ်ချက်

ဤစာတမ်းသည် ဇော်နောင်၏ နှလုံးသားခံစားမှု ကဗျာများ ကို ရေးဟန် အနုပညာ နယ်ပယ်ရှိ သွေဖည်ခြင်းသဘောကို အသုံးပြု၍ လေ့လာထားခြင်း ဖြစ်ပါသည်။ စာဆိုသည် လူ့လောကဝန်းကျင်နှင့် ခေတ်ကာလကို အစဉ်လေ့လာ သုံးသပ်နေသူ ဖြစ်သည်။ ထို့ကြောင့် ဆရာဇော်နောင်သည် သူ၏ ကဗျာများတွင် အကြောင်းအရာ အားဖြင့် တရားဓမ္မ အကြောင်း၊ လူ့လောက အကြောင်း၊ ဘဝအကြောင်း၊ နိုင်ငံရေးအကြောင်း၊ လူ့ပတ်ဝန်းကျင် အကြောင်းတို့ကို မြင်သာအောင် သရော်လှောင်ပြောင်၍ လည်းကောင်း၊ အတည်အခံ ဖြင့် လည်းကောင်း၊ ဆုံးမသံ ဖြင့် လည်းကောင်း၊ မျိုးချစ်စိတ် ထက်သန်လာစေရန် လည်းကောင်း၊ နည်းအမျိုးမျိုး၊ ခံစားချက် အမျိုးမျိုးဖြင့် ကဗျာများကို သူ၏ နှလုံးသားတွင်းမှ မွေးဖွားခဲ့သည်။ ထိုသို့ မွေးဖွား အသက်သွင်းလိုက်သော ကဗျာများသည် ရှေးခေတ် စည်းကမ်းတင်းကျပ်သော ကာရန်စံနစ်ကို ဦးစားမပေးဘဲ အတွေးအခြင် ကိုသာ ဦးစားပေးပြီး လွတ်လပ်စွာ ရေးဖွဲ့ထားသည့် ကိုယ်ပိုင်ဟန် ကို တွေ့ရသည်။ ထို့ပြင် အစဉ်အလာ သဒ္ဒါ စည်းမျဉ်းကို မလိုက်နာဘဲ သွေဖည်၍ ရေးသားခြင်းသည် ကဗျာဆရာ၏ အခွင့်ထူးဟုပင် ဆိုရပေမည်။ ထိုသို့ သွေဖည် ရေးဖွဲ့ရာတွင် ဖွဲ့ထုံးစည်းကမ်းဘောင် အတွင်းမှ ကိုယ်ပိုင်ဟန် ဖြင့်ရေးဖွဲ့ထားသည်မှာ ကဗျာ ဖတ်သူတို့၏

ရင်ထဲသို့ ထိထိမိမိ ရောက်ရှိပြီး ကဗျာ အာနိသင် ပိုမိုထူးခြားနေသည် ကို လေ့လာတွေ့ရှိရပါသည်။

နိဂုံး

အချစ်လည်း မဟုတ်အလွမ်းလည်း မဟုတ်သော ဇော်နောင်၏ ကဗျာများသည် အဆွေး သက်သက်လည်း မဟုတ်၊ အသော သက်သက်လည်း မဟုတ်ဘဲ လောက၏ သဘောသဘာဝ တို့ကို နှစ်သက်ဖွယ် သွေဖည်ရေးဖွဲ့မှု ဖြစ်သည်ကို တွေ့ရပါသည်။ ထို့ကြောင့် စာဆို အခွင့်ထူးဖြင့် သွေဖည်မှုဖြစ်ပေါ်လာခြင်း ၏ အကျိုး သက်ရောက်မှုကို လေ့လာ ဖော်ထုတ်ရခြင်းကြောင့် မတူကွဲပြား ခြားနားသော ကဗျာဆရာတို့၏ ဝိသေသ လက္ခဏာများကို တွေ့မြင်နိုင်ပါသည်။

ကျမ်းကိုးစာရင်း

[၁]ခင်မင်၊ မောင်(ဓနုဖြူ)။ (၂၀၁၁)။ ***ရေးဟန်ပညာနိဒါန်း***။ ရန်ကုန်၊ စိတ်ကူးချို့ချို့စာပေ။

[၂]ဇော်နောင်။ (၂၀၁၇)။ ***နှလုံးသားမာတိကာ ကဗျာများ***။ ရန်ကုန်၊ ဇွန်ပွင့်စာအုပ်တိုက်။

[၃]စိမ်းနောင်၊မောင်။ (၂၀၁၃)။ ***လွင်ပြင်ထဲကလမ်းကဗျာများ***။ ရန်ကုန်၊ အင်ကြင်းမြိုင်ပုံနှိပ်တိုက်။

[၄]မင်းသုဝဏ်။(၁၉၉၇)။***ကဗျာပေါင်းချုပ်***။ ရန်ကုန်၊ စာပေလောက။

[၅]မြန်မာစာအဖွဲ့။ ***မြန်မာအဘိဓာန်***။(၁၉၉၀)။ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

[၆]Wales,Katie.(2007). ***A Dictionary of Stylistics.*** 2nd edn . Edinburgh Gale.Person Education Ltd.

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စာတမ်းအကျဉ်း

မြန်မာ စာပေနယ်ပယ်တွင် ဘာသာရပ် နယ်ပယ် အဖြစ် ဘာသာနှင့် စာပေဟူ၍ နှစ်မျိုးရှိရာ ဤစာတမ်းသည် စာပေနယ်ပယ်ကို အခြေခံ၍ လေ့လာ ထားသော စာတမ်း ဖြစ်ပါသည်။ စာပေနယ်ပယ်ရှိ ခေတ် ကဗျာ ကဏ္ဍတွင် ပါဝင်သော ကြည်အေး၏ ကဗျာများမှ **“တစ္ဆေ”** ကဗျာကို လေ့လာထားသော စာတမ်း ဖြစ်ပါသည်။ ရည်ရွယ်ချက်မှာ အကြောင်းအရာ ဆန်းသစ်ပုံကို တင်ပြလိုခြင်း ဖြစ်ပါသည်။ ဤသို့ လေ့လာရာတွင် ကြည်အေး၏ ကဗျာများ (၁၉၉၂) စာအုပ်ကို အလေ့လာခံ အဖြစ် သတ်မှတ်၍ အစဉ်အလာ ကဗျာ လေ့လာနည်းဖြင့် လေ့လာ တင်ပြသွားပါမည်။ ဤ စာတမ်းကို လေ့လာခြင်းဖြင့် ခေတ်သစ်ကဗျာ လေ့လာလိုသူများ အတွက် အထောက်အကူပြုနိုင်မည် ဖြစ်ပါသည်။

သော့ချက်ဝေါဟာရများ - တစ္ဆေ၊ စိတ်ညစ်၊ ရုပ်ရုပ်၊ ငုတ်တုတ်၊ စမ်းလျှောက်

နိဒါန်း

ကဗျာသည် စာပေ၏ အခက်အလက် ဖြစ်၍ ယဉ်ကျေးမှု၏ တစ်စိတ်တစ်ဒေသ ဖြစ်သည်။ ကဗျာ လမ်းကြောင်းသည် သူ့ခေတ် သူ့အခါ သူ့လမ်းကြောင်း နှင့် ရှိလေသည်။ ၂၀-ရာစုခေတ်တွင် ရေးဖွဲ့သော ကဗျာများ တွင် အကြောင်းအရာ ပြောင်းလဲလာသည် ကိုတွေ့ရသည်။ အရေးအဖွဲ့တွင် ကဗျာသည် လွတ်လပ်လာပြီး ကဗျာအဖွဲ့ ဟန်သစ်ကို တီထွင်လာကြသည်။ လေးလုံးစပ် လင်္ကာ၏ ကာရန် စည်းမျဉ်း အတင်းကျပ်ဆုံး ဖြစ်သော သင်္ကေန့်က သုံးချက်ညီ ကို အစဉ်တစိုက် မသုံးဘဲ ကာရန်စည်း လျော့လျော့ ဖြင့် သစ်လွင်သော အကြောင်းအရာ ကို ဆန်းကြယ်သော စိတ်ကူးဖြင့် ဖော်ကြူးသော ကဗျာမျိုးကို ဒဂုန်တာရာ နှင့် ကြည်အေးတို့ စတင်ခဲ့လေသည်။ ဤ စာတမ်းတွင် ကဗျာဟန်သစ်ကို စတင်ခဲ့သော ကြည်အေး၏ “တစ္ဆေ” ကဗျာကို လေ့လာတင်ပြသွားပါမည်။ ထိုသို့ တင်ပြရာတွင် အကြောင်းအရာပိုင်း လေ့လာချက် နှင့် အရေးအဖွဲ့ပိုင်း လေ့လာချက် ဟူ၍ ခွဲခြား လေ့လာသွားပါမည်။

၁။ ကြည်အေး၏အတ္ထုပ္ပတ္တိအကျဉ်း

ကဗျာဆရာမ ကြည်အေးကို ရန်ကုန်မြို့ လှည်းတန်း ရပ် အဖ ကုန်သည်ကြီး ဦးဟန်၊ အမိ ဒေါ်ငွေယုံတို့မှ ၁၉၂၉-ခုနှစ် တွင် ဖွားမြင်ခဲ့သည်။ အမည်ရင်း မှာ ဒေါ်ကြည်ကြည် (သို့) မသောင်းကြည် ဖြစ်သည်။ အသက်(၇) နှစ်အရွယ် က စပ်ဆိုခဲ့သော ကဗျာတစ်ပုဒ် တွင် ကြည်အေး၏ ကဗျာ စွမ်းရည်ကို အံ့ဩဖွယ် တွေ့ရသည်ဟု ဆိုသည်။ ကြည်အေး သည် ငယ်စဉ် ကလေးဘဝမှာပင် သူ့ ပတ်ဝန်းကျင်တွင် တွေ့မြင်ရသော အဖြစ်အပျက် တစ်ခုကို ကာရန်မိစွာ ကဗျာ စပ်ဆိုနိုင်သူ တစ်ဦး ဖြစ်သည်။ အသက်(၉)နှစ် အရွယ်တွင် ပထမတန်း ကို စတင် ပညာသင်ယူ ခဲ့ပါသည်။ တတိယ တန်းတွင် ပညာသင်ယူနေစဉ် ဒုတိယ ကမ္ဘာစစ်ကြီးဖြစ်၍ စစ်ဘေးမှလွတ်ကင်းရာ တောမြို့တောရွာများ၌ ပြေးလွှား ရင်း ကွမ်းခြံကုန်းမြို့သို့ စစ်ပြေးကာ အချိန်ကုန်ခဲ့သည်။ ကွမ်းခြံကုန်းမြို့ကို စစ်ပြေးလာသော စာပေဗိမာန်မှ ဆရာ များက လူငယ်များကို သင်တန်းတစ်ခုပေးရန် စီစဉ်သည်။ ကြည်အေးသည် ဦးဝန်၏ မြန်မာစာ၊ ဆရာတက်တိုး ၏ အင်္ဂလိပ်စာနှင့် သတင်းစာလုပ်ငန်း၊ ဒေါ်မမကြီး ၏ ကမ္ဘာ့သမိုင်း စသော သင်တန်းများကို တက်ရောက် ခဲ့သည်။ ကြည်အေး သည် သတ္တမတန်း ကျောင်းသူဘဝ မှစ၍ ဝတ္ထု၊ ကဗျာများကို ရေးသားခဲ့သည်။ ပထမဦးဆုံး ပုံနှိပ်ဖော်ပြခံ ရသောဝတ္ထုမှာ “ထိုည” ဝတ္ထုဖြစ်ပြီး တာရာ မဂ္ဂဇင်းတွင် ဖော်ပြခဲ့သည်။ ကြည်အေးသည် မက်ထရစ် စာမေးပွဲကို မြန်မာတစ်ပြည်လုံး တွင်အတော်ဆုံး(၁၀)ဦး စာရင်းတွင် ပါဝင်ကာ အောင်မြင်ခဲ့သည်။ ၁၉၄၈-ခုနှစ် တွင် ရန်ကုန် တက္ကသိုလ် သို့ ရောက်ရှိခဲ့သည်။ ဆေးပညာကို ယူခဲ့ရာ တတိယနှစ် တွင် ကျောင်းထွက်ခဲ့သည်။ ဝိဇ္ဇာစာမေးပွဲ ကို ဖြေဆို အောင်မြင်ခဲ့သည်။ ၁၉၅၃-ခုနှစ် တွင် ဘဏ်မန်နေဂျာ ဦးတင်မြနှင့် အိမ်ထောင်ကျခဲ့သည်။ ရန်ကုန်တက္ကသိုလ်၊

အင်္ဂလိပ်စာ ဌာနတွင် နည်းပြ အဖြစ် တာဝန်ထမ်း ဆောင်ခဲ့ဖူးသည်။ အင်္ဂလန်ပြည် ဘီဘီစီ အသံလွှင့်ဌာန တွင်လည်း တာဝန်ထမ်းဆောင်ခဲ့သည်။ ထို့နောက် ဆေးပညာကို ပြည်လည် တက်ရောက် သင်ကြားပြီး ဆရာဝန်ဘွဲ့ရခဲ့သည်။ ဆရာဝန် အဖြစ် အမှုထမ်းရင်း စာပေများကို ရေးသားပြုစုလျက် ရှိသည်။ ၁၉၄၆ မှ ၁၉၅၀ အတွင်း တာရာမဂ္ဂဇင်းတွင် ကဗျာအများဆုံး ရေးသားခဲ့သည်။ ၁၉၇၂ ခုနှစ် ဒီဇင်ဘာတွင် အမေရိကန် ပြည်ထောင်စု သို့ ထွက်ခွာသွားသည်။ မမိုးသူ ကလောင်အမည်ဖြင့် အင်္ဂလိပ်ဘာသာ ဆောင်းပါးများ ရေးခဲ့သည်။ ကြည်အေး၏ ထင်ရှားသော လုံးချင်း ဝတ္ထုများမှာ "ကျွန်မပညာသည်"၊ "နွမ်းလျအိမ်ပြန်"၊ "ဖုန်းထက်တိုင်"၊ "မီ"၊ "တမ်းတတတ်သည်"၊ "ကေဖွဲ့ဆိုသီ"၊ "ကြည်အေး၏ ကဗျာများ"[၂] စသော ကဗျာပေါင်းချုပ် စာအုပ်များ ရေးသား ပြုစုခဲ့သည်။

၂။ ကဗျာဝေါဟာရနှင့်ကဗျာသမိုင်းအကျဉ်း

ကဗျာဟူသော ဝေါဟာရ နှင့်ပတ်သက်၍ မြန်မာ အဘိဓာန် တွင် -

ကဗျာ/ဂဗျာ/န - စည်းမျဉ်းများနှင့်အညီ စာလုံး၊ စာပိုဒ် အရေအတွက်၊ ကာရန် အချိတ်အဆက်၊ အသံ အနေအထား စသည်ဖြင့် စီကုံးထားသော အဖွဲ့အနွဲ့။[၈][သ၊ကာဝျ]

ဟူ၍လည်းကောင်း ၊ ဦးထွန်းမြင့်၏ ပါဠိသက်ဝေါဟာရ အဘိဓာန်တွင်-

ကဗျာ - အကြောင်းအရာတစ်ခုကို သတ်မှတ်ထား ရှိသော စည်းကမ်း နှင့်အညီ ကာရန် ညီညွတ်စွာ စီကုံး နွှန်းဖွဲ့ထား သော စာ။[၇] [ပါ၊ကဗျ]

ဟူ၍လည်းကောင်း၊ ဆရာဇော်ဂျီ၏ ရသစာပေအဖွင့် နှင့် နိဒါန်းစာအုပ်တွင်-

ကဗျာကောင်း မည်သည် နှလုံးသားမှ ယိုစီးလာသော စေတနာ၊ နှလုံးသားမှ စိမ် ဖန်တီးလိုက်သော စိတ်ကူး၊ နှလုံးသားမှ မြည်လာသော အသံတို့ ကိန်းဝပ်ရာ စာမျိုး ဖြစ်သည်။[၃]

ဟူ၍လည်းကောင်း ဖွင့်ဆိုထားပါသည်။ ထို့ကြောင့် ကဗျာ ဟူသည် ပညာရှိတို့ ဖွဲ့စီသီကုံးသောစာ ဖြစ်သည်။ သတ်မှတ် ထားသောစည်းမျဉ်းများနှင့်အညီ ကာရန် ညီညွတ်စွာ သီကုံးထားသော စာပေအဖွဲ့ဖြစ်သည်ဟု ဆိုရပေမည်။

မြန်မာစာပေသမိုင်းကို လေ့လာကြည့်လျှင် အေဒီ ၁၁-ရာစုတွင် မြန်မာနိုင်ငံသို့ ဗုဒ္ဓသာသနာ ရောက်ရှိလာ ခဲ့ရာမှ စတင်ခဲ့သည်ဟု ဆိုရပေမည်။ ထို့ကြောင့် ကဗျာ မျိုးစေ့သည် ပုဂံခေတ်ကျောက်စာများတွင် သန္ဓေတည် ခဲ့သည်ဟု ဆိုရမည်။ "သိုးကလေ"ချီကဗျာ၊ "မြကန်" ကဗျာ၊ "သူတည်းတစ်ယောက်"ချီ မျက်ဖြေ လကာ် စသည့်ကဗျာ များမှာလည်း ပုဂံခေတ်တွင် ပေါ်ပေါက် ခဲ့သော ကဗျာ များဟု ပညာရှင်တို့က ယူဆခဲ့ကြပါသည်။

ပင်းယခေတ်တွင် ကဗျာဘွဲ့နှင့် ကာချင်းကဗျာများ ပေါ်ပေါက်လာသည်။ အင်းဝခေတ်တွင် ဧချင်း၊ မော်ကွန်း၊ တောလား၊ ရတု၊ ပျို့စသည့်ကဗျာအမျိုးအစားများ ပေါ်ထွန်း ခဲ့သည်။

တောင်ငူခေတ်သည် ရတုတံခွန်စိုက်ခဲ့သော ခေတ် ဖြစ်သည်။ ရတုကဗျာများအပြင် ဧချင်း၊ အန်ချင်း စသည့် ကဗျာ အမျိုးအစားများလည်း ပေါ်ပေါက်လာသည်။

ညောင်ရမ်းခေတ်တွင် ဆင်းရဲသားပြည်သူတို့၏ အကြောင်းကို ရေးဖွဲ့ထားသော ဝန်ကြီး ပဒေသရာဇာ၏ တျာချင်း ကဗျာများ ပေါ်ပေါက်ခဲ့သည်။ ထို့ပြင် ကျေးတောနေ မိန်းမပျိုလေးများက မိမိတို့၏ အကြောင်း ချင်းရာများကို သူငယ်ချင်းများထံ ပြန်လည် ပြောပြဟန် ရေးဖွဲ့ထားသည့် အိုင်ချင်းများလည်း ပေါ်ပေါက် လာခဲ့ သည်။

ကုန်းဘောင်ခေတ်တွင်မူ ကဗျာအမျိုးအစား စုံလင်စွာ ပေါ်ပေါက်လာသကဲ့သို့ ကဗျာ စာဆိုတို့သည်လည်း လူတန်းစား အလွှာအသီးသီးမှ ပေါ်ထွက်လာခဲ့သည်။

ပါတော်မူခေတ်တွင် ပေါ်ပေါက်ခဲ့သောကဗျာများမှာ လွတ်လပ်ရေး ဆုံးရှုံးရခြင်း အကြောင်းရင်းနှင့် ပတ်သက်၍ စာဆိုတို့သည် မိမိတို့၏အမြင်များကို တင်ပြရေးဖွဲ့ လာကြ ရာ ဇာတိမာန်ကို လှုံ့ဆော်သည့် ကဗျာများဟု ဆိုရ ပေမည်။

ကိုလိုနီခေတ် နှောင်းပိုင်းတွင်မူ ရှေးမြန်မာကဗျာ အစဉ်အလာများမှ ခွဲထွက်လာသော ခေတ်သစ်ကဗျာဟု ဆိုရမည့် ခေတ်စမ်းကဗျာများ ပေါ်ပေါက်လာသည်။ ထို ကဗျာများသည် ဒီဌဓမ္မလူလောကတွင် တွေ့မြင်ကြုံတွေ့ ရသည့် အကြောင်းအရာများကို စိတ်ကူးဆန်းကြယ်စွာ ရေးဖွဲ့ထားခြင်းဖြစ်သည်။

ထို့ကြောင့် ကဗျာ သမိုင်းကြောင်းကို ကြည့်လျှင် ရှေးအစဉ်အလာ ကဗျာများသည် ဗုဒ္ဓသာသနာနှင့် မြန်မာ့ ထီးနန်း ပတ်ဝန်းကျင်ကို အခြေခံ၍ ထွန်းကားလာ

သက့ဲသို့ ကိုလိုနီခေတ်နှင့် နှောင်းပိုင်းကာလများတွင် ပေါ်ပေါက် လာခဲ့သော ကဗျာများသည် လူထုနှင့် နီးစပ်သော သာမန် အကြောင်းအရာလေးများကို အများ နားလည်လွယ်သော စကားလုံလေးများဖြင့် ရိုးရိုးရှင်းရှင်း ရေးဖွဲ့လာကြသည်ကို တွေ့ရသည်။

၃။ ကြည်အေး၏ "တစ္ဆေ"ကဗျာလေ့လာချက်

စစ်ပြီးခေတ်တွင် မျိုးချစ်စိတ်ဓာတ် ရှင်သန်တက်ကြွ စေသည့် အားမာန်ကို ဖော်ကျူးသော ကဗျာများ ဖွဲ့ဆို နေချိန် တာရာမဂ္ဂဇင်း(၁၉၄၆-၅၀)တွင် "စာပေသစ်" ဟူသော ကြွေးကြော်သံဖြင့် ကဗျာနှင့် ဝတ္ထုတိုများ အစဉ်တစိုက် ရေးသားရာမှ ထင်ရှား လာခဲ့သည့် အမျိုးသမီး စာဆို ကြည်အေးသည် ဆန်းသစ်သော အတွေးအမြင်များ ဖြင့် အချစ်ကဗျာများ ရေးသားခဲ့သည်။ စာပေသစ်ကဏ္ဍကို တစ်ခန်း လှစ်ခဲ့သော တာရာ မဂ္ဂဇင်းတွင် ကြည်အေး၏ကဗျာ များလည်း ပါဝင်ခဲ့သည်။ ကြည်အေးသည် ကဗျာများကို ရေးဖွဲ့ရာတွင် ကဗျာ နည်းစနစ်ထက် ကာရန်အချိတ်အဆက် မိအောင် လွတ်လပ် ကာရန်များကို သူ၏ ပင်ကိုယ်ဟန်ဖြင့် ရေးဖွဲ့ခဲ့သည်။ မိမိတင်ပြလိုသော အကြောင်းအရာ အတွေး ခံစားချက်တို့ကို လွတ်လပ်စွာ တွေးခေါ်ရေးဖွဲ့ရာ တွင်လည်းကောင်း၊ အမျိုးသမီးငယ်တို့၏ မျှော်လင့်ချက်၊ နာကျင်ခံစားမှုများ ၊မွန်းကြပ်မှုများ ကိုလည်းကောင်း ပွင့်လင်းလွတ်လပ်စွာ ရေးဖွဲ့ခဲ့ပါသည်။

၃၊၁။ အကြောင်းအရာပိုင်းလေ့လာချက်

ကြည်အေး၏ ကဗျာများမှ အထင်ရှားဆုံးကဗျာ တစ်ပုဒ် ဖြစ်သော "တစ္ဆေ"ကဗျာသည် ၁၉၄၇-ခုနှစ်ထုတ် တာရာ မဂ္ဂဇင်းတွင် ဖော်ပြခဲ့သော ကဗျာတစ်ပုဒ် ဖြစ်သည်။ ဤကဗျာသည် စိတ်ဝင်စားဖွယ်ကောင်းသော ထူးခြားသော ကဗျာတစ်ပုဒ် ဖြစ်သည်။ မိန်းမပျိုလေး တစ်ဦး၏ ယောက်ယက်ခတ် နေသော ပြင်းထန်လှသည့် စိတ်လှုပ်ရှား ခံစားမှုကို ပေါ်လွင်အောင်ရေးဖွဲ့ထားသည်။ ကဗျာတွင်-

အိပ်လို့မရ၊ ညကြီးမင်းကြီး၊
ထပြီးထိုင်နေ၊ မွေ့ရာတွေလဲ၊
ကြေမွတွန့်လိပ်၊ သိပ်စိတ်ညစ်တယ်၊
သတိပြယ်လွင့်၊ ခိုတွယ်စရာ၊
အတည်မကျ။[၁]

ဟူ၍ ဖွဲ့ဆိုထားပါသည်။ မိန်းမပျိုလေးသည် အိပ်မရ သောကြောင့် ညဉ့်နက်သန်းခေါင်အချိန်တွင် အိပ်ရာမှ ထထိုင်လိုက်ပုံ၊ လူလှိမ့်ထားသော အိပ်ရာမှာ ကြေမွ တွန့်လိပ် နေပုံတို့ကို မြင်ယောင်လာ စေသည်။ ဆောက်တည်ရာ ခိုကိုးရာမရသော မိန်းမပျိုလေး၏ "သိပ်စိတ်ညစ်တယ်" ဟူသော ညည်းသံကို ကြားရ စေသည်။ ညကြီးမင်းကြီး အိပ်မရသဖြင့် အိပ်ရာပေါ်တွင် ထထိုင်နေသော မိန်းမပျို လေး၏ ကိုယ်စိတ်နှစ်ပါးလုံး မတည်မငြိမ် ဖြစ်နေပုံကို ပေါ်လွင်အောင် သရုပ် ဖော်ထားသည်။ မိန်းမသားတစ်ဦး၏ စိတ်ခံစားမှုကို ရဲဝံ့ပွင့်လင်းစွာဖော် ထုတ်ပြခဲ့သည်ဟုဆိုနိုင် ပါသည်။ မိန်းမပျိုလေးတစ်ဦး၏ လွင့်မျောနေသော စိတ်ကို သရုပ်ဖော်နိုင်သည့်အတွက် ယနေ့ခေတ်အရ "မိ"သည်ဟု ဆိုရပေမည်။

မြန်မာ အမျိုးသမီးတို့သဘာဝ မိမိတို့၏ ခံစားမှုကို သူတစ်ပါးသိ၍ အပြစ်ပြောမည်ကို စိုးရိမ်တတ်ကြသော ခေတ်အခါတွင် စာဆို ကြည်အေးက အများသိအောင် ဖွင့်ဟ ပြခဲ့သည်ဟုဆိုရပေမည်။

ထိုသို့ တစ်ယောက်တည်း ဆောက်တည်ရာမရ ဖြစ်နေသော မိန်းမပျိုလေးသည် ပြတင်းပေါက်မှအပြင်သို့ ကဲ၍ လှမ်းကြည့်လိုက်သောအခါ သစ်ရွက်တွေကြားမှ ကြယ်လေး ငါးပွင့်ကို လည်းကောင်း၊ ရေကန်အပါးရှိ စကား ပင်အိုကို လည်းကောင်း၊ စကားပင်အိုကြီးအောက် မြက်ပင် ချုံပင်တွေကြားတွင် တလှုပ်လှုပ်နှင့် စမ်းတဝါးဝါး လျှောက်သွားနေပုံတို့ကို လည်းကောင်း မိမိစိတ်တွင် မြင်ယောင် နေသည်။ ထိုသူကို မြင်နေရသည်မှာ မိမိကိုယ်ပွား တစ္ဆေဟု ထင်ယောင် ထင်မှား ဖြစ်နေပုံကို တွေ့ရသည်။ မိန်းမပျိုလေး က ထိုတစ္ဆေမှာ မိမိကိုယ်တိုင် ဖြစ်နေပုံ၊ 'တစ္ဆေ ငါ ကိုယ်တိုင်ပါပဲ'ဟု ဖွင့်ဟပြခဲ့လေသည်။ ထိုရေရွတ်သံ ကြားရ ပုံကို ကဗျာတွင်-

အပြင်ဘက်မှာ
သစ်ရွက်တွေကြား၊ ကြယ်လေးငါးပွင့်၊
စကားပင်အို၊ ကန်ရေစိုစွတ်၊
ဟိုမှာလှုပ်လှုပ်၊ ငုတ်တုတ်လက်ကမ်း၊
စမ်းလျှောက်သွားနေ၊ မြက်ချုံတွေထဲ၊
တစ္ဆေငါကိုယ်တိုင်ပါပဲ။[၂]

ဟူ၍ ဖွဲ့ဆိုထားသည်။ မိန်းမပျိုလေး တစ်ဦးတည်း အထီးကျန်နေချိန် စိတ်ခြောက်ခြားမှုကို ပေါ်လွင်အောင် သရုပ်ဖော် ရေးဖွဲ့ထားသည်။ ထိုစိတ်ခြောက်ခြားမှုကြောင့် တလှုပ်လှုပ်နှင့် လက်ကမ်းခေါ်နေသူမှာ တစ္ဆေ ဟုထင်မိ ခြင်းဖြစ်လေသည်။ စိတ်လှုပ်ရှား ခံစားမှုကြောင့် မတည်

မငြိမ်ဖြစ်နေမှုကိုလည်း ပွင့်ပွင့်လင်းလင်း ထုတ်ဖော်ရေးဖွဲ့ပြခဲ့လေသည်။

ဤကဗျာသည် တက္ကသိုလ်ကျောင်းသူ မိန်းကလေးတစ်ဦး ဆံပင်ဖရိုဖရဲနှင့် ကြေကွဲသော မျက်နှာဖြင့် ညကြီးမင်းကြီး အပြင်ဘက်သို့ မျှော်ငေးရင်း တွေးချင်ရာတွေးငေးချင်ရာငေးနေပုံကို ပေါ်လွင်လာစေသည်။ ကဗျာစာဆို၏ အတွင်းစိတ်ကို ဖော်ပြနိုင်သော ကဗျာဖြစ်ပေသည်။ **တစ္ဆေ ကဗျာ၌ ကာရန်စည်းအတော်ကြီးလျော့ပြီး ကဗျာ ဟန်သစ် ထွင်စပ်ခဲ့သည်။ ကဗျာစည်း လျော့လွန်း၍ အဖတ်ရ အဆိုရ ထောင်းသော်လည်း အကြောင်းအရာနှင့် အစပ်အဆို ဟန်ချက်ညီသဖြင့် "တစ္ဆေ" ကဗျာနာမည်ကြီးသွားပြီ**[၆] ဟု ဒေါ်မြမြသန်းက "မြန်မာကဗျာသမိုင်း" ဟူသော စာတမ်းတွင် သုံးသပ်ပြထားပါသည်။ ကြည်အေး၏ ကဗျာဟန်သစ်ကို လိုက်ကြသော ကဗျာများသည် ကြည်အေးကို မမီသဖြင့် ဟန်မသစ်နိုင်ဘဲ ကဗျာပုံပျက်သည်ဟု ဆိုပါသည်။

ထို့နောက် မိန်းမပျိုလေး၏ စိတ်လှုပ်ရှားမှုတို့ကို ဆက်တိုက်တွေ့ရသည်။ မိန်းမပျိုလေးသည် ခုတင်ခြေရင်းမှ ဖြည်းဖြည်းချင်း တရှပ်ရှပ် လျှောက်လာသော ခြေသံကို ကြားယောင် လာသည်။ ထို့ကြောင့် မိန်းမပျိုလေးက ဆတ်ခနဲ မတ်တတ် ထရပ်လိုက်သည်။ ခြေသံသည် အခန်းဝရောက်ပြီးမှ ကြားရသလိုလို၊ ဝရန်တာဘက်မှ ကြားရသလိုလိုဖြစ်ကာ တစ္ဆေခြောက်ပြီဟု မှတ်ထင်မိ ပြန်သည်။ တစ္ဆေ အခြောက်ခံရသည်ဟု ထင်ကာ ကြောက် ကြောက်လန့်လန့်နှင့် လှမ်းကြည့်မိသောအခါ သူနှင့် တစ်ပုံစံတည်း တူသောသူကို တည့်တည့်ကြီး မြင်လိုက်ရာမှ အော်ငိုချင်စိတ်ပေါက်လာပြီး တစ္ဆေမှာ မိမိကိုယ်တိုင် ဖြစ်နေပုံကို-

ခုတင်ခြေရင်း
ဖြည်းနင်းရှပ်ရှပ်၊ မတ်တတ်ထလိုက်၊
ခန်းဝကိုလာ၊ ဝရန်တာမှာ၊
သည်မှာတစ်ယောက်၊ တစ္ဆေခြောက်လှန့်၊
ကြောက်ကြောက်နှင့်ကြည့်၊ မျက်နှာလှည့်စမ်း၊
တည့်တည့်လှမ်းမြင်၊ အော်ငိုချင်မိ
တဆင်တည်းပဲသူနှင့်ငါ။[၁]

ဟူ၍ ဖွဲ့ထားပါသည်။ မိမိစိတ်က မိမိကို ပြည်လည် ခြောက်လှန့်နေမှုမှာပို၍ပေါ်လွင်လာစေသည်။ မိန်းမပျိုလေး၏ စိတ်လှုပ်ရှားခံစားမှုကြောင့် ဖြစ်ပေါ်လာ သော ခံစားချက်ကို ပေါ်လွင်အောင် ဆက်တိုက် သရုပ်ဖော်ပြခဲ့သည်။ အချစ် အတွက် စိတ်အားငယ်နေသူ တစ်ဦး၏စိတ်ရှပ်ပုံလွှာ တစ်ချပ် ဟု ဆိုချင်ပါသည်။ ကိုယ်ခွဲစိတ်များ အစိတ်စိတ်ကွဲပြီး "ငါ" များစွာ ဖြာထွက်သွားကာ စိတ်အမျိုးမျိုး ဖြစ်ပေါ်နေပုံကို ရဲရဲဝံ့ဝံ့ တင်ပြလိုက်သော ကဗျာဖြစ်လေသည်။

မိန်းမပျိုလေး၏ ထင်ယောင် ထင်မှားစိတ်ကြောင့် မိမိသည် မြစ်နက်ထဲ ရေနစ်မြုပ်ပြီး တစ်ကိုယ်လုံး ရွံစိကာ ချမ်းနေသူအဖြစ် လည်းကောင်း၊ ထိုသို့ ရေနစ်၍ ချမ်းအေးလွန်း သောကြောင့် နက်ရှိုင်းကျယ်ပြန့်သော ကုက္ကိုကိုင်းကြား တွင်နားနေသူ အဖြစ် လည်းကောင်း၊ ဘုရားရှေ့မှောက်တွင် ကြောက်ရွံတုန်လှုပ်မှုကြောင့် ဒူးထောက် ဆုတောင်းနေသူ အဖြစ်လည်းကောင်း ခံစားနေရသော ခံစားချက် အမှုအရာ အမျိုးမျိုး ဖြစ်နေပုံကိုကဗျာတွင်-

မြစ်နက်ထဲမှာ
ငါရေနစ်မြုပ်၊ ချမ်းပြီးကုပ်နေ၊
ကုက္ကိုကိုင်းကြား၊ ငါနားနေလိုက်၊
ဘုရားရှေ့မှောက်၊ ဒူးထောက်ရောက်ပြန်။[၁]

ဟူ၍ရေးဖွဲ့ထားသည်။ မိန်းမပျိုလေး၏ စိတ်ခံစားချက် အမျိုးမျိုးကြောင့် တုန်လှုပ် ခြောက်ခြား နေမှုကို ပေါ်လွင်စေ သောသရုပ်ဖော်အဖွဲ့ပင် ဖြစ်ပါသည်။ စာဆိုကြည်အေးသည် "ငါ" ကို စူးစမ်း၍ "ငါ" စေရာကို သွားကာ "ငါ" ခံစားရ သည်ကို ရဲရဲဝံ့ဝံ့ ရေးခဲ့ပေသည်။ မှုန်ဝါးဝါး ဝိုးတဝါးညတွင် ကြုံရသော ခြောက်လှန့်အိပ်မက်တစ်ခု ဖြစ်ပေမည်။

ကြည်အေး၏ ကဗျာများကို နှစ်သက်ခဲ့သော မိန်းမပျိုတစ်ဦးက **ကြည်အေးရဲ့ ကဗျာတွေဟာ နုနယ်တယ်၊ ပျိုမျစ်တယ်၊ လတ်ဆတ်တယ်၊ တကယ် ခံစားချက်ကို ဖော်ပြ တဲ့ အသံပါတယ်။ ရဲရင့်တယ်၊ ပွင့်လင်းတယ်၊ တွေးပုံရော ရေးပုံရော လွတ်လပ်တယ်။ ဘယ်သူကဲ့ရဲ့ ကဲ့ရဲ့ ဂရုမစိုက်ဘဲ လွတ်လွတ်လပ်လပ် လှုပ်ရှားတတ်တဲ့ လူငယ်တွေရဲ့ စရိုက်နဲ့ လိုက်လျောညီထွေ ရှိတယ်။ တစ်နည်းပြောရရင် ကြည်အေးဟာ သူခေတ်ရဲ့ ပေါ့(ပ်) ကဗျာဆရာမပါပဲ။**[၅] ဟု လေ့လာသုံးသပ်ပြ ထားပါ သည်။

ထို့ပြင် မိန်းမပျိုလေး၏ စိတ်သည် ကြောက်ရွံစိတ်ကြောင့် အားကိုးရာ အဖြစ် ချစ်သူမောင်ကို တမ်းတမိခဲ့ ဟန်တူပါသည်။ ထို့ကြောင့် ချစ်သူထံပါးသို့ မိမိစိတ်က လွှင့်မျောရောက်ရှိသွားကာ ချစ်သူမောင်ကို စကားပြောနေ မိပြန် သည်။ မိမိပြောသော စကားကို

ချစ်သူကမကြား သလို မသိကျိုးကျွန် ပြုလေသောအခါ ချစ်သူထံပါးသွား၍ ငိုသံပါနှင့်မိမိကို 'သတိမရဘူးလား၊ အိပ်မက်မမက် ဘူးလား' ဟုမေးမြန်းမိသည်အထိ အတွေးစိတ်တွင် အမျိုးမျိုး မှတ်ထင် ခံစားနေမိလေသည်။ ထိုအတွေး ခံစာမှုကို-

ထလာလွင့်ပါး၊ မောင့်အနားကို၊
စကားထွေရာ၊ ငိုသံပါနှင့်
ဘာမှမကြား၊ မောင့်အနားမှာ
"ထသွားစို့ဆို၊ မေ့ကိုအိပ်မက်
မမက်ဘူးလား"၊တစ္ဆေဖြားယောင်း၊
မှုန်မှားစိတ်ဝယ် အရိပ်ထင်။[၅]

ဟူ၍ သရုပ်ဖော်ရေးဖွဲ့ထားပါသည်။ စိတ်လှုပ်ရှား ခံစား နေရ မှုများကြောင့် ထင်မိထင်ရာ တွေးမိတွေးရာမှ တစ္ဆေဟု ထင်နေသော်လည်း ထိုတစ္ဆေသည် မိမိသာဖြစ်ကြောင်း ခံစားမှု အမူအရာကို သရုပ် ဖော်ပြခဲ့သည်။ ဤကဗျာပါ မိန်းမပျိုလေး ၏ စိတ်အစဉ်ကိုလေ့လာသုံးသပ် ရင်း အတွေး ဂယက်များ အကျယ်အပြန့် ရိုက်ခတ်လာသည်။ ထိုခေတ် အခါက မိန်းမပျိုလေးများ၏ ခံစားချက်ကို စာဆိုကြည်အေး က ကိုယ်စားခံစား၍ ဖွင့်ဟပြခဲ့သည်ဟု ဆိုနိုင်ပါသည်။ ထို့ကြောင့် ဤကဗျာတွင် စာဆိုက သာမန် မိန်းကလေးများ မတွေးရဲ မရေးရဲသော အကြောင်း အရာများကို နှေစဉ်သုံး စကားလေးများ၊ အပြော စကားလေးများဖြင့် မိန်းကလေး တစ်ဦး၏ ယောက်ယက်ခတ် နေသော စိတ်လှုပ်ရှား မှုကို ပေါ်လွင် အောင်ရေးဖွဲ့နိုင်သော ကဗျာတစ်ပုဒ် ဖြစ်ပါသည် ဟုဆိုနိုင်ပါသည်။ ကြည်အေး၏ ကဗျာ များတွင် အတွေး ဆန်းကြယ်စွာ ရေးဖွဲ့ထားမှုနှင့် ပတ်သက်၍ ဒဂုန် တာရာက "နိုင်ငံရေးနှင့်ကဗျာ" ဆောင်းပါးတွင်-

ကြည်အေးသည် ကာရန်ညီသော ကဗျာထက် အတွေးဆန်းသော ကဗျာကိုရေးသည်။ သူမ၏ ကဗျာ စိတ်ကူးများမှာ ရုပ်လုံးပေါ်၍ စိတ်လှုပ်ရှားမှုကို တိုက်ရိုက် ထိခိုက်ကြသည်။ အများအားဖြင့် အချစ်ကဗျာများ ဖြစ်ကြ သည်[၆] ဟု သုံးသပ်ထားပါသည်။ ဆရာဒဂုန်တာရာ သုံးသပ် သကဲ့သို့ ဆရာမ ကြည်အေးသည် ထိုခေတ် အခါက သာမန် မိန်းကလေးတစ်ယောက် ဖွင့်မပြောရဲ ချမရေးရဲသော မိန်းမသားတို့၏ ခံစားချက် စိတ်ခံစားမှုကို ကိုယ်စား ရေးဖွဲ့ပြခဲ့သည်။ 'တစ္ဆေ' ကဗျာသည် စာဆိုကြည်အေး၏ သင်္ကေတ တစ်ခု ဖြစ်လာကာ နာမည်ကြီး ဂယက်ထ သွားခြင်းဖြစ်ပေမည် ဟုယူဆမိ ပါသည်။

၃၊၂။ အရေးအဖွဲ့ပိုင်းလေ့လာချက်

ခေတ်သစ်ကဗျာဆရာများသည်အတွေးစိတ်ကူးနှင့် စကားသုံး များ၏ တန်ဖိုးကို ဦးစား မပေးလိုသောကြောင့် သုံးချက်ညီ ကာရန် စနစ်ကို လျှော့ချ ခဲ့သည်။ ထိုသူများတွင် ကဗျာစာဆို ကြည်အေးလည်း ပါဝင် လေသည်။ စာဆို ကြည်အေးသည် ကဗျာများကို ရေးဖွဲ့ရာတွင် ကဗျာနည်း စနစ်ထက် ကာရန် အချိတ် အဆက်မိအောင် လွတ်လပ် ကာရန်ပုံစံ၊ သူမ၏ ပင်ကို ဟန်ဖြင့် ရေးဖွဲ့ခဲ့သည်။

"တစ္ဆေ"ကဗျာတွင် မိန်းမပျိုလေးတစ်ဦး အိပ်ရာထဲ တွင် အိပ်မရဘဲ စိတ်မတည်မငြိမ်ဖြစ်နေပုံကို "လိပ်၊ သိပ်၊ စိတ်" ဟူသော သံလတ်များကို သုံးကာရေးဖွဲ့ထားသည်။ "သိပ်စိတ်ညစ်တယ်" ဟူ၍လည်း ညည်းညူသံပါသော အပြောစကားဖြင့် မိန်းမပျိုလေး၏ စိတ်ခံစားမှုကို ပေါ်လွင် အောင်ရေးဖွဲ့ပြထားသည်။ မိန်းမပျိုလေး အပြင်သို့ လှမ်း ကြည့် လိုက်ပုံကိုဖွဲ့ ဆိုထားရာတွင်လည်း "လှုပ်လှုပ်၊ ငုတ်တုတ်၊ စမ်းလျှောက်သွား"ဟူသော အဖွဲ့အရ နှေစဉ်သုံး စကားဖြင့် လှုပ်ရှားမှုကို မြင်သာ စေသည့်အပြင် စိတ်ချောက်ချား နေမှုကိုလည်း မြင်ယောင် လာစေသည်။ "တစ္ဆေ ငါကိုယ်တိုင်ပါပဲ" ဟူသောအဖွဲ့အရ ထင်ယောင် ထင်မှား ဖြစ်နေသည့် စိတ်ခံစားမှုကို တကယ်မြင်တွေ့ နေရသကဲ့သို့ ခံစားရစေသည်။

မိန်းမပျိုလေး အခန်းတွင်း၌ စိတ်ချောက်ချား နေမှုကို ဖွဲ့ဆိုရာတွင်လည်း "မတ်တတ်ထလိုက်"၊ "ကြောက် ကြောက်နှင့်ကြည့်"၊ "မျက်နှာလှည့်စမ်း"၊ "တည့်တည့် လှမ်းမြင်" စသည်ဖြင့် ရိုးရှင်းသော အမူအရာပြစကား များဖြင့် သရုပ်ဖော်ပြခဲ့သည်။ ခြေသံကို ကြားယောင်လာ အောင် "ရှပ်ရှပ်" ဟူသော ရိုးရှင်းသောအသံ စကားလုံးဖြင့် သရုပ်ဖော်ထားရာ ခြေသံကို ကြားယောင် လာစေသည်။ ခြောက်လှန့်နေသူမှာ မိမိကိုယ်တိုင် ဖြစ်ကြောင်း "တဆင် တည်းပဲသူနှင့်ငါ" ဟူသော အသုံးကြောင့် ပို၍ထင်ရှားစေပါ သည်။ ကဗျာတွင် "မောင့်အနားကို"၊ "မောင့်အနားမှာ" ဟူသော စကားလုံး ကို ထပ်ကာထပ်ကာ သုံးထားခြင်းဖြင့် မိန်းမပျိုလေး၏ ချစ်သူအပေါ် အားကိုးမှုကို ပေါ်လွင် စေသည်။ "မေ့ကိုအိပ်မက်မမက်ဘူးလား" ဟူသော အပြော စကားလေးသည် မိန်းမပျိုလေး၏ သနားစဖွယ် မေးမြန်း

နေဟန်ကို ပေါ်လွင်လာစေသည်။ စာဆိုကြည်အေး ၏ “တစ္ဆေ” ကဗျာသည် အစဉ်အလာ ကဗျာလမ်းကြောင်းမှ ခွဲထွက်၍ ရေးဖွဲ့ထားမှုကြောင့်လည်းကောင်း၊ တင်ပြပုံ ဆန်းသစ်မှုကြောင့် လည်းကောင်း ထိုခေတ်အခါက စာဖတ် သူတို့ကို ဆွဲဆောင်နိုင်ခဲ့သော ကဗျာ တစ်ပုဒ် ဖြစ်ခဲ့သည်။ ထိုခေတ်က ကြည်အေး၏ စာပေများကို ဝေဖန်ပြစ်တင်မှု များလည်း ရှိခဲ့သည်ဟု ကြားသိခဲ့ ရသည်။ စာဆို ကိုယ်တိုင် ကလည်း မိမိ၏ ကဗျာများ၌ လေးလုံးစပ် သုံးချက်ညီ ကာရန်စည်းကို လျှော့ချရခြင်း နှင့်ပတ်သက်၍-

> **လေးလုံးစပ်ဆိုသည့်အတိုင်း**
> **ကိုယ်ပြောချင်တာကို စာလေးလုံး တစ်တွဲတွဲပြီး ပြောရရုံမျှ ကာရန် ကလည်း စည်းကမ်း အကြီးချင်သား**[၁]

ဟူ၍လည်းကောင်း၊ **အိပ်ငိုက် နေသူကို လှုပ်ရမ်း လိုက်သလို ကာရန်ကစားချင် စိတ်လည်း ရှိတော့ ကျွန်မ ကြိုက်သလိုပဲ ရေးခဲ့တာ သိကြတဲ့ အတိုင်းပဲ။**[၁]

ဟူ၍လည်းကောင်း ဖွင့်ဟရှင်းလင်းပြခဲ့သည်။ ထိုသို့ ရှင်းပြခဲ့ သည့်အတိုင်း ကြည်အေး၏ ကဗျာများသည် သုံးချက်ညီ ကာရန်စည်းလျော့မှုများရှိသည်ကို တွေ့ရ သည်။မည်သို့ပင် ဆိုစေကာမူ ကြည်အေး၏ ကဗျာ များသည် ခေတ်ပေါ်ကဗျာ များ၏ရှေ့ပြေးဖြစ်သည်ဟု ဆိုပါကဆိုနိုင်သည်ဟု ထင်မြင် မိပါသည်။

ခြုံငုံသုံးသပ်ချက်

ဤစာတမ်းသည် ကဗျာဆရာမ ကြည်အေး၏ “တစ္ဆေ” ကဗျာကို လေ့လာတင်ပြထားခြင်း ဖြစ်ပါသည်။ ဤကဗျာ သည် အတွေးဆန်းကြယ်သော အထင်ရှားဆုံး ကဗျာ တစ်ပုဒ် ဖြစ်ပါသည်။ သာမန်မိန်းကလေးများ မတွေးရဲ မရေးရဲသော အကြောင်းအရာကို ပေါ်လွင်အောင် ရေးဖွဲ့ ထားသော ကဗျာတစ်ပုဒ်ဖြစ်သည်။ စိတ်တွင်းရှိ မှတ်ထင် လှုပ်ရှားမှုကို ပေါ်လွင်အောင် အမိအရ ဖွဲ့ဆိုထားသည်။ ဖြတ်ကနဲ ဖြတ်ကနဲ မတည်မငြိမ် ပြောင်းလဲ လှုပ်ရှားနေ သော စိတ်ခံစားချက် ပေါ်လွင်အောင် ကာရန်သစ် ယူထား၍ စကာလုံးသစ်များ တွဲစပ်ဆန်းသစ် ထားသည်။

ထို့ကြောင့် “တစ္ဆေ” ကဗျာမှာ အကြောင်းအရာ အရရော အရေး အဖွဲ့ပိုင်း ဖွဲ့ဆိုပုံပါ ထူးခြားပေါ်လွင် ခဲ့သည်။ အထူးစွဲမက် နှစ်သက်သူများရှိသကဲ့သို့ ရွံးရိုး အစဉ်အလာ ကဗျာ စည်းကမ်းကို ရဲတင်းစွာ လမ်းခွဲ သည်ဟု ယူဆကာ အပြစ် တင်သူများလည်း ရှိခဲ့သည်ဟု ဆိုကြသည်။ သို့သော် ကြည်အေး၏ ကဗျာများသည် မြန်မာစာပေ နယ်ပယ်တွင် မားမားမတ်မတ် ရပ်တည်နိုင်ပြီး အောင်မြင် ကျော်ကြား ခဲ့သည်ဟု ဆိုချင်ပါသည်။ ခေတ်သစ်ကဗျာများ၏ ရှေ့ပြေး ဟုလည်းဆိုနိုင်ပါသည်။

နိဂုံး

ဤစာတမ်းသည် ကြည်အေး၏ အတွေးစိတ်ကူးနှင့် ကာရန်စနစ် ထူးခြားချက်ကိုသာ လေ့လာတင်ပြ ခဲ့ခြင်း ဖြစ်ပါသည်။ ထိုခေတ်အခါက ကြည်အေး၏ ကဗျာ များသည် ကဗျာစည်း လျော့လွန်း၍ အဖတ်ရ ထောင့် သော်လည်း အကြောင်းအရာနှင့် အစပ်အဆို ဟန်ချက်ညီ သဖြင့် ထင်ရှား ခဲ့လေသည်။ နှောင်းလူတို့က ဤနည်းလမ်း ကိုလိုက်၍ ချောင်ချိသည်၊ လွတ်လပ်သည် ဟုယူဆကာ ကာရန်လျော့ ကာရန်မဲ့ကဗျာများကို ရေးဖွဲ့ ခဲ့ကြသည်။ ယနေ့ခေတ်တိုင် ထိုနည်းကို အသုံးပြုခဲ့ကြ သည်ဟု ဆိုချင်ပါသည်။

ကျမ်းကိုးစာရင်း

[၁]ကြည်အေး။ (၁၉၉၂)။ ***ကြည်အေး၏ကဗျာများ***။ ရန်ကုန်၊ အားမာန်သစ်စာပေ။

[၂]စာတည်းအဖွဲ့။ ပြန်ကြားရေးနှင့် ပြည်သူ့ဆက်ဆံရေး ဦးစီးဌာန (ရုံးချုပ်)။ (၂၀၁၃)။ ***နှစ်ဆယ်ရာစု မြန်မာ စာရေး ဆရာများနှင့်စာစုစာရင်း***။ ရန်ကုန်၊ ပညာရွှေတောင် စာအုပ်တိုက်။

[၃]ဇော်ဂျီ။ (၂၀၀၄)။ ***ရသစာပေအဖွင့်နှင့်နိဒါန်း***။ ရန်ကုန်၊ စိတ်ကူးချိုချိုအနုပညာ။

[၄]တာရာ၊ဒဂုန်။ (၁၉၆၇)။ ***စာပေသဘောတရား စာပေဝေဖန်ရေး စာပေလှုပ်ရှားမှု***။ ရန်ကုန်၊ နံသာတိုက်။

[၅]တင်မိုး။ (၂၀၁၇)။ ***ပင်လယ်များကို ဖြတ်သန်းခြင်း***။ ရန်ကုန်၊ စိတ်ကူးချိုချိုပုံနှိပ်တိုက်။

[၆]တင်မောင်ဌေး၊ ဦးနှင့်အများ။ (၁၉၈၃)။ ***မြန်မာကဗျာ စာတမ်းများ*** (ပထမတွဲ)။ ရန်ကုန်၊ စာပေဗိမာန်ပုံနှိပ်တိုက်။

[၇]ထွန်းမြင့်၊ ဦး။ (၂၀၁၄)။ ***ပါဠိသက်ဝေါဟာရအဘိဓာန်၊(၃-ကြိမ်)***။ ရန်ကုန်၊ စာပေလောကပုံနှိပ်တိုက်။

[၈]မြန်မာစာအဖွဲ့။ (၁၉၉၁)။ ***မြန်မာအဘိဓာန်၊(၁-ကြိမ်)***။ ရန်ကုန်၊ ဖိုတိုလစ်သိပုံနှိပ်တိုက်။

ရှေးခေတ်ပုဂံပြည်ကဗျာမှ စာဆိုဆရာဇော်ဂျီ၏ ကဗျာဖန်တီးမှုလေ့လာချက်

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စာတမ်းအကျဉ်း

ဤစာတမ်းသည် ဆရာဇော်ဂျီ၏ ကဗျာတစ်ပုဒ် ဖန်တီးပုံကို လေ့လာ တင်ပြထားသော စာတမ်း ဖြစ်ပါသည်။ ခေတ်စမ်းစာ ပေလောကကို ဦးဆောင်ခဲ့သူ တစ်ဦးဖြစ်သည့် ဆရာ ဇော်ဂျီ သည် ရှေးခေတ်ပုဂံပြည် ကဗျာကို ရေးဖွဲ့ရာ၌ ရာဇဝင် သမိုင်းတွင် အထင်အရှား ရှိခဲ့သည့် အကြောင်းအရာတို့ကို အခြေခံကာ ခံစားမှု သိစိတ်ဖြင့် ကဗျာကို ရေးဖွဲ့သည်။ အတိတ်သမိုင်း ရှိ ပုဂံပြည်၏ ဂုဏ်ရည်ကို ဇာတိမာန် ထက်သန်စေလိုသော အတွေး ပုံရိပ်တို့ဖြင့် ဖော်ပြထားသည်ကို စာပေ အကိုးအကား များဖြင့် ဖော်ထုတ်တင် ပြထားပါသည်။

သော့ချက်ဝေါဟာရများ - ပုဂံ၊ ဖန်တီး၊ စစ်သည်၊ သာသနာ၊ စိတ်ထား။

နိဒါန်း

ခေတ်စမ်းစာပေလောကကို ဦးဆောင်ခဲ့သူ တစ်ဦး ဖြစ်သော ဆရာ ဇော်ဂျီသည် ရှေးခေတ် ပုဂံပြည် ကဗျာတွင် နိုင်ငံကို တည်ထောင်ခဲ့သော မင်းနှင့် ပြည်သူ တို့၏ စည်းလုံး ညီညွတ်သော ဂုဏ်ရည်ကို ဖော်ပြရင်း နှောင်းလူတို့အား မျိုးချစ်စိတ်နှင့် ဇာတိမာန်ကို နှိုးဆော် ပေးခဲ့သည်။

ရှေးခေတ် ပုဂံပြည်ကဗျာကို ဖန်တီးပုံဖော် ရေးဖွဲ့ ရာတွင် ပုဂံဧကရာဇ်နိုင်ငံကို တည်ထောင်ခဲ့သော အနော်ရထာမင်း၊ မြန်မာ့သမိုင်းတွင် စာတင်ခဲ့ရသော သူရဲကောင်းလေးဦး၊ လက်ရုံးရည် နှလုံးရည်တို့နှင့် ပြည့်စုံခဲ့သော ပုဂံ စစ်သည်များနှင့် တစ်စိတ်တစ်ဝမ်း ညီညာခဲ့သော ပြည်သူများ၊ သာသနာထွန်းလင်းအောင် ဆောင်ရွက်ခဲ့သော ရှင်အရဟံတို့ကို အဓိက ဇာတ်ဆောင်များအဖြစ် ထည့်သွင်း ရေးဖွဲ့သည်။

ကဗျာတွင် စာဆိုသည် ပကတိ အရှိမြင်ကွင်းကို ပြန်လည် ပုံဖော်ခြင်းမျိုးမဟုတ်ဘဲ ခံစားမှု အသိတစ်ခုမှ ဖြစ်ပေါ် လာသော ချီးကျူးအံ့သြဖွယ်၊ လေးစား ဂုဏ်ယူဖွယ် နှစ်သက်ခြင်း ရသတစ်ခုကိုပါ ပါဝင်အောင် ပုံဖော်ရေးဖွဲ့ ထားပါသည်။

၁။ ပုဂံပြည်နှင့်စာဆိုဆရာဇော်ဂျီ

ပုဂံမြို့သည် ဧရာဝတီမြစ်၏ အရှေ့ဘက်ကမ်း ပေါ်တွင် တည်ရှိသော ရှေးဟောင်း မြို့တော် ဖြစ်သည်။ ဧရာဝတီ မြစ်၏ အနောက်ဘက်ကမ်းတွင် တန့်ကြည်တောင်ရှိသည်။ ပုဂံမြို့၏ တောင်ဘက်တွင် တူးရွင်းတောင်ကြီး ရှိသည်။ မြန်မာတို့၏ ရှေးဟောင်း မြို့တော်ဖြစ်သော ပုဂံမြို့သည် မြို့အင်္ဂါရုပ်များနှင့် လည်း ပြည့်စုံခဲ့သည်။

မြန်မာတို့၏ ယဉ်ကျေးမှု အဆင့်အတန်း၊ ဘာသာ၊ စာပေ စသည်တို့သည် ပုဂံခေတ် ကတည်းကပင် စတင်ခဲ့ပြီး အစဉ်အလာကောင်းများ ရှိခဲ့သည်။

ပုဂံနှင့်ပတ်သက်၍ မြန်မာ့စွယ်စုံကျမ်းတွင် -

" ပုဂံခေတ်တွင် မြန်မာတို့၏ ယဉ်ကျေးမှု အဆင့်အတန်း မည်မျှတိုးတက်နေသည်ကို သာဓကပြုလျက်ရှိသည်။ ပုဂံသူ၊ ပုဂံသား တို့၏စိတ်ဓာတ်၊ အယူအဆ၊ အုပ်ချုပ်ပုံစနစ် တို့ကိုဖော်ပြသော ကျောက်စာပေါင်း မြောက်များစွာလည်း ယခုတိုင်ရှိနေသေးသည် " [၈]

စေတီပုထိုးများနှင့် သာသနာထွန်းပသော ပုဂံ ပြည်တွင် စားနပ်ရိက္ခာလည်း ပေါများ ကြွယ်ဝလှသည်။ မင်းနှင့် ပြည်သူတို့သည် လက်တွဲညီကြသည်။ မင်းနှင့် ပြည်သူတို့၏ အားထားရာသည် သူရဲကောင်းများနှင့် ပုဂံစစ်သည်များ ဖြစ်ပြီး ထိုသူရဲကောင်းများနှင့် ပုဂံစစ်သည် များသည်လည်း လက်ရုံးရည်၊ နှလုံးရည်နှင့် ပြည့်ဝသောသူများ၊ တိုင်းပြည် အပေါ်သစ္စာရှိသောသူများ ဖြစ်ကြသည်။

စာဆို ဆရာဇော်ဂျီသည် ပုဂံမြို့ဟောင်းသို့ အကြိမ်ကြိမ် ရောက်ခဲ့သည်။ ပုဂံနှင့် ပတ်သက်သော သူ၏ ခံစားမှုကို ဖော်ပြရာတွင် -

"စာတွေ့ပုဂံသည် လွမ်းစရာမျှသာဖြစ်သည်။ ကိုယ်တွေ့ပုဂံသည်ကား ဝမ်းမြောက်စရာ၊ အံ့သြစရာ၊ အားမာန်တက်စရာပင်ဖြစ်တော့သည်" [၄]

ဟု ဆိုထားသည်။ စာဆို၏ ပုဂံကိုချစ်မြတ်နိုးခြင်းသည် မြန်မာကို ချစ်မြတ်နိုးခြင်းပင် ဖြစ်ပါသည်။

ထို့ပြင် မောင်ဟုမ်ဝမ်ကလည်း -

"ပုဂံသားဘိုးဘွား ရှေးမြန်မာကြီးများ၏ ပညာရည်၊ နှလုံးရည်၊ လက်ရုံးရည်ပြည့်ဝမှု တစ်နည်းအားဖြင့် ပုဂံသားဘိုးဘွား ရှေးမြန်မာကြီးများ၏ စိတ်ထားအရာ၊ စိတ်ဓာတ်အရာ၌ မြင့်မြတ်မြင့်မားခြင်းရှိပုံကို ပြန်ပြောပြချင်သောကြောင့်ဖြစ်သည်" [၅]

ဟု စာဆို၏ ပုဂံချစ်စိတ်ကိုဖော်ပြသည်။

ထို့အတူ မမိုးမြေကလည်း -

"ဆရာကြီး၏ ပုဂံကဗျာများသည် စေတနာလှသည်။ သမိုင်းလှသည်။ ထို့အတူပင် စာလည်းလှပါပေသည်" [၆]

ဟု စာဆို၏ ကဗျာဖန်တီးပုံ အလှကို ဖော်ပြထားသည်။

ပုဂံကိုချစ်သော ဆရာဇော်ဂျီသည် မည်သူမျှ မကြားနိုင်သော ပုဂံသားတို့၏ စကားသံကို ကြားယောင်လာသကဲ့သို့ ထည်ဝါခဲ့သော ပုဂံ၏ပုံရိပ်တို့ကို မြင်ယောင်လာသည်။ ရှေးခေတ်ပုဂံပြည်ကြီး၏ မြင်ကွင်းကို ခံစားမှုအသိနှင့်ယှဉ်၍ ဂုဏ်ယူဖွယ်၊ လေးစား ကြည်ညိုဖွယ် အတွေးကို ရသနှစ်သက်ခြင်းပါအောင် ဖန်တီးရေးဖွဲ့သည်။ ရာဇဝင်ပါ အဖြစ်အပျက်အကြောင်း အရာတို့နှင့် ထိတွေ့ဖြစ်ပေါ်လာသော စာဆို၏ခံစားမှုအသိ၊ ထိုခံစားမှုအသိနှင့် စိတ်ကူးဉာဏ်ကို မွမ်းမံပုံဖော်ကာ ရေးဖွဲ့သော စာဆို၏ ကဗျာဖန်တီးပုံကို ရှေးခေတ်ပုဂံပြည် ကဗျာတွင် တွေ့မြင်နိုင်ပါသည်။

၂။ ရှေးခေတ်ပုဂံပြည်ကဗျာဖန်တီးပုံ

စာဆိုဆရာဇော်ဂျီ၏ ရှေးခေတ်ပုဂံပြည် ကဗျာဖန်တီးပုံကို အကြောင်းအရာအလိုက် (၃)မျိုးခွဲခြား လေ့လာနိုင်ပါသည်။

(၁) ရာဇဝင်အကြောင်းအရာကို အခြေခံခြင်း

(၂) စစ်ရေးအင်အား တောင့်တင်းမှုကို အခြေခံခြင်း

(၃) သာသနာထွန်းကားမှုနှင့် စားနပ်ရိက္ခာပေါများမှုကို အခြေခံခြင်း

ဟူ၍ပိုင်းခြားလေ့လာနိုင်သည်။

စာဆိုဆရာဇော်ဂျီသည် ခေတ်စမ်းစာပေလောကကို ဦးဆောင်ခဲ့သူ တစ်ဦးဖြစ်ရာ ကဗျာတွင် အမိနှင့် သားမောင် တို့၏ အမေးစကားသံ အဖြေစကားသံတို့ကို ပါထည့်သွင်း ရေးဖွဲ့ထားခြင်းကလည်း ကဗျာဖန်တီးပုံ ထူးခြားမှု တစ်ရပ်ဟုဆိုရမည် ဖြစ်ပါသည်။

၂၊ ၁။ ရာဇဝင်အကြောင်းအရာကို အခြေခံခြင်း

မြန်မာအဘိဓာန်တွင် - **"ရာဇဝင်ဟူသည် မင်းစဉ်မင်းဆက်အကြောင်းအရာမှတ်တမ်း"**[၁] ဟုအဓိပ္ပာယ်ဖော်ပြသည်။ စာဆို ဆရာဇော်ဂျီသည် ရှေးခေတ်ပုဂံပြည် ကဗျာတွင် မြန်မာ့ရာဇဝင်တွင် သမိုင်းမှတ်တမ်းရှိခဲ့သော အနော်ရထာမင်း လက်ထက်က အကြောင်းအရာကို အခြေခံပြီး ရေးဖွဲ့သည်။ ထိုသို့ရေးဖွဲ့ရာတွင် အနော်ရထာမင်းလက်ထက်က အဖြစ်အပျက်တို့ကို စာဆို၏ အတွေးအမြင် စိတ်ကူးနှင့်ပေါင်းစပ် ဖန်တီးရေးဖွဲ့ထားပါသည်။

စာဆိုသည်ကဗျာ၏ အစတွင် -

" မောင်တို့ကြားကုန် လော့၊
မယ်တို့ကြားကုန်လော့" [၅]

ဟုအစချီကာ အနော်ရထာမင်းကောင်းမင်းမြတ်အုပ်စိုးစဉ်က ပုဂံပြည်ကြီးသည် 'မော်စရာခေတ်' ဖြစ်ခဲ့ပုံကို ပြန်လည် တမ်းတ ကြည်ညိုနိုင်စေရန် ပုံဖော်ထားသည်။ ဘုန်းလက်ရုံးနှင့် ပြည့်စုံသည့်အပြင် ခမ်းနား ထည်ဝါခဲ့သော အတိတ်ခေတ် ပုဂံပြည်ကြီးသည် ရတနာရွှေငွေများ ပေါများကြွယ်ဝခဲ့သည်။ မင်းကောင်းမင်းမြတ် အုပ်စိုး ခဲ့ခြင်းကြောင့် ခမ်းနားထည်ဝါခဲ့သော တိုင်းပြည်ကြီးကို စိတ်ဘဝင်တွင် မှန်းဆ၍ ကြည်ညိုစေလိုသည်။ မင်းကြီး၏ ဘုန်းတန်ခိုးကြီးမြတ်မှုကြောင့် သူရဲကောင်းလေးဦးတို့ ပေါ်ထွန်းခဲ့သည်။ ထိုသူရဲကောင်းလေးဦးတို့သည်လည်း တိုင်းပြည်ကို ချစ်မြတ်နိုးသော သူများဖြစ်

ကြောင်း ရာဇဝင်ပါ အကြောင်းအရာ တို့ကို ထည့်သွင်းရေးဖွဲ့ထားသည်။ ကဗျာတွင် -

" ရာဇဝင်မှာ စာတင်လို့ကြူးခဲ့ကြ
ငထွေရူး လုံးလက်ဖက်
ညောင်ဦးနယ် ကိုရွှေဖီး
ရွှေထီးလောင်းမင်းကျန်စစ်
ထီမထင်အောင် ပြည်ခွင်ကိုချစ်ခဲ့ကြ " [၅]

ဟု ရေးဖွဲ့ထားသည်။ ပုဂံသူရဲကောင်းများ ဖြစ်ကြသည့် ကျန်စစ်သား၊ ငထွေရူး၊ ငလုံးလက်ဖက်၊ ညောင်ဦးဖီး ဟူသော သူရဲကောင်းလေးဦးတို့သည် စစ်သည်လေးသိန်းအင်အားနှင့် ညီမျှသော သူရဲကောင်းများအဖြစ် မြန်မာ့ရာဇဝင်သမိုင်းတွင် ထင်ရှားသော အကြောင်းအရာကို ထည့်သွင်းရေးဖွဲ့သည်။ ထိုသူရဲကောင်းလေးဦးတို့သည် တိုင်းပြည်ကိုချစ်ရာတွင် 'ထီမထင်အောင်' ချစ်ကြသည် ဟူသော စာဆို၏ စကားလုံး ရွေးချယ်သုံးမှုက ချစ်ခြင်း၏အနက်ကို များစွာတာသွား စေပါသည်။ ထို့အတူ အနော်ရထာမင်း လက်ထက်တွင် ပေါ်ထွန်းခဲ့သော သူရဲကောင်းတို့၏ စွမ်းရည်နှင့် မိမိတိုင်းပြည် အပေါ်ထားသော စိတ်ထား ခံယူချက်တို့သည် ချီးကျူးလေးစားဖွယ် ဖြစ်တည်လာရသည်။ အတိတ်ခေတ် ဟောင်းမှ ပုဂံပြည်ကြီးသည် လေးစားဂုဏ်ယူဖွယ်၊ ဇာတိမာန် တက်ကြွဖွယ် ပြည်ကြီးဖြစ်ပါသည်။

၂၊ ၂။ စစ်ရေးအင်အား တောင့်တင်းမှုကို အခြေခံခြင်း

စာဆိုဆရာဇော်ဂျီသည် ပုဂံစစ်သည်တို့၏ လက်ရုံးရည်၊ နှလုံးရည် ပြည့်ဝပုံကိုလည်း ကဗျာတွင်ထည့်သွင်းပုံဖော်သည်။

ရဲစွမ်းသတ္တိနှင့် ပြည့်စုံသော ပုဂံစစ်သည်တော်တို့သည် ဘုရင်မင်းမြတ်နှင့် သူရဲကောင်းများ ကဲ့သို့ပင် စစ်ရေး စွမ်းရည် ပြည့်ဝသူများဖြစ်ကြသည်။ မြန်မာ့ပိုင်နက်တစ်ခွင် ရန်လိုလာသော ရန်သူအပေါင်းကို ချိုးဖဲ့ဖျက်ဆီးတိုက်ဖျက် နိုင်စွမ်းရှိသည်။ ပုဂံတပ်တော်ကြီးသည် တိုက်ပွဲတိုင်းကို အောင်နိုင်ခဲ့သည်။ အောင်စည်အောင်မောင်းများ တီးခတ်ကာ အောင်လံများ လွှင့်ထူ၍ ပြည်တော်ပြန် လာသော ပုဂံတပ်တော်ကြီးကို ပုဂံသားတို့သည် အားရ ဝမ်းသာစွာ ကြိုဆိုခဲ့ကြသည်။

စာဆို ဆရာဇော်ဂျီသည် ပုဂံစစ်သည်တို့၏ ပုံရိပ်ကို ဖော်ပြရာတွင် -

" ရဲစစ်တပ်ခြံအရံ မြန်မာ့နယ်တစ်ရိုး
ရန်ထိုထိုကို ရန်လိုလျှင်ချိုးခဲ့၍
မြို့ရိုးမြင့်ပြေပုဂံ ရဲစစ်တပ်အပြန်မှာ
အောင်လံတွေရောင်ပျံမြူးကာပါ့
တပ်ဦးမှာတချီချီနဲ့ ရွှေအောင်စည်
အောင်သံညှင်းလိုက်တော့ " [၅]

ဟု ဖော်ပြရေးဖွဲ့သည်။ အတိတ်ခေတ်က ပုဂံစစ်သည်တို့၏ စစ်ရည်စစ်သွေးမှာ ဇာတိမာန်တက်ဖွယ် ပုံပေါ်လာရသည်။

စာဆို ဆရာဇော်ဂျီသည် ရှေးခေတ်ပုဂံပြည်ကဗျာတွင် မိခင်နှင အောင်ပွဲပြန် သားမောင် စစ်သည်တို့၏ အပြန် အလှန် အမေးစကား အဖြေစကားတို့ဖြင့် ပုဂံစစ်သည်တို့၏ ဂုဏ်ရည်ကိုလည်း မြင်သာအောင် ပုံဖော်ရေးဖွဲ့သည်။ ပုဂံစစ်သည်တို့၏အသွင်ကို ဖော်ပြရာတွင် -

" ပခုံးနဲ့လက်ပြင် ကျောခြင်ကသံချောင်း
တစ်နှစ်တွင်းမျာ ချက်ချင်းပဲပြောင်းရော့ " [၅]

ဟု မိခင်၏ အံ့သြဂုဏ်ယူဟန်၊

" ပုဂံမှာမွေး ပုဂံသွေးမို့
အလေးမမှု အသက်ပင်လှူခဲ့ပေါ့
ပြည်သူသက်စွန့်
လက်ရုံးအင်သည်တစ်အားနဲ့
ဘယ်တိုင်းခြားသားဝံ့မတုံး " [၅]

ဟူသော စစ်သည်သားမောင်၏ ဝံ့ကြွားသံ၊

" ယာလက်ရုံးငဲ့ပြင် နှလုံးမှာဖြူစင်ကြယ်နဲ့
လူတွင်ကျယ် ပုဂံသားတွေတို့
ကိုယ့်အားကို ကိုယ်ယုံကိုးကာပါ့
ကိုယ့်မျိုးဂုဏ် တစ်မာန်တက်ပေလိမ့်
မားထက်တဲ့ ပုဂံမှာ " [၅]

စသည့် ပုဂံစစ်သည်တို့၏ စိတ်ထားခံယူချက်ကို စာဆိုသည် ကြားယောင်လာအောင် အသံကိုပါထည့်သွင်းဖန်တီးရေးဖွဲ့ ထားသည်။ ဂုဏ်ယူ လေးစားဖွယ်ကောင်းသော ပုဂံပြည်ကြီး၏ စစ်ရေးအင်အား တောင့်တင်း ခိုင်မာမှုကို ရုပ်လုံးပေါ်လာအောင် ပုံဖော်ဖန်တီးနိုင်မှု စွမ်းရည်ပင် ဖြစ်သည်။

၂၊ ၃။ သာသနာ ထွန်းကားမှုနှင့် စားနပ်ရိက္ခာ ပေါများ မှုကို အခြေခံခြင်း

စာဆိုဆရာဇော်ဂျီသည် ပုဂံပြည်ကြီး၏ သာသနာ ထွန်းကားခဲ့ပုံကို ကဗျာတွင် ထည့်သွင်း ပုံဖော်သည်။

အနော်ရထာမင်း စတင် တည်ထောင်ခဲ့သော ပုဂံ ဧကရာဇ် နိုင်ငံတော်ကြီးတွင် သာသနာထွန်းကားခဲ့ ပါသည်။ ရှင်အရဟံမထေရ်မြတ်၏ ဆုံးမသွန်သင်မှုကို ခံယူရင်း ပုဂံသားတို့သည် ဗုဒ္ဓ၏ သာသနာတော်ကို ယုံကြည်သက်ဝင် ကြသည်။ ဘုရားတည်၊ ကျောင်း ဆောက်ကြသည်။ ကုသိုလ်ပြုကြသည်။ သာသနာနှင့် ဆက်နွယ်သော ပွဲသဘင်များ ကျင်းပကြသည်။ စားနပ်ရိက္ခာပေါများ ကြွယ်ဝပြီး အိမ်စျေး သဘင်နှင့် လည်း ပြည့်စုံသည်။ ထိုသို့သော ပုဂံပြည်ကြီး၏ အသွင်ကို -

" စေတီနဲ့တန်ဆောင်း ဆည်ချောင်းနဲ့စပါးနှံ
ရွှေပေါက္ကံပြည်တစ်ကြောမှာ
ပေါချင်တိုင်းပေါတဲ့ပြင်
ဝပြောတဲ့သာသနာ
ခေါင်းလောင်းသံ ညံမစဲရယ်နဲ့ " [၅]

ဟု ကဗျာဖတ်သူ၏ စိတ်မျက်စိတွင် မြင်ယောင်လာ အောင် ပုံဖော် ရေးဖွဲ့ထားသည်။ သာသနာ စည်ပင်မှု၏ ပြယုဒ်ဖြစ်သော စေတီ၊ တန်ဆောင်းများကို သာမက စားနပ်ရိက္ခာ ကြွယ်ဝမှု၏ ပြယုဒ်ဖြစ်သော ဆည်၊ ချောင်း၊ စပါးနှံ တို့သည် 'ပေါချင်တိုင်းပေါ' ကြောင်း ပုံဖော် ရေးဖွဲ့မှုက ကဗျာဖတ်သူ၏စိတ်ကို ယူကျုံးနိုင်သော ပုံဖော်မှု တစ်ရပ်ပင် ဖြစ်ပါသည်။

ထို့ပြင် ရှေးခေတ်ပုဂံပြည်ကြီးတွင် မင်းနှင့် ပြည်သူတို့ တစ်စိတ်တစ်ဝမ်းတည်း နိုင်ငံ စည်ပင် သာယာရေး၊ သာသနာ စည်ပင် ထွန်းကားရေးအတွက် ဆောင်ရွက် ခဲ့ကြပုံကို ပုံဖော် ဖန်တီးရေးဖွဲ့ထားသည်။ ကဗျာတွင် -

" လယ်တွင်းသား ပြည်တော်သား
အသည်သား မင်းမှုထမ်း
တစ်စိတ်ဝမ်း တစ်လက်ညီ
ပြည်ရေးကိုဖြိုင်တူချီတော့ " [၅]

ဟု မင်းနှင့်ပြည်သူတို့ တစ်စိတ်တစ်ဝမ်းတည်း ညီညာ ကြပုံကို ပုံဖော် ရေးဖွဲ့ထားသည်။ ရှေးခေတ်ပုဂံပြည်တွင် နိုင်ငံသားအားလုံးတို့သည် တစ်စိတ်တစ်ဝမ်း တည်း ညီညွတ်ခဲ့ကြသည်ကို ကဗျာဖတ်သူ၏ စိတ်တွင် မြင်ယောင် ရင်း ကြည်နူးခြင်း ဟူသော ခံစားမှုအသိကို ဖြစ်ပေါ်လာ အောင် ဖန်တီးနိုင်မှုသည် စာဆိုဆရာ ဇော်ဂျီ၏ စွမ်းရည် တစ်ရပ်ပင်ဖြစ်ပါသည်။

စာဆိုဆရာဇော်ဂျီသည် **"ဤကမ္ဘာမှာ ပြည်မြန်မာရယ်လို့ ဝင်းခဲ့ "** ရသော ရှေးခေတ်ပုဂံပြည်ကြီး ၏ဂုဏ်ရည်ကို နှောင်းလူတို့ လေးစားအားကျ ဂုဏ်ယူ စေရန်ရေးဖွဲ့နိုင်ခဲ့သည်။ ထိုမျှမက ကဗျာဖတ်သူ၏ရသ အတွေးက အသိစိတ်ကို လှုပ်နှိုးနိုင်အောင်လည်းပုံဖော် ရေးဖွဲ့နိုင်ခဲ့သည်။

၃။ ရှေးခေတ်ပုဂံပြည်ကဗျာနှင့်ရေးဟန်

ရေးဟန်ဟူသည် နေရာတကျသုံးထားသော စကားလုံးများ ဖြစ်သည်ဟု အိုင်းရစ် စာရေးဆရာ ဆွစ်[၂]က ဖွင့်ဆိုသည်။ ဆရာကြီး ဝိမိုးနင်းက စာရေးခြင်း အတတ်ပညာ နှင့်ပတ်သက်၍ စာကိုရေးသော အတတ်မဟုတ်၊ စိတ် ကိုရေးသော အတတ်ဖြစ်သည်[၂] ဟုမိန့်ဆိုသည်။ စာဆိုသည် ကဗျာတစ်ပုဒ်ကို ဖန်တီး ရေးဖွဲ့ရာတွင် ရေးသည့် အကြောင်းအရာ၊ ရေးသူ၏ ရည်ရွယ်ချက် သဘောထား၊ ရေးသူနှင့်ဖတ်သူတို့ ဆက်သွယ်မှု၊ ပတ်ဝန်းကျင်အခြေ အနေများ စသည်ဖြင့် ဆက်စပ်မှု နယ်ပယ်သည် ကျယ် ဝန်းသည်။

ဆရာဇော်ဂျီ၏ ရေးဟန်ကို လေ့လာပါက 'စံ' အဖြစ် သုံးလေ့ရှိသော ဘာသာစကား၏ သွင်ပြင်နှင့်မတူ ဘဲ 'ရေးဟန်စံသွေမှု' များကိုတွေ့မြင်နိုင်သည်။ ထိုသို့ ရေးဟန်စံ သွေမှုများက စာဆို၏ရေးဟန်ပင်ဖြစ်သည်။

ဆရာဇော်ဂျီ၏ ရှေးခေတ်ပုဂံပြည်ကဗျာတွင် -

(၁) စကားသံစံသွေခြင်း

(၂) စကားလုံးဖွဲ့ပုံစံသွေခြင်း

(၃) ထူးခြားသောအသုံးများ

ဟူ၍ ပိုင်းခြားလေ့လာနိုင်ပါသည်။

၃၊ ၁။ စကားသံစံသွေခြင်း

စကားသံစံသွေခြင်း ဟူသည် ''စကားလုံး၏အစိတ် အပိုင်းများကို လိုသလိုဖျောက်သုံးခြင်း၊ ထပ်တိုးသုံးခြင်း၊ ကာရန်လိုက်အောင် သရသံပြောင်းသုံးခြင်း၊ စကားလုံး တစ်လုံး၏ ရှေ့နောက် ဗျည်းသရသံများနေရာ လဲလှယ် သုံးခြင်း တစ်နည်းလည်း သုံးရိုးသုံးစဉ်မှ သွေဖည် သုံးသောနည်းများ''[၂] ဖြစ်သည်။ ထိုစံသွေမှုများကို စာဆိုဆရာဇော်ဂျီ၏ ကဗျာတွင် တွေ့ရပါသည်။

ကဗျာတွင် -

" ငထွေရွှး **လုံးလက်ဖက်**"

တွင် 'ငလုံးလက်ဖက်' ကို အစသံ 'ငလုံးလက်ဖက်' ကို ဖျောက်၍ 'လုံးလက်ဖက်' ဟု သုံးခြင်း၊

" နေ့တိုင်းပဲ **တောင်း**ရတယ်"

တွင် 'ဆုတောင်း' ကို အစသံ 'ဆု' ကို ဖျောက်၍ 'တောင်း' ဟုသုံးခြင်း၊

"သားလှ**တွက်**တာ"

တွင် 'အတွက်' ကို အစသံ 'အ' ကို ဖျောက်၍ 'တွက်' ဟုသုံးခြင်း၊

"နောင်များဖြင့် ပူပါနဲ့"

တွင် 'မပူ' ကို အစသံ 'မ' ကို ဖျောက်၍ 'ပူ' ဟုသုံးခြင်း၊

"ကိုယ့်အားကို ကိုယ်ယုံ**ကိုး**ကာပါ့"

တွင် 'အားကိုး' ကို အစသံ 'အား' ကို ဖျောက်၍ 'ကိုး' ဟုသုံးခြင်း၊

"**ဝ**ပြော်တဲ့သာသနာ"

တွင် 'သာယာဝပြော' ကိုအစသံ 'သာယာ'ကို ဖျောက် ၍ 'ဝပြော' ဟု သုံးထားသည်များကို တွေ့မြင်နိုင်ပါ သည်။

ထို့အတူပင် အဆုံးသံကို ဖျောက်၍သုံးသော အသုံးများ ကိုလည်း ထည့်သွင်းရေးဖွဲ့ထားသည်။

" ဘဝင်မှာ အမြင်**မှန်း**ကာပေါ့"

တွင် 'မှန်းဆ' ကို အဆုံးသံ 'ဆ' ကို ဖျောက်၍ 'မှန်း' ဟုသုံးခြင်း၊

" စာတင်လို့ **ကျွး**ခဲ့ကြ"

တွင် 'ကျွးရင့်' ကို အဆုံးသံ 'ရင့်' ကို ဖျောက်၍ 'ကျွး' ဟုသုံးခြင်း၊

" အမယ်မင်း **ထွား**လိုက်တာ"

တွင် 'ထွားကျိုင်း' ကိုအဆုံးသံ 'ကျိုင်း' ကိုဖျောက်၍ 'ထွား' ဟုသုံးခြင်း၊

"ချက်ချင်းပဲ **ပြောင်း**ရော့"

တွင် 'ပြောင်းလဲ' ကို အဆုံးသံ 'လဲ' ကို ဖျောက်၍ 'ပြောင်း' ဟုသုံးခြင်း၊

"ရန်လိုလျှင် **ချိုး**ခဲ့၍"

တွင် 'ချိုးဖျက်' ကို အဆုံးသံ 'ဖျက်'ကို ဖျောက်၍ 'ချိုး' ဟုသုံးခြင်း၊

"**ပေါ**ချင်တိုင်း **ပေါ**တဲ့ပြင်"

တွင် 'ပေါများ' ကို အဆုံးသံ 'များ' ကို ဖျောက်၍ 'ပေါ' ဟုသုံးခြင်း၊

"မလေးမောင် ချစ်မ**ငြိုး**နိုင်ဘု"

တွင် 'ငြိုးငွေ့' ကို အဆုံးသံ 'ငွေ့' ကို ဖျောက်၍ 'ငြိုး' ဟုသုံးခြင်းတို့သည် စကားသံစဆွေ၍ သုံးထားသော အသုံးများဖြစ်ပါသည်။

၃၊ ၂။ စကားလုံးဖွဲ့ပုံစံသွေခြင်း

စကားလုံးဖွဲ့ပုံစံ သွေခြင်း ဆိုသည်မှာ "စကား တစ်လုံး ဖြစ်အောင် ထိုစကားလုံးထက် ပို၍ သေးငယ်သော အစိတ်အပိုင်းများကို ပေါင်းစပ် ဖွဲ့စည်း ရာတွင် သုံးနေကျ ဖွဲ့စည်းပုံကို သွေဖည်ပြီး ဖွဲ့စည်းခြင်း"[၂] ဖြစ်သည်။

စာဆို ဆရာဇော်ဂျီ၏ ရေးခေတ်ပုဂံပြည် ကဗျာတွင် စကားလုံးဖွဲ့ပုံ စံသွေခြင်းများကို တွေ့ရပါသည်။

ကဗျာတွင် -

" ညော် **ပြည်မြန်မာ**ခေတ်ထူး"

တွင် 'မြန်မာပြည်' ကို 'ပြည်မြန်မာ' ဟုလည်းကောင်း၊

" မြို့ရိုးမြင့် **ပြေပုဂံ**မှာ"

တွင် 'ပုဂံပြည်' ကို 'ပြေပုဂံ' ဟုလည်းကောင်း ကဗျာ၏ ကာရန် အသံတို့နှင့် ကိုက်ညီအောင် စကားလုံးအစိတ် အပိုင်းများကို ရှေ့နောက်ပြောင်းသုံးထားသည်။

ထို့အတူ -

" **ညောင်ဦး**နယ် ကိုရွှေ**ဖီး**"

တွင် 'ညောင်ဦးဖီး' ကို နှစ်ပိုင်းခွဲ၍ အလယ်မှ 'နယ်' နှင့် 'ကိုရွှေ'ကို ထည့်ကာ 'ညောင်ဦးနယ် ကိုရွှေဖီး' ဟု လည်းကောင်း၊

"လက်ရုံး**အင်**သည်တစ်**အား**နဲ့"

တွင် 'အင်အား' ကို နှစ်ပိုင်းခွဲ၍ အလယ်မှ 'သည်' နှင့် 'တစ်' ကို ထည့်ပြီး 'လက်ရုံးအင်သည်တစ်အား' ဟု လည်းကောင်း သုံးနေကျ ဖွဲ့စည်းပုံကို သွေဖည်၍ စကားလုံး ဖွဲ့ထုံး စည်းကမ်းဘောင်ကို ချဲ့ထွင်ကာ စကားလုံးသစ်ကို ဖန်တီး တီထွင် သုံးနှုန်း ထားသည်ကို တွေ့မြင် နိုင်ပါသည်။

၃၊ ၃။ ထူးခြားသောအသုံးများ

စာဆိုဆရာဇော်ဂျီသည် ကဗျာကိုရေးဖွဲ့ရာတွင် ရိုးရှင်း လွယ်ကူသော ဝေါဟာရများကိုလည်း ထူးခြားစွာ ထည့် သွင်းရေးဖွဲ့ထားသည်။

ကဗျာတွင် ပုဂံသူရဲကောင်း လေးဦးကို ဖော်ပြရာ၌ 'ကျန်စစ်သား' ကို -

"**ရွှေထီးလောင်း** မင်းကျန်စစ်"

ဟု ဖော်ပြသုံးနှုန်းထားသည်။ ကျန်စစ်သားသည် မင်းလောင်းမင်းလျာ ဖြစ်ကြောင်း သူရဲကောင်း လေးဦး အနက်မှ ခွဲထုတ်ပြသည်။ အနော်ရထာ လက်ထက် အချိန်ကို ဖော်ပြရင်း ကျန်စစ်သား၏ ဂုဏ်ရည်ကို သိမြင်စေ သည်။

ထို့အတူပင် ပုဂံသူရဲကောင်း လေးဦးတို့သည် ပုဂံပြည်ကြီးကို ချစ်မြတ်နိုးသည်ကို -

" ငထွေရူး လုံးလက်ဖက်
ညောင်ဦးနယ် ကိုရွှေဖီး
ရွှေထီးလောင်း မင်းကျန်စစ်
ထီမထင်အောင် ပြည်ခွင်ကိုချစ်ခဲ့ကြ"

ဟု ဖော်ပြသုံးနှုန်းသည်။ 'ထီမထင်' ဟူသောအဓိပ္ပာယ်သည် 'မလေးစား၊ မခန့်ညား' သောအနက်ဖြစ်ပါသည်။ ထိုသို့အနက်ကို 'ချစ်ခြင်း' နှင့်တွဲဖက်၍ 'တိုင်းပြည်ကို ချစ်ရာတွင် မည်သူတစ်ဦးတစ်ယောက်၏ လွှမ်းမိုးခြင်း

ကိုမျှ ကြောက်ရွံခြင်း၊ ခန့်ညားခြင်းမရှိဘဲ ချစ်သူများ' ဖြစ်ကြောင်း အသိမှတစ်ဆင့် အတွေးခံစားမှုကို ဖြစ်ပေါ်လာအောင် ထည့်သွင်းရေးဖွဲ့ထားသည်။

ဝေါဟာရအသုံးများကို ရွေးချယ်ဖန်တီးရာတွင် ထူးခြားသော ဆရာဇော်ဂျီသည် မိမိဖော်ပြလိုသော အနက်ကို ကဗျာဖတ်သူ ခံစားသိမြင်နိုင်အောင် ရေးဖွဲ့ဖန်တီးနိုင်စွမ်းရှိသူလည်းဖြစ်ပါသည်။ အောင်စည်အောင် မောင်းများတီးခတ်ကာ အောင်ပွဲနှင့်အတူပြန်လာသော ပုဂံစစ်သည်တို့ကို ပုဂံသူ၊ ပုဂံသားတို့က ဝမ်းမြောက် ဂုဏ်ယူစွာ ကြိုဆိုကြသည်။ အောင်ပွဲရစစ်သည်တို့ကို ကြိုဆိုသော ပြည်သူတို့၏အသံကိုဖော်ပြရာတွင် -

"ပြည်တွင်းမှာ **ညံဆူဆူ**နဲ့
ကျန်ရစ်သူ ပုဂံသားတို့မှာလ
အားတက်ကြမှာ"

ဟုဖော်ပြရေးဖွဲ့ထားသည်။ 'ဆူဆူညံ' ဟူသော အနက်သည် 'အသံများနားမခံသာအောင်ဖြစ်သည်' ဟု အနက်ရသည်။ 'ဆူဆူညံ' ကိုပင် 'ညံဆူဆူ' ဟု အရှေ့အနောက် စကားလုံး လဲလှယ်လိုက်သောအခါ နားမခံသာအောင်ဖြစ်သော ဆူညံမှု အနက်မှ နှစ်သက်သဘော ကျဖွယ်ဖြစ်သော အသံသို့ အနက်ပြောင်းသွားရသည်။ တစ်နည်းလည်း ပုဂံစစ်သည်တို့၏ အောင်မြင်မှုကို ဂုဏ်ယူစွာကြိုလင့်သော ပုဂံသူ၊ ပုဂံသားတို့၏ အသံများထွက်ပေါ်လာမှုကို နှစ်သက်ဖွယ် ခံစားမှုဖြစ်လာစေ သည်။

ဆရာဇော်ဂျီသည် မျိုးချစ်စိတ်နှင့် ဇာတိမာန် ထက်သန်သူပီပီ ရှေးအတိတ်သမိုင်းကြောင်းမှ ပုဂံသားတို့၏ ဇာတိမာန်ရင့်သန်မှုကို နှစ်သက်မြတ်နိုးမိသည်။ ထို့ကြောင့်လည်း စိတ်ထား ဖြူစင်သည့်အပြင် အရာရာတွင် ထက်မြတ်သော ပုဂံသားတို့သည် မိမိကိုယ့်ကို ယုံကြည်ကိုးစားသူများဖြစ်ကြောင်းကို -

" နှလုံးမှာဖြူစင်ကြယ်နဲ့
လူတွင်ကျယ် ပုဂံသားတွေတို့
ကိုယ့်အားကို ကိုယ်ယုံကိုးကာပါ
ကိုယ့်မျိုးဂုဏ် တစ်မာန်တက်ပေလိမ့်"

ဟု ဖော်ပြရေးဖွဲ့ထားသည်။ ပုဂံသားတို့သည် အမျိုး ဂုဏ်၊ ဇာတိဂုဏ် တက်စေသူများဖြစ်၍ အရာရာတွင် ထက်မြက်သူများ၊ ပုဂံပြည်ကြီးအတွက် အရေးပါအရာရောက် သူများ ဖြစ်သည်ကို 'လူတွင်ကျယ်' ဟူသော အသုံးဖြင့် သိသာ စေခဲ့သည်။

ဆရာဇော်ဂျီသည် ရှေးခေတ်ပုဂံပြည် ကဗျာ၌ အနော်ရထာမင်း လက်ထက်က ပုဂံပြည်ကြီးကို ဖော်ပြရာတွင် -

"**မားထက်**တဲ့ ပုဂံမှာ
မြန်မာတို့ ခေတ်ဟောင်း "

ဟု ဖော်ပြသုံးနှုန်းထားသည်။ အနော်ရထာမင်း၏ဘုန်းလက်ရုံး၊ သူရဲကောင်းလေးဦးတို့၏စွမ်းရည်၊ ပုဂံစစ်သည်တို့၏ ရဲစွမ်းသတ္တိနှင့် ပုဂံသားတို့၏ စည်းလုံးညီညွတ်မှုကြောင့် ထိုခေတ်ထိုအချိန်က ပုဂံ၏ဩဇာသည် ပတ်ဝန်းကျင်နိုင်ငံများအပေါ် ဖြန့်ကျက် သက်ရောက်မှုကို သိမြင်ခံစားစေနိုင်သည်။

စာဆိုသည် ပုဂံပြည်တွင် စားနပ်ရိက္ခာပေါများကြွယ်ဝပုံကိုဖော်ပြရာတွင်လည်း -

"စေတီနဲ့တန်ဆောင်း
ဆည်ချောင်းနဲ့စပါးနှံ
ရွှေပေါက္ကံပြည်တစ်ကြောမှာ
ပေါချင်တိုင်း ပေါတဲ့ပြင်"

ဟု ရေးဖွဲ့ထားသည်။ အတိုင်းအဆမရှိ အလွန်ပေါများသည်ကိုပင် 'ပေါချင်တိုင်းပေါ' သည်ဟု ရိုးရိုးရှင်းရှင်း

နှင့်ထိမိပေါ်လွင်အောင်သုံးနှုန်းထားသည်။ ထိုသို့ရိုးရှင်းခြင်းသည်ကပင် ပေါ်လွင်ထိမိသော ထူးခြားသည့်အသုံးဖြစ်ပါသည်။

ထို့အတူပင် ဗုဒ္ဓသာသနာ ထွန်းပခဲ့သော ရှေးခေတ် ပုဂံပြည်ကြီးတွင် ပုဂံသူ၊ ပုဂံသားတို့သည် ဗုဒ္ဓ၏ အဆုံးအမတွင် တည်ကြည်ဖြိုး ဘုရားတည်၊ ကျောင်းဆောက် အလှူဒါနများပြုကြသည်ကို -

" ဝပြောတဲ့သာသနာ
ခေါင်းလောင်းသံ ညံမစဲရယ်နဲ့
ပုဂံပွဲသာလွန်းလို့
လာသူလာ သွားသူသွား"

ဟု ဖော်ပြ ရေးဖွဲ့ထားသည်။ အလှူအတန်းများ ပြုကြရာတွင် ခေါင်းလောင်းထိုးသံမှာ မပြတ်ကြားနေရသည်ကို 'ညံမစဲ' ဟူသော အသုံးဖြင့် ဖော်ပြသုံးနှုန်းထားသည်။ နေ့စဉ် အခါမလပ် အလှူအတန်းရှိနေသော ပုဂံပြည်၏ ပုံရိပ်ကို ကဗျာဖတ်သူ၏စိတ်တွင် မြင်ယောင်လာစေသည်။ စာဆို၏ ထူးခြားသောအသုံး ဖြစ်ပါသည်။

ခေတ်စမ်းစာပေလောကကို ဦးဆောင်ခဲ့သော ဆရာဇော်ဂျီသည် ကဗျာတွင် အပြောသုံး စကားများကို ထည့်သွင်း သုံးနှုန်းထားခြင်းကလည်း စာဆို၏ ကဗျာဖွဲ့ပုံထူးခြားမှု ဖြစ်ပါသည်။ ကဗျာထဲတွင် စာဆိုသည် -

"ဩော် ပြည်မြန်မာခေတ်ထူး"
"လာစမ်းဟဲ့ မေ့သား"
"အမယ်မင်း ထွားလိုက်တာ"
"နေ့တိုင်းပဲတောင်းရတယ်"
"အမယ် မမ"
"နောင်များဖြင့် ပူပါနဲ့"
"ဘယ်တိုင်းခြားသား ဝံ့မတုန်းတဲ့"
"ပုဂံပွဲ သာလွန်းလို့"
"ဘဝဂ်ကပြန်ပါရော့"
"ပြည်မြန်မာရယ်လို့ဝင်းခဲ့သတဲ့"

စသည့် အပြောသုံးစကားများကို ထိုက်သည့် အားလျော်စွာ ထည့်သွင်းရေးဖွဲ့ထားသည်။ ထိုအပြော သုံးစကားများကြောင့် ကဗျာသည် ပေါ့ပါး သွက်လက်လာ ရသည်။

ထိုသို့ ထူးခြားသော အသုံးများဖြင့် ကဗျာကို သက်ဝင်စေခြင်းကလည်း စာဆို၏ ထူးခြားသော ရေးဖွဲ့ဖန်တီးပုံ စွမ်းရည်တစ်ရပ်ပင် ဖြစ်ပါသည်။

ခြုံငုံသုံးသပ်ချက်

ခေတ်စမ်းစာပေလောကကို ဦးဆောင်ခဲ့သူတစ်ဦးဖြစ်သော ဆရာဇော်ဂျီ၏ "ရှေးခေတ်ပုဂံပြည်" ကဗျာတွင် စာဆို၏ သိမ်မွေ့နက်ရှိုင်းသောအတွေးနှင့် ကဗျာဖန်တီးမှုစွမ်းရည် တစ်ရပ်ကို တွေ့မြင်နိုင်ပါသည်။ ပုဂံကို ချစ်သောစာဆို၏ ရှေးခေတ်ပုဂံပြည်၏ ပုံရိပ်တို့သည် ကြည်ညို လေးစားဖွယ် နှစ်သက် ဂုဏ်ယူဖွယ်ကောင်းလှပါသည်။ ထိုရှေးခေတ်ပုဂံပြည်ကြီး၏နှလုံးမွေ့လျော်ဖွယ်၊ နှစ်ထောင်းအားရဖွယ်တို့ကို နှောင်းခေတ် လူငယ်တို့အား ကြားမြင် သိရှိခံစားစေလိုသည်။ ထို့ကြောင့်လည်း စာဆိုသည် ရှေးခေတ် ပုဂံပြည်၏ ဂုဏ်ရည်များကို ကဗျာအဖြစ် ဖန်တီးပုံဖော် ရေးဖွဲ့ခဲ့သည်။

ဆရာဇော်ဂျီ၏ ကဗျာဖန်တီးပုံနှင့် ပတ်သက်၍ မင်းယုဝေက -

"ပုဂံစိတ်ဓာတ်ကို ပုဂံကဗျာကို ကျကျနန လေ့လာထားရင် တစ်ကြိမ်ဖတ်ရင် တစ်မျိုး နှစ်ကြိမ်ဖတ်ရင် တစ်မျိုး၊ သုံးကြိမ်၊ လေးကြိမ်၊ ငါးကြိမ်ဆိုရင် တစ်ခါတည်း အဲဒီစိတ်ဓာတ်၊ အဲဒီမျိုးချစ်စိတ်တွေ ပြည့်ထွက်သွားမယ်" [၆]

ဟုဖော်ပြထားသည်။ စာဆို၏ကဗျာမှတစ်ဆင့် ကဗျာဖတ်သူတို့သည် နိုင်ငံချစ်စိတ်၊ မျိုးချစ်စိတ်နှင့် ဇာတိမာန်များဖြစ်ပေါ်လာစေသည်။

စာဆိုဆရာဇော်ဂျီသည် ရှေးခေတ်ပုဂံပြည် ကဗျာကို ခံစားမှုအသိနှင့် ယှဉ်၍ အတွေးပုံရိပ်တစ်ခုကို ထင်ဟပ်လာအောင် ရေးဖွဲ့ဖန်တီးသည်။ ထိုမှတစ်ဆင့် ကဗျာဖတ်သူ၏ အတွေးနှင့် ရသခံစားမှုကိုပုံ ဖော်စေသည်။ ထို့ကြောင့်လည်း ဆရာဇော်ဂျီ၏ ကဗျာ နှင့်ပတ်သက်၍ မောင်စွမ်းရည်က -

" မြန်မာစာပေလောကမှာ လောကအမြင် (ဒဿနကဗျာ) အမျိုးအစားကို စတင်ဖွဲ့ဆိုသူ၊ စိုက်လိုက်မတ်တတ်ဖွဲ့ဆိုသူဟာ ဆရာဇော်ဂျီပဲဖြစ်တယ် ဆိုရင်လည်း အထူးအငြင်းပွားဖွယ်မရှိပါဘူး" [၃]

ဟုဆိုခဲ့သည်။

ရာဇဝင်တွင် ဂုဏ်ယူရသော သမိုင်းရှိခဲ့သည့် ပုဂံပြည်၏ အစ အနော်ရထာမင်း အုပ်စိုးခဲ့စဉ်က မင်း၏ ဘုန်း လက်ရုံးကြောင့် ပတ်ဝန်းကျင် နိုင်ငံများ၏ ကြောက်ရွံ့ ရိုသေမှုနှင့်အတူ ပုဂံပြည်ကြီးသည် ခမ်းနားထည်ဝါခဲ့သည်။ ထို့အတူ တိုင်းပြည်ရှိ သူရဲကောင်း လေးဦး တို့၏ အတုမရှိ သော လက်ရုံးရည်၊ နှလုံးရည်ကြောင့် ပုဂံဧကရာဇ် နိုင်ငံကြီး၏ အဝန်းအဝိုင်းသည် ထည်ဝါ ကြီးမားခဲ့ကာ ပုဂံသားတို့ မော်ကြွားနိုင်ခဲ့ကြသည်။

စစ်ရေးအင်အား တောင့်တင်းခိုင်မာသော ပုဂံ နိုင်ငံတော် ကြီးအပေါ် ပုဂံစစ်သည်တို့ထားရှိသော စိတ် ထားနှင့် ခံယူချက်တို့ကလည်း လေးစားဖွယ်ကောင်း လှသည်။ မိခင် နှင့် စစ်ချီရာမှပြန်လာသော သားမောင် စစ်သည်တို့၏ အပြန်အလှန် အမေးအဖြေစကားသံတို့ က စစ်သည်တို့၏ ကြံ့ခိုင်မှုနှင့် နိုင်ငံအပေါ် သစ္စာရှိမှုကို မြင်သာစေသည်။ နိုင်ငံအတွက် အသက်ကိုပေးလှူ ထားသော စစ်သည်တို့ ဝန်းရံထားသည့် အတိတ်ခေတ် ပုဂံပြည်ကြီးသည် "မားထက်သောပုဂံ" ပြည်ကြီး ဖြစ်ခဲ့သည်။ အားမာန် တက်ကြွသော စစ်သည်တို့၏ အသွင်၊ မြင့်မား ထက်မြတ်သော စစ်ရည်စစ်သွေး တို့ကြောင့် ပုဂံပြည်ကြီး၏ စစ်ရေးအင်အား တောင့်တင်း ခိုင်မာမှုသည် ရုပ်လုံးကြွ လာရသည်။

ထို့အတူ သာသနာထွန်းကားမှုနှင့် စာနပ်ရိက္ခာ ဖူလုံမှုကလည်း ရှေးခေတ်ပုဂံပြည်ကြီး၏ ပြယုဒ်တစ်ခု ပင်ဖြစ်ပါသည်။ အနော်ရထာမင်း စတင်တည်ထောင် ခဲ့သော ပထမ မြန်မာနိုင်ငံတော်ဖြစ်သည့် ပုဂံဧကရာဇ် နိုင်ငံတော်တွင် ရှင်အရဟံ၏ဦးဆောင်မှုဖြင့် ဗုဒ္ဓသာသ နာထွန်းကားခဲ့သည်။ စစ်မှန်သောဗုဒ္ဓ၏ အယူဝါဒ အောက်တွင် ပုဂံသားတို့သည် တစ်စိတ်တစ်ဝမ်းတည်း သွေးစည်း ညီညွတ် ခဲ့ပုံသည် နှလုံး မွေ့လျော်ဖွယ်ရာ ကောင်းသော ရှေးခေတ်ပုဂံပြည်ကြီး၏ လေးစားဖွယ် ဂုဏ်ရည်တစ်ရပ်ပင်ဖြစ်ပါသည်။

နိဂုံး

ရှေးခေတ်ပုဂံပြည်ကဗျာသည် ပုဂံကို စတင်တည် ထောင်ခဲ့သော အနော်ရထာမင်းလက်ထက်က ပုဂံပြည် ကြီး၏အခြေအနေကို သိမြင်ခံစားစေသည့်ကဗျာတစ် ပုဒ်ဖြစ်သည်။ ရာဇဝင်သမိုင်းတွင် ဘုန်းတန်ခိုးကြီး မားခဲ့သော အနော်ရထာမင်းကြီး၏ ကြိုးပမ်းဆောင် ရွက်မှုကိုလည်းကောင်း၊ တိုင်းပြည်ကို ချစ်မြတ်နိုးသော ပုဂံသူရဲကောင်းလေးဦးနှင့် ပုဂံစစ်သည်တို့၏ စွမ်းရည် ကို လည်းကောင်း၊ ပုဂံသားတို့၏ စိတ်ထား ခံယူချက် နှင့် သာသနာ ထွန်းကားမှုကိုလည်းကောင်း သိမြင်လာ စေသည်။ ထိုမှတစ်ဆင့် ပုဂံပြည်ကြီး၏ ဂုဏ်ရည်ကို တွေးခေါ် နိုင်မှုအသိစိတ် နိုးကြားလာအောင်နှိုးဆွပေး နိုင်ခဲ့သည်။ စာဆိုဆရာဇော်ဂျီ၏ ရှေးခေတ်ပုဂံပြည် ကဗျာဖန်တီးပုံကို လေ့လာခြင်းဖြင့် မျိုးချစ်စိတ်နှင့် ဇာတိမာန်များ နိုးကြား လာစေသည်။ အတိတ်ခေတ် ပုဂံပြည်ကြီး၏ ဂုဏ်ရည်ကို လေးစားကြည်ညိုဖွယ် သိမြင်ခံစား လာစေသကဲ့သို့ ရသနှင့်ယှဉ်သော အသိ၊ စိတ်ကူးဉာဏ်ကိုပါ တိုးပွား လာစေသော အကျိုး ကျေးဇူးများကို ရရှိစေပါသည်။

ကျမ်းကိုးစာရင်း

[၁]***ခရီးဆောင်မြန်မာအဘိဓာန်***(တ-ကြိမ်)။(၂၀၁၃)။ နေပြည်တော်၊ မြန်မာစာအဖွဲ့။

[၂] ခင်မင်၊မောင်(ဓနုဖြူ)။ (၂၀၁၁)။ ***ရေးဟန်ပညာ နိဒါန်း***။ ရန်ကုန်၊ စိတ်ကူးချိုချိုစာပေ။

[၃] စွမ်းရည်၊ မောင်နှင့် အများ။ (၁၉၉၉)။ အမှတ်တရ ဇော်ဂျီ။ ရန်ကုန်၊ ရွှေပုံနှိပ်တိုက်။

[၄] ဇော်ဂျီ။ (၁၉၉၄) ။ ***ဆရာဇော်ဂျီစာပေါင်းချုပ်***(၃-တွဲ)။ ရန်ကုန်။ ပြည်ထောင်စုမြန်မာနိုင်ငံ စာပေနှင့်စာနယ်ဇင်းအဖွဲ့။

[၅] ဇော်ဂျီ။ (၂၀၁၂) ။ ***ဇော်ဂျီကဗျာပေါင်းချုပ်*** (၃-ကြိမ်)။ ရန်ကုန်။ စိတ်ကူးချိုချိုစာပေ။

[၆] မင်းယုဝေနှင့် အများ။ (၂၀၀၆)။ ***ဇော်ဂျီရာပြည့်အမှတ်တရ ဟောပြောချက်များ***။ ရန်ကုန်၊ စိတ်ကူးချိုချိုစာပေ။

[၇] မိုးမြေ၊ မ။ (၂၀၁၀)။ ***စိတ်အလှ စာအလှ***။ ရန်ကုန်၊ ရွှေကုံကော်စာပေ။

[၈] ***မြန်မာ့စွယ်စုံကျမ်း အတွဲ-၆***။ (၁၉၆၂)။ ရန်ကုန်။ စာပေဗိမာန် ပုံနှိပ်တိုက်။

[၉] ဟုန်ဝမ်၊ မောင်။ (၂၀၁၂) ။ ***ဇော်ဂျီနှင့်ကဗျာ*** ။ ရန်ကုန်၊ ဓူဝံပုံနှိပ်တိုက်။

လင်္ကာရည်ကျော်၏ ပန်းဒေါင်းဝတ္ထုမှ ဇာတ်လမ်းနှင့်ဇာတ်ဆောင်ဖန်တီးပုံ လေ့လာချက်

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စာတမ်းအကျဉ်း

ဤစာတမ်းသည် စာရေးဆရာ လင်္ကာရည်ကျော်၏ **"ပန်းဒေါင်း"** ဝတ္ထုရှည်မှ ဇာတ်လမ်းနှင့် ဇာတ်ဆောင် ဖန်တီးပုံကို လေ့လာ တင်ပြ ထားသော စာတမ်း ဖြစ်ပါသည်။ ရည်ရွယ်ချက်မှာ မြန်မာဝတ္ထုရှည်များ၏ အတတ်ပညာနှင့် အကျိုးပြုမှုကို လည်းကောင်း၊ လူငယ် လူရွယ်များကို အတ္တစိတ်များကို ဖယ်၍ အများအကျိုးကို ဆောင်ရွက် တတ်သည့် ပရဟိတစိတ်များ ပေါ်ပေါက် လာစေရန် လည်းကောင်း၊ အထောက်အကူ ပြုနိုင် သည်ဟု ရည်ရွယ်ပါသည်။ အလေ့လာခံ နယ်ပယ်မှာ လင်္ကာရည်ကျော် ၏ **"ပန်းဒေါင်း"** (၂၀၁၄)ကို စာပေနယ်ပယ် အတွင်းရှိ ဝတ္ထုရှည် သဘောတရား အတတ်ပညာ နည်းနာများဖြင့် လေ့လာ တင်ပြသွား ပါမည်။ ဤစာတမ်းတွင် "ဝတ္ထုရှည် သဘောသဘာဝ၊ ဇာတ်လမ်း အကျဉ်း၊ ဇာတ်လမ်းဖန်တီးပုံ လေ့လာချက်၊ ဇာတ်ဆောင် ဖန်တီးပုံ လေ့လာချက်၊ အရံဇာတ်ဆောင် များ ဖန်တီးပုံ လေ့လာချက်" စသည်တို့ကို ဖော်ထုတ် တင်ပြ ထားပါသည်။ ထို့ကြောင့် ဝတ္ထုစာရေးသူ တစ်ယောက်၏ ခံစားမှု အတွေးအမြင်၊ စေတနာများကို လည်းကောင်း၊ စာရေးသူ၏ ဝတ္ထုဖန်တီးမှု အတတ် ပညာများ ကိုလည်းကောင်း ဖော်ထုတ်ခွင့် ရသည့် အကျိုးကျေးဇူးများကို ရရှိနိုင်မည့်အပြင် မြန်မာစာပေရှိ ရသစာပေ တစ်ခုဖြစ်သော ဝတ္ထုရှည် အခန်းကဏ္ဍ အတွက် အထောက်အကူ ဖြစ်နိုင်မည် ဖြစ်ပါသည်။

သော့ချက်ဝေါဟာရများ - ဝတ္ထုရှည် သဘောသဘာဝ၊ ဝတ္ထုရှည်ဖန်တီးမှု အတတ်ပညာ၊ ဇာတ်လမ်း၊ ဇာတ်ဆောင်

နိဒါန်း

"ပန်းဒေါင်း" ဝတ္ထုသည် ပရဟိတလုပ်ငန်းကို လုပ်ဆောင် နေသည့် လူငယ်များ၏ စိတ်ဓါတ်ကို ဖော်ကျူးထားရုံမက၊ လူငယ်များ၏ **"ပန်းလိုမွေးပြီးဒေါင်းလိုကတဲ့၊ သို့သော် လိုအပ်လာလျှင် ခွပ်ဒေါင်းလို ရဲပုံနိုင်သည့် အမျိုးသမီးငယ်ကို ကိုယ်စားပြုထားသည့်"** တိုင်းပြည်အကျိုးပြု ဝတ္ထုရှည် တစ်ပုဒ် ဖြစ်ပါသည်။ ဤဝတ္ထုသည် စာဆို၏ ရင်တွင်း၌ ကိန်းအောင်းနေသော အများအကျိုးကို ကူညီဆောင်ရွက် လိုသည့် ပရဟိတစိတ်နှင့် တိုင်းပြည်အတွင်းရှိ ပြည်သူတို့၏ ဘဝဒုက္ခများကို ပုံဖော်ကာ ဖန်တီး ထားသည့် ဝတ္ထုကောင်း တစ်ပုဒ် ဖြစ်သည်။ ထို့ကြောင့် ပန်းဒေါင်းဝတ္ထုကို အခြေခံ၍ ဇာတ်လမ်း ဖန်တီးပုံနှင့် ဇာတ်ဆောင် ဖန်တီးပုံများကို လေ့လာရခြင်း ဖြစ်ပါသည်။

၁။ ဆရာလင်္ကာရည်ကျော်၏ အတ္ထုပ္ပတ္တိ

စာရေးသူ၏ အမည်ရင်းမှာ ရဲမြင့်ကျော် ဖြစ်သည်။ ၁၉၆၁ ခုနှစ်တွင် ဧရာဝတီတိုင်းဒေသကြီး၊ မြန်အောင်မြို့နယ်၊ မြို့မ တဲကြီးကုန်းကျေးရွာတွင် အဖ ဦးညွန့်၊ အမိ ဒေါ်မြရီတို့မှ မွေးဖွားခဲ့သော ဒုတိယသား ဖြစ်သည်။ ကလေးအထူးကု ဆရာဝန်ကြီးတစ်ဦးဖြစ်ပြီး ပြည်တွင်းပြည်ပမှ ဘွဲ့လွန်နှင့် ဒီပလိုမာကိုးခု ရရှိခဲ့သည်။ ကမ္ဘာ့နိုင်ငံပေါင်း ၁၀နိုင်ငံကျော်ခန့်သို့ ပညာတော်သင် လေ့လာရေးနှင့် ဆေးပညာနှီးနော ဖလှယ်ရေး အစည်းအဝေးများ သွားရောက်ခဲ့သည်။ ပြည်တွင်းနေရာ ဒေသ အနှံ့အပြားတွင်လည်း ရာထူးအဆင့် အမျိုးမျိုးနှင့် တာဝန်ထမ်းဆောင်ခဲ့သည်။

၂၀၀၄ခုနှစ်မှ စ၍ လင်္ကာရည်ကျော် ကလောင် အမည်ဖြင့် ရသစာပေများ ထုတ်ဝေခဲ့ပြီး ၂၀၀၇ခုနှစ်တွင်

ထုတ်ဝေသော ပထမဦးဆုံး ဝတ္ထုရှည် **"ကြိုးကြာတောင်ပံခတ်သံ"** ဖြင့် အမျိုးသား စာပေဆုကို လူငယ် စာပေကဏ္ဍမှ ရရှိခဲ့သည်။ ထို့ပြင် ၂၀၀၉ခုနှစ်တွင် ထုတ်ဝေသော ဒုတိယ ဝတ္ထုရှည် **"ဒေါက်တာ ရွှေသွေး နှင့် မပန်းမှုံ"** သည်လည်း အမျိုးသား စာပေဆုကို ဝတ္ထုရှည် ကဏ္ဍမှ ရရှိခဲ့ပြန်သည်။ ၂၀၁၃ခုနှစ်တွင်လည်း **"မမွေးဖွားမီမှ အရွယ်ရောက်သည်အထိ ကလေးပြုစုစောင့်ရှောက်နည်းများ"** စာအုပ်နှင့် သုတစွယ်စုံ စာပေဆုကို အသုံးချသိပ္ပံဘာသာရပ် ကဏ္ဍမှ ဆုရရှိခဲ့သည်။

ယခုအခါ ဆရာသည် ရန်ကုန်ဆေးတက္ကသိုလ်(၁) ကလေးကျန်းမာရေး ပညာဌာနတွင် ပါမောက္ခ၊ ဌာနမှူး၊ ရန်ကုန် ကလေးဆေးရုံကြီးတွင် တာဝန်ခံ ကလေး အထူးကု ဆရာဝန်ကြီးနှင့် (ကလေး ကျန်းမာပညာအဖွဲ့) ဥက္ကဋ္ဌ၊ မြန်မာ နိုင်ငံဆရာဝန်များအသင်းတွင် တာဝန်များ ထမ်းဆောင်ရင်း ရသ၊ သုတနှင့်ဓမ္မစာပေများ စဉ်ဆက် မပြတ် ရေးသားလျက် ရှိသည်။

၂။ ဝတ္ထုရှည်သဘောသဘာဝ

စာပေအဖွဲ့အစွဲပုံသဏ္ဌာန် အမျိုးမျိုးရှိသည့်အနက် ယနေ့ တိုင် စာဖတ်ပရိသတ်များ လက်ခံအားပေးနေဆဲ၊ ခံစား နှစ်ခြိုက်နေဆဲ၊ ဖွံ့ဖြိုးတိုးတက်နေဆဲဖြစ်သော စာပေ အဖွဲ့မှာ ဝတ္ထုပင် ဖြစ်သည်။ မြန်မာအဘိဓာန်တွင် ဝတ္ထုဆိုသည်မှာ **"အထည်ဒြပ်ရှိသောပစ္စည်း။ ရဟန်းတော်အတွက် နဝကမ္မလုပ္ပဒါန်းသောငွေ။ အကြောင်းအရာ။ လူသဘာဝ အဖြစ်အပျက် တို့ကို စိတ်ဝင်စားဖွယ် ရေးသားထားသောစာ"**[၂] ဟူ၍ အဓိပ္ပာယ် ဖွင့်ဆိုထား ပါသည်။

ဝတ္ထုရှည်နှင့် ပတ်သက်၍ **"ခေတ်ရေစီးကြောင်း၌ ဝတ္ထုရှည်သည် သရုပ်မှန်စာပေ ဖြစ်သည်။ ကျွန်ုပ်တို့၏ ဘဝအတွေ့အကြုံကို ပုံကြီးချဲ့ရခြင်းထက် စိတ်ကူးယဉ်ဆိုသော ယဉ်ဖြင့် ပို၍ရောင်စုံဖြာနေသော ကမ္ဘာကြီးသို့ ပို့ဆောင် သည်။"**[၄] ဟုဆိုထားပါသည်။

ထို့ကြောင့် ဝတ္ထုဆိုသည်မှာ စာရေးသူ၏ စိတ်ခံစား ချက်၊ မိမိတွေ့ကြုံလာသည့် အဖြစ်အပျက် အကြောင်း အရာတို့ကို အခြေခံပြီး မိမိစိတ်တွင် သန္ဓေတည် ကိန်းအောင်းလာသည့် စေတနာများကို ပုံဖော် ထုဆစ် ထားခြင်း ဖြစ်ပါသည်။ ထို့ပြင် ဝတ္ထုတွင် စာရေးသူ၏ အတွေးအမြင်၊ နိုင်ငံရေးအခြေအနေ၊ ခေတ်ကာလ အခြေအနေ၊ လူမှုပတ်ဝန်းကျင် မြင်ကွင်း၊ စာရေးသူ၏ ရင်ထဲတွင် ခံစားနေရသော ခံစားချက်များ၊ စာဖတ်သူ ပရိတ်သတ်များအပေါ် ထားရှိသော စေတနာ စသည် တို့ကိုလည်း တစ်သားတည်း မြင်တွေ့နိုင်ပါသည်။

၃။ ပန်းဒေါင်း ဝတ္ထုရှည် ဖန်တီးပုံလေ့လာချက်

ဝတ္ထုရှည်ဖန်တီးသူတို့သည် တစ်ခါတစ်ရံ မိမိ ဇာတ်လမ်းကို ဒိဋ္ဌလောက နှင့်တူအောင် တုပ၍ ဖန်တီးသည်။ တစ်ခါတစ်ရံ တုပအောင် ဖန်တီးသော်လည်း ဒိဋ္ဌလောကနှင့် ဝတ္ထုအတွင်းတွင် အကွာအဝေး ရှိနေပါသည်။ သို့သော် လက်ံရည်ကျော်သည် မိမိ၏ ဝတ္ထုရည်ရွယ်ချက်ကို ပေါ်လွင်စေရန်အတွက် ဇာတ်လမ်း ဇာတ်ဆောင်များကို ဖန်တီးရာ၌ အကောင်းဆုံး ဒိဋ္ဌလောကနှင့် နီးစပ်အောင် ဖန်တီး နိုင်ခဲ့ပါသည်။

၃၊ ၁။ ဇာတ်လမ်းအကျဉ်း

ဇာတ်လမ်းတွင် အဓိကဇာတ်ဆောင် ဖြစ်သော ခင်နွယ်စိုးသည် သူဌေးသမီးတစ်ဦး ဖြစ်ပြီး နိုင်ငံခြား တက္ကသိုလ်တွင် ဘွဲ့ယူထားသူလည်းဖြစ်သည်။ သူသည် ဖခင်ဦးစီးသော စီးပွားရေးတွင် အလုပ် မဝင်သေးဘဲ တစ်ကိုယ်တော် ပရဟိတအသင်း ထူထောင်ကာ ဆင်းရဲပြီး မဖွံ့ဖြိုးသေးသော ဒေသများတွင် ကျောင်းများ ဆောက်လုပ် လှူဒါန်းခြင်း၊ ရေတွင်း ရေကန်များ တူးဖော်ပေးခြင်း၊ အိမ်ခြေယာမဲ့ ကလေးများကို ပညာသင်ပေးခြင်း စသည့် ပရဟိတ လုပ်ငန်းများကို သူငယ်ချင်းများနှင့်အတူ ကျယ်ကျယ်ပြန့်ပြန့် ဆောင်ရွက် လုပ်ကိုင်နေသူ ဖြစ်သည်။

အရံဇာတ်ဆောင် ဦးမြသွေးသည် ပရဟိတ လုပ်ငန်း ကို ကူညီ ထောက်ပံ့ ပေးရာမှစ၍ ခင်နွယ်စိုး တို့၏ အသင်းဝင် တစ်ဦးဖြစ်လာကာ ခင်နွယ်စိုး အခက် အခဲများနှင့် ကြုံတွေ့ နေရသည့် အချိန်တိုင်း ကူညီ ပေးရာမှ တစ်ဦးနှင့် တစ်ဦးသံယောဇဉ် ပိုမိလာသည်။ ဦးမြသွေးသည် မိမိ၏ဇနီး သည်နှင့် တူသည်က တစ်ကြောင်း၊ ခင်နွယ်စိုး၏ လုပ်ဆောင်မှုများနှင့် စိတ်ဓာတ်ကို တန်ဖိုးထား လေးစားမိသည်က တစ်ကြောင်း၊ ခင်နွယ်စိုးအပေါ် ၁၅၀၀ မေတ္တာနှင့် ၅၂၈မေတ္တာ လွန်ဆွဲနေရာမှ နောက်ဆုံး ၅၂၈ မေတ္တာက အားသာပြီး ညီမကလေး တစ်ယောက်ပမာ သဘောထား ခဲ့သည်။

အရံဇာတ်ဆောင် သားကြီးသည် ဦးမြသွေး၏ မယားပါ သားဖြစ်ပြီး ဦးမြသွေးနှင့် ဆက်နွယ်ကာ ခင်နွယ်စိုးတို့၏ အသင်းဝင်တစ်ဦး ဖြစ်လာပါသည်။

သားကြီးသည်လည်း ခင်နွယ်စိုးကို တန်ဖိုးထား လေးစား မိရာမှ ပြောမထွက် လောက်အောင် ချစ်ကြိုက်မိသွားသူ ဖြစ်သည်။

ဇာတ်လမ်း နောက်ဆုံးတွင် ခင်နွယ်စိုး၏ ပရဟိတ လုပ်ငန်းဆောင်ရွက်မှုများကို ခင်နွယ်စိုး ကျောင်းတက် ခဲ့သည့် ကင်ဘာရာမှာ ရှိသည့် သြစတြေးလျ အမျိုးသား တက္ကသိုလ်မှ ပါမောက္ခများ သိရှိကာ ခင်နွယ်စိုးကို ချီးကျူးပြီး ဂုဏ်ထူး ဆောင် ဘွဲ့ပေးရန် ဖိတ်ကြားခဲ့သည်။ ဦးမြသွေးသည် ခင်နွယ်စိုး ကင်ဘာရာသို့ သွားပြီး ဆုသွားယူရာသို့ လိုက်ပါ ခဲ့ပြီး အပြန်တွင် စက််ပူ လေယာဉ်ကွင်း၌ တစ်ဦးတည်း ဝင်ရောက် ကျန်နေ ခဲ့သည်။ ထိုလေယာဉ်ကွင်းတွင်ပင် နှလုံးအောင့်လာပြီး စက််ပူတွင် ကွယ်လွန်ခဲ့သည်။ ထိုသတင်းကို ကြား ရသော ခင်နွယ်စိုးမှာ သည်းအူပြတ်မျှ ခံစားရပြီး ဖြေမဆည်နိုင်အောင် ငိုကြွေး ခံစားခဲ့ရသည်။ ထို့နောက် ဦးမြသွေး မသေဆုံးမီက ရေးဆွဲခဲ့သော ပန်းချီကားများကို ခင်နွယ်စိုးတို့ အသင်းအတွက် လှူဒါန်း ခဲ့သည်။ ခင်နွယ်စိုးတို့သည် ပန်းဒေါင်း ပန်းချီကားမှလွဲ၍ ကျန်ပန်းချီကားများကို ရောင်းချကာ အသင်းရန်ပုံငွေ လုပ်ခဲ့သည်။

သူ၏ ပရဟိတအသင်းကိုလည်း ဦးမြသွေးကို ဂုဏ်ပြု သည့်အနေနှင့် **“ပန်းဒေါင်း”** ဟု အမည်ပေးလိုက်သည်။ ခင်နွယ်စိုးသည် ဝမ်းနည်းပူဆွေးမှုကို မည်သို့ပင် ခံစားရစေကာမူ သူ၏ဘဝ၊ သူ၏အသက်၊ သူတန်ဖိုး ထားရသော ပရဟိတလုပ်ငန်းကို ဆက်လက် လုပ်ဆောင် သွားခြင်းဖြင့် ဝတ္ထုကို အဆုံးသတ်ထားပါသည်။

၃၊ ၂။ ဇာတ်လမ်းဖန်တီးပုံလေ့လာချက်

ဇာတ်လမ်းဆိုသည်မှာ **“ ရုပ်ရှင်၊ ပြဇာတ်၊ ဝတ္ထု စသည်တို့ တွင်ပါဝင်သော အဖြစ်အပျက်၊ အကြောင်း အရာ၊ အစအဆုံး၊ ဇာတ်ကြောင်း”**[၂] **ဟု မြန်မာအဘိဓာန် တွင် ဖော်ပြထားပါသည်။**

“ပန်းဒေါင်း”ဝတ္ထုသည် ၂၁ရာစုတွင် ပေါ်ထွန်းသော ဝတ္ထုတစ်ပုဒ် ဖြစ်ပါသည်။ စာရေးသူသည် လူငယ် လူရွယ်များကို လမ်းဟောင်းမှထွက်၍ လမ်းသစ် ကိုထွင်ကာ အတွေးသစ် အမြင်သစ်များဖြင့် တိုးတက် စေချင်သူ တစ်ဦး ဖြစ်သည်။ ထို့ကြောင့် **“ပန်းဒေါင်း”** ဝတ္ထုတွင် ခေတ်သစ် လူငယ်များ၏ လှုပ်ရှားမှု ဟန်ပန်များ၊ အတွေးအမြင် ကျယ်ပြန့်ပြီး နိုင်ငံ့တာဝန်ကို မိမိကျရာ နေရာမှ အုတ်တစ်ချပ် သဲတစ်ပွင့်ပမာ တာဝန်ယူတတ် သူများအဖြစ် ဖန်တီးထားပါသည်။ ထိုဝတ္ထုမှ တစ်ဆင့် စာဖတ်ပရိသတ်များကို အများ၏ ဘဝအတွက် မိမိဘဝကို နှစ်မြှုပ်ထားရသည့် လူသား ပီသသော အတွေးအမြင် အသိများ အတုယူစေခြင်း ဖြစ်သည်။

ဝတ္ထုစစချင်းမှာပင် ဇာတ်ဆောင် ခင်နွယ်စိုးနှင့် သူရောက်ရှိနေသော မဖွံ့ဖြိုးသေးသည့် နေရာဒေသတွင် ပရဟိတ လုပ်ဆောင်ခြင်းဖြင့် စာဖတ်သူကို မိတ်ဆက် ပေးထားကာ ဇာတ်လမ်းဖန်တီးထားပါသည်။ စာရေးသူ မိတ်ဆက် ပေးထားသည့် ကာလဒေသ နောက်ခံ ဝန်းကျင်သည် ဝတ္ထု၏ ရည်ရွယ်ချက်ကို ရောက်အောင် ပို့ဆောင်ရန်အတွက် အရေးပါသော အချက်တစ်ချက်ပင် ဖြစ်သည်။

ရှေးဦးစွာ ခင်နွယ်စိုး ထောက်ပံ့ လှူဒါန်းပေးနေသည့် တောင်ပေါ်ရှိ သစ်တောကြိုးဝိုင်း အတွင်းမှ ကျောင်းသို့ သွားရာ လမ်းခရီးမှာ အတော်ပင် ကြမ်းတမ်းပြီး သွားရလာရ ခက်ခဲမှု များရှိကြောင်းကို ဖော်ပြရာတွင်-

“နွယ်စိုးခြေထောက် အောက်မှာ ရှိနေသော အဝေးပြေး ကားဝင်းမြေသည် ရန်ကုန်၊ မန္တလေး မြို့ကြီး တွေကလို ကတ္တရာခင်း၊ ကွန်ကရစ်ခင်း မဟုတ်။ မညီမညာ ချိုင့်ခွက် များပြည့်နေသည့် မြေသားဖြစ်သည်။ အဲဒီ မြေပေါ်မှာ မြွေရေခွံအိတ် များဖြင့် စနစ်တကျ ထုပ်ပိုး၍ “ခင်နွယ်စိုး” ရန်ကုန်ဟု စာတန်းထိုးထားသော ပစ္စည်း ထုပ်ကြီးများ ရှိနေသည်။ တော်သေးတာပေါ့။ မိုးတွင်းသာ ဆိုရင်မိုးနဲ့ဗွက်နဲ့သွားပြီ” (စာ-၂၀)ဟူ၍ ပရဟိတလုပ်ဆောင် နေသူများအတွက် မိန်းမသား ဖြစ်သော်လည်း အများ အတွက်ဟူသော အားမာန်ဖြင့် ခရီးလမ်းပန်း အခက်အခဲ များစွာကို ရင်ဆိုင်ရပုံ၊ မြို့ပြများနှင့်အပြိုင် မဖွံ့ဖြိုး သေးသော ဒေသနောက်ခံ၏ ယိုယွင်းနေပုံ စသည်တို့ဖြင့် စာဖတ်ပရိသတ်တို့အား မိတ်ဆက် ပေးထားပါသည်။

ခင်နွယ်စိုး၏ နှလုံးသားသည် နူးညံ့သိမ်မွေ့ပြီး ကလေးများအပေါ် ချစ်ခင် ကြင်နာတတ်သူ တစ်ဦး ဖြစ်သည်။ စာသင်ကျောင်းရှိ ကလေးများအပေါ် မေတ္တာ စေတနာ အပြည့် အဝထားကာ ပုံပြောနေပုံနှင့် စာသင်ကျောင်း ကလေး၏ ချို့တဲ့နေသော အသွင်အပြင် များကို ထည့်သွင်း ကာ အားနည်းနေသေးသော ဒေသနောက်ခံကို ဇာတ်လမ်းဆင် ဖန်တီး ထားပါသည်။ ဤသည်ကို-

“ကလေးတွေကနှစ်ဆယ်လောက်။ နွယ်စိုး ဘေးက ကြမ်းပြင်မှာ ဝိုင်းနေကြသည်။ တစ်ချို့ လည်း

မှောက်လျက်။ အငယ်ကလေး တစ်ယောက် ကတော့ နွယ်စိုးပေါင်ပေါ်မှာ ခေါင်းအုံးလျက် အိပ်ပျော်နေသည်။ ညစ်ပေနေသော မျက်နှာ ကလေး သည်ပင်လျှင် အိပ်ပျော်နေသော အခါ အပြစ်ကင်း စင်စွာ ချစ်စရာ ကောင်းလျက် ရှိနေသည်။ နံရံ မရှိသော မူလတန်းကျောင်းကလေးက လေတဝူးဝူး နှင့်မို့ နွေဆိုပေမယ့် အေးမြနေသည်။ မိုးဆိုလျှင်တော့ မတွေးရဲစရာ” (စာ-၂၆) ဟု စာသင်ကျောင်းကလေး၏ မပြည့်မစုံ ပုံပန်းသွင်ပြင် သဏ္ဌာန်များဖြင့် စာဖတ်သူ၏ နှလုံးသားဝယ် ကရုဏာ သက်စေသည့် စိတ်များ ဖြစ်ပေါ်လာအောင် နှိုးဆွပေးထား ပါသည်။ စာဖတ်သူ များသည်မိမိတို့ တိုင်းပြည်တွင် ဤကဲ့သို့ မပြည့်စုံ သေးသည့် နေရာဒေသများ အမှန်တကယ် ရှိနေ ကြောင်းသိရှိကာ ထောက်ပံ့မှုများ ပေးလိုသည့် စိတ်ကို တဖွားဖွား ပေါ်လာအောင် ဇာတ်လမ်းဆင်ဖန်တီးထား ပါသည်။

ထို့ပြင် ပရဟိတ လုပ်ငန်းများ လုပ်ဆောင်ရာတွင် အနုပညာသည် များလည်း ပါဝင်ကာ အားဖြည့် ထားကြောင်း ဖြင့် ဇာတ်ရှိန်ကို မြှင့်ထားပါသည်။ ဤအချက်သည် နေရာတိုင်းတွင် ကူညီထောက်ပံ့မှု သည်လည်း အများကြီး လိုအပ်နေကြောင်းကို ပေါ်လွင်စေရုံမျှမက အရံဇာတ်ဆောင် တို့၏ ပြုမူ ဆောင်ရွက်ပုံ တို့နှင့် ဆက်စပ်ဖန်တီးပြထားပုံကို-

“စင်အောက်မှာလည်း ခေါင်းတုံးကလေးတွေ အစီအရီ။ ခေါင်းတုံးကလေးတွေ ကြားမှာ လူငယ် အဆိုတော် ကလေး တွေနှင့် လူငယ် ဆရာဝန် ကလေးတွေ တရင်းတနှီး ဝင်ထိုင်နေကြရင်းက စင်ပေါ်က သီချင်းသံကို လက်ခုပ် စည်းချက် လိုက်နေကြတာကို ကြည့်ရတာ မျက်ရည်ဝဲမတတ် ကြည်နူးစရာ”(စာ-၆၈) ဟု သွေးကင်ဆာရောဂါ ရနေသော ကလေးလေးများအပေါ် အနုပညာသည်များ ကလည်း မေတ္တာထားကာ ဝိုင်းဝန်းကူညီ လုပ်ဆောင် ပေးကြရုံ၊ ရုပ်ခန္ဓာ ချမ်းသာအောင် ဆောင်ရွက် ပေးရုံမျှမက စိတ်ခန္ဓာပိုင်းကိုပါ ပျော်ရွှင်အောင် နှစ်သိမ့် ဖျော်ဖြေနေရုံ စသည့် မြင်ကွင်းများဖြင့် ဇာတ်လမ်းဆင်ကာ ဖန်တီး သရုပ်ဖော် ထားပါသည်။ ထိုမြင်ကွင်း သရုပ်ဖော်များသည် စာဖတ်သူ၏ ရင်ထဲတွင် စာနာ သနားစိတ်များကို ယိုဖိတ် ကျလာသကဲ့သို့ နှလုံးလှ ဆရာဝန် လူငယ်လေးများ၏ စိတ်ဓါတ်ကို ချီးကျူး မိပါသည်။

ထို့ပြင် ပရဟိတလုပ်ငန်းများ ဆောင်ရွက်ရာတွင် လူသူမရွေး၊ လူတန်းစားမရွေး လူတိုင်းကို ဆောင်ရွက် ပေးသင့်ကြောင်းဖြင့် ဇာတ်လမ်းကို ဖန်တီးပုံဖော် ထားပြန်ပါသည်။ လောကကြီးတွင် မေတ္တာတရားများ လိုအပ်နေသည့် နေရာအများအပြား ရှိပါလားဟု စာဖတ် ပရိသတ်ရင်ထဲတွင် အတွေးများကို ပေါ်ပေါက် လာစေသည့် ဇာတ်လမ်း ဖန်တီးမှုပင် ဖြစ်သည်။ စာရေးသူသည် အိမ်ခြေယာမဲ့ ကလေးများကို လမ်းဘေး ပလက်ဖောင်း ပေါ်တွင် စာသင်ပေးနေသည့် ခင်နွယ်စိုးတို့ အပေါ် မေတ္တာသက်ဝင်စေပြီး၊ ထိုကလေးများကို လေလွင့်ကလေး များအဖြစ် ဖမ်းသွားခြင်းကလည်း ကလေးများ၏ ဘဝပေး အခြေအနေကို မစုံစမ်း၊ မိမိတို့ တိုင်းပြည်ရှိ အစစအရာရာ ချို့ငဲ့နေသော ထိုကလေးများ အတွက် အလုပ်အကိုင်၊ ပညာရေးတို့ကို မည်သို့ဖြေရှင်း ပေးနိုင်မည်နည်း ဆိုသည့် အဖြေကို မရှာဘဲ အနုသဘောထက် အကြမ်းသဘောကို ဆောင်ပြီး ထိုခေတ် အစိုးရ၏ အုပ်ချုပ်မှုပုံစံများကို အားမလို အားမရ စိတ်များ ပေါ်ပေါက်လာအောင် ဇာတ်လမ်း ဇာတ်ကွက်ဆင်ကာ ဖန်တီးထားပါသည်။

စာရေးသူသည် ဇာတ်လမ်း၊ ဇာတ်ကွက်ဆင်ရာတွင် ဇာတ်လမ်း၏ နိမိတ်ပုံရိပ်များဖြင့်လည်း ဖန်တီးထား ပါသည်။ ခင်နွယ်စိုးသည် ဦးမြသွေး၏ ရုံးခန်းအတွင်းရှိ ပန်းချီကားကို စိတ်ဝင်စားသည့် အချက်ဖြင့် နောင်တွင် **“ပန်းဒေါင်း”**ဟု အမည်တွင်စေမည့် အကြောင်းကို ဇာတ်နိမိတ် ပြထား ပါသည်။

“လှလိုက်တဲ့ ဒေါင်းကြီးပါလား။ နံရံမှာ ချိတ်ထား သော ပေါင်သွင်းထားသည့် ပန်းချီကားထဲက ဒေါင်းကြီးကို ကြည့်ရင်း နွယ်စိုးရင်သပ် အံ့သြနေမိသည်။ ဒေါင်းက ရိုးရိုး ဒေါင်းမဟုတ်။ ပန်းပွင့်ကလေးများ အချပ်လိုက်ကပ်၍ ဒေါင်းပုံ ဖော်ပြထား ခြင်းဖြစ်သည်။ ပန်းတွေကို စုံလို့၊ မြစိမ်းရောင် နေရာမှာတော့ ပန်းပွင့်မဟုတ်ဘဲ သစ်ရွက် စိမ်းစိမ်း ကလေးများကို ကပ်ထားခြင်းဖြစ်သည်။” (စာ-၃၀)ဟူ၍ ဖော်ပြထား သည်။

ဤတွင် **“ပန်း”**မှာ စိတ်နှလုံးနူးညံ့သိမ်မွေ့ပြီး ပန်းကဲ့သို့ ဖြူစင်သည့် ခင်နွယ်စိုးကို ကိုယ်စားပြုထားပြီး **“ဒေါင်း”** မှာ ခင်နွယ်စိုးတို့ကို အဘက်ဘက်မှ အမြဲတမ်း အဆင့်သင့် အစစ အရာရာ ကူညီပေးနေသည့်၊ အခက်အခဲ ကြုံလာတိုင်း ကူညီဖြေရှင်း ပေးတတ်သည့်

ခင်နွယ်စိုးအတွက် ခွန်အား တစ်ခု ဖြစ်သည့် ဦးမြသွေးကို ကိုယ်စားပြုထားပါသည်။

ထို့ကြောင့် ခင်နွယ်စိုးတို့၏ ပရဟိတလုပ်ငန်း ပိုမို အောင်မြင် လာစေသည့် အကြောင်းအရင်းမှာ ပန်းနှင့် တူပြီး နူးညံ့သည့် နှလုံးသားပိုင်ရှင် ခင်နွယ်စိုးနှင့် ဒေါင်းနှင့် တူသည့် ဦးမြသွေး **"ပန်းဒေါင်း"** နှစ်ယောက် ပေါင်းမှုကြောင့် ပိုမို အောင်မြင်လာကြောင်းဖြင့် ဇာတ်လမ်း ဖန်တီးထားပါသည်။ စာရေးသူသည် မည်သည့် အလုပ်ကိုမဆို စိတ်နှလုံး နူးညံ့ နေရုံနှင့် မပြီး ကူညီ ဖြေရှင်းပေးနိုင်သည့် လူမျိုးနှင့်ပူးပေါင်းမှ သာလျှင် အရာရာ အောင်မြင်မှု ရနိုင်သည့်အချက်ကို စာဖတ်သူများ အတွေးသို့ ထိုးဖောက်ဝင်ရောက် စေသည့် အချက်ဖြင့် ဇာတ်အတက်ပိုင်းကို ပိုမိုစိတ်ဝင်စား လာအောင် ဖန်တီးခဲ့ပါသည်။

စာရေးသူ လက်ံရည်ကျော်သည် ဇာတ်လမ်းကို ဖန်တီးရာတွင် ဇာတ်ဆောင် တို့၏အပြုအမူများဖြင့်လည်း ဇာတ်လမ်း ရည်ရွယ်ချက်ကို ပေါ်လွင်အောင် ဖန်တီး ထားပါသည်။ အဓိကဇာတ်ဆောင် ခင်နွယ်စိုးကို သူဌေးသမီး တစ်ဦးအဖြစ် လည်းကောင်း၊ ခက်ခဲ ကြမ်းတမ်းစွာ ဖြတ်သန်း ရသော ပရဟိတလုပ်ငန်းကို ကိုယ်ကျိုးမဖက် ဆောင်ရွက်သူ အဖြစ်လည်းကောင်း၊ ကလေးများအပေါ် သနားကြင်နာ တတ်သူ၊ ကူညီပေးသူ အဖြစ်လည်းကောင်း၊ ဖန်တီးထား ပါသည်။ ထို့အပြင် ပရဟိတ လုပ်ငန်းကို လုပ်ဆောင်ရာတွင် ပေါ်ပေါက် လာသည့် အခက်အခဲများကို စိတ်ဓာတ်ခိုင်မာ စွာဖြင့် ဖြတ်သန်းနိုင်သော်လည်း မိန်းကလေးပီပီ အစစ အရာရာ ကူညီ ပေးနေသည့် ဦးမြသွေးအပေါ် သံယောဇဉ် တွယ်မိသူ အတ္တစိတ်နှင့် ပရစိတ်အားပြိုင်မှုဖြင့် ထက်မြတ်သည့် ဇာတ်ကောင် စရိုက်ကို ဖန်တီးထား ပါသည်။

ဦးမြသွေးကို ပန်းချီဆရာလုပ်ငန်းရှင် သူဌေးတစ်ဦး အဖြစ် လည်းကောင်း ပရဟိတ လုပ်ငန်းများကို စိတ်ဝင်စားသူ တစ်ဦးအဖြစ် လည်းကောင်း ဖန်တီးထားသည်။ တစ်ဖန် သူ၏ ဇနီးချောနှင့် အလွန် တူသည့် ခင်နွယ်စိုးအပေါ် သံယောဇဉ် တွယ်မိ သော်လည်း ခင်နွယ်စိုး၏ စိတ်ဓာတ်ကို တန်ဖိုးထား လေးစားမှုကြောင့် ၁၅၀၀ မေတ္တာမှ ၅၂၈ မေတ္တာဘက်သို့ ကူးပြောင်းသွားပြီး ညီမအရင်း တစ်ယောက်ပမာ ကူညီစောင့်ရှောက် ပေးသွားသူအဖြစ် ပုံဖော်ခဲ့သည်။

အရံဇာတ်ဆောင်များဖြစ်သော မိုးကြီးနှင့် သားကြီး တို့သည် ခင်နွယ်စိုးအပေါ် မေတ္တာသက်ဝင် ချစ်မိသူများ ဖြစ်သော်လည်း မိမိ မြတ်နိုး တန်ဖိုးထားရသော ဖြူစင်သော ပန်းပွင့်ကလေးကို မချွေရက်သကဲ့သို့ ချစ်မိကြောင်းဖွင့် မပြောရက်ဘဲ ညီမ၊ နှမအရင်း တစ်ယောက် ကဲ့သို့ စောင့်ရှောက် သူများအဖြစ် လည်းကောင်း၊ ပရဟိတ စိတ်ကို မွေးမြူသူများအဖြစ် လည်းကောင်း ဇာတ်ဆောင် စရိုက်ကို ကျစ်ကျစ်လျစ်လျစ် သိမ်သိမ်မွေ့မွေ့ ဖန်တီး တင်ပြထားပါ သည်။

ထို့ကြောင့် **"ပန်းဒေါင်း"** ဝတ္ထုသည် သာမန် ဝတ္ထုရှည်များ ကဲ့သို့ အချစ်၊ အလွမ်းကို ဦးစား ပေးထားသည့် ဝတ္ထုများထဲမှ သွေဖည်ကာ ပရဟိတ လုပ်ငန်း ဆောင်ရွက်မှုများကို ဦးစား ပေးထားသော ဆန်းသစ်ပြီး တစ်မူထူးခြားသည့် ဝတ္ထုရှည် တစ်ပုဒ်အဖြစ် ဖန်တီးထားသည်ကို တွေ့ရှိရပါသည်။

၃၊ ၃။ ဇာတ်ဆောင်စရိုက်လေ့လာချက်

ဇာတ်ဆောင်စရိုက်အဖွဲ့ ဆိုသည်မှာ ဇာတ်လမ်းတွင် ပါဝင်သော ဇာတ်ဆောင်တို့သည် အဖြစ်အပျက် အရေး အခင်း တစ်ခုခုနှင့် ကြုံတွေ့ ရသောအခါ မည်သို့ ပြုမူ ပြောဆို တွေ့ကြုံသည်ကို ဖော်ပြလိုသော အဖွဲ့ဖြစ်သည်။ စရိုက်နှင့် ပတ်သက်၍ မြန်မာ အဘိဓာန်တွင် **"အပြုအမူ။ အလေ့၊ အကျင့်"**[၂] ဟူ၍ အဓိပ္ပာယ် ဖွင့်ဆိုထားပါသည်။

မမိုးမြေ၏ ဝတ္ထုရှည် ဖန်တီးသူနှင့် ဝတ္ထုရှည် ခံစားသူစာအုပ်တွင်- ဇာတ်ဆောင်နှင့် ပက်သက်၍ **"ဝတ္ထု တစ်ပုဒ်တွင် ပါဝင်သောဇာတ်လမ်း၌ ပါဝင်လှုပ်ရှား ပြုမူ သူများကို ဇာတ်ဆောင်ဟု ခေါ်ပါသည်။ ထိုဇာတ်ဆောင် တို့ကိုဇာတ်လမ်းဖြစ်ရပ်နှင့် ကြောင်းကျိုး ဆက်သွယ်၍ အပြုအမူ အပြောအဆို ခံစားမှုအတွေးအမြင်တို့ကို လူသဘာဝနှင့်အညီ အနုစိတ် သရုပ်ဖော်ရေးဖွဲ့ခြင်းကို ဇာတ်ဆောင်စရိုက် သရုပ်ဖော်ခြင်းဟု ခေါ်ပါသည်။"** [၁] ဟု အဓိပ္ပာယ် ဖွင့်ဆိုထားပါသည်။

သို့ဖြစ်၍ ဇာတ်ဆောင်စရိုက် ဆိုသည်မှာ - "ဝတ္ထုတစ်ပုဒ်တွင် စာရေးသူ ပို့ဆောင်လိုသော ရည်ရွယ်ချက်သို့ ရောက်အောင် စာရေးသူ၏ အတွေး အမြင်၊ ဗဟုသုတများကို စာဖတ်သူများ စိတ်ဝင်စား လာစေရန် အတွက် မိမိကျရာ နေရာမှ တာဝန် ကျေပွန်စွာဖြင့် ပြုမူလှုပ်ရှား သရုပ်ဆောင်ရသူများ ဖြစ်ပါသည်။" ဟု ယူဆမိပါသည်။

"ပန်းဒေါင်း" ဝတ္ထုတွင် အဓိကဇာတ်ဆောင်ကို အပြင် လောကတွင် အမှန်တကယ် ရှိခဲ့သည်

ခင်နှင်းကြည်သာ၏ ကိုယ်စား ဇာတ်ဆောင် ခင်နွယ်စိုးကို ဖန်တီးခဲ့သည်။ ဦးမြသွေးမှာ ခင်နွယ်စိုး၏ စရိုက်ကို ပိုမိုပီပြင်လာအောင် ပံ့ပိုးကူညီပေးသည့် အရံဇာတ်ဆောင် ဖြစ်သည်။ မိုးကြီး၊ သားကြီး၊ အိတုတ်၊ ကိုသိန်းဟန်စိုးနှင့် ဦးဇော်တို့ကို အဓိကဇာတ်ဆောင်၏ စရိုက်နှင့် ဇာတ်လမ်းကို ပေါ်လွင် စေရန်အတွက် သိုင်းဝိုင်းခြံရံ ပေးထားသော အရံဇာတ်ဆောင်များအဖြစ် ဖန်တီးထားပါသည်။

၃၊ ၃၊ ၁။ အဓိကဇာတ်ဆောင်ဖန်တီးပုံ

စာရေးဆရာ လက်ံာရည်ကျော်၏ ပန်းဒေါင်း ဝတ္ထုသည် ပရဟိတ စိတ်ဓါတ်ပြင်းထန်ပုံကို အဓိက ပုံဖော် ဖန်တီး ထားခြင်း ဖြစ်ပါသည်။ **"ပရ"** ဆိုသည်မှာ ယေဘုယျအားဖြင့် **"ဖြူစင်ခြင်း၊ ဖြောင့်မတ်ခြင်း၊ ပွင့်လင်းရိုးသားခြင်း၊ တက်ကြွမှု ရှိခြင်း၊ အနစ်နာခံခြင်း၊ ရဲရင့်မှု ပိုင်ဆိုင်ခြင်း"** တို့ဖြစ်ပြီး ၊**"အတ္တ"** ဆိုသည်မှာ **"ကိုယ်အကျိုးစီးပွားကိုသာ မက်မောသည့်စိတ်ရှိခြင်း"** တို့ ဖြစ်ကြောင်း ပညာရှင်တို့က ဖွင့်ဆို ထားပါသည်။ ထို့ကြောင့် **"ပရဟိတ"** ဆိုသည်မှာ မိမိ၏အတ္တစိတ်ကို ဆန့်ကျင်ပြီး မိမိ ကိုယ်ကျိုး စီးပွားကို မကြည့်ဘဲ အများ အကျိုးကို ဆောင်ရွက် တတ်သည့် အတ္တစိတ်ကင်းမဲ့သူ ဖြစ်ပါသည်။

"ပရဟိတသမား" ဆိုသည်မှာ ကိုယ်ချင်းစာစိတ်နှင့် ချစ်သည့်စိတ်ကိုပေါင်းစပ်ပြီး မိမိလက်ဖြင့် လောကအလှကို ဖော်ဆောင်ချင်သူမျိုးကိုဆိုလိုပါသည်။ ပရဟိတလုပ်ဆောင် ခြင်း၏ အကျိုးကျေးဇူးများမှာ (၁) အပင်ပန်းခံနိုင်ခြင်း၊ (၂) ဒုက္ခများကိုသိလာပြီး လူဘဝ ပြဿနာများကို အတူတကွ ရင်ဆိုင် ဖြေရှင်းနိုင်သည့် ခွန်အား ရှိလာခြင်း၊ (၃) ဥပေက္ခာတရားကို လက်ကိုင် ထားနိုင်လာခြင်း၊(၄) တူသောအကျိုးပေးခြင်း၊ (၅) ခံယူချက် မှန်ကန်လာခြင်း နှင့် ဘဝအဓိပ္ပာယ်ရှိလာခြင်း၊ (၆) လူမှုကွန်ရက် ကျယ်ပြန့်လာခြင်းနှင့် လုပ်ငန်းခွင် အောင်မြင်လာခြင်း၊ (၇) စီမံခန့်ခွဲမှုစွမ်းရည် ပြည့်ဝ လာခြင်း နှင့် (၈) လူအများဖြင့် တွဲဖက် လုပ်ကိုင် နိုင်စွမ်းရှိခြင်း တို့ပင် ဖြစ်သည်ဟူ၍ ဘာသာရေး နယ်ပယ်တွင် ပြဆိုထားပါသည်။

ထို့ကြောင့် စာရေးသူသည် ပရဟိတစိတ်ဖြင့် လောက အလှဆင်နေသော အဓိကဇာတ်ဆောင် ခင်နွယ်စိုး စရိုက်ကို ပုံဖော်ဖန်တီးရာ၌ ပရဟိတလုပ်ဆောင်ခြင်း၏ အကျိုးကျေးဇူး (၈)ရပ် ကို အခြေခံ၍ ဖန်တီးပုံဖော် သွားသည်ဟု ယူဆရပါသည်။

စာရေးသူ လက်ံာရည်ကျော် ဖန်တီးထားသော အဓိက ဇာတ်ဆောင် ခင်နွယ်စိုးသည် ဘွဲ့ရပညာတတ် သူဌေး သမီး တစ်ဦး ဖြစ်သော်လည်း မိမိ၏ဘဝ တိုးတက်မှုကို မကြည့်၊ ကိုယ်ကျိုးစွန့်ကာ ပရဟိတ လုပ်ငန်းများကို စွမ်းစွမ်းတမံ ကူညီလုပ်ဆောင် ပေးနေသည့် မိန်းမသား တစ်ဦး ဖြစ်ပါသည်။ စာရေးသူ သည် ဇာတ်ဆောင် ခင်နွယ်စိုးကို မဖွံ့ဖြိုးသေးသည့် ဆင်းရဲ မွဲတေပြီး ဝေးလံခေါင်သီသည့် နေရာဒေသများတွင် သွားရောက် ကူညီထောက်ပံ့ပေးနေသူ တစ်ဦ ဖြစ်ကြောင်း ဖန်တီး ရာ၌-

"ကျွန်မ ကြိုးပိုင်းထဲက မူလတန်းကျောင်းကို ရောက်တာ နှစ်ခေါက်ရှိပြီ၊ အဲဒီကလေးတွေမှာ ဗလာ စာအုပ် လည်း မရှိဘူး၊ စားပွဲလည်းမရှိဘူး၊ ခဲတံ ဘောပင် လည်း မရှိဘူး၊ ဆရာမမှာလည်း ကျောက်သင်ပုန်း မရှိဘူး၊ ကျောက်သင်ပုန်း ဝေးလို့ ကျောက်သင်ပုန်း ချိတ်စရာ နံရံ တောင် မရှိဘူး၊ အဲဒါ ကျွန်မ ရန်ကုန်မှာလိုက်စုလို့ ရသမျှ သူတို့အတွက် လိုတာ ကလေးတွေပဲ၊ အဝတ်အစားတွေလည်းပါတယ်၊ ကျွန်မ မိဘရယ် သူတို့ မိတ်ဆွေတွေရယ်၊ ကျွန်မ သူငယ်ချင်း တွေရယ်စုပြီး လှူလိုက်ကြတာ သူတို့က စစ်မယ် ဆိုပြီး သာချထားတာ ကားကလည်း တစ်နေ့ တစ်စီးပဲ ထွက်တာ၊ဒီနေ့ ကားမမီလိုက်ရင် ဒီပစ္စည်းတွေ ကျွန်မ ဘယ်သွား ထားရမလဲ ကျွန်မမသိဘူး" (စာ-၂၄) ဟုဝေးလံပြီး လမ်းခရီး ခက်ခဲကြမ်းတမ်းသည့် နေရာတွင် လိုအပ်သည်များကို ကူညီ ထောက်ပံ့ပေးခြင်းအားဖြင့် လည်းကောင်း၊ **"ညနေပိုင်းတွေမှာ အဲဒီ မီးပွိုင့်မှာ ပန်းရောင်း နေတဲ့ ကလေးတွေကို ငါတို့ စာသွား သင်ပေးကြတာ၊ အဲဒီနားက ကြော်ငြာ ဆိုင်းဘုတ်ကြီး နားမှာပဲ သူတို့ ပန်းရောင်း မပျက်ရအောင် ငါနဲ့ အိတုတ် စာသင်ပေးနေတဲ့ အချိန် ဟိုကောင်တွေ ပန်းရောင်း ပေးထားတာ"** (စာ-၁၅၂) ဟု လမ်းဘေး စာသင်ဝိုင်း ထူထောင်ပြီး ပညာရေးထက် ဝမ်းရေးကို ဦးစားပေး နေရသည့် ကလေးများ၏ ဖွံ့ဖြိုး တိုးတက်ရေးကို ကူညီပေးနေသည့် အချက်ကို လည်းကောင်း ဖန်တီး ပုံဖော် ထားပါသည်။ ထိုအချက်များကြောင့် စာရေးသူ သည် သူ၏ ဇာတ်ဆောင် စရိုက်ကို ပရဟိတ လုပ်ဆောင်ခြင်းမှ ရရှိသည့် အကျိုး ကျေးဇူးဖြစ်သည့် "အပင်ပန်းခံနိုင်သည့် အချက်ဖြင့် ကိုက်ညီမှုရှိသူ" တစ်ဦးအဖြစ် ဖန်တီးထားခြင်း ဖြစ်ပါသည်။

ထို့ပြင် ခင်နွယ်စိုးသည် အများအကျိုးကို ဆောင်ရွက် သယ်ပိုးရာတွင် မိမိတစ်ဦးတည်းတွင်သာ အခက်အခဲ

အကျပ်အတည်းများဖြင့် ဒုက္ခရောက်နေခြင်း မဟုတ်ဘဲ လူတိုင်းလူတိုင်းတွင် သူဒုက္ခနှင့် သူရှိကာ ဘဝပြဿနာများ ကို ရင်ဆိုင်ဖြေရှင်းနေရပါလား ဆိုသည့်အချက်ကို ပရဟိတ လုပ်ဆောင်ရင်းဖြင့် တဖြည်းဖြည်း သိလာရကြောင်းကို-

"နှယ်စိုးထက် ဆိုးတဲ့လူတွေရှိတယ်" (စာ-၇၆)

"ဒီက ဆရာဝန်တွေလို ဝန်ထမ်းတွေပေါ့ သူတို့ ရတဲ့ လစာနဲ့ခံစားခွင့်နဲ့စာရင်သူတို့စွမ်းဆောင်နေတဲ့ လုပ်ငန်းတွေ ကလည်း ပရဟိတ စစ်စစ်တွေပဲ၊ ဒါဆရာဝန်ထဲမှာမှ မဟုတ်ဘူး၊ ကျောင်းဆရာတွေ ရှိတယ်၊ အင်ဂျင်နီယာတွေ ရှိတယ်၊ ဝန်ဆောင်မှုတွေ အမျိုးမျိုး ပေးနေတဲ့ ဝန်ထမ်းမျိုးစုံ ရှိတယ်၊ ငါးမတွေလိုပဲ ဥဥပြီး အသံမပြုကြတော့ သူတို့ ဘယ်လောက် လုပ်ပေးနေတယ် ဆိုတာကို ဘယ်သူမှ မသိကြဘူး၊ ဒီကြားထဲမှာ သူတို့ထဲမှာပဲ လုပ်ပိုင်ခွင့်ကို ကိုယ်ကျိုး အတွက် အသုံးပြုတဲ့ လူတွေ ပေါ်လာ ပြန်တယ်" (စာ-၇၇)

"ကိုယ့်ဖို့မပါ အများအတွက်ချည်းပဲ ကျားကုတ် ကျားခဲ လုပ်ပေး နေကြတဲ့ ဒီက ဆရာဝန်ကြီးတွေ အပါအဝင် စေတနာရှင် ဝန်ထမ်းတွေလည်း ငါးမတွေ ဖြစ်ကုန်ရော" (စာ-၇၇)

"ဦးသွေး ပြောတာ ဟုတ်တယ်၊ ကတော် ကတော် တွေကိုပဲ ဘုန်းတော်ဘွဲ့ပေးနေတဲ့ လူတွေ ကျွန်မ တွေ့ဖူးတယ်" (စာ-၇၇)

ဟု ဦးမြသွေးနှင့် ခင်နွယ်စိုးတို့ အပြန်အလှန် ပြောစကားဖြင့် ခင်နွယ်စိုးသည် မိမိထက် ဒုက္ခရောက် နေသူများ လောကၥ ရှိကာ သူတို့ဘာသာ အခက်အခဲများကို ရင်ဆိုင် ဖြေရှင်းနေရ ပါလား ဟူသော အသိရလာသူအဖြစ် ဖန်တီးထားပါသည်။ ထို့ပြင် "လူ့ဘဝ ပြဿနာများကို တတ်စွမ်းနိုင်သမျှ ရင်ဆိုင် ဖြေရှင်းနိုင်သည့် ခွန်အား ရှိနေကြောင်း"ကိုပါ ပုံဖော် ထားရုံမက တလွဲဆံပင်ကောင်းသည့် ခေတ်ကာလ ပုံရိပ်ကိုပါ ပုံဖော် ဖန်တီးထားသည်။

ခင်နွယ်စိုးသည် မိမိစိတ်သဏ္ဌာန် ကြည်လင် အေးချမ်းရန် ဗြဟ္မာစိုရ်တရား လက်ကိုင် ထားကာ ဥပေက္ခာတရားနှင့် နေတတ်သူ တစ်ဦးအဖြစ်ကို-

"စိတ်နာတာလည်း မရှိဘူး၊ သတိရတာလည်း မရှိဘူး၊ ရှင်းရှင်း ပြောရရင် ဟောဒီကမ္ဘာကြီးမှာ သီဟ ဆိုတဲ့ ကောင်တစ်ယောက် ရှိနေသလား၊ ရှိမနေဘူး လားကို စိတ်မဝင်စားတာ"(စာ၁၄၉)ဟု

ချစ်သူဟောင်းနှင့်ပြန်ဆုံတွေ့ သည့်အခါ သူ၏ခံစားမှုကို သူငယ်ချင်းများအား ပြောပြခြင်း ဖြင့်လည်းကောင်း၊

"အသိအမှတ်ပြုခံရတယ် ဆိုတော့လည်း ဝမ်းသာ စရာပေါ့ သိပ်တော့လည်း အရေးမကြီးပါဘူး ဦးသွေးရယ်၊ သူတို့ ဆုပေးပေး မပေးပေး၊ နှယ်စိုးက ကိုယ်ယုံကြည်တာကို ကိုယ်ဆက်လုပ်မှာပါ" (စာ-၁၈၈)ဟု ကင်ဘာရာတွင် ဆုလာ ယူရန်ခေါ်သည် နှင့်ပတ်သက်၍ လည်းကောင်း ဇာတ်ဆောင် အချင်းချင်း ပြောစကားတို့ဖြင့်ဖန်တီးထားသည်ကို တွေ့ရ ပါသည်။ ဤတွင် မပြည့်စုံသော ဘဝတို့၏ ခံစားချက်များကို မျှဝေ ခံစားနေရသော ခင်နွယ်စိုးသည် မိမိရင်တွင်း ခံစားချက် ဖြစ်သော ချစ်သူဟောင်းသီဟအပေါ်တွင် လည်းကောင်း၊ စေတနာနှင့် ရပ်တည်သူဖြစ်၍ ဂုဏ်ထူး ဘွဲ့ထူး ဝိသေသ များကို လည်းကောင်း "ဥပေက္ခာ ထားနိုင်လာသည့် စရိုက်"ကို ပေါ်ပေါက်လာအောင် ဖန်တီးထားပါသည်။

ထို့ပြင် ခင်နွယ်စိုးသည် အများအကျိုး အတွက် ဆိုလျှင် ကိုယ်ကျိုးမကြည့်ဘဲ အနစ်နာခံ ကူညီတတ်သူ ဖြစ်သဖြင့် ကောင်းကျိုး ချမ်းသာများနှင့်တူသော အကျိုး ကို ပြန်လည် ခံစားရသူအဖြစ် ပုံဖော် ဖန်တီးထား သည်ကို -

"ကျွန်မလည်း နားမလည်နိုင်အောင် ဖြစ်နေတာ မူးမူးနေလို့ မျက်စိအထူးကု ဆရာဝန်သွားပြတာ၊ မျက်မှန်ပါဝါ ကလျော့လျော့ လာနေတယ်။ အခုဆို မရှိသလောက် ဖြစ်နေ လို့ဖြုတ်ထားတာ" (စာ-၁၄၂) ဟူ၍ ဖော်ပြထားရာ မျက်မှန် တပ်ထားရာမှ မျက်မှန်ဖြုတ်လိုက်ရသည်အထိ "ကောင်းကျိုး ချမ်းသာ ခံစားရသူ" အဖြစ် တွေ့ရပါသည်။

တဖန် လမ်းဘေးတွင် ပန်းရောင်းနေသော ကလေး များကို ပညာသင်ယူစေရန် အတွက် သူတို့အစား ပန်း ကူရောင်း ပေးပြီး ကူညီကာ ခံယူချက် မှန်ကန်လာသူ တစ်ဦး ဖြစ်ကြောင်းကိုလည်း-

"ပန်းရောင်းတဲ့ အလုပ်က ရှက်စရာ၊ အားငယ်စရာ မဟုတ်ဘူးလို့လည်း သဘောပေါက် စေချင်တယ်။ ပန်းရောင်း နေရတဲ့ လူမို့ ပညာသင်စရာ မလိုဘူးဆိုတဲ့ အတွေးကိုလည်း ဖျောက်စေချင်တယ်" (စာ-၁၅၂-၁၅၃) ဟူ၍ လောကတွင် အလုပ်ဟူသမျှ ဂုဏ်ရှိလှကြောင်း၊ သမာအာဇီဝ အလုပ် ဖြစ်လျှင် မည်သည့် အလုပ်မဆို လုပ်ကိုင်သင့်ကြောင်း ခံယူထားသည့် စိတ်ဓာတ်စရိုက်ကို ခင်နွယ်စိုး၏ ပြောစကားဖြင့် သိရပါသည်။

စာရေးသူသည် ခင်နွယ်စိုးကို မှန်ကန်သော ဆုံးဖြတ်ချက်ကို ချတတ်သူအပြင် မိမိ ခံယူချက်ကို ယုံကြည်သူ အဖြစ် ဖန်တီးထားပါသည်။

ထို့နောက် ခင်နွယ်စိုး၏ ပရဟိတလုပ်ငန်းများ ဆောင်ရွက်ခြင်းကြောင့် အများသူငါ လူထုအပေါင်းက ခင်နွယ်စိုးအား တန်ဖိုးထား လေးစားလာကြသည်။ ထိုအချက်မှာ - **"ဆရာဝန်တောင် မဖြစ်သေးခင် အဲဒီ လောက် အဖိုးတန်တဲ့အစ်မ တစ်ယောက်ရဲ့ အသက်ကို လုတဲ့ နေရာမှာပါဖူးရရင် သားလည်း ပျော်မှာပဲ"** (စာ-၁၁၁) ဟု သားကြီး၏ ပြောစကားဖြင့် လည်းကောင်း၊

"ခင်နွယ်စိုးအသက်အတွက်ဆိုလျှင်သူတို့ အသက် နှင့် ရင်း၍ စွန့်စားကြမှာပဲ" (စာ-၁၀၈) ဟူ၍ လည်းကောင်း၊ ခင်နွယ်စိုး ကင်ဘာရာမှာ ဆုယူစဉ် ပါမောက္ခ ဆရာမကြီးက

"သိပ်ချစ်ဖို့ ကောင်းတာပဲကွယ်၊ မင်းကို တို့အားလုံး ချစ်တယ်" (စာ-၂၁၄) ဟု လူထုအပြင် တစ်ကမ္ဘာလုံးကပါ တန်ဖိုးထား ချစ်ခင်လာကြသဖြင့် ပတ္တမြားမှန်လျှင် နှံမနစ် ဟူသော သဘောတရားကဲ့သို့ ခင်နွယ်စိုး၏ "ဘဝကို အဓိပ္ပာယ် ရှိလာသူ"အဖြစ် ဖန်တီး ထားပါသည်။

ခင်နွယ်စိုးသည် အများအကျိုးအတွက် ကူညီ ဆောင် ရွက်ပေးနေသဖြင့် သူ၏ လူမှုကွန်ရက်သည် ကျယ်ပြန့် လာပြီး လုပ်ငန်းခွင်လည်း အောင်မြင်မှု ရှိလာခြင်းကို -

"နွယ်စိုးကို ကင်ဘာရာမှာရှိတဲ့ ဩစတြေးလျ အမျိုးသား တက္ကသိုလ်က နွယ်စိုး လုပ်နေတဲ့ ပရဟိတ လုပ်ငန်းတွေမှာ စွမ်းစွမ်းတမံ ဆောင်ရွက်ခဲ့တဲ့ သတင်း တွေကို သိရလို့တဲ့၊ ဂုဏ်ထူးဆောင် တက္ကသိုလ် ကျောင်းသားဟောင်းဆု၊ မက်ဒယ်လ် အော့ဖ် အေအန်ယူကို ချီးမြှင့်မယ်တဲ့၊ ကင်ဘာရာကို လာခဲ့ပါ၊ ဘွဲ့နှင်းသဘင် အခမ်း အနားမှာပေးပြီး ဂုဏ်ပြုချင် ပါတယ်တဲ့" (စာ-၁၈၇) ဟုဆိုသော အချက်ဖြင့် ဖန်တီးတင်ပြ ထားပါသည်။

ခင်နွယ်စိုးသည် စီမံခန့်ခွဲမှုစွမ်းရည် ပြည့်ဝသူ တစ်ဦး ဖြစ်ကြောင်းကို ကျောင်းတက်ရင်း ပန်းရောင်း နေရသည့် ကလေးလေးကို မကြည့်ရက်၍ မိုးကြီးကိုခေါ်ကာ ကူညီ ခိုင်းသည့် အချက်ဖြင့် သိရသည်။ ထိုအချက်မှာ-

"သူ့အိမ်က ဒီနားမှာပဲ၊ ဒီအချိန်ဆို သူ့အမေလည်း ရှိတတ်တယ်၊ နင် ကလေးကို မိတ်ဆက်ပြီး လိုက်သွား၊ ငါတို့အဖွဲ့ ကလေးအကြောင်း ပြောပြ၊ ကလေးကို သတိထားမိနေလို့ ကူညီချင်လို့ လို့ပြော ၊ ကလေး တစ်လ ပန်းရောင်းလို့ရတဲ့ ပိုက်ဆံ ဘယ်လောက်ရှိလဲ မေး ၊ ပြီးတော့ ထုတ်ပေးလိုက်၊ တစ်လ တစ်ခါ လာပေးမယ်၊ ကလေး ပန်းမရောင်း ပါစေနဲ့ လို့ပြော"(စာ-၈၉) ဟု ခင်နွယ်စိုး၏ ပြောစကားအရ ခင်နွယ်စိုးသည် ဒုက္ခရောက်နေသူတို့၏ အပေါ်ယံ ပြဿနာများသာမက မိသားစု တစ်စု၏ နောက်ကွယ်မှ ပြဿနာများကိုပါ စဉ်းစား၍ ဖြေရှင်းပေးသည့် အချက်ကလည်း "စီမံခန့်ခွဲမှုနှင့် ပတ်သက်၍ စွမ်းရည်ပြည့်ဝမှုရှိသူ" တစ်ဦးအဖြစ် ပုံဖော်ဖန်တီးထားပါသည်။

ထို့ပြင် ခင်နွယ်စိုးသည် ပရဟိတလုပ်ငန်းများကို ဆောင်ရွက်ရာတွင် တစ်ဦး တစ်ယောက်တည်း ဆောင်ရွက် ခြင်း မဟုတ်ဘဲ လူအများနှင့်လည်း တွဲဖက်၍ လုပ်ကိုင်နိုင်သူ တစ်ဦးဖြစ်ကြောင်းကို-

"ငါအဲဒါတွေကို စိတ်မဝင်စားဘူး၊ ငါစိတ်ဝင်စား တာက နာဂစ်တုန်းက အန်ဂျီအိုတွေ တဲ့ ငါးလုံးလောက် ပြီးတဲ့အချိန်မှာ သူအလုံး ၃၀ ဘေးချင်းယှဉ် ပြီးအောင် ဘယ်လိုဆောက်ခဲ့သလဲဆိုတာပဲ၊ အခု ငါသွားဆောက်ချင် နေတဲ့ နေရာက တို့မဝင်ရင် ဘာသာခြားဝင်တော့မယ်၊ ဟိုလူတွေကဝင်ရင် သူတို့ဘာသာဝင်ရမယ်ဆိုတာမျိုး အကန့်အသတ်တွေနဲ့၊ ငါ သူတို့ထက် ဦးအောင် ဆောက်ပြီး ကြိုက်တဲ့ဘာသာ ဝင်နေပါလို့ ပြောပြ လိုက်ချင်တာ၊ ဒါမျိုး ပုံပိုးနိုင်မှာက သူအသေအချာဆုံးပဲ" (စာ-၂၉) ဟု သူ၏ ပရဟိတ လုပ်ဆောင်ရာတွင် လူမျိုးမရွေး၊ ဘာသာမရွေး ကူညီချင်စိတ်ရှိပြီး သူ့အလုပ်နှင့် ပတ်သက်၍ ဘယ်လိုလူမျိုး နှင့် ပူးပေါင်းပြီး လုပ်ရမလဲဆိုသည့် အချက်ကို သိရှိသူ ဖြစ်သည်။ ထိုအချက်အရ ခင်နွယ်စိုးသည် ပရဟိတ လုပ်ရခြင်း အကျိုးကျေးဇူးများထဲမှ " လူအများဖြင့် တွဲဖက်လုပ်ကိုင် နိုင်စွမ်းရှိသည်" ဆိုသည့် အချက်ဖြင့် ကိုက်ညီမှုရှိစေရန် ဖန်တီးတင်ပြထားပါသည်။

စာရေးသူ လက်ံရည်ကျော်သည် **"ပန်းဒေါင်း"** ဝတ္ထုတွင် အဓိကဇာတ်ဆောင်ခင်နွယ်စိုးကို ဖန်တီး ပုံဖော်ရာတွင် ဝတ္ထုတွင် ပါဝင်သော အချစ်အလွမ်း ဇာတ်ကောင်တို့၏ သဘောသဘာဝမှ သွေဖည်၍ ယနေ့ခေတ်နှင့် အံဝင်ခွင်ကျ ဖြစ်သည့် လောကကြီး အတွက် အုတ်တစ်ချပ် သဲတစ်ပွင့်ပမာ တန်ဖိုး ထား ရသော ပရဟိတစိတ်ဓါတ် အပြည့်အဝ ရှိသည့် ပရဟိတသမား လူငယ်တစ်ဦး၏ အရည်အချင်း ပြည့်မီသူ တစ်ဦးအဖြစ် စာဖတ်သူများ စိတ်ဓါတ် တက်ကြွ လာစေရန် ဖန်တီး ပုံဖော်ထားသည်ကို တွေ့ရှိရပါသည်။

၃၊ ၃၊ ၂။ အရံဇာတ်ဆောင်များ ဖန်တီးပုံ

စာရေးသူ လက်ံကျော်ရည်သည် အရံဇာတ်ဆောင်များ ကိုလည်း မိမိစိတ်ကြိုက် ပုံဖော် ဖန်တီးထားပါသည်။ ခင်နွယ်စိုး၏ ဇာတ်ဆောင်စရိုက် ပေါ်လွင်စေရန်အတွက် အဓိကတွန်းအား ပေးသည့် အရံဇာတ်ဆောင် တစ်ဦးမှာ သူနှင့်ပရဟိတလုပ်ငန်း များကို အတူတကွ ဆောင်ရွက် ပေးနေသည့် ဦးမြသွေးပင် ဖြစ်သည်။

ဦးမြသွေးသည် ပန်းချီပညာရှင်၊ စီးပွားရေး လုပ်ငန်းရှင် တစ်ဦးဖြစ်ပြီး ရုပ်ရည်မှာ ချောမောခံ့ညားပြီး အရွယ်တင် နုပျိုသူတစ်ဦးဖြစ်ပါသည်။ မုဆိုးဖိုတစ်ဦး ဖြစ်ပြီး မယားဘက် မှကျန်ခဲ့သော သားနှင့် သမီးကို ထိန်းသိမ်းစောင့်ရှောက်နေသူ တစ်ဦးလည်းဖြစ်သည်။

ဦးမြသွေးကို ဖန်တီးရာတွင် အတွေးအခေါ် ရင့်ကျက်သူ၊ မမြဲသော တရားဖြစ်သည့် နုပျိုခြင်း၊ အိုခြင်း သဘောတရား ကိုလည်း နှလုံးသွင်းတတ်သူ ဖြစ်ပေါ်လာသော ကိလေသာ စိတ်ကို ပယ်သတ်ကာ မိမိကိုယ်ကို ထိန်းသိမ်းနိုင်သူတစ်ဦး အဖြစ် ဖန်တီးထားပါသည်။ သာဓကအားဖြင့်-

“မအိုတဲ့လူတော့ ဘယ်သူမှ မရှိဘူး၊ ကိုယ့် ပတ်ဝန်းကျင်မှာကိုယ့်ထက်နဲနဲကြီးတဲ့သူတွေအိုသွားကြ တာ ဒီလိုပဲတွေ့နေရတာပဲလေ၊တို့ကတော့ ဖျတ်ခနဲ အိုသွားမယ် ထင်ပါရဲ့” (စာ-၄၄) ဟု မိမိအား အရွယ်နုပျိုသည်ဟု ပြောသောအခါ ပြန်လည် ပြောဆိုသော စကားဖြင့် သော်လည်းကောင်း၊

“ကာမဂုဏ်အာရုံ၏ ညှို့ယူဖမ်းစားမှု၊ ဦးနှောက် နှင့် ဆင်ခြင်တုံ တရားက ဘာမှ အလုပ်လုပ်ချိန် မရလိုက် ဟော်မုန်းတွေကလောင်စာထည့်ပြီးသွေးသားကို ခုတ်မောင်း ပစ်လိုက်ကြတာ ငါးမိနစ် လောက်ကြာ တယ်” (စာ-၇၀) ဟုမိမိကိုယ်ကိုတရား သဘောမှတ်ယူ တတ်သူတစ်ဦးအဖြစ် လည်းကောင်း ဖန်တီးထားသည်ကို တွေ့ရပါသည်။

ထို့ပြင် ကွယ်လွန်သူဇနီးအပေါ် သစ္စာရှိသူအဖြစ် ဖန်တီးရာတွင် **“ယောကျ်ားတစ်ယောက်၏ နံဘေးမှာ မိန်းမ တစ်ယောက်မရှိလျှင် ရှိအောင် နောက်တစ်ယောက် ထပ်ရှာ သင့်သည်ဟု ခံယူထားသူမျိုး မဟုတ်ပါ”** (စာ-၄၁) ဟူသော ဇာတ်ဆောင် ပြောစကားဖြင့် ပေါ်လွင်စေခဲ့ပါသည်။ သို့သော် လည်း ဦးသွေးသည် ကွယ်လွန်သူ ဇနီးချောနှင့် အလွန်တူသော ခင်နွယ်စိုးကို တွေ့ရသော အခါတွင် ပုထုဇဉ်ပီပီ စိတ်ယိမ်းယိုင်မိသည်။ သို့သော် ခင်နွယ်စိုး၏ စိတ်ဓါတ်နှင့် လုပ်ဆောင်ချက်များအပေါ် လေးစားမှုကြောင့် ၁၅၀၀ မေတ္တာထက် ၅၂၈ မေတ္တာက အားသာသွားပြီး ခင်နွယ်စိုး အပေါ် ညီမအရင်း တစ်ယောက်ပမာ တန်ဖိုးထား စောင့်ရှောက်ခဲ့ပါသည်။

ခင်နွယ်စိုး၏ တချို့အပြုအမူကိစ္စများတွင် အဖေ နှင့် အစ်ကို သာမက သူငယ်ချင်းများပင် တားမရသောအခါ ဦးမြသွေးက အကျိုးအကြောင်း ပြောပြပြီး တားမြစ် သည်ဆိုလျှင် ခင်နွယ်စိုး လက်ခံသည်ဆိုသည့် အချက်အရ ခင်နွယ်စိုးအပေါ် သြဇာ လွှမ်းမိုးနိုင်သူ ဖြစ်သည်။

ထို့ပြင် ဦးမြသွေးကို ကင်ဘာရာသို့ လိုက်ပို့ရန် ပြောသောအခါ နေမကောင်းသည့်ကြားမှ ခင်နွယ်စိုး နောက်သို့ ရောက်အောင် လိုက်ခဲ့သည်။ မသွားခင်ညတွင် ခင်နွယ်စိုး စာသင်ပေးနေသည့် လေလွင့် ကလေးများကို ရဲက ဖမ်းသွားသည့် ကိစ္စကိုလည်း ဖြေရှင်းပေးရ ပြန်သည်။ ခင်နွယ်စိုး မြန်မာပြည် ပြန်ရောက်လျှင် ပတ်စပို့ အသိမ်းခံရမည့် ကိစ္စကိုလည်း ကြိုတင် တွေးမိကာ ဖြေရှင်း ထားသည့် အချက်ကလည်း ခင်နွယ်စိုး အပေါ် အသေးစိတ် ဂရုစိုက်သူ တစ်ဦးအဖြစ် ဖန်တီးထားပါသည်။

ဦးမြသွေးသည် အများအမြင်တွင် သူဌေး တစ်ယောက် ဖြစ်သော်လည်း အမှန်တွင် မည်သည့် ပိုင်ဆိုင်မှုမျှမရှိ။ သားနှင့်သမီး အရွယ်ရောက်လျှင် အားလုံးလွှဲပေး ရမည် ဟူသော အချက်ကလည်း လောဘ ကင်းသူ အဖြစ် ဖန်တီးထားသည်။ စာရေးသူသည် ဆက်လက်၍ ဦးမြသွေး ကို ဖန်တီးရာတွင် မယားပါ သမီးငယ်၏ **“ပထွေး”** ဟူသော အမြင်နှင့် မချေမငံ ဆက်ဆံမှုကို သည်းခံ နိုင်လောက်သည် အထိ သဘောထား ပြည့်ဝသူ၊ မိမိ၏ရင်သွေး အရင်းအချာ မဟုတ်သော်လည်း သားသမီးများပမာ သံယောဇဉ် ကြီးသူ၊ ပန်းချီပညာရှင် တစ်ယောက်ပီပီ စိတ်နှလုံး နူးညံ့သိမ်မွေ့သူ၊ စိတ်ထားကောင်းမွန်ပြီး အတွေးအခေါ် အမြော်အမြင်ကြီးသူ တစ်ဦးအဖြစ် ဖန်တီးထားပါသည်။

စာရေးသူသည် ဦးမြသွေးကို ဇာတ်လမ်းအစမှ အဆုံးတိုင် ခင်နွယ်စိုး အပေါ် သံယောဇဉ်ကြီးသူအဖြစ် ခင်နွယ်စိုး၏ စရိုက်ကို ပေါ်လွင်စေရန် အတွက် တွန်းအား ပေးထားသည့် အဓိကအရံ ဇာတ်ဆောင် တစ်ဦးအဖြစ် ဖန်တီးထားသည် ကို တွေ့ရပါသည်။

အရံဇာတ်ဆောင်တစ်ဦးဖြစ်သည့် မိုးကြီးကို ဖန်တီး ရာတွင် ခင်နွယ်စိုး၏ လုပ်ဖော်ကိုင်ဖက်သူငယ်ချင်း၊ ပရဟိတ လုပ်ငန်းများကို စိတ်ဝင်စားသူ ခင်နွယ်စိုးအပေါ် အနှံအတာ ခံပြီးမေတ္တာသက်ဝင်နေသူဖြစ်သော်လည်း

ညီမတစ်ယောက် ပမာ စောင့်ရှောက်သူ၊ အခွင့်အရေး မယူ၊ အနစ်နာခံသူ၊ တန်ဖိုးထား လေးစားသူ တစ်ဦး အဖြစ် ဖန်တီးထား ပါသည်။ ခင်နွယ်စိုး အပေါ် ချစ်သည့် အကြောင်းကို ဖွင့်မပြောရက်ဘဲ အရိပ်တကြည့်ကြည့် ဖြင့် စောင့်ရှောက်နေသူ တစ်ဦး ဖြစ်ကြောင်းနှင့် မိုးကြိုး၏ တစ်ဖက်သတ် မေတ္တာတရား သံယောဇဉ်ကို ဖန်တီး ခဲ့ပါသည်။

အရံဇာတ်ဆောင် သားကြီးကို ဖန်တီးရာတွင်လည်း သားကြီးသည် စာဖတ်ဝါသနာပါသဖြင့် အတွေးအခေါ် အမြော်အမြင်ရှိသူ၊ ငယ်ရွယ်သော်လည်း ရင့်ကျက်သည့် အတွေးအခေါ်ရှိသူ၊ အနေအေးသူ၊ ဦးမြသွေး အပေါ် တွင်လည်း "ပထွေး"ဟူသော အမြင်မရှိဘဲ လေးစား တတ်သူ၊ ခင်နွယ်စိုး အပေါ် မေတ္တာသက်ဝင် နေသော်လည်း ဖွင့်ဟမပြောရဲ လောက်အောင် တန်ဖိုးထား လေးစားရသူ၊ ဆေးကျောင်း တက်နေသည့် ဆရာဝန်ပေါက်စ ပရဟိတ သမားတစ်ယောက်အဖြစ် ဖန်တီးထားပါသည်။

အရံဇာတ်ဆောင် တစ်ဦးဖြစ်သည့် အိတုတ်သည် ခင်နွယ်စိုး ၏ သူငယ်ချင်းတစ်ဦး ဖြစ်ပြီး ညီမအရင်း သဖွယ် ချစ်ခင်သူ၊ ပရဟိတ လုပ်ငန်းများကို စိတ်တူ ကိုယ်တူ လုပ်ဆောင် ပေးသည့် နောက်တန်း စစ်ကူ ပရဟိတသမား တစ်ဦးအဖြစ် ဖန်တီး ထားပါသည်။

သမီးငယ်ကို ဖန်တီးရာတွင် ဦးမြသွေး အပေါ် **"ပထွေး"** ဆိုသောအသိဖြင့် အမြင်မကြည်သူ၊ ခပ်ပေါ့ပေါ့ နေတတ်သူ၊ ခေတ်မီစွာ ဝတ်စားဆင်ယင်တတ်သူ၊ မောက်မာသူ၊ မာန်မာနကြီးသူ၊ အလိုလိုက် ခံရသူ ဖြစ်သဖြင့် ခပ်ဆိုးဆိုး စရိုက် ရှိသူအဖြစ် ရေးဖွဲ့ထားပြီး နောက်ဆုံးရောက်မှ အသိတရား ရလာပြီး ပရဟိတ အဖွဲ့တွင် ပါဝင် ကူညီပေးသူ တစ်ဦးအဖြစ် ဖန်တီး ထားပါသည်။ ထိုသမီးငယ်၏ စရိုက်ဖြင့် ဦးမြသွေး၏ စိတ်ထားကို ကြွတက်လာအောင် ဖန်တီး ပုံဖော် ထားခြင်းသည် အမည်းအပေါ် အဖြူရောင် ထင်အောင် ဖန်တီး ပြသခြင်း ယှဉ်ပြခြင်း သဘောပင် ဖြစ်သည်။

စာရေးသူ လင်္ကာရည်ကျော်သည် သူ၏ ဇာတ်ဆောင် များအားလုံးကို ဇာတ်လမ်းအစမှအဆုံးတိုင် "ငါ" ဆိုသည့် အတ္တ စိတ်ကင်းမဲ့ကာ ကိုယ်ကျိုးမကြည့်ဘဲ အများအကျိုး ဆောင်ရွက်ပေးသည့် နှလုံးလှသည့် ပရဟိတသမားများ အဖြစ် ဖန်တီးထားပါသည်။ ထို့ပြင်စာဖတ်သူများကို ၅၂၈ မေတ္တာ တရား၏ အရှိန်အဟုန်ကြီးမားမှုကို မီးမောင်း ထိုးပြခဲ့သည်။ စာရေးသူဖန်တီးခဲ့သော ဇာတ်ဆောင်များ အားလုံးသည် ဒိဋ္ဌမင်္ဂလောကတွင် တွေ့မြင်နိုင်သည့် လူသဘာဝနှင့် နီးစပ်အောင် ပုံဖော် ဖန်တီးထားသည်ကို တွေ့ရှိရပါသည်။

ခြုံငုံသုံးသပ်ချက်

လင်္ကာရည်ကျော်သည် **"ပန်းဒေါင်း"** ဝတ္ထု ဇာတ်လမ်း ကို ဖန်တီးရာတွင် ဇာတ်ဆောင် အချင်းချင်း အပြန်အလှန် ပြောစကားတို့ဖြင့် အကြောင်းဆက်နည်း၊ အနုစိတ်ခြယ် မှုန်းနည်းနှင့် အားပြိုင်မှုနည်းတို့ကို အသုံးပြု၍ ဖန်တီး ထား သည်။

မြို့ပဝိကွက်၊ လှည့်ကွက် များကို အသုံးမပြုဘဲ ရိုးရိုး ရှင်းရှင်းဖြင့် ကြောင်းကျိုးဆက်စပ် ကာဇာတ်ဆောင်တို့၏ ကိုယ်၊ နှုတ်၊ နှလုံး အမူအရာများဖြင့်သာ ဝတ္ထုကို စိတ်ဝင်စား အောင် ဖန်တီးထားပါသည်။ စာရေးသူသည် ယနေ့ခေတ် လူငယ်လူရွယ် တစ်ချို့၏ အတွေးအမြင်သစ် များဖြင့် နိုင်ငံတော်၏တာဝန်များကို မိမိတတ်နိုင်သည့် ဘက်မှ ကူညီ ဖြေရှင်းပေးနေခြင်း၊ ပရဟိတ စိတ်ဓါတ် အပြည့်အဝရှိခြင်း၊ မည်သည့် အခက်အခဲများကိုမဆို ရင်ဆိုင် ကျော်လွှားကာ ဖြေရှင်းနိုင်ခြင်း၊ ထိုခေတ်ကာလ အစိုးရအပေါ် အားမလို အားမရဖြစ်ခြင်း၊ ချီးကျူး ထိုက်သူကို ချီးကျူးရမည့် အချက် များနှင့် လောကမံ အဆိုးအကောင်း ကြုံတွေ့လာသောအခါ မည်သို့မည်ပုံ ရင်ဆိုင်ရမည်ကို သိရှိလာခြင်း စသည်ဖြင့် ပုံပေါ် လာအောင် ဖန်တီးရေးဖွဲ့ ထားသည်ကို တွေ့ရပါသည်။ ထို့ပြင် ရွှထောင့်အမျိုးမျိုးဖြင့် ဇာတ်လမ်းကို ဖန်တီးပြီး ဇာတ်ဆောင်များ၏ စရိုက်ကို ဒိဋ္ဌမင်္ဂလောကတွင် အမှန် တကယ်ရှိသည့် လူသဘာဝများနှင့် ကိုက်ညီ နီးစပ်အောင် ပုံဖော်ခဲ့ပါသည်။ ဇာတ်သိမ်းပိုင်းတွင် မြန်မာ စာဖတ် ပရိတ်သတ် တို့၏ အကြိုက် ဖြစ်သော ချစ်မေတ္တာဖြင့် ဇာတ်သိမ်းခြင်း သဘောကို သွေဖည်၍ စာဖတ်သူ၏ အကြိုက်ကိုမလိုက်ခဲ့ပေ။ သို့သော် ဘဝအမောကို ရင်ဆိုင်နေရသော ကလေးသူငယ်တို့ အတွက် သော်လည်းကောင်း၊ အများအကျိုး ဆောင်ရွက် မှုကို နှစ်သက်သော သူတော်ကောင်းတို့ အတွက် သော် လည်းကောင်း၊ ကျေနပ် ပီတိဖြစ်စေသည့် အပြင် တိုင်းပြည်အတွက် များစွာ အကျိုးပြုသည့် ဝတ္ထုကောင်း တစ်ပုဒ် ဖြစ်သည်ဟု ဆိုနိုင်ပါသည်။

နိဂုံး

"ပန်းဒေါင်း"ဝတ္ထုသည် ၂၁ရာစု ဝတ္ထုရှည်တစ်ပုဒ် ဖြစ်ပါ သည်။ ငွေအားဓနအားမရှိသော ဖွံ့ဖြိုးဆဲတိုင်းပြည်

တစ်ခုတွင် လူစွမ်းအားနှင့်သာ ဘဝ ပြဿနာ ဖြေရှင်းနေရပုံ၊ ထိုလူစွမ်းအားတွင် ပြီးပြည့်စုံသော စွမ်းအားရှိသူတို့မှ သူတို့၏ နှလုံးသားအလှ စွမ်းအားနှင့် အတူ ကူညီဖြေရှင်းပေး နေရကြောင်းကို ဖန်တီး တင်ပြထားသည်။ တင်ပြပုံမှာရိုးဂုဏ် နှင့် ဆန်းသစ်သည်။ အတွေးအခေါ် အယူအဆ ခေတ်နှင့်ညီသည်။ ထို့ကြောင့် ၂၁ရာစုတွင် ရေးသားထားသော တိုင်းကျိုးပြည်ပြု ဝတ္ထုများ၏ ဖန်တီးမှု အတတ်ပညာများကို လေ့လာခြင်းဖြင့် မြန်မာစာပေ၏ အခန်းကဏ္ဍတစ်ခုကို ဖော်ထုတ်နိုင်သည်ဟု ယုံကြည်မိပါသည်။

ကျမ်းကိုးစာရင်း

[၁] မိုးမြေ၊ မ။ (၂၀၁၉)။ ***ဝတ္ထုရှည် ဖန်တီးသူနှင့် ဝတ္ထုရှည် ခံစားသူ***။ ရန်ကုန်၊ ရွှေကံ့ကော်ပုံနှိပ်တိုက်။

[၂] မြန်မာစာအဖွဲ့။ (၂၀၀၈)။ ***မြန်မာအဘိဓာန်၊ ဒုတိယ အကြိမ်***။ ရန်ကုန်၊ နေလင်းပုံနှိပ်တိုက်။

[၃] လက်ဘရည်ကျော်။ (၂၀၁၄)။ ***ပန်းဒေါင်း***။ ရန်ကုန်၊ နန်းဒေဝီပုံနှိပ်တိုက်။

[၄] Boulton,Marjorie.(1975).***The Anatomy of The Novel***. Taylor& Francis Ltd,London,United Kingdom.

ခင်ခင်ထူး၏ 'ကျေးတစ်ရာ ရသစာစုများ'မှ ထိန်းသိမ်းအပ်သော မြန်မာ့ယဉ်ကျေးမှုများ

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ဌေးဌေးအောင်
ကွန်ပျူတာတက္ကသိုလ်(မကွေး)

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် မြန်မာ့ရိုးရာ ယဉ်ကျေးမှု အမွေအနှစ်များ ထိန်းသိမ်း စောင့်ရှောက် သင့်ကြောင်း ဖော်ပြလိုသော စာတမ်းဖြစ် သည်။ မြန်မာ့မြေတွင်ကြီး၊ မြန်မာ့ရေသောက်ပြီး၊ မြန်မာ့ရိုးရာ ယဉ်ကျေးမှုကို မထိန်းသိမ်းနိုင်လျှင် စာပေနှင့်ယဉ်ကျေးမှု ပျောက်၍ လူမျိုးပျောက်ကာ တိုင်းပြည် ပျောက်ရမည့် အဖြစ်ကို မရောက်လို၍ မိမိတို့ယဉ်ကျေးမှုကို မြတ်နိုးလာစေရန် တင်ပြထား သည့် စာတမ်းဖြစ်သည်။ ယနေ့ခေတ် လူငယ်များ အနေဖြင့် နည်းပညာပိုင်း ဖွံ့ဖြိုးတိုးတက်လာသော်လည်း ရသစာပေကို ချစ်ခင်မှု အားနည်းလာကြသည်။ ထို့ကြောင့် ကိုယ့်နိုင်ငံ ကိုယ့်လူမျိုး၊ ကိုယ့်စာပေ၊ ကိုယ့်ယဉ်ကျေးမှုကို အမြတ်တနိုး တန်ဖိုးထား တတ်စေရန် ရည်ရွယ်ပါသည်။

သော့ချက်ဝေါဟာရ - ရိုးရာ၊ ဓလေ့၊ ရသ၊ ယဉ်ကျေးမှု၊ ပွဲတော်။

နိဒါန်း

ရိုးရာဟူသည် မိဘစဉ်ဆက် ကျင့်သုံးခဲ့သော အလေ့အထ ဖြစ်သည်။ ဓလေ့သည် ထုံးစံဓလေ့ဖြစ်သည်။ ထို့ကြောင့် မြန်မာ့ရိုးရာဓလေ့ ဟူသည်မှာ မြန်မာနိုင်ငံ၏ အခြေခံယဉ်ကျေးမှုဖြစ်သော မြန်မာနိုင်ငံသားတို့ မျိုးရိုးစဉ်ဆက် ကျင့်သုံးခဲ့သော ဓလေ့ထုံးစံများ ဖြစ်သည်။ မြန်မာ့ ယဉ်ကျေးမှု ရိုးရာ ဓလေ့များသည် ပထဝီအနေအထား လိုက်ပြီး သူ့နေရာနှင့်သူ ရှိကြသည်။ ထိုယဉ်ကျေးမှုများ မပျောက်ပျက်အောင် ထိန်းသိမ်းရမည့် တာဝန်သည် လူငယ် များ၏ တာဝန်ဖြစ်သည်။ ခေတ်မီတိုးတက်လာပြီး နည်းပညာများ ဖွံ့ဖြိုး တိုးတက်လာသည်နှင့်အမျှ ယဉ်ကျေးမှု လည်း ပျောက်ကွယ်လု ဖြစ်ခဲ့သည်။ ထိုပျောက်ကွယ်လု ဖြစ်သော ယဉ်ကျေးမှုများကို ထိန်းသိမ်းရန် အရေးကြီး လှသည်။ တစ်ခါတစ်ရံတွင် ရှေးခေတ် အကြောင်းအရာများနှင့်ပတ်သက်၍ လက်မခံနိုင်ဖွယ်ရာ ဖြစ်သော်လည်း တစ်ခါတစ်ရံတွင် လိုက်နာကြရမည် ဖြစ်သည်။ ယဉ်ကျေးမှု အမွေအနှစ်များကို ထိန်းသိမ်းစောင့်ရှောက်ရန် ကလောင် လက်နက်ဖြင့် တိုက်ပွဲဝင်ခဲ့သော စာရေးဆရာပေါင်း များစွာ ရှိသည့်အနက် ဆရာမခင်ခင်ထူးလည်း ပါဝင်သည်။ ဤစာ တမ်းတွင် ခင်ခင်ထူး၏ 'ကျေးတစ်ရာ ရသစာစုများ' စာအုပ်ကို အလေ့လာခံအဖြစ် သတ်မှတ်၍ တင်ပြပါမည်။

၁။ ရသစာတမ်း၏သဘောသဘာဝ

ရသစာတမ်းဟူသည် စာရေးသူ၏ အတွေ့အကြုံမှ ပေါက် ဖွားလာသော အမြင်၊ အသိ၊ အတွေးတို့ကို ခံစားမှုစွက်၍ ပုံဖော်ထားသည့် ရသမြောက်စာပေ အဖွဲ့တစ်မျိုး ဖြစ်သည်။ ရသစာတမ်း၏ သဘောကို မြန်မာပညာရှင်အချို့က အဓိပ္ပာယ် အမျိုးမျိုး ဖွင့်ဆို ခဲ့ကြသည်။

ရသစာတမ်းနှင့် ပတ်သက်၍ ဇော်ဂျီ၏ စိတ်ပင်လယ် စာတမ်းတွင်-

> **"ကိုယ့်ပတ်ဝန်းကျင်၌ နေ့စဉ်နေ့တိုင်း လူပ်ရှားသွားလာရင်း မြင်မိ၊ ကြားမိ၊ သတိရမိ၊ တွေးမိသမျှကို ပရိသတ်၌ မြင်ယောင်၊ ကြားယောင် ဖြစ်လာအောင်၊ ခံစားမှုတစ်ခုခုပေါ်အောင် ခံစား မှုအသိဖြင့် လည်းကောင်း၊ စိတ်ကူးဉာဏ်စွက်၍ လည်းကောင်း ရေးသော ရသ စာပေဟန် စာတမ်း မျိုး ဖြစ်သည်"[၃]**

ဟု ဖွင့်ဆိုထားသည်။

မောင်ခင်မင်နုဖြူ၏ စာတမ်းငယ် ဟူသည်တွင် -

> **"စာတမ်းငယ် ဟူသည် အကြောင်းအရာ တစ်ခုခု ကို စာရေးသူ ကိုယ်တိုင် တွေ့မြင်**

ခံစားသည့် အနေအထားဖြင့် ရသပါအောင် ရေးဖွဲ့ထားသော မတိုမရှည် စကားပြေအဖွဲ့မျိုး ဖြစ်သည်”[၂]

ဟု ရှင်းလင်းတင်ပြထားသည်။

တက္ကသိုလ်ဝင်းမွန်က အတွေးအမြင်ကို ဖော်ထုတ်သည့် ရသစာတမ်း၏သဘောကို စာတမ်းငယ်စာပေ စာတမ်းများတွင်-

“အကြောင်းအရာ တစ်ရပ်ရပ်ကို မူတည်ပြီး စာရေးသူ၏ အတွေးအမြင် ခံယူချက်တို့ကို ဦးစား ပေးပြီး ဖတ်ချင့်စဖွယ် ရေးဖွဲ့ထားသော စာတမ်း ငယ်များကို ဆိုလိုပါသည်”[၅]

ဟု ထုတ်ဖော်ထားသည်။

ထို့ကြောင့် ရသစာတမ်းဟူသည် စာရေးသူ၏ အတွေ့အကြုံ၊ အတွေးအမြင် ခံစားမှုများကို စိတ်ကူးဉာဏ်ဖြင့် ဖွဲ့ယှက်၍ တစ်ဆင့်ဖောက်သည်ချကာ တိုတိုကျဉ်းကျဉ်း ရေးသားထားသည့် ရသမြောက်စကားပြေ ပုံသဏ္ဌာန် ဖြစ်သည်ဟု ဆိုနိုင်ပါသည်။

၁၊ ၁။ ယဉ်ကျေးမှု

ယဉ်ကျေးမှု၏ အဓိပ္ပာယ်ကို မြန်မာအဘိဓာန်တွင် “ယဉ်ကျေးမှုဟူသည် သိမ်မွေ့ ပြေပြစ်သော တတ်သိလိမ္မာမှု၊ တိုးတက် ထွန်းကား လာသော လူမှု အဆင့်အတန်း၊ အစဉ် အလာအားဖြင့် ထိန်းသိမ်းတည်ရှိလာသော ဓလေ့ထုံးတမ်း စသည်တို့ကို ဆိုလိုသည်။”[၄]

ယဉ်ကျေးမှုတွင် ‘ရုပ်ပိုင်းဆိုင်ရာ ယဉ်ကျေးမှုနှင့် စိတ်ပိုင်းဆိုင်ရာ ယဉ်ကျေးမှုဟူ၍ ခွဲခြားနိုင်ပါသည်။ ရုပ်ပိုင်း ဆိုင်ရာ ယဉ်ကျေးမှုတွင် ‘ဒြပ်ရှိယဉ်ကျေးမှုနှင့် ဒြပ်မဲ့ ယဉ်ကျေးမှု’ ဟူ၍ ခွဲခြားနိုင်ပါသည်။ ဒြပ်ရှိ ယဉ်ကျေးမှုတွင် အဆောက်အဦများ အထိမ်းအမှတ် အဆောက်အဦများ၊ အနုပညာလက်ရာများ၊ ရှေးဟောင်း ဆိုင်ရာ ပစ္စည်းများ၊ မြေယာ ရှုခင်းများ ပါဝင်သည်။ ဒြပ်မဲ့ယဉ်ကျေးမှုတွင် ကျေးလက်အနုပညာ၊ ဓလေ့ထုံးတမ်းများ၊ ဘာသာစကား များ ပါဝင်သည်။ ဤစာတမ်းသည် ဒြပ်မဲ့ယဉ်ကျေးမှုတွင် ပါဝင်သော ဓလေ့ထုံးတမ်းများ အကြောင်းကို တင်ပြထား ပါသည်။

၂။ ခင်ခင်ထူး၏ ‘ကျေးတစ်ရာ ရသစုများ’မှ ထိန်းသိမ်းအပ်သာ မြန်မာ့ယဉ်ကျေးမှုများ

ရသစာတမ်းအချို့တွင် တစ်ခါတစ်ရံ ရင့်ကျက်သော အသိ ဉာဏ်များနှင့် ပြည့်နေတတ်ပြီး တစ်ခါတစ်ရံ တစ်လောက လုံးရှိ လူတို့၏ အတွေးအခေါ်ကို ပေးစွမ်းတတ် ပါသည်။ ရသစာတမ်းသည် အတွေးခံစားမှု တစ်ခုခုကို ရသမြောက် စကားပြေ အရေးအသားဖြင့် ရေးဖွဲ့ထားသော စာမျိုး ဖြစ် သည်။ ဤစာတမ်းတွင် စာရေးသူသည် သူ၏ရွာရှိ ရိုးရာ ဓလေ့များကို ပြန်ပြောင်း တွေးနေဟန် ရေးသားထားပါ သည်။

သင်္ကြန်ဟု ဆိုလိုက်သည်နှင့် လူတို့၏ ရင်ထဲ နှလုံးသား ထဲတွင် သင်္ကြန်နှင့်အတူ ကင်းကွာ၍ မရသော အရာ သည် ‘ပိတောက်’ ဖြစ်သည်။ ‘ပိတောက်’၏ အကြောင်းကို စာရေးသူက မိမိအိမ်ရှေ့ရှိ ပိတောက်ပန်း ပွင့်ပုံနှင့် ရွာတွင် ပိတောက်ပန်း ပွင့်ပုံတို့ကို နှိုင်းယှဉ်ရင်း ရွာက ပိတောက်ပွင့် များ၏ ရနံ့မွှေးကြိုင်ပုံကို -

“ကျွန်မတို့ အိမ်ရှေ့က ပိတောက်ပင်ပျိုကလည်း သည်နှစ်တော့ ပွင့်လိုက်စမ်း မယ်ဟဲ့ ဆိုသည့်ပုံ နှင့် ရွက်နဲတွေ ကဗျာကသီထိုးနေခဲ့ပြီ။ ပိတောက်ပင် ဆိုပြန်တော့ ရွာက ‘တောပိတောက် ပင်ကြီး’ကိုလည်း သတိရရပြန်ပါ၏။ ဘာ့ကြောင့် မှန်းမသိ။ ကျွန်မတို့ တစ်ရွာလုံးကသည် ပိတောက် ပင်ကြီးကို တောပိတောက်ပင် လို့ပဲ ခေါ်ကြ ပါသည်။ တောထဲ (ရွာအပြင် ခပ်ဝေးဝေး အခင်းစပ်) မှာ ပေါက်နေသည့်အတွက်ကြောင့်များလား။ သူ့ အရောင်က အဝါတစ်မျိုး သင်္ကန်းတော်ရောင် ဘက်ကို လှသည်။ သီတင်းရောင်လို့လည်း သုံးကြပါ၏။ အပွင့်စွာသည် ရနံ့ကလည်း ကြိုင်လှသည်။”[၁]

ဟု ဖော်ပြထားသည်။

ပိတောက်တွင် အရောင်အမျိုးမျိုး ရှိကြောင်း တော ပိတောက်၊ မြို့ပိတောက် ခွဲခြား နိုင်ကြောင်း တောပိတောက် မှာ အဝါရောင် ခပ်ရင့်ရင့် ဖြစ်ပြီး အခြားပိတောက်နှင့်မတူဘဲရနံ့မှာ အလွန်မွှေး ကြိုင်ပုံကို -

“မြို့က ပိတောက်တွေက ကုလား ပိတောက်တွေ၊ တို့ရွာက တောပိတောက်ကမှ ပိတောက်အစစ် အမွှေးကလည်း ရက်စက်သယ်”[၁]

ဟုဖော်ပြထား၍ လူငယ်များ အနေနှင့် ပိတောက်ပန်း ဟုသာ လူသိ များကြပြီး ပိတောက်ပန်းကို တောပိတောက်၊ မြို့ ပိတောက်၊ ကုလားပိတောက်၊ ဗမာ ပိတောက်ဟု ခွဲခြားနိုင် သည်။ ပိတောက်များအနက် ရွာရှိ

ပိတောက်ကသာ ပို၍ မွှေးကြောင်းကို ဖော်ပြထားသဖြင့် သူ၏ဇာတိကို ချစ်ခင် ကြောင်း၊ အစွဲအလန်းကြီးကြောင်း ပေါ်လွင်စေသည်။ ပိတောက်ပန်း၏ အဖွဲ့ကြောင့် စာဖတ်သူ၏ ရင်ထဲတွင် လည်း ပိတောက်ရနံ့ကို မွှေးပျံသင်းကြိုင် လာစေသည်။ မြန်မာ့ရိုးရာဓလေ့တွင် သင်္ကြန်နှင့်ပိတောက် ခွဲခြားမရနိုင် ကြောင်း ပိတောက်ကို လူတိုင်း အမြတ်တနိုး တန်ဖိုး ထားကြောင်း သိမြင် ခံစားစေပါသည်။

မြန်မာနိုင်ငံသည် ဗုဒ္ဓဘာသာအများဆုံး ကိုးကွယ် သည့်နိုင်ငံ ဖြစ်သည့်အလျောက် သင်္ကြန်အခါ ရောက်ပြီ ဆိုလျှင် ကျွေးလက်၊ မြို့ရွာမကျန် ဘုရားကျောင်းကန်၊ စေတီပုထိုးများကို ရေသပ္ပာယ်သည့် အလေ့အထ၊ ထုံး သင်္ကန်းကပ်သည့် အလေ့အထ ရှိကြသည်။ ထို့အတူ စာ ရေးသူ၏ ကျေးရွာတွင်လည်း ထိုအလေ့အထ ရှိပုံကို -

“သင်္ကြန်ဘုရားက ရွာနှင့် လှမ်းသောကြောင့် တစ်နှစ်ပတ်လုံး အရောက်အပေါက် နည်းကြသော်လည်း အခါရက် နီးပြီဆိုလျှင် ဘယ်သူကမှ မတိုက်တွန်းဘဲ ရောင်တော် ဖွင့်ကြတော့သည်။” [၁]

ဟု ဖော်ပြထားသည်။ ထိုအလေ့အထများသည် မြို့ကြီးများ တွင် အတွေ့နည်းပြီး ကျေးလက် တောရွာများ တွင်သာ အများဆုံး တွေ့ရသည်။ ထို့ကြောင့် ကျေးလက် ရိုးရာဓလေ့ ကို မပျောက်ပျက် ရအောင် ထိန်းသိမ်း ကြရမည်ဟု ဆင်ခြင် သတိ ဝင်မိစေသည်။ သင်္ကြန် ချိန်ခါတွင် စတုဒိသာမုန့်များ ကျွေးသော အလေ့အထ လည်း ရှိပါသည်။ ထိုအလေ့အထ သည် ကျေးလက် တောရွာ များတွင်မက မြို့များတွင်လည်း တွေ့နိုင်ပါသည်။ စာရေးသူသည် သင်္ကြန်ချိန်ခါရောက်လျှင် ရွာမှ မုန့်များကို တမ်းတမိကြောင်း ဖော်ပြထားသည်မှာ -

“ကျွန်မတို့ မန္တလေးရောက်တာ ကြာပါပြီ။ အခါ ရက်တွေဆိုလျှင် အမေက ရွာမုန့်တွေကို လွမ်း စကား ဆိုလေ့ရှိသည်။ မောင်းတင်းကုပ်၊ မောင်းပက်လက်တွေမှာ အပျိုတွေ တရုန်းရုန်း၊ မိန်းမကြီးတွေ တအုန်းအုန်း၊ တစ်ရွာလုံးက မောင်းတွေ တကျိကျို တကျောင်းကျောင်း”[၁]

ဟု လည်းကောင်း ၊

“မုန့်ဖက်ထုပ်များ အတွင်းက ဌာပနာလည်း မြေပဲ နဲ့ထန်းလျက် အချိုးပြေချက်တော့။ တစ်ထုပ် လောက်စားရင် ရင်ထဲ တင်းတိမ် သွားတာပဲ။ မုန့်ဖက်ထုပ်ကို ယူကြည့်လျှင် ဘယ်ထောင့်က ကြည့်ကြည့် ကြိုဂံပုံကျသည်။ အနားတွေညီ တော့ အထုပ်လှသည်။ တည်းစပ် ကလေးထိုး ထားသော မုန့်ဖက်ထုပ် ကပင် အနုပညာ ဆန်လှ ပါသည်။ တည်းစပ်တွေက ဝါးကိုလည်း သုံးသည်။ ဆူးဖြူချောင်း သန်သန်ကြီး တွေကိုလည်း သုံးသည်။ ဆူးဖြူချောင်းကို အဆိပ်ပါသည့် အချွန်ဘက်က ဖြတ်ထားတော့ စူးမိ၊ ခိုက်မိ မရှိ” [၁]

ဟု လည်းကောင်း ၊

“မုန့်ဗန်းတွေထဲကို အိမ်ရိုက်သံ တစ်ချောင်းစီ ထည့်တတ်ကြတာကလည်း ဘာသဘော များပါလိမ့်။ သံချောင်း ထည့်ထားတော့ မုန့်မချဉ်ဘူး ဆိုတာကလည်း ဘယ်တုန်း ဘယ်အခါ ဘယ်သူ က စခဲ့သည်မသိ။ ဓလေ့ပင် ဖြစ်နေပါသည်။”[၁]

ဟု လည်းကောင်း ဖော်ပြထားသည်။

ယနေ့ လူငယ်များ အနေဖြင့် မောင်းတင်းကုပ်၊ မောင်းပက်လက် ဟူသော အသုံးမျိုးကို သိနိုင်မည်မထင်၊ တွေ့ဖူးရန်လည်း ရှားလိမ့်မည်။ မုန့်ဖက်ထုပ်ဟု ဆိုသည် နှင့် ဆိုင်မှ ဝယ်စား၍ ရသည်ဟုသာ အသိများ ပေလိမ့်မည်။ မုန့်ဖက်ထုပ်ပြုလုပ်ပုံ အဆင့်ဆင့်ကို သေချာ သိနိုင်သူ ရှားပါ လိမ့်မည်။ တည်းစပ် ဟူသောအသုံး၊ ဆူးဖြူချောင်းဟူသော အသုံးများကလည်း လူငယ်များ အတွက် တွေးတောစရာ ဖြစ်သည့်အပြင် မုန့်မချဉ်ရန် အိမ်ရိုက်သံတစ်ချောင်း ထည့် သည်မှာလည်း မယုံနိုင်စရာ ဖြစ်ပေလိမ့်မည်။ မြန်မာ့ရိုးရာ မုန့်လုပ်နည်း များကို ယဉ်ကျေးမှုဓလေ့ထုံးစံအဖြစ် သိရှိထား ရမည်။ မြန်မာ့ရိုးရာ မုန့်လုပ်နည်းများကို ကျေးလက်တော ရွာများတွင်သာ တွေ့နိုင်ပြီး မြို့များတွင် တွေ့ရခဲသည်။ မြို့ပြတွင် နေထိုင်သော ကလေးလူငယ်များသည် မုန့်ပဲ သွားရည်စာဟု ဆိုလျှင် အသင့်စားမုန့်များကိုသာ စားသုံး ကြသည်။ မြန်မာ့မုန့်များကို အရောင်းပွဲတော်ပြုလုပ်၍ ရောင်းချသော်လည်း မုန့်ကို မည်သို့ ပြုလုပ်ပုံ အဆင့်ဆင့် ကို မသိကြပေ။ ဥပမာ- ကောက်ညင်းနှင့် ပြုလုပ်သော မုန့် များတွင် ကောက်ညင်းမှုန့်သည် အသင့်စား အနေအထား ရရှိပြီးဖြစ်၍ ကောက်ညင်းကို မည်သို့ ကြိတ်ရသည်၊ ဆန်ကြမ်း အချိုးအစား မည်မျှ ထည့်ရသည်ကို မသိရှိ ကြပေ။ မုန့်ကြိတ်ခြင်း၊ မောင်းထောင်း ခြင်းများကို မသိသူက များလာ၍

မြန်မာ့ရိုးရာဓလေ့ ဖြစ်သည့် မုန့် လုပ်ငန်းကိုလည်း ရိုးရာဓလေ့အဖြစ် ထိန်းသိမ်းရန် လိုအပ်သည် ဟု တွေးခြင်မိပါသည်။

ကျေးလက်တောရွာ ဓလေ့ဖြစ်သော သင်္ကြန်ချိန်ခါ တွင် ပြုလုပ်ကြသည့် အလေ့အထများကိုလည်း -

> **"ရွာလမ်းတွေမှာ ထိုးသမျှ ဆူးကိုင်း မွှားကိုင်း တွေကို ခုတ်ကြသည်။ လမ်းဘေး ကိုင်းကြ သမျှ ဆူးခက်၊ သစ်ခက်တွေကို သင်ကြ ဖျင်ကြသည်။ ရွာ့ ရေတွင်းတွေ ဆည်ကြသည်။ ကိုယ့် စည်းရိုး၊ သူ့စည်းရိုး အမြင့် သပ်ရပ်အောင် တုတ်ကြ နှောင်ကြသည်။ လယ်ယာသုံးပစ္စည်း၊ လှည်းသုံးပစ္စည်း တွေ ရေနံ သုတ်တန်သုတ် သိမ်းတန်တာ သိမ်း ကြပြီ။ တင်း၊ တောင်း၊ ဆန်ကော၊ ဆန်ကာ တွေ အိမ်ထရံမှာ ချိတ်ကြပြီ။ အိမ်မ၊ အဖိ၊ ပဲမှော်တိုက်၊ နွားစာကျင်း၊ တင်းကုပ်တွေ မိုးကြပြီ။"[၁]**

ဟု ဖော်ပြထားပါသည်။ ထိုဓလေ့များမှာလည်း ကျေးလက် များတွင်သာ တွေ့ရသည်။ ရေတွင်း သည်လည်း ယခင် ကသာ အသုံးများပြီး ယခု နောက်ပိုင်းတွင် ခေတ်မီလာသည် နှင့်အမျှ တုံကင် ရေစုပ်စက်များ သုံးလာကြ၍ ရေတွင်းကိုပင် အသိ နည်းလာသည်။ လယ်ယာသုံးပစ္စည်းများကိုလည်း သိသူ ရှားပါးလာသည်။ ယခင် လက်မှုလယ်ယာမှ စက်မှု လယ်ယာသို့ ပြောင်းလာသောအခါ တင်း၊ တောင်း၊ ဆန်ကော၊ ဆန်ကာများပင် ပျောက်ကွယ်လု ဖြစ်နေပြီ။ ယခင်က ထယ်တုံး၊ ထွန်တံများဖြင့် လယ်ထွန်၊ လူကိုယ်တိုင် စပါးစိုက်၊ တံစဉ်များဖြင့် ရိတ်သိမ်း သော်လည်း ယခုအခါ ချွေလှေ့စက်များ အသင့် ဖြစ်နေကြ၍ လယ်ယာလုပ်ငန်းသုံး ပစ္စည်းများကို အသိနည်းလာကြသည်။ ရှေးယခင်က ဝါး၊ ထရံ၊ သစ်သားကို သုံးသော အိမ်များနေရာတွင် တိုက်တာ အဆောက်အဦများက နေရာယူလာကြပြီး ရေနံ သုတ် သည့် အလေ့အထလည်း ပျောက်ကွယ်လုပြီ။ စုပေါင်း အိမ်မိုးသည့် ဓလေ့မှာလည်း ပျောက်ကွယ်ခဲ့ပြီး အိမ်ခေါင်မိုးတွင် သွပ်များ အစားထိုး လာကြသည်။ ယခု အခါတွင် နည်းပညာများ ခေတ်မီ တိုးတက် လာသည်နှင့်အမျှ မြန်မာ့ရိုးရာဓလေ့များ လည်း ပျောက်ကွယ် လုပြီ ဖြစ်ကြောင်းကို မီးမောင်းထိုးပြ လိုက်ခြင်း ဖြစ်သည်။

စာရေးသူသည် သူ့ရွာ၏ ချစ်စရာဓလေ့များကို ဖော်ပြ ရာတွင် 'ပိတောက်လှည်း' အကြောင်းကို တင်ပြ ထားသည်။ ရွာဦးက ပိတောက်ပင်ကြီး ပွင့်လျှင် နန္ဒင်းရောင် ထိန်ထိန် တောက်ပြီး အလွန်မွေးသည်။ သင်္ကြန်တွင် မိုးလေး တစ်ဖြောက်နှစ်ဖြောက် ကျလျှင် မနက် စောစောထ၍ ပိတောက် ပွင့်၊ မပွင့် ပြေးကြည့် ကြသည်။ မခူးချင်သူ မရှိ။ မပန်ချင်သူ မရှိ။ ကြုံရာလူက ပိတောက်ကိုင်း တက်ချိုင်ကာ လှည်းတစ်စီးတိုက် တင်လာလျှင် တစ်ရွာလုံးက တစ်ခက် တစ်ကိုင်းမျှ တောင်းကြသည်။ ပိတောက်လှည်းတွင် အပျို တွေ ဝိုင်းနေတော့ လှည်းဆရာ ကာလသားကလည်း ဖိုးညိုမြ ဖြစ်ရသည်။ ရွာထဲရှိ **ငအေး**သည် ရုပ်ဆိုး အကျည်းတန်လွန်း၍ ဘယ်အပျိုကမှ သိုးသိုးသီသီ အစမခံ။ ကြိုက်ဖို့ဝေးသည်။ သို့သော်လည်း သင်္ကြန်ချိန်ခါ ရောက်လျှင် ငအေးက တောထဲရှိ ပိတောက်ပင်ကို ချိုး၊ ပိတောက်ပွင့်များ ကို လှည်းပေါ်တင်၊ ရွာထဲ မောင်းဝင်း လာလျှင် အပျို တသိုက်က ငအေး လှည်းနား ဝိုင်းလာ ကြပြီး ကိုအေး ကျုပ်ကို ပေးစမ်းပါ တစ်ကိုင်းလောက်၊ တစ်ခက်လောက်နှင့် ကိုအေး မျက်နှာကလည်း ပျားတုပ် ခံရတဲ့အတိုင်းပဲ ဖီးဖီးထ လို့ဟု ရွာဓလေ့ကို ဖော်ပြ ထားသည်။ ငအေး၏ ပိတောက်လှည်းနှင့် ပတ်သက်ပြီး ပြောစမှတ်ပြုကြသည်များ မှာ ရွာတွင် တစ်ခါတလေမှ ထီပေါက်သလို အလုပ် အကိုင်လေး အဆင်ပြေတာမျိုး ရှိလျှင် -

"ငအေး ပိတောက်လှည်း လိုပါကွာ ပွင့်တုန်း ခဏပ"
[၁]

ဟု လည်းကောင်း၊ အလုပ်အကိုင် အဆင်မပြေသည့် အခါ များတွင်-

> **"ငအေး ပိတောက်လှည်းလိုပဲ တစ်လှည်းလုံး မောက်အောင် ခုတ်လာတဲ့ ပိတောက်ပန်းတွေ ရော့ . . . တစ်ခက်၊ အင့် . . . တစ်ခက် ပေးသာနဲ့ ကုန်သလို တစ်ရက်တစ်ရက် မျှော်ရ မောရသာနဲ့ ဘဝကုန်ကြရသာ"[၁]**

ဟု လည်းကောင်း၊ ပုံခိုင်း တတ်ကြသည် အထိ ဖြစ်ခဲ့ရသည်။ စည်းလုံးညီညွတ်မှု ရှိသော ရွာ၏ချစ်စရာ ဓလေ့လေးကို ဖော်ပြထားသည်မှာလည်း ယဉ်ကျေးမှု တစ်ရပ်ပင် ဖြစ်သည်။ လောကရှိ လူတို့သည် သံသရာခရီး တစ်လျှောက်လုံး တွင် မိမိတို့ ဘဝရပ်တည်နိုင်ရေး အတွက် မရပ်မနား ကြိုးစား ရှာဖွေ လုပ်ကိုင်ကြရသော်လည်း နောက်ဆုံးတွင် ဘဝနေဝင်

ခဲ့ရပုံကို ဖော်ပြထားသည်။ ငအေး၏ပိတောက် လှည်းဖြင့် ခိုင်းနှိုင်းကာ လောကသဘာဝတရားကို မြင်သာ အောင် ဖော်ပြထားသည်ဟုလည်း ဆိုနိုင်ပါသည်။

နှစ်ဆန်းတစ်ရက်နေ့ ရောက်လာလျှင်လည်း မြန်မာ တို့၏ ယဉ်ကျေးမှု ဓလေ့ထုံးစံအရ အဟောင်းကို စွန့်၍ အသစ်ကို ဖြည့်ဆည်းတတ်သော သဘောများကို -

"နှစ်ဆန်းတစ်ရက်ဆိုလျှင် မင်္ဂလာ ယူရသယ်။ ကြွေးဟောင် ချေရသယ်။ တစ်နှစ်ကို အပါမခံကြ နဲ့။ အကြွေးထုံ ပါတတ်သယ်။ ဆန်ကောမှောက် သယ်ဆိုတာ နိမိတ် မကောင်းဘူး။ ဆန်ကော ပက်လက်၊ တောင်းပက်လက် ထားရသယ်။ ထည့်စရာ ဝင်လာမယ် ဆိုသဲ့ နိမိတ်ပေါ့။ အုပ် ဆိုင်း ထားတာတွေ ရှိရင် လှပ်ထား။ ပဲတီချဉ်အိုး၊ ငါးပိအိုးတွေ ပြေးလှပ်စမ်း။ ဘုရားစင်က ပန်း တွေ ဝေအောင်ထား။ ရေအိုးတွေ ရေပြည့်အောင် ဖြည့်။ ခါတိုင်း ငါးပိနှင့် ပဲပြုတ်စားသူတို့ ဝက်သား ဘီးဆံပတ်ခွေ ကြီးတွေ ပါးစောင်က ဆီယိုကျ အောင် စားကြ ရသည်။"[၁]

ဟု ဖော်ပြထားသည်။ မြန်မာတို့၏ ယဉ်ကျေးမှုအရ နှစ်ဆန်း တစ်ရက်နေ့တွင် အဝတ်အစားအသစ် ဝတ်ရသည်။ ယခုနှစ်မှ အကြွေးကို နောင်နှစ်သို့ မကူးစေခြင်း၊ နှစ်ဆန်း တစ်ရက်နေ့တွင် ပြည့်စုံမှ လာမည့် ရက်များတွင်လည်း ပြည့်ပြည့်စုံစုံ နေထိုင် နိုင်ရမည် ဖြစ်ခြင်း၊ နှစ်ဆန်းတစ်ရက် နေ့တွင် မင်္ဂလာရှိသော အပြုအမူများကို ပြုလုပ်မှသာ နေ့ရက်တိုင်းတွင် မင်္ဂလာရှိနိုင်မည် ဟူသော အယူအဆ ယဉ်ကျေးမှုများကို တွေ့ရသည်။ ထိုယဉ်ကျေးမှုများသည် မြန်မာ့ယဉ်ကျေးမှုဟု ဆိုနိုင်သော်လည်း ယခုခေတ်တွင်မူ မိမိတို့၏ ဝမ်းရေးအတွက် ခက်ခဲစွာဖြင့် ဖြေရှင်း လာရသူများ များလွန်း၍ ထိုယဉ်ကျေးမှုများကို လုပ်ကိုင် သူများ နည်းပါး လာကြသည်။ သို့သော်လည်း ယခင်က မြန်မာ့ရိုးရာ ယဉ်ကျေးမှု တစ်ရပ်အဖြစ် သိမှတ် ထားသင့်သည် ဟု တွေးမြင်မိပါသည်။

မြန်မာတို့၏ ဓလေ့ထုံးစံများတွင် ဝါတွင်းကာလ စောင့်ထိန်းကြသော ယဉ်ကျေးမှုများလည်း ရှိသည်။ စာရေး သူတို့၏ ရွာတွင် ဝါတွင်းကာလ ရောက်ပြီဆိုလျှင် စောင့်စည်းအပ်သော ဓလေ့များကိုလည်း -

"ဝါဆိုရင် ပုန်းညက်ပန်းတွေကို ညောင်ရေအိုး တကာ ဖွေးဖွေးလှူပ်လို့ ဝါဆိုနံ့ကလေးကို ရလို့ တော်။ ဝါဝင်လျှင် အရက်ဖြတ်ရမည်။ ဝါတွင်း လေးလ အရက်သောက်ခွင့် ပါမစ် အပိတ်ခံရ သည်။ ကျွန်မတို့ ဘကြီးဘုန်းကြီးများက စာတတ်ဘုန်းကြီးများဖြစ်၍ ရွာကျောင်းမှာ သီတင်းသုံးကြပေရာ ရွာထဲရပ်ထဲက အရက် သောက်ကြသူ တူသားနောင်မယ် တပည့် တပန်း များကို ဝါတွင်း သုံးလ အရက် အလှူခံလေ့ ရှိသည်။ ဒါ့ကြောင့် ပုန်းညက်ပွင့်လျှင် ဝါဝင်တော့မည်။ ဝါဝင်လျှင် အရက်ဖြတ်ရမည်။ အရက်ဖြတ် ရခြင်းကိုပင် ကုသိုလ် တစ်မျိုးလို့ သဘောထား နိုင်ကြပြီ။ "[၁]

ဟု ဖော်ပြထား၍ ကျေးလက်တောရွာများတွင် ဝါတွင်း ကာလ အရက်လှူကြသည့် ဓလေ့မှာလည်း မှတ်သားဖွယ် ဖြစ်သည်။ ဝါတွင်းကာလ ရောက်လျှင် မြန်မာလူမျိုးတို့ ကျင့် သုံးသော ယဉ်ကျေးမှု ဓလေ့များတွင် ဥပုသ်ဆောက်ခြင်း၊ သက်သက်လွတ် စားခြင်းတို့ကိုသာ အသိများကြသည်။ အရက်လှူသော ဓလေ့ကို ကျေးလက် တောရွာများတွင်သာ တွေ့ရှိ ရပေလိမ့်မည်။ ဗုဒ္ဓဘာသာ ဝင်များအဖို့ ဝါတွင်းကာလ ဥပုသ်သီတင်း ဆောက်တည် ရုံသာမက မကောင်းမှုရှောင် ကောင်းမှုဆောင်သည့် မွန်မြတ်သော ယဉ်ကျေးမှုဟုလည်း ဆိုနိုင်ပါသည်။ မြန်မာ နိုင်ငံတွင် နွေ၊ မိုး၊ ဆောင်း ရာသီဥတုသုံးမျိုး ပြောင်းလဲ လည်ပတ်နေသည်။ ထိုရာသီဥတု သုံးမျိုးနှင့်အညီ သဘာဝ ပတ်ဝန်းကျင်တို့သည်လည်း ပြောင်းလဲ ခဲ့ပါသည်။ စာရေးသူသည် သူ၏ရွာရှိ ဆောင်းရာသီ လှုံမီးဓလေ့ အကြောင်းကို -

"ဆောင်းရောက်လျှင် လှုံမီးဓလေ့ ရှိသည်။ ထင်း ခြောက်ကလေးတွေ စုကာ၊ ပွေ့ကာ တလင်း ပြောင်ပြောင်မှာ မီးဖိုပြီး မီးလှုံကြခြင်း ဖြစ်သည်။ လှုံမီးထည့်ပြီဆိုလျှင် မြင်သူက ချက်ချင်း ရောက် လာကြသည်။ မီးလှုံရင်း ရပ်ရွာအကြောင်း၊ စီးပွား ရေးအကြောင်း ပြောကြသည်။ ဆောင်းတွင်း ဆိုတော့ ဆောင်းသီးနှံတွေ လှိုင်လေပြီ။ ပြောင်း ဖူး ရနိုင်ပြီ။ ကုလားပဲ နုတ်နိုင်ပြီ။ ထန်းမြစ် ဖော်နိုင်ပြီ။ ကုလားပဲပင် နှစ်ပင်လောက် နုတ်ပြီး မီးဖိုထဲ ထည့်လိုက် ဖျိုးဖျိုးဖျစ်ဖျစ် မြည်ကာ အရွက်တွေ ကျသွားမည်။ အသီးတွေ မီးနာ လောက်ပြီ ဆိုလျှင် မီးဖိုဘေးပစ်ချကာ

အအေးခံ။ တစ်ဖြုတ်ဖြုတ် ချွေစားလို့ ရပါပြီ။ ပါးစပ်တွေ မည်းလို့။"[၁]

ဟု ဖော်ပြထားသည်။ ရွာ၏ ချစ်စရာဝေလေ့နှင့် တစ်ဦးနှင့် တစ်ဦး ရိုင်းပင်းကူညီကာ စုစုစည်းစည်း နေထိုင်ကြသော သဘောကို တွေ့နိုင်သည်။ မီးဖိုဘေးတွင် ပြောကြဆိုကြ၊ စားကြသောက်ကြပြီး ရပ်ရွာအကြောင်း ဆွေးနွေးတိုင်ပင် ကြသည့် ဝေလေ့ဟုလည်း ဆိုနိုင်ပါသည်။ ယခုအခါတွင် နွေ၊ မိုး၊ ဆောင်း ရာသီဥတုများ ဖောက်ပြန်လာသည်။ သဘာဝ သစ်တောများ ပျက်စီးလာသည်။ ထို့ကြောင့် နွေရာသီတွင် ယခင်ကထက်ပို၍ အပူဒဏ် ခံကြရသည်။ မိုးတွင်းတွင် ရေ ကြီးရေလျှံမှုများ ဖြစ်လာသည်။ ဆောင်းရာသီတွင် ယခင် ကကဲ့သို့ ခိုက်ခိုက်တုန်အောင် ချမ်းသည့် အရာသာမျိုး သိပ် မတွေ့ရတော့ပေ။ ဆောင်းတွင်း မီးဖိုပြီး မီးဖိုဘေး စုဝေးကာ စားသောက်ပြောဆိုသည့် ဝေလေ့မှာလည်း တွေ့ရခဲလှသည်။ ယခင်က မြန်မာ့ရိုးရာ ယဉ်ကျေးမှု ဝေလေ့များတွင် လှုံမီး လှုံ သော ဝေလေ့များ ရှိကြောင်း မီးဖိုဘေးတွင် ရပ်ရွာအကြောင်း ပြောဆိုဆွေးနွေးကာ တစ်ဦးနှင့်တစ်ဦး စည်းလုံးမှုများ ရှိကြ ကြောင်း သိရှိနိုင်သည်။ ယခုအခါတွင် ကျေးလက်တောရွာမှ အများစုသည်လည်း မိမိဝမ်းရေးအတွက် မြို့ပြများသို့ သွား ရောက်နေထိုင်သူ အလုပ်လုပ်ကိုင်သူ များလာသည်။ ထို့ကြောင့် ရွာတွင် နေထိုင်မှု နည်းပါးလာပြီး လှုံမီးဝေလေ့မှာ လည်း ပပျောက် လာခဲ့သည်ဟု တွေးမြင်မိပါသည်။

မြန်မာ့ယဉ်ကျေးမှု ဝေလေ့ထုံးစံများတွင် မြန်မာအိမ်မှန်လျှင် သောက်ရေအိုး ရှိစမြဲဖြစ်သည်။ ရေသန့်ဗူးများ၊ ဝါတာကူလာများ သုံးစွဲလာသည့်တိုင် သောက်ရေအိုး စိုစို ဖန့်ဖန့်ကို မက်မောကြတုန်း ဖြစ်သည်။ စာရေးသူတို့ ရွာတွင် ယခင်က အိုးဖြင့် ချက်ပြုတ်သော ဝေလေ့ကို -

"အမေတို့ ခေတ်တုန်းက ထမင်းချက်တော့လည်း မြေအိုး၊ ဟင်းချက်တော့လည်း မြေအိုး၊ ငါးပိကျို့ တော့လည်း ငါးပိရည်ကျို့အိုးတွေ အသုံးတွင်လှ ပါ၏။"[၁]

ဟုလည်းကောင်း၊

"အညာမှာ နွေပေါက်ပြီဆိုသည်နှင့် ရေချမ်းစင်တွေမှာ အိုးသစ်တွေ လဲကြသည်။ အောက်က သဲခံကာ ရေစိုအောင်လောင်း၊ စပါးစေ့တွေ ဖြူးလိုက်တော့ စပါးပင်ကလေးတွေ စိမ်းစိမ်းစိုစို အဝေးရွာတွေက ကူးကြ၊ လူးကြသူတွေ၊ လှည်း သမားတွေက ရေအိုးစိုစိုတွေ့တော့ မသောက်ဘဲ မနေနိုင်၊ ရေတဝသောက်ပြီး အမျှဝေ တတ်ကြသည်။ သာဓု ခေါ်တတ်ကြသည်။ ရေအကျိုး ဆယ်ပါး တောင်းစရာ မလိုဘဲ ပြည့်သည်"[၁]

ဟုလည်းကောင်း ဖော်ပြထားသည်။ ရှေးယခင်က ကျေးလက် တောရွာများတွင် မြေအိုးဖြင့် ထမင်းဟင်းချက်ပြုတ် သော ယဉ်ကျေးမှုဝေလေ့ကို တွေ့ရသည်။ ယခုအခါ နည်းပညာများ တိုးတက်လာပြီဖြစ်၍ မြေအိုးကို အသုံးပြုသူ များ နည်းပါးလာသည်။ ရေချမ်းစင်တွင် ရေအိုးထားသော ဝေလေ့မှာလည်း ကျေးလက်တောရွာများတွင်သာ တွေ့ရ သည်။ မြို့ကြီးပြကြီးများတွင် ရေချမ်းစင်ကို တွေ့ရသော် လည်း သောက်ရေအိုးအစား ရေသန့်ဗူးများ သုံးလာသည်ကို တွေ့ရှိရသည်။ ထို့ကြောင့် မြေအိုးနှင့် ချက်ပြုတ်စားသုံး သော ဝေလေ့နှင့် ရေချမ်းစင်တွင် ရေအိုးထားသော ဝေလေ့ ကိုလည်း ယဉ်ကျေးမှုတစ်ရပ်အဖြစ် ထိန်းသိမ်းထားသင့် ပါသည်။

မြန်မာ အမျိုးသမီးတို့၏ လိုက်နာ အပ်သော ယဉ်ကျေးမှုများ ကိုလည်း -

"အိပ်ရာက နိုးသည်နှင့် အပေါ့သွားခိုင်း၊ လက်ဆေးပြီး မီးသွေးမှုန့်နှင့်ဆား ရောထားသော သွား တိုက်ဆေးနှင့် သွားတိုက်ခိုင်းသည်။ သနပ်ခါး မှုန်နေအောင် လိမ်းရသည်။ အုန်းဆီကလေး ပွတ် ပေးပြီး ကြက်တောင်စည်းကလေး မြောက်နေ အောင် စည်းပေးသည်။ မျက်နှာသစ်သည့်အခါ ဗုဒ္ဓံ သရဏံ ဂစ္ဆာမိ၊ ဓမ္မံ သရဏံ ဂစ္ဆာမိ၊ သံဃံ သရဏံ ဂစ္ဆာမိ လို့ ရွတ်ရင်း သစ်ပေး သည်။ ...ထမင်းစားတော့ ထမင်းလုံး မဖိတ်ရဘူး၊ မဆဲရဘူး၊ လက်ထောက်ပြီး မထိုင်ရဘူး"[၁]

ဟု ဖော်ပြထားသည်။ ထိုယဉ်ကျေးမှုများကို ယနေ့ခေတ် လူငယ် မိန်းကလေးများ သိထားသင့်သည်။ ယနေ့ခေတ်နှင့် ကြည့်လျှင် မြို့ပြတွင်ရှိသော မိန်းကလေး အများစုသည် သနပ်ခါးကို တန်ဖိုးမထားဘဲ နိုင်ငံခြားဖြစ် အသုံးအဆောင် ပစ္စည်းများဖြစ်သည့် မိတ်ကပ်များကိုသာ သုံးလာကြသည်။ သနပ်ခါး လိမ်းခြင်းသည်လည်း မြန်မာ့ယဉ်ကျေးမှု တစ်ရပ်ဟု ဆိုနိုင်ပါသည်။ သနပ်ခါးကို မျက်နှာပေါ်တွင် လိမ်းရုံ မဟုတ်ဘဲ ကလေးသူငယ်များအတွက် ဆေးအဖြစ် အသုံးပြု ပုံကို -

“ညည်း ကလေး ညော်မစင်ဘူး... မှင်လွန်း သယ်... ဘာမှ မလုပ်ပါနဲ့အေ...သနပ်ခါးသာ အနှစ်ပါအောင်သွေးပြီး လိမ်းတိုင်း ခွံ့စမ်း... သနပ်ခါးက အဖန်ဓာတ်, အခါးဓာတ်ကလေး ဖန့်ဖန့်ပါတော့ ဆေးဖက်ဝင်လိုက်သာမှ... ငတို့ကလေးတွေ တစ်နေ့တစ်နေ့ ဆီးဖြူသီး တစ်လုံးစာတော့ ဝမ်းထဲ မရောက်မရှိဘူး။ မွေးကတည်းက သနပ်ခါး ဆေးလုပ် ကြီးရသဲ့ ကလေးချည်းပဲ”[၁]

ဟု ဖော်ပြထားသည်။ ကျေးလက်တောရွာများတွင် ယခု အချိန်အထိ ကလေးကို သနပ်ခါး ကျွေးသည့်ဓလေ့ တွေ့နိုင် သော်လည်း မြို့ပြတွင် ကြီးပြင်းသော ကလေးများ အဖို့ သနပ်ခါးကို ကျွေးခြင်းဓလေ့မှာ မရှိသလောက် ဖြစ်သည်။ မြို့ပြတွင် မွေးဖွားသော ကလေးများသည် နိုင်ငံခြားဖြစ် ဆေးမျိုးစုံကိုသည် လက်ကိုင်ပြုခဲ့ကြသည်။ ထို့ကြောင့် မြန်မာ့ရိုးရာ သနပ်ခါး၏ ဆေးဖက်ဝင်ပုံ ကိုလည်း လူငယ် များ သိထားသင့်ပါသည်။

ခြုံငုံသုံးသပ်ချက်

ဤစာတမ်းတွင် “ကျေးတစ်ရာ ရသစာစု”များမှ ယဉ်ကျေးမှုဓလေ့များကို တင်ပြခဲ့သည်။ ထိုရသစာစုတွင် စာရေးသူသည် သူနေထိုင်ခဲ့ရသော ရွာဓလေ့စရိုက်များကို စာဖတ်သူတို့ မြင်ယောင်လာစေရန် ဝေဝေဆာဆာ ဖော်ပြ ထားသည်။ ယနေ့အချိန်တွင် မြန်မာ့ရိုးရာ ယဉ်းကျေးမှု ဓလေ့များသည် ပျောက်ကွယ်လုနေပြီ ဖြစ်သည်။ ထို ယဉ်ကျေးမှုများကို မမေ့မလျော့ ရလေအောင် မီးမောင်းထိုး ပြထားခြင်းလည်း ဖြစ်သည်။ ယနေ့လူငယ်များအနေဖြင့် ဝိုင်းဝန်းလုပ်ဆောင်မှု၊ ယဉ်ကျေးမှုကို ထိန်းသိမ်းမှု များသည် အလွန် အရေးကြီးလှပါသည်။ ထိုရိုးရာဓလေ့များမှ စာဖတ် သူအား ယဉ်ကျေးမှုကို မြတ်နိုး တန်ဖိုးထားတတ်လာစေ သည်။ ယနေ့လူငယ်များအနေဖြင့် အသိနည်းနေသော မြန်မာမုန့် အဆင့်ဆင့် ပြုလုပ်ပုံ၊ ရွာဦးစေတီ ရေသပ္ပာယ်ပုံ၊ ရွာတွင်ရှိသော လမ်းတံတားများ စုပေါင်းဆောင်ရွက်ပုံ၊ ပိတောက်ပန်းများကို ချစ်ခင် တန်ဖိုးထားတတ်ပုံ၊ ကျေးလက် တောရွာများတွင် ဝါတွင်းကာလ အရက်လှူကြပုံ၊ ဆောင်းရာသီတွင် ကျေးလက်တောရွာများ၌ လှုံမီးဓလေ့ ရှိခဲ့ပုံ၊ မြန်မာ တို့သည် ရေချမ်းစင် ထားပြီး ရေကုသိုလ် ယူကြပုံနှင့် မြန်မာ့ရိုးရာ သနပ်ခါး၏ အသုံးဝင်ပုံများကို ဖော်ပြ ထားသည်။ သို့ဖြစ်၍ ယခုခေတ်လူငယ်များ မသိရှိ သေးသော အကြောင်းအရာများကို သိရှိလာစေသည်။ ယဉ်ကျေးမှုကို မြတ်နိုး လာစေသည်။ ရှေးယခင်က ချစ်စရာ ယဉ်ကျေးမှုများကို မြင်ယောင်လာစေသည်။

နိဂုံး

နိုင်ငံတစ်နိုင်တွင် ယဉ်ကျေးမှုသည် ယင်းနိုင်ငံ၏ နှလုံးသည်းပွတ်ဖြစ်သည်။ ယဉ်ကျေးမှုပျောက်လျှင် လူမျိုး ပျောက်၍ ဘာသာ၊ သာသနာနှင့် စာပေများလည်း ပျောက်ဆုံး ပျက်သုဉ်း သွားနိုင်သည်။ ထို့ကြောင့် ယဉ်ကျေးမှုသည် နိုင်ငံတစ်နိုင်ငံ၊ လူမျိုးတစ်မျိုး၏ အခြေခံ အုတ်မြစ် ဖြစ်သည်။ ဤစာတမ်းကို ဖတ်ရှု ရခြင်းဖြင့် မြန်မာ့ရိုးရာ ယဉ်ကျေးမှု ဓလေ့ ထုံးတမ်းများနှင့် အသုံးအနှုန်း အခေါ်အဝေါ် ဝေါဟာရ များကို နှစ်သက် မြတ်နိုး တန်ဖိုးထား တတ်လာမည်ဟု ယုံကြည်မိပါသည်။

ကျမ်းကိုးစာရင်း

[၁] ခင်ခင်ထူး ။ (၂၀၁၂) ။ ***ကျေးတစ်ရာ ရသစာစုများ*** ။ မန္တလေးမြို့ ၊ ဥဒယကျေးရွာစာပေ။

[၂]ခင်မင် ၊ မောင် (ခနုဖြူ) ။ (၁၉၈၇) ၊***စာတမ်းငယ် စာပေ စာတမ်းများ*** (ပ-တွဲ) ၊ ရန်ကုန် ၊ စာပေဗိမာန် ပုံနှိပ်တိုက် ။

[၃] ဇော်ဂျီ ။ (၁၉၆၇) ။ ***စိတ်ပင်လယ်စာတမ်း*** ။။ ရန်ကုန်၊ ခင်ဇော် စာပေ ။

[၄] မြန်မာစာအဖွဲ့။ (၂၀၁၃)။ ***မြန်မာအဘိဓာန်။*** ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

[၅] ဝင်းမွန် ၊ (တက္ကသိုလ်) ။ (၁၉၈၇)။ ***စာတမ်းငယ် စာပေစာတမ်းများ*** (ခု-တွဲ) ။ ရန်ကုန် ၊ စာပေဗိမာန် ပုံနှိပ်တိုက်။

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