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Multipath Routing Protocol by Breadth First Search Algorithm in Wireless Mesh Networks

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Abstract: *In this paper, we propose a multipath routing protocol in wireless mesh networks. In this protocol, the source discovers multiple paths to the destination using parallel layer based approach. This approach organizes the nodes and discovers multiple paths using breadth first search algorithm. From multiple paths, the primary path is elected using Expected Forwarding Counter (EFW) metric. We evaluate quality linked based in our approach using network simulator 2 (NS-2). Our approach discovers multiple paths effectively and the elected primary path is more reliable. The approach makes use of Expected Forwarding Counter (EFW) metric to elect the primary path. We have evaluated the protocol using NS-2. The results show that the proposed protocol attains more throughput and packet delivery ratio with reduced packet drop and delay.*

Keywords: *Breadth first search (BFS), Expected Forwarding Counter (EFW), Network simulator 2 (NS-2), Wireless mesh networks (WMNs).*

I. Introduction

The promising two-tier architecture constructed with multi hop transmission characteristic is termed as Wireless Mesh Networks (WMNs). This communication network includes radio nodes that are arranged in a mesh topology. The main components of WMN are Wireless Mesh Routers (WMRs) and Wireless Mesh Clients (WMCs). The WMRs are act like APs and it provides connectivity to the WMCs [1]. However, WMNs are constructed by means of several technologies, in that WiFi and WiMAX contributes more[2]. Infrastructure mesh, Client mesh and Hybrid mesh are the three types of Wireless Mesh Networks (WMNs)[3].

• Infrastructure/Backbone WMNs

The infrastructure mesh is constructed using more radio technologies. Infrastructure mesh is also known as backbone WMN as it endows backbone for clients. It also integrates WMN with prevailing wireless networks using gateway/bridge functionalities.

• Client WMNs

Link Quality Based Multipath Routing Protocol in Wireless Mesh Networks 369 Client meshing achieves routing in the current network and it provides configuration functionalities by providing end user applications to customers. Client meshing is responsible for accomplishing peer- to- peer networks among client devices.

• Hybrid WMNs

As the name implies, hybrid WMNs are the combination of both infrastructure and client meshing. This architecture access the network through mesh routers and provide routing functionalities, which is the function of client WMNs. Simultaneously, it makes use of infrastructure mesh, by providing connectivity to other networks. The wireless mesh network is the prominent technology to provide broadband wireless connectivity including urban, suburban and rural areas without requiring costly-wired network architecture. Transportation services can be controlled using wireless mesh networks. It is the adaptable solution for public safety such as police, fire department and emergency services [4].

1.1 Routing in WMN Network

There are several routing protocols exists for wireless networks, in that, some routing protocols are best fit for WMNs. The suitable routing techniques are classified into two types as, on demand routing and proactive routing. Apart from these categories, WMN routing protocols are further divided into two types namely source routing and hop- by- hop routing. This classification is based on how packets are routed along the paths. All these routing protocols have costs that they may differ in message overhead and process complexity [5].

1.2 Need for Routing

WMN offers an ideal Internet access to both fixed and wireless networks. As it provides transmission between mesh nodes and the Internet through mesh gateways, an efficient routing mechanism is necessary to facilitate both forward and backward data transmission.[6]

1.3 Issues of Routing in Wireless Mesh Networks

Implementing routing mechanism in Wireless Mesh Networks (WMNs) introduce more difficulties in the network. Some of them are described below [7]. Since, WMN offers multihop communication to transmit information, the routing protocols may suffer to discover reliable routing paths. As network size increases, complexity also increases to find a reliable path. If a route breaks due to network complication, finding a new route (i.e) recovery procedure is costly. The components of WMN such as mesh router and mesh client have different characteristics such as mobility and power constraints. These heterogeneity behaviors complicate the routing process [7]. Therefore, the routing mechanism should be able to address all these issues at the same time to provide an efficient routing mechanism.

In this paper the Proposed Work evaluates AODV-CGA (Reactive Hop-by-hop Routing), FBR (Proactive Field-based Routing) and GSR (Gateway Source Routing) routing protocols for achieving backward path routing. However, in their mesh network scenarios, the AODV-CGA protocol exhibits poor performance. FBR inherently does not scale to the network size, but for smaller networks, it seems to be a good fit. In [8], they formulate the logical topology formation, interface assignment, channel allocation, and routing as a joint linear optimization problem and their proposed MC-WMN architecture called TiMesh. The main drawback in this paper is more co- channel interference between some of the neighboring links in MC WMNs.

II. Related Work

The three protocols for routing from the Internet to mesh nodes in static and mobile scenarios. These protocols all represent different classes of routing strategies. Based on their findings, they proposed and evaluate enhancements of a routing protocol GSR is scalable; it delivers the best trade-off between packet delivery ratio, routing overhead, and scalability to the\ network size. Mohsenian-Rad et al [8] have proposed the TiMesh MC-WMN architecture by formulating the logical topology design, interface assignment, channel allocation, and routing as a joint linear mixedinteger optimization problem. And this model formulation takes into account the number of available NICs in routers, the number of available orthogonal frequency channels, expected traffic load between different source and destination pairs, and the effective capacity of the logical links. This scheme balances the load among logical links and provides higher effective capacity for the bottleneck link(s). The available NICs and frequency channels are also better utilized. The TiMesh also offers better fairness among different flows. Yong Ding et al [9] have proposed two heuristic multipath discovery algorithms namely iterative path discovery (IPD) and parallel path discovery (PPD) to find multiple independent paths from senders to the receiver for each Video on Demand request. The proposed algorithms considered wireless interference in the multipath discovery, so it was able to balance the video streaming traffic both spatially and on different channels in the network. Based on the multipath discovery algorithms, then they have proposed a joint routing and rate allocation algorithm to find the routes and rate allocation with the goal of minimizing the network congestion. Chun-Wei Chen et al. [10] have proposed a Gateway Zone Multi-path Routing protocol called GZMR. Their protocol use nodes around the gateway to form a gateway Cooperative Zone and ceases the routing control messages flooding outside the zone. Border nodes in the zone can help replying gateway information to reduce route discovery delay and can solve gateway-congested problem.

The reducing routing overheads and multiple paths from source to the gateway can help reducing average end to-end delay and improving the packet delivery in wireless mesh networks. They do not consider some important metrics such as node stability and residual power to determine gateway cooperative zone and border nodes. Jack W. Tsai and Tim Moors [11] have proposed an interference-aware multipath selection technique for reliable routing in wireless mesh networks. Initially, they have investigated using interference minimization to provide reliable data delivery. They have defined weight function based on the ETT metric and interference minimization known as WIM. They have provided heuristic for multipath selection that will exploit the frequency diversity offered in a multi-radio, multi-channel network. They have focused on improving resilience against random link failures by factoring in the interference between multiple paths that could adversely affect redundant data delivery.

III. System Design

The system design has been in two phases-logical design and physical design. In the logical design, the user specification for the proposed system were formulated, i.e. features like input files, transferring files etc. also procedures were designed in a manner that would meet the project requirement. Physical design follows the logical design phase, in this phase, emphasis is put on how the requirements are to be achieved in terms of

hardware equipment's and procedures were formulated. The method of inputting data to the system and to process them so as to produce the desire output was decided after the advantage and disadvantages of each available alternative.

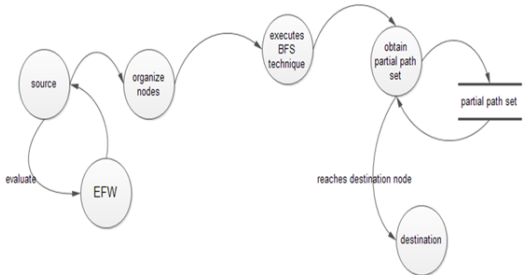

Fig.1 Data flow diagram for iteration

Data flow models are an intuitive way of showing how data is processed by a system. At the analysis level, they should be used to model the way in which data is processed in the existing system. The notations used in these models represents functional processing, data stores and data movements between functions. Data flow models are used to show how data flows through a sequence of processing steps. The data is transferred at each step before moving on to the next stage. These processing steps or transformations are program functions when data flow diagrams are used to explain a software design.

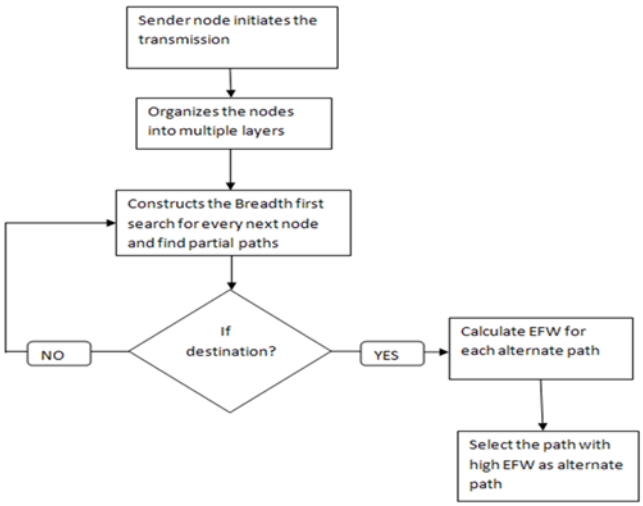

Fig.2 Block diagram of Breadth first search

The implementation phase of any project development is the most important phase as it yields the final solution, which solves the problem at hand. The implementation phase involves the actual materialization of the ideas, which are expressed in the analysis document and developed in the design phase. Implementation should be perfect mapping of the design document in a suitable programming language in order to achieve the necessary final product. Often the product is ruined due to incorrect programming language chosen for implementation or unsuitable method of programming. It is better for the coding phase to be directly linked to the design phase in the sense if the design is in terms of object oriented terms then implementation should be preferably carried out in a object oriented way. The factors concerning the programming language and platform chosen are described in the next couple of sections. There are three major implementation decisions that have been made before the implementation of this paper.

IV. Multipath Path Discovery Algorithm

The WMN can be denoted by a directional connectivity graph as G(V,E) , whereas V represents the set of mesh routers and E denotes the set of undirected edges in the network. The undirected edges 1 2 1 2 (e , e)ÎE if d (e , e)£ R whereas, 1 2 d (e , e) is the Euclidean distance between 1 e and 2 e and R denotes the radio transmission range.

Parallel Layer based Approach

Let S and D be the source and destination respectively. Let T be the current topology of the network. Our approach discovers multiple paths between the source and the destination using parallel layer based approach. Initially, the source arranges the nodes that are in V into multiple layers. The nodes are categorized into multiple layers based on their distances from the destination (D). During the discovery of multiple paths, our approach executes breadth first search for all iterations. The search starts from S, which is in outer most and attains partial paths that connect nodes in the lower layer. The partial paths that are obtained in the search are stored in P, which is the set that contains all possible partial paths that connects the destination. This process is iterated until the destination node is reached. The search process is described in Algorithm.

Algorithm-1

Let P be the set that contains partial paths

Let T be the current topology of the network

Step-1 Execute Breadth First Search in T

Step-2 Store the obtained partial paths in P

P = {p1, p2}

Step-3 Repeat step-2 and 3 until it reach the destination

Figure-3 describes the parallel layer based approach. In that, S and D denote the source and destination respectively 1, 2 … 11 represents mesh nodes. While discovering multiple paths in the network, the source executes breadth first search. During its first iteration, it founds partial paths as

P1 = {S −1, S − 2, and S − 3} and this iteration is denoted in red color. In second iteration,

P2 = {2 − 5,1− 4, 3− 6,3− 7}, which is represented in brown color. Again, in third iteration is colored in green,

P3 = {5 −12,4 −8,6 − 9,7 −10}. Finally, the fourth iteration is mentioned in blue color,

P4 = {11− D,8 − D,9 − D,10 − D}. Thus, the iteration process is repeated until the source finds paths to the destination. By summing up P1, P2 , P3 and P4 , we attain the multiple paths from source S to destination D .

P=P1+P2+P3+P4 (1)

Now, the available multi paths (M) can be summarized as follows,

$$M = \begin{Bmatrix} M\,1 = S-3-7-10-D \\ M\,2 = S-3-6-9-D \\ M\,3 = S-1-4-8-D \\ M\,4 = S-2-5-11-D \end{Bmatrix} \quad (2)$$

This S-D pair contains four alternate paths between the source and destination. Among these available paths, the primary path can be elected based on EFW metric and it is described below

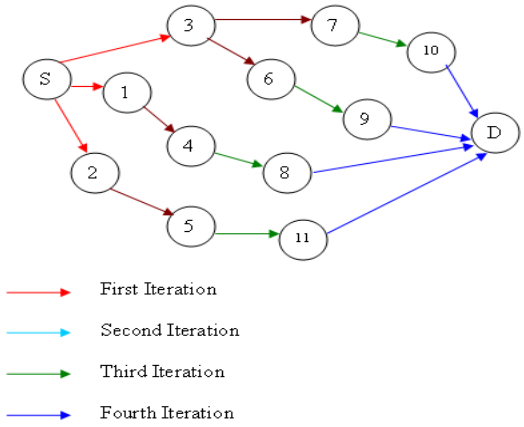

Fig. 3 Parallel paths Primary Path Selection

We obtain multiple paths for any source and destination pairs using layer based multipath selection approach as discussed in the availability of multiple paths, the primary path is elected using Expected Forwarded Counter (EFW) metric proposed by Stefano.

Expected Forwarded Counter (EFW)

The EFW metric enhances the Expected Transmission Count (ETX) metric. It associates the link reliability measurement of ETX with forwarding behavior of relaying nodes to assure high throughput requirements. EFW introduced the forward probability estimation technique in view of the fact that packets may drop even after the reception of successful ACK packets.

Let L_i and L_j be the links formed between nodes i and j . , $P_{Li,}$ P_{Lj} and $P_{Lj,}$ P_{Li} represents the packet loss probability of the link in forward and backward direction respectively. Then the transmission probability of link

(L_i , L_j) is formulated as below

$$T(L_{i,}Lj)=(1-P_{Li,Lj})*(1-P_{Lj,Li}) \quad (3)$$

whereas, $T(L_{I,} L_{j})$ denotes the transmission probability of the link and j is the relaying node. Assume, j Li L D be the dropping probability then its forwarding probability (F) is denoted as,

$$F =1 - D_{Li,\ Lj} \quad (4)$$

From the computation of transmission probability and forward probability we can easily derive successful transmission probability ($S_{(Li\ ,\ L\ j}$) of link L_i and L_j as follows

$$(S_{(Li\ ,\ L\ i}) = T(L_{i,}Lj)* 1 - D_{Li,\ Li} \quad (5)$$

$$EFW = \frac{1}{S_{(Li,Lj)}} = \frac{1}{(1- P_{Li,Lj})\ \ (1- P_{Lj,Li})} \bullet \frac{1}{1- D_{Li,Lj}} \quad (6)$$

In the above equation, the first part denotes the reliability of physical and MAC layers, the latter part contribute to the reliability of network layer. In equation (4), we have defined the forward probability (F) as a function of dropping probability of a relaying node. This forward probability function is evaluated at MAC layer. The broadcasting nature of wireless networks facilitates straight forward method for estimating forward probability. Due to this characteristic, every node can overhear the transmission of other nodes within its transmission range R. In network, the value of F is computed as follows,

(i) Each node in the network is in monitoring mode

(ii) While deploying the nodes in the network, every node transmits HELLO message to all its neighbors and construct neighbor table (NT)

(iii) The NT includes node ids of neighbors and number of packets that are forwarded successfully (F). The format of NT is shown below

Table.1 Header of Neighbour table

Node ID	Neighbour Node ID	Sequence Number	Tranmitted packet

(iv)Transmitted packet is calculated from

$$F = \frac{N_{fwd}}{N_{ack}} \quad (7)$$

N_{fwd} is number of forwarded packets

N_{ack} is number of acknowledgement packets

(v) During the evaluation of S , the N_{fwd} is incremented only if the node hears the transmission of packet that was previously acknowledged.

(vi) If the node does not hear the neighbor transmission even after t_{fwd} then it increment only the value of N_{ack}

Path Selection

When the source obtains multiple paths to the destination, it evaluates EFW metric for each alternate paths. After this estimation, the source elects the path that has higher EFW value as a primary path. Through this path, the source transmits data to the destination. In this the path M1 has higher EFW value and it is chosen as the primary path. The selection of primary path is symbolized in figure-4.

Algorithm-2

Let T be the initial topology

Step-1 The source arranges the nodes in multiple layers

Step-2 The source performs breadth first search to find partial paths

Do

Breadth First Search on T

Until (T= Destination)

Step-3 The source estimates EFW metric for each alternate path

Step-4 It selects the path with high EFW value as a primary path

Step-5 Through this path, the source transmits data to the destination

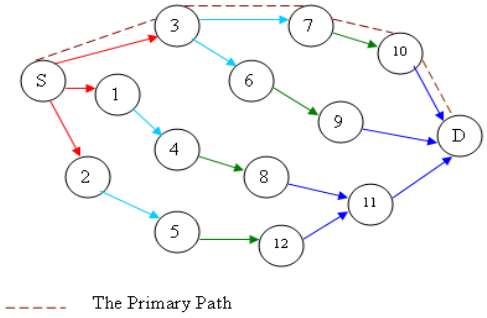

Fig.4 Primary path selection

V. Materials And Methods

NS2 consists of two key languages: C++ and Object-oriented Tool Command Language (OTcl). While the C++ defines the internal mechanism (i.e., a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events (i.e., a frontend). The C++ and the OTcl are linked together using TclCL. Mapped to a C++ object, variables in the OTcl domains are sometimes referred to as handles. Conceptually, a handle (e.g., n as a Node handle) is just a string (e.g., _o10) in the OTcl domain, and does not contain any functionality. Instead, the functionality (e.g., receiving a packet) is defined in the mapped C++ object (e.g., of class Connector). In the OTcl domain, a handle acts as a frontend which interacts with users and other OTcl objects. It may defines its own procedures and variables to facilitate the interaction. Note that the member procedures and variables in the OTcl domain are called instance procedures

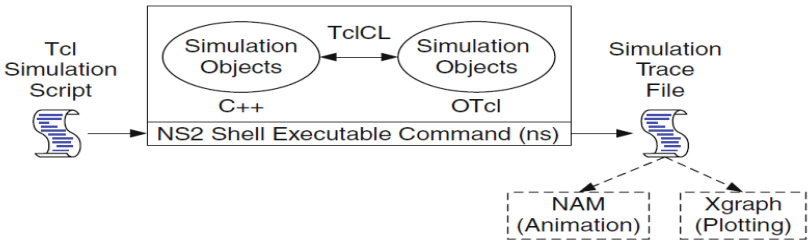

Fig.5 Network Simulator components

(instprocs) and instance variables (instvars), respectively. Before proceeding further, the readers are encouraged to learn C++ and OTcl languages. We refer the readers to [14] for the detail of C++, while a brief tutorial of Tcl and OTcl tutorial are given in Appendices A.1 and A.2, respectively.

VI. Results And Discussion

Multi npath routing protocol by BFS technique we evaluate link quality and reliable primary path from partial path set.Here in this proposed work we sequential modules are Network creation and routing, Analysis of AODV routing protocol, Implementation of link quality based multi path routing technique , Performance and analysis.

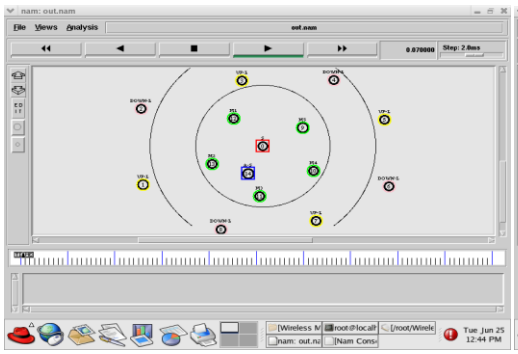

Fig. 6 Multi path routing

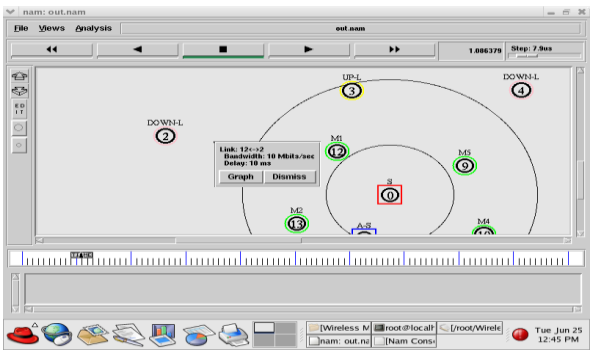

Fig.7 Data transmitted packet

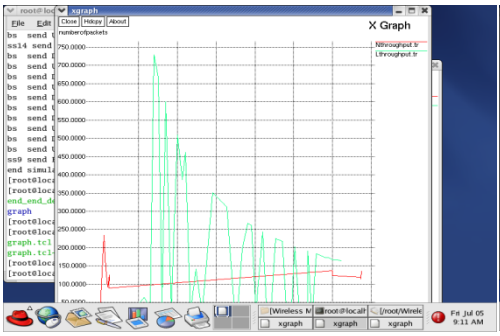

Fig.8 Throughput graph

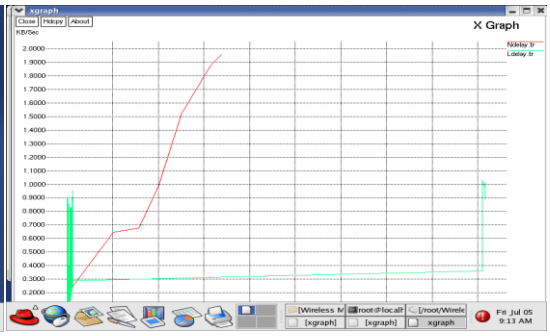

Fig.9 Delay graph

VII. Conclusion

In this paper, we proposed multipath routing protocol by BFS Algorithm in Wireless Mesh Networks. In this protocol, the source discovers multiple paths to the destination using parallel path based approach. This approach organizes the nodes into multiple paths for every iteration; it executes the breadth first search approach to find partial paths. The obtained partial paths are stored in partial path set. This process is repeated until it reaches the destination. By bringing together all partial paths, the source obtains multiple paths to the destination. From multiple paths, the primary path is elected using primary path selection approach. The source uses the primary path to transmit data packets to the destination. The approach makes use of Expected Forwarding Counter (EFW) metric to elect the primary path. We have evaluated the protocol using NS-2. The results show that the proposed protocol attains more throughput and packet delivery ratio with reduced packet drop and delay.

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A Review on Image Inpainting to Restore Image

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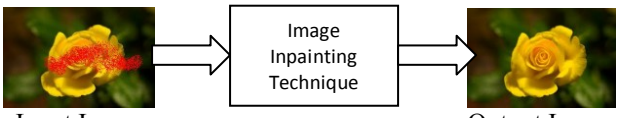
Abstract : *With the advent of lots of multimedia instruments in today's world peoples are clicking lots of Picture of theirs and also trying to preserve their past pictures. As the time goes on those pictures got damaged. Image inpainting is technique which tries to recover such images which are damaged. Inpainting is an art of modifying the digital image in such a way that the modifications/alterations are undetectable to an observer who has no idea about the original image. Image Inpainting is used to filling the region which are damaged and want to recover from unwanted object by collecting the information from the more promising neighbouring pixels which will add details to the image such that image have close resemblance to the original image and we are not able to differentiate between original image and the inpainted image. In this paper we are trying to study various technique of image inpainting, where the authors used the multiresoultion technique, wavelet transform, counterlet transform, fragment based image completition etc. to complete the image. We also discuss about the advantages and disadvantages of that technique with respect to efficiency and time limit.*
Keywords: *Image Inpainting, multiresoultion, neighboring pixels, undetectable, wavelet transform.*

I. Introduction

Image Inpainting or Image completion is technique which is used to recover the damaged image and to fill the regions which are missing in original image in visually plausible way. Inpainting, the technique of modifying an image in an undetectable form, it is art which is used from the ancient year. Applications of this technique include rebuilding of damaged photographs & films, removal of superimposed text, removal/replacement of unwanted objects, red eye correction, image coding. In image inpainting technique the user first selects the region which we want to recover and then he selects the portion from the source region which is more promising in the sense of matching the information and closely identical to the original image, the selected region is also called as patch. The selected patch is applied to damaged image, after that we get the result which we want. In past the inpainting was performed by two classes of algorithms (i) "diffusion based inpainting" and (ii) "texture synthesis". If we are trying to define the inpainting technique then the first thing come in to mind is that this algorithm try to fill the regions by collecting the information from the available environment of that source region, it is trying to form the image which is nearly identical to the original image and found the close identity to the original image. The image design with this technique is alternative to the original image but this technique is such accurate that the person who is unaware of original image will not able to detect that we have reconstruct the image. This method is called inpainting.



Input Image Output Image
Fig 1 Image Inpainting Method

1. Basic concept of Image Inpainting

Inpainting is not only to recover the images which got damaged but also the technique to remove unwanted objects from the image. This technique remove the cracks from the image, fills the missing part from the image, remove the text, dates etc. Inpainting is conceivable by the person who has more idea about this technique or he is specialized in that area or known as artist. Due to manual process it's consume lots of time to give the required result. Image Inpainting could also be called as method which creates alternate image and exploitation of an image. Image inpainting technique creates the original image which is only possible with the help of the information available from the source image/image to recover. In case of digital images, only the available image is taken for the experiment and thus filling in a hole that encompasses a whole object. It is not technique which creates the new image but it try to recover the image which content more promising pixels and that pixels available from the source image and with the help of that we create the clone of the image which is recovered from damaged and the clone of that image is such accurate that if any casual observer going to view

that image he will detect that image as original image. By using image inpainting along with rebuilding we have to keep this thing in to mind also that image is to recover with maximum accuracy. Image Inpainting not only try to find the texture to be inpainted but also propagate that structure by matching dimensions. Only after matching the dimensions it inserts the patch into the damaged image and then completes the image.

In this paper, different types of image inpainting techniques are discussed. Section 2 discussed about the review on image inpainting techniques. Problems of previous techniques are discussed in section 3. Section 4 is about the conclusion.

II. Literature Review

1. Image Inpainting Using PDE

A novel algorithm for digital inpainting of images was done with the help of Partial Differential Equation [1]. That attempts to replicate the basic techniques used by professional rebuilders. In this algorithm the user has to select the area to inpainted and after that algorithm rebuild the image by collecting the information available from the surrounding area of the source image. While filling this region this algorithm considers the way in which isophote lines arriving at the regions' boundaries are completed inside. During completition of image like other algorithm we have no need to provide the surrounding information. This is automatically done, thereby allowing to simultaneously fill-in numerous regions containing completely different structures and surrounding backgrounds. By using the isophote direction this algorithm completed the image.

Advantages: Due to Isophote driven Approach we find the line of equal gray scale values which contains the more promising information and this used to complete the image with less time.

Disadvantage: The main problem with this algorithm is reproduction of large texture regions. This algorithm also unable to recover Partially Degraded Image

2. Multiresoultion Image Inpainting

In the multiresoultion approach the damaged image block is divided into equal number of blocks of equal size. After dividing the image, the three threshold values were consider first for the threshold of variance of pixel colors, second and third- for the threshold of percentage [2]. Variance of color pixels has strong indication of containing the details of the image. By using this value we can able to rebuild the image. While rebuilding the image the percentage of damaged pixel was consider. In case the damaged pixel percentage is high, then to inPaint the image we have to consider the global average color. If the percentage is low, in that case we have to consider the information available from the image. After completition of image it evaluates the image with the help of PSNR value. This multilevel PSNR value decides how good the image is inpainted.

Algorithm

1 a. Let DIB be a damaged image block
  b. Let a be a threshold of variance
  c. Let ß1, ß2 be a threshold of percentage, ß1 < ß2

Algorithm inPaint (block DIB)

2 a. If DIB is a small block then return
    Divide DIB into *n*n* image blocks
  b. for each image block IB
    Let *var* be the color variance of IB
    Let *Mcolor* be the mean color of IB
  c. if *var* < a then
    {
     let PB be an *x*y* pixel block in IB
     let *Ncolor* be the mean color of PB
      for each PB in the image block
       {
        if the percentage of damaged pixels in PB > ß2
        inpaint the damaged pixels using *Mcolor*
       else if the percentage of damaged pixels in PB > ß1
       inpaint the damaged pixels using *Ncolor*
      else
      inpaint the damaged pixels using neighbor pixels
      }
  d. for each pixel in the boundary of each PB

smooth boundary pixels using neighbor pixels
}
3. else
call inPaint(IB)

Advantages: The Single Resolution approach produces the blurred result that overcome by this approach. It also covers the different level of details.

Disadvantages: The issue with this technique is that there is no friendly environment is provided to mark the region which we have to rebuild.

3. Fragment-Based Image Completition

In this technique to complete the image we have to remove the background and foreground elements from the image. The parts of the image which are seen with the naked eye can be used as spare parts to repair the image. In this method the first step is to select the region which we want to inPaint for that iterative process is used which selects the region approximately. After that we have to use composite image fragments to complete the image. To select the patch ,values of inverse matte is used which gives the high confidence pixels to complete the image and a level is set that provides the incremental approach to travel into the unknown region of image from high to low confidence. In each step we have to select the image fragment from frequently appearing examples. it processed to complete the image with this technique, the image fragments which is composited their probability rise with mean confidence of image.
Process:

Input: image *C*, inverse matte $\bar{a}$ (9 pixel with $\bar{a} < 1$)
Output: completed image, $\bar{a} = 1$
Algorithm:
1. for each scale from coarse to fine
Approximate image from color and coarser scale
2. Compute confidence map from $\bar{a}$ and coarser scale
3. Compute level set from confidence map
4. while μ (b) < 1−e
a. for next position *p* in level set
Compute adaptive neighborhood *N*(*p*)
b. search for most similar and frequent match *N*(*q*)
c. composite *N*(*p*) and *N*(*q*) at *p*, updating color and $\bar{a}$
5. Compute approximation, confidence map and update level set

Advantage: The Image completed with this approach composition of similar fragment is used which iteratively fills the missing regions. We can apply any method like scaling, transformation to composite the fragment.
Disadvantage: The limitation of this technique is that it has direct proportion with examples available from the global image. If we reach in availability of fragments then we can able to complete the image. The building blocks are required to complete the image from unknown regions to the known regions.

4. Completition Of Images With Natural Scenes

This method used to done the completion of images of natural scenery, where the removal of a foreground object creates a hole in the image. In this technique to select a patch from the image we limit the search into the horizontal direction only for that purpose we have to use Fourier transform which gives the distinct vertical line at center , by using this approach we gets the more promising pixels in horizontal direction only [4]. This whole process reduces the effort of searching the portion of image which we require to complete the image. We are able to locate the patch that imposed into the rest of image horizontally. During this method if we are trying to recover the area of slopes then privileges also provided for that image. The grid algorithm is used to complete the image in which the image first completed from the left region and then completed from right side. We fill-up the unknown regions of the matte with grid blocks from the source image.

Advantage: These method Saves lots of time with the help of Fourier transform by limiting the search in horizontal direction only. If we compare the result with other technique then we can get the good result in quick time.
Disadvantage: This Method does not apply the computation over all levels and also search is applied to small regions only not at different levels.

5. Graph cut Patch Algorithm

Zhang et. al [5] created a method to inpaint the image which divided into the three steps, First step is spatial range model is decided to get the direction of selecting the patch from the image.in second step source patch is selected by matching the dimensions of the source patch with target patch and if the dimensions doesn't match in that case we have to adjust the dimensions and then we have to enforce the searching areas into the neighborhood around the previous source patch. Third, to guarantee about the non-blurred result graph cut patch updating algorithm is designed. The quality of result corresponds to the human image recognition after image is completed.

Advantage: As algorithm divided into three steps the blurring of images is greatly reduced in this image. The graph cut patch algorithm performs nonblurring updating in this algorithm.

Disadvantage: In this algorithm we need to take care of filling order as well as patch matching and finally the patch updating.

6. Criminisis Algorithm

To recover the old techniques of texture synthesis algorithm and inpainting algorithm used to fill the image gaps, the technique is designed to combined advantages of the two approaches. Exemplar based technique contains the method for reinstalling the both texture and structure [6]. This algorithm divided into the few steps. First step is consisting of finding the source region, target region and finally the patch. In first step we have to find the patch, after finding the patch we have to decide the priorities of that patch because it may be the case that we can found the more patch for the same region with maximum accuracy. In this case we have to calculate the product of the confidence term and the data term. The result of this product will give us the more promising patch and that patch can found the close resemblance with the original image. By finding the patch with maximum priority we have to propagate the structure and texture information. The patch we found it can also called as exemplar means the copy of image. The patch we found has a maximum confidence pixel which minimizes the difference between the original image and the image which is result of the exemplar based technique.

Steps
Extract the manually selected initial front.
Repeat until done:
1 a. Identify the fill front.
  b. Compute priorities.
2 a. Find the patch with the maximum priority.
  b. Find the exemplar.
  c. Copy image data from exemplar to image.
3. Update confidence value.

Advantage: This approach is not only helpful to remove the objects from small scale images but this can be applied with the large scale image also. This approach by combining the two techniques provides us the better results.

Disadvantage: This algorithm does not handle the depth of ambiguities. If this algorithm does not found similar patches for synthesis, we can't get desirable result.

7. Image Inpainting Using Wavelet Transform

Dongwook Cho et. al [7] presented the technique with the help of the wavelet transform. Here we expect the best global structure estimation of damaged regions in addition to shape and texture properties. If we consider the fact of multiresoultion analysis, data separation, compaction along with the statistical properties then we have to consider the wavelet transform due to its good image representation quality. Wavelet transform try to satisfy the human visual system (HVS). In this algorithm decomposition of incomplete image is done with the help of wavelet and after that wavelet and scaling coefficients is found. The image inpainting process is applied in the wavelet domain by considering both scaling and wavelet coefficient from coarse to fine scales in the target region.

Advantage: This utilizes inter and intra scale dependency to maintain image structure and texture quality using Wavelet Transform.

Disadvantage: In this algorithm mask for regions are defined manually.

8. Image Inpainting Using MCA

Holes present in an image are filled with texture by a new image inpainting technique. Same process applied in cartoon image layer. This algorithm is a direct extension of a recently developed sparse-

representation-based image decomposition method called MCA (morphological component analysis), designed for the separation of linearly combined texture and cartoon layers in a given image. Our method is based on the ability to represent texture and cartoon layers as sparse combinations of atoms of predetermined Dictionaries. So if we want to fill simultaneously the image of texture which has unknown regions and image which consist of the cartoon image layer in that case we have to consider the MCA method to get the desired reconstructed image which providing the more promising result. The confidence pixels are going to help in both the cases to fill the incomplete image and reconstruct the both texture and cartoon image layer.
Advantage: This method is fusion of variation and regularization of the image that allows missing data and also automatically filling the missing holes in texture and also in the cartoon image layer.
Disadvantage: In this method there is necessity to consider the numerical solution to extend this approach. If the object has sparse representation then it creates the problem for this technique.

9. Multiscale Image Modeling

If we consider the nonseparable filter banks and direction based filter banks then we have to think differently because for this purpose it is not good idea to fully resemble on wavelet transform. To extend and to add this detail we have to consider the contourlet transform [9]. It can efficiently take control over the edges of image along with small number coefficient one dimensional contour because of its multiscale and directional properties. Contourlet transform region and its advantages helps author to inspect the image. The Detail study of contourlet coefficient makes clear idea about non-Gaussian trivial statics and strong dependencies. Contourlet coefficient is calculated about the Gaussian by considering the difficulty of neighboring coefficient magnitude. Technique is applied on the images which are affected by noise and the image where we have to retrieve the texture. While recovering the texture it shows too much improvement and additional things than wavelet transform and performance is also better.
Advantage: In denoising process the contourlet transform provides the better result than wavelet transform and in comparison to other technique it provides the good result in terms of human visual quality (HVS) and peal signal-to-noise ratio (PSNR).
Disadvantage: It is complex than the wavelet transforms and it also found difficulty to find the neighbouring coefficient.

10. Image Completition with Patch Propagation

This author described the necessities of semi-automatic image inpainting techniques. To complete this research the user plays the role of guide to help in the complete the structure and he found as favorer of the image [10]. This process works in two steps. In which first step user defined the region to be inpainted by drawing the object area border and physically specifies the missing information in the image. The border defined for that object move from the known region to unknown region. The patches are used to complete the texture in case of texture based synthesis. Author consider this problem as worldwide problem were he has to optimized the variety of structural and constancy constraints in that case the misplaced image patches produced all along the user defined curve. If we found the single curve in attendance then to get the optimum result we have to perform the dynamic programming. To produce the result with great accuracy dynamic programming importance is increased in this technique. The dealing with this propagation will decide the approximation of the result and how close is the result. In this way this technique are designed to complete the image which are damaged due to cracks, noise in the image , superimposed text, unknown object and each and every image inpainting techniques produces the good result or approximate result.
Advantage*:* Dynamic programming helps this algorithm to complete the image from single level to multilevel. If we able to found the single curve in this image then we can complete the image quickly and can also get the optimum result which is closely resemble with original image.
Disadvantage: For multiple objects the difficulty level is increased to optimize the result we have to propagate the technique to get approximate result.

III. Discussion And Problems

The above discussed techniques are providing the better result but they are also lacking in certain things. If we consider the size of object to recover, some of the techniques unable to produce the good result, because some of the techniques are designed for small image gaps only. If we complete the images with large gaps then it will give the result but the result quality will be poor and blurring effects also comes in act. Some of the techniques produce single resolution image result, to overcome that drawback multiresoultion approach is proposed. Wavelet transform is overcome by the contourlet transform for better result. PSNR values are used in some techniques which measured with the help of number of parts of images we created to complete the image.

The PSNR value is ratio of value decomposed image to value of the entire image which is calculated at the different level. This PSNR value satisfies the human visual system (HVS). After HVS is satisfy the image

produce will be having maximum resemblance with original image. But this PSNR also creates problem when number of level increases.

Table 1 Comparison of Techniques

Sr.No.	Author	Proposed Method	Time Efficiency
1	M. Bertalmio	Image inpainting	85%
2	Timothy K. Shih	Multiresoultion Image Inpainting	90%
3	Iddo Drori	Fragment-Based Image Completion	88.8%
4	Siddharth Borikar	Completion of Images With Natural Scenes	92.7%
5	Zhang	Region Completion in single image	87.9%
6	Criminisis	Exemplar Based Inpainting	96.2%
7	Dongwook Cho	Image Inpainting Based On Wavelet Transform	93.2%
8	M. Elad	Image Inpainting Using MCA	87.4%
9	Duncan D.K.	Image Inpainting Using Contourlet Transform	94.9%
10	Jian et.al	Image Inpainting By Patch Propagation	97%

IV. Conclusion

In this paper a variety of image inpainting techniques are discussed which consist of PDE based Inpainting, Multiresoultion Image Inpainting, Fragment based Image completition, Completition of image with natural scenes, Exemplar based Inpainting etc. For each of the image detailed discussion consist of the working of the inpainting techniques which are used to fill out the missing regions also remove the unwanted object. From this detailed survey we discussed the advantages and shortcomings of all image inpainting techniques. Some of the techniques work only for small image gaps which overcome by the other inpainting technique. When we come across the removal of large region exemplar based inpainting provides the better result, this technique is design in such manner we can able to recover the object from small image gaps to large image gaps. This algorithm works for texture as well as structure synthesis. But this work with maximum accuracy when regions contains simple texture and structure. Contourlet transform technique design in such manner that it overcomes disadvantages of nearly all technique. Overall study tells that all technique trying to provide better result in terms of quality of the image and also trying to improve the efficiency in terms of time taken by image completition algorithm.

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A Survey on the Social Impacts of On-line Social Networking Sites

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Abstract: *In the contemporary information age, the social networking sites (SNS) have been proved to be very popular where a significant number of total global populations are habituated in using the social networking platforms for interaction and collaboration purpose. The on-line social networking platforms have evolved to be the on-line collaboration platform in social, professional and personal settings that helpe people to be in touch for socializing or for professional interactivity purpose. The social networking interaction has become an integral part of human life and being used in diversified fields with dynamic reasons. As social networking platforms are becoming an integrated part of human life, the impact of those platforms subsequently has become part of interest on which significant level of research and studies have been carried out. This paper enlists the surveys, studies and research on the impact of social networking sites from a critical evaluation viewpoint.*
Keywords: *Social Networks, Social Networking Site, Digital Culture, On-line Collaboration, SNS.*

I. Introduction

In the conteporary information age, social networking platforms have been emerged to be an integral part of life. A significant number of total world populations who have access to online facilities and thus adapted to digital culture are accustomed to using social networking platforms [1 - 5, 7, 9, 13]. As a result, social networks and associated topics are becoming well known field of discussion in the society. It is the time when the total global population could be divided into two broad categories in terms of having access to the online social networks or not. The social networks are platforms for all the people where they could essentially form as a platform of interaction and collaboration for general purpose or for specific interest groups. Gathering on the social networking platform for people is associated with a number of objectives ranging from socialization and collaboration to research, education and exchange of expertise views [10, 18]. There have been very popular social networking sites where just anyone could join. This types of general purpose social networking platforms are being used by different people for different purposes. In this regard, the usefulness and the credibility of using such platforms are under scrutiny. Besides, the online safety for individuals is a major concern as people develop their on-line profile as well as their ongoing activities in the social networking sites [1, 8, 9, 14]. As stated earlier, the social networking platforms are being used for diversified reasons. People use the social networking platforms for social online gathering as well as part of leisure and amusement. The use of social networking tools have also been evolved for special interest groups to share expertise and opinions [17]. The social networking sites have emerged as an excellent tool to collaborate online. As such platforms have become an unavoidable part for people in their social and professional life, the impact of these social networks were part of interest for the researchers. Various aspects of the usefulness of SNSs in different applicable fields have been explored. At the same time, the adverse effect of these platforms have also been considered by the researchers.

The addictive nature of social networking sites and their impact on human life is one of the most crucial parts that demands exploration indeed. It is worth to explore the impact of the social networking sites to outline whether they are most credible in creative and constructive way or not.

II. Related Studies

Using social networking site have associated impact on the mindset and mental aspects of human being. The use of technology have different level of impact on different age groups. It is found that the adolescence aged people had a negative mental impact in the form of depression that resulted by using the social networking sites. The social networking sites are found to be the most popular online activity among the adolescence people. It is suggested that the use of social networking sites might result in depression for the people in their adolescence period [1]. The impact on the cognitive ability as a result of using the social networking sites (SNSs) have also been addressed in some research. It is quite a crucial matter to outline whether using the social networking sites (SNS) makes someone smarter by improving the cognitive perception or not. It was found that while the use of SNS does not essentially have a positive impact on the cognitive improvement, they did have some good aspects from different viewpoint, for example, stronger social relationship maintenance. But at the same time, it is sought to determine the feature that needs to be present in the SNSs. Besides, the type and nature of the SNS also work as influential factors for different impacts. For example, the contemporary and very

popular two SNSs are Face book and YouTube that are used for different purposes and thus have different impact on the cognitive aspects on human being [2, 11]. Some researchs suggested that the use of social networking had detrimental effect on the adolescence group which had been the reason for IAD (Internet Addiction Disorder). The concept of IAD is not introduced by the social networking sites but it has gradually become the topmost reason for IAD by defeating on-line gaming in a very short period of time [3]. The imposed corporate risks as a consequence of presence in social network are an important part to be concerned with. Though the use of social network are seen to pose threats at personal level, later it has emerged that the corporate culture could also be threatened by the social networking platforms. The presence on social networking platform potentiality helps a business but at the same time, brand damage could also be happened with this practice which would put very adverse effect on any business. The negative impact could also extend by the uncontrolled use of the social networking site by the employees who have a clear profile indication on their connection with the organization they work for. The vulnerability features of the social networking sites might also be a contributor where organizational sabotage as well as social engineering could take place to risk the image of an organization [4]. The beneficial part of using SNSs have also been listed where the argument clearly show that an organization could essentially extend its brand recognition by enriching its profile on SNSs [16]. One of the most alarming part arise from the use of social networking sites is its negative impact in the education sector. It is found that the use of social networking site and its integration within the educational and academic contexts and settings have resulted in the deterioration of the productivity as well as the overall efficiency. In a survey, the relationship between the SNS and the GPA of the students was found to be negative [5, 13]. At the same time, some argument established the strength that was provided by social networking in academia in the form of strong on-line collaboration [20]. In a study it was found that being ICT savvy did not essentially mean to be a strong activist within the social networking platform. When it comes to the social networking platform, people intended to build connections more in a personal way even with a basic goal of online collaboration [7]. On the contrary, there are evidences where renowned Universities have found the SNSs to be of particularly assisting in research and collaboration activities [17]. There have been some key quality factors on which the perception of the social networking depends to its users. Entertainment, community drivenness, efficiency, user friendliness, privacy and navigability are seen to be the quality factors on which the perception of any social networking site depend [6, 10, 12]. It is also controversial whether online social networks pose threat to the children by having potentiality to do any harm. Various studies yielded a number of results in this regard which can be summarized in the way that kids with online activity and specifically with social networking practice are prone to greater online risk and abuse than those who do not. The overall impression of these studies have established the social networking sites to be a definite avoidable one for the children and teens [8, 15]. In social networking websites, people create and share personal information that exceeds far above the line of official resume level information. The evolving profile of a person on a social networking site might interestingly hold the total information of a person including activities and preferences. The privacy of this information is quite a matter of concern as the information sharing on the social networking sites could potentially make the sensitive personal information available to unwanted third parties. It is a matter of concern especially with the people who were not IT literate to sufficient level on privacy and other digital culture awareness aspects [9, 14]. Knowledge and information sharing are some of the key driving forces in the advancement of the knowledge base and knowledge management of human being, which dramatically facilitated the advancement of the society to some extent and it also has some impact on the quality of peoples' life. But at the same time, at least some of the social networking sites are found to be extremely addictive where the observation of spending up to nine hours a days with the social networking sites existed [19]. If used properly, the social networking platforms could be evolved to be beneficial as it is found that the social networking sites offer potential benefits despite of having a number of drawbacks [18].

III. Analysis Of The Studies

The research and studies that is evaluated within the context of this paper, have indications on the pros and cons of the SNSs. While some of the research argued on the potential benefits of the social networking platform and its application within social, educational and academic context; most of the studies sought for the initiative to tackle the inherent disadvantages of such social networking platforms. The negative impact on the teenage and the children of the SNSs suggested that further study on how to control the issue including any further parenting needs is a crucial aspect to include in the relevant research. Also, the negative and sensitive impact in the form of deterioration of the cognitive ability resulted from extensive use of social networking would put the necessity of awareness on using such sites into perspective. The credibility of such necessity is further strengthen on the finding of the social networking sites being a major reason for IAD (Internet Addiction Disorder) among the teenage population. While the corporate culture could be blessed by these networking platforms, the devastating impact on the corporate image as a consequence of using the SNSs were also evident.

The academic research sector could be benefited by SNS in terms of online collaboration, but again, the

adverse effect on the students points finger to the effectiveness of the SNS within social context. On top of all these, the information privacy remains as an all time concern that demands a robust framework and security model for the SNSs. The addictive nature of SNS indicates one of the worst phenomenons of the social networking. Due to this aspect, the SNSs could be considered as the intangible counter part of the real life drugs. The analyzed studies and research lead to the fact that the social networking sites might be associated with some advantages, but the adverse effects of the social networking sites are something not to be overlooked at any cost.

IV. Conclusion

Despite of having tremendous dynamic and creative aspects, the social networking sites (SNSs) exhibit the impact in human life in a way to established its negative potentiality to emerge as a digital drug for people. A digital drug can be thought of as the digital equivalent of real life drugs. It would not be possible to exclude the online social networking concept from the society as of its having potentiality to help and further the knowledge base; the desired practice of the social networking site is rather expected to be within a robust secured framework with initiatives on growing proper awareness among the people to make effective use of such social collaboration tools and platforms.

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Efficient Forecasting of Exchange rates with Recurrent FLANN

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***Abstract**: In this paper, Functional link artificial recurrent neural network (FLARNN) ensemble forecasting model is proposed for foreign exchange rates prediction. In the survey of existing literature, it is revealed that there is need to develop efficient forecasting models involving less computational load and fast forecasting capability. We compare the FLARNN model performance with some existing neural network models such as LMS and FLANN in terms of the exchange rates between US Dollar and other three currencies (Indian Rupees, British pound, Japanese Yen). Experimental results reveal that the predictions using the proposed approach are consistently better than the above mentioned methods on the basis of various parameters including error convergence and the Mean Average Percentage Error (MAPE).*

***Keywords:** Artificial neural networks; Recurrent; Currency Exchange rate Forecasting; FLANN; FLARNN.*

I. Introduction

Financial Forecasting is one of the hottest fields of research lately due to its commercial applications owing to the high stakes and the kind of attractive benefits that it has to offer. Prediction of foreign exchange (FX) rates and stock prices has been an active area of research in computational intelligence. Forecasting the price movements in exchange rate markets has been a major challenge for common investors, businesses, brokers and speculators. As more and more money is being invested the investors get anxious of the future trends of the exchange rate in the market. The FX market is the largest and most lucrative financial markets [1].

Researchers have devoted a great deal of effort in order to find a good explanation (model) of the movement of FX rates between major currencies during the last decade [2, 3]. It is widely known that FX rates are affected by many co-integrated, macro-economic, political and even psychological factors. So far, there is lack of modeling technique that can completely accommodate all the factors and their complex interactions. Therefore, modeling and forecasting FX rate movements poses a great challenge in today's global economy.

Since financial time series are complex, the researchers consider the processes, which change the time series data as a black box and they just study the fluctuations of the series (Anastasakis & rt, 2009).In order to predict nonlinear time series such as exchange rate time series, it is better to employ neural networks that are nonlinear in nature. Neural networks can be divided into two major types, feed forward and recurrent networks. Feed forward neural networks, such as the Multilayer Perceptron (MLP) and the Radial Basis Function (RBF) net, have been successfully used for time series prediction (Lee and Haykin, 1999-4). However, MLPs utilize computationally intensive training algorithms (such as the error back-propagation (Rumelhart et al., 1986-5) and can get stuck in local minima. In addition, these networks have problems in dealing with large amounts of training data, while demonstrating poor interpolation properties, when using reduced training sets. In the case of RBFs, the networks are trained only once on a large example set taken from the signal such that the dynamics of the underlying system can be captured. Therefore, the networks produce sequential outputs in response for newly arriving data. This means that such a system can be used when the dynamics of the time series does not change considerably over time, a condition which is usually contravened in practice (Lee and Haykin, 1999-4).

Recurrent neural networks have advantages over feed forward networks in that they have the ability to store previous state information and prevent the need to predict the model order of the time series (Pao et al., 1992-6).

This study proposes a Functional Link or FLANN architecture based model to predict the movements of prices in the foreign exchange rates. The functional link ANN is a novel single neuron based architecture first proposed by Pao [4]. It has been shown that this network may be conveniently used for functional approximation and pattern classification with faster convergence rate and lesser computational load than a Multi-layer Perceptron (MLP) structure.

This paper shows the comparison three models such as RBF, FLANN and FLARNN for prediction of three different exchange rates for one , five, ten ,thirty and sixty days ahead. There performance has been assessed through simulation study with MAPE parameters. The rest of this paper is organized as follows. The development of FLARNN model dealt in section 2. The design of input data of these models is covered in section 4. In section 5 the simulation of experiment is carried out. Finally, conclusions are given in Section 6

II. Introduction To Flarnn Based Model For Exchange Rate Conversion.

This study proposes a FLARNN architecture based model to predict the movements of prices in the exchange rates between US Dollar and other three currencies. The FLARNN is a novel single neuron based architecture first proposed by Pao [5]. It has been shown that this network may be conveniently used for functional approximation and pattern classification with faster convergence rate and lesser computational load than a Multi-layer Perceptron (MLP) structure. It is a flat net without any need for a hidden layer. Therefore, the computations as well as learning algorithm used in this network are simple. The functional expansion of the input to the network effectively increases the dimensionality of the input vector and hence the hyper planes generated by the FLARNN provide greater discrimination capability in the input pattern space. Various system identifications, control of nonlinear systems, noise cancellation and image classification systems [6] have been reported in recent times. These experiments have proven the ability of FLARNN to give out satisfactory results to problems with highly non-linear and dynamic data [7]. Further the ability of the FLARNN architecture based model to predict exchange rate movements, both for short term (next day) and medium term (one month and two months) prediction using statistical parameters consisting of well known technical indicators based on historical index data is shown and analyzed.

2.1 Structure of Functional Linked ARNN

FLARNN is a single layer, single neuron recurrent architecture, first proposed by Haykin and Li [8], which has the exceptional capability to form complex decision regions by creating non-linear decision boundaries. The architecture of the FLARNN is different from the linear weighting of the input pattern produced by the linear links of the better known Multi Layer Perceptron (MLP). In a FLARNN, each input to the network undergoes functional expansion through a set of basic functions as well as Technical indicator (TE). The functional link acts on an element or the entire pattern itself by generating a set of linearly independent functions.

The inputs expanded by a set of linearly independent functions in the function expansion block, causes an increase in the input vector dimensionality. In our experiment, the functional expansion block comprises of a set of trigonometric function.

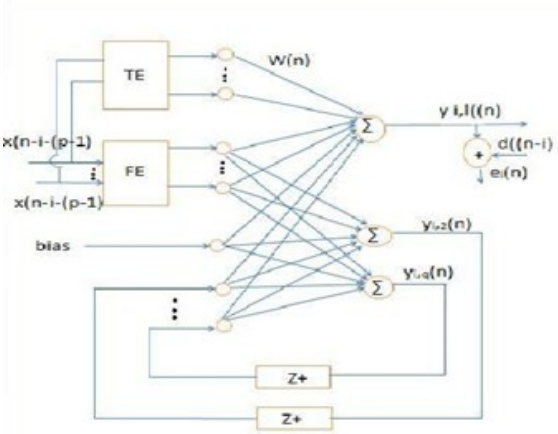


Fig-1. Structure of FLARNN with single output

The basic function for the FLARNN, $B = \{\phi_i \in L(A)\}_{i \in x}$ is to be selected keeping the following properties into consideration 1)$\emptyset_i = 1$, 2) the subset $b_j = \{\emptyset_i \in B\}^{j}_{i=1}$ is a linearly independent set, i.e., if $\sum_{i=0}^{n} w_i \emptyset_i = 0, w_i = 0$ for all i=1,2,3…….j, and 3)sup$_j$ $[\sum_{i=1}^{n} \| \theta_i \|_A^2]^{\frac{1}{2}} < \infty$.

Let $B_N = \{\varphi\}_{i=1}^{N}$ be a set of basic functions to be considered to the FLARNN as shown in fig. 1. Thus, the FLARNN consists of N basis functions $\{\varphi_1, \varphi_2, \varphi_3, \ldots\ldots\ldots, \varphi_N\} \in B_N$ with following input-output relationship for the *j*th output:

$$\hat{y}_f = p\,(S_f);$$

$$Sf = \sum_{i=1}^{N} w_{ij}\, \phi_i\,(x) \qquad (1)$$

Where $X \in A \subset R^n$ i.e. x = $[x_1 x_2 \ldots\ldots x_n]^t$ is the input pattern vector, $\hat{y} \in R^m$ i.e., $\hat{y} = [\hat{y}_1\ \hat{y}_2 \ldots\ldots \hat{y}_m]^T$ is the output vector and $W_j = [w_{j1} w_{j2} \ldots\ldots w_{jn}]$ is the weight vector associated with the

jth output of the network. The non–linear function considered in this case $\rho(\cdot) = \tanh(.)$ Considering the m-dimensional input vector, equ(1) can be written as S =WΦ Where W is $(m\ X\ N)$Weight matrix of FLARNN given by, $W = [w_1 w_2 \dots \dots w_m]^T$,$\emptyset = [\emptyset_1(X) \emptyset_2(X) \dots \dots \emptyset_N(X)]^T$ is the basic function vector, and $S = [S_1 S_2 \dots \dots S_n]^T$is a matrix of linear outputs of FLARNN. The m–dimensional output vector $\hat{y}$ may be given by

$$\hat{y} = \rho(S) = f_w(X) \qquad (2)$$

2.2 Learning with Functional Linked ARNN

The learning of ARNN can be described as approximating a continuous, multivariate function f(X) by an approximating function fw(X) .Given a function the objective of the learning algorithm is to find the optimum weights such that fw (X) obtained approximates f(X) within an error e. This is achieved by recursively updating the weights. Let the training sequence be denoted by {xk ,yk } and the weight of the network be W(k), where k is the discrete time index given by k= κ +λ K where λ=0,1,2,….., and κ = 0,1,2,…,K. From (1) the j th output of FLARNN at a given time k can be given as:

$$\hat{y}_j = \rho\left(\sum_{i=1}^{N} w_{ji}(k)\phi_i(x_k)\right)$$
$$= \rho\left(w_j(k)\phi_i(x_k)\right) \qquad (3)$$

For all $X \in A$ and j =1,2,3,……,m where $\phi = [\phi_1(X_k)\phi_2(X_k)..\phi_N(X_k)]^T$ .Let the corresponding error be denoted by $e_j(k) = y_j(k) - \hat{y}_i(k)$ .The Least Mean Square (LMS) update rule for all the weights of the FLARNN is given by

$$W(k+1) = W(k) + \mu\delta(k)\phi(x_k) \qquad (4)$$

Where , $W = [w_1(k)w_2(k)...w_m(k)]^T$ is the $M \times N$ dimensional weight matrix of the FLARNN at the k-th time instant is $\delta(k) = [\delta_1(k)\delta_2(k)..\delta_m(k)]^T$ and $\delta_j(k) = \left(1 - \hat{y}_j(k)^2\right)e_j(k)$ **(5)**.

Similarly the Recursive Least Square (RLS) update rule for all weights of the FLARNN is given by

W(k +1) =W(k) + ej(k)zzk '(k) (6)

Where, zzk(k) = z(k) /(1+ q) ,

q = X (k).zk(k) and zk(k) = R(k).X (k) (7)

The autocorrelation matrix R(k) is updated with the equation,

R(k +1) = R(k) − zzk(k).zk(k) ' (8)

Which is initialized using the expression, R(0) =η.I, where I is the identity matrix and η is a constant. The motivations for using trigonometric polynomials in the functional expansion stage are explained below. Of all the polynomials of N-th order with respect to an ortho-normal system {φ i(x)}I N =1 gives the best approximation in the metric space L2 is given by the N-th partial sum of its Fourier series with respect to this system.

Thus, the trigonometric polynomial basis functions given by {1,cos(π x),sin(π x),cos(2π x),sin(2π x),....,cos(Nπ x),sin(Nπ x)} provide a compact representation of the function in the mean square sense. However, when the outer product terms are used along with the trigonometric polynomials for function expansion, better results were obtained in the case of learning of a two-variable function.

III. Network Input Selection Data Preprocessing

The data for the exchange rate prediction experiment has been collected for three different currency converter indices namely 1 US $ to Rupees, Pound and Yen from Canada bank currency converter.. The proposed forecasting model is developed to forecast the closing price of the index in each day of the forecasting period. Different technical and fundamental indicators are used as inputs to the network. Technical indicators are any class of metrics whose value is derived from generic price activity in a currency. Technical indicators look to predict the future price levels, or simply the general price direction, of a security by looking at past patterns. Out of the many technical indicators used by traders, 10 indicators (Table-1) have been chosen as input to the network which has been used before by many researchers for exchange rate forecasting problems.

IV. Experiment Model Setup

Data samples are collected from the historical values of 10-year currency converter- Bank of Canada. We employ models using Radial Basis Function and Functional Link Neural Network architecture (FLANN) and FLARNN structure where the parameters of each of the structure is updated using LMS algorithm learning.

4.1 Modeling FLARNN structure

For our experiment, the total input to the single neuron FLARNN is 30 plus a bias. This gives us 31 weights that are to be trained using a suitable adaptive algorithm for a particular exchange rate index. The neuron adds up the input weight products and bias. The sum is then taken up by a suitable activation function to give the output of the network. For this particular case we used the tan hyperbolic activation function. In the FLARNN model prediction, four trigonometric functions namely Cos πx, Cos 2πx, Sin πx and Sin 2πx were used along with the technical indictor. An optimum value of the convergence coefficient was taken as 0.1 for all the prediction experiments. The inputs are normalized to values between +1 and -1. This can be done by a number of normalization techniques. One of the popular techniques we used was expressing the data in terms of the maximum and minimum of the data set. All the values are normalized by using the following equation

Y = (2*X – (Max + Min))/ (Max + Min)

Where Y: - normalized values, X: - present value.

Table-1

Technical Indicators	Formula
Simple Moving Average (SMA)	$\frac{1}{N}\sum_{i=1}^{N} x_i$ N = No. of Days. x_i = today's price
Exponential Moving Average (EMA)	$(P \times A) + (\text{Previous EMA} \times (1 - A))$; A=2/(N+1) P – Current Price, A- Smoothing factor, N-Time Period
Accumulation/ Distribution Oscillator (ADO)	$\frac{(\text{C.P - L.P}) - (\text{H.P - C.P})}{(\text{H.P - L.P}) \times (\text{Period's Volume})}$ C.P – Closing Price, H.P – Highest price, L.P – Lowest price
Stochastic Indicator (STOC)	$\%K = \frac{(\text{Today's Close - Lowest Low in K period})}{(\text{Highest High in K period - Lowest Low in K period})} \times 100$ $\%D$ = SMA of $\%K$ for the Period.
On Balance Volume (OBV)	If Today's Close > Yesterday's Close OBV = Yesterday's OBV + Today's Volume If Today's Close < Yesterday's Close OBV = Yesterday's OBV – Today's Volume
WILLIAM's %R	$\%R = \frac{(\text{Highest High in n period - Today's Close})}{(\text{Highest High in n period - Lowest Low in n period})} \times 100$
Relative Strength Index (RSI)	$\text{RSI} = 100 - \frac{100}{1 + (\text{U/D})}$
Price Rate Of Change (PROC)	$\frac{(\text{Today's Close - Close X-period ago})}{(\text{Close X-period ago})} \times 100$
Closing Price Acceleration (CPAcc.)	$\frac{(\text{Close Price - Close Price N-period ago})}{(\text{Close Price N-period ago})} \times 100$
High Price Acceleration (HPAcc.)	$\frac{(\text{High Price - High Price N-period ago})}{(\text{High Price N-period ago})} \times 100$

4.2 Training Process

The training of the network takes place in the following fashion. The weight update is epoch based. Since we have three different networks namely RBF, FLANN and FLARNN. As mentioned in section 4.1, altogether 31 weights of FLARNN model need to be updated by learning algorithm. The weights remain unchanged till all of the training data set is fed into the network, compared with the desired output and their respective error stored. The mean error for the entire epoch is calculated, and then the adaptive weight update takes place. The Least Mean Square (LMS) update algorithm is used in our experiment updates the weights by adding the product of the convergence constant, the respective input with the mean error for the epoch to the weights of the previous epoch. The cost function for the training process is the Mean Square Error (MSE). It is suitable to end the training of the network when the minimum level of the cost function is observed. The number of iteration is decided upon by gradient of the MSE curve. If it is observed that there is no significant decrease in the MSE then the training experiment can be stopped. There exists a trade-off between the time taken and quality of training. High number of iterations tends to give better training of the network at the cost of time taken to train

4.3 Testing Process

At the end of the training process of the network, the weights are frozen for testing the network on inputs that were set apart from the training set. The testing set patterns are the input to the network and the output is compared with desired output. The percentage of error is recorded for each data set. The Mean Absolute Percentage Error (MAPE) is used to gauge the performance of the trained prediction model for the test data. In our simulation, we have calculated both MSE and MAPE, but the analysis and comparison is done on the basis of MAPE only. The effort is to minimize the MAPE for testing patterns in the quest for finding a better model for forecasting exchange rate movements. The MAPE is given as

$$MAPE = \frac{1}{N}\sum_{j=1}^{N}\left|\frac{y_j - \hat{y}_j}{y_j}\right| \times 100$$

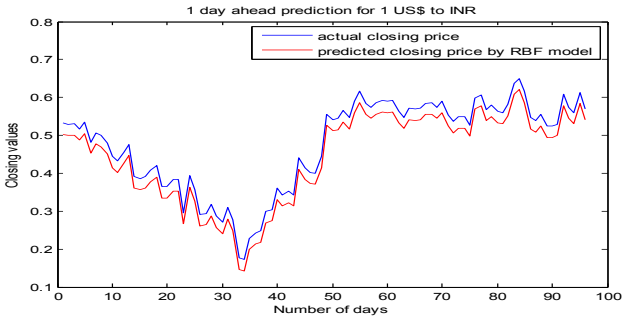
V. Simulation Results

5.1 Simulation Results for 1 US$ to Rupees

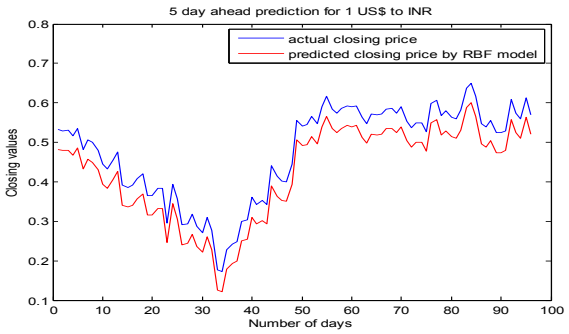
Out of around 3000 days data of 1 US$ to Rupees it was found that only 1000 days data is Sufficient enough to train the various models for 1 day, 5 day, and 10 days ahead prediction. For 30 and 60 day ahead prediction, up to 2000/2500 days data is used to train the network. Model is tested with fresh 600 days data, out of which only 100 are shown for clarity.

Testing for RBF model**:**

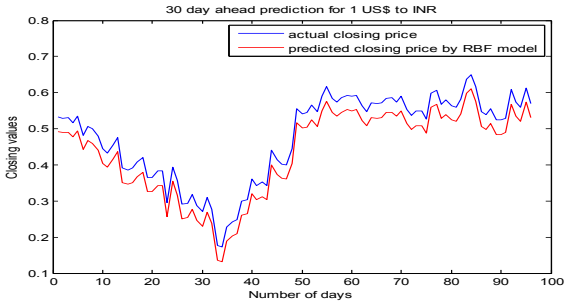
For 1 day ahead prediction



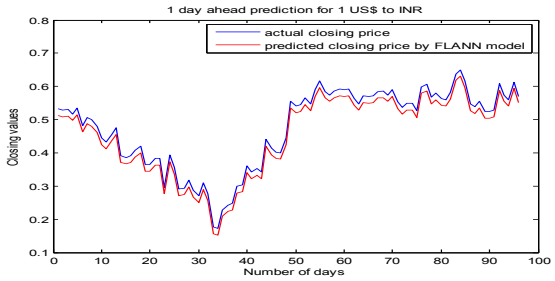
For 5days ahead prediction



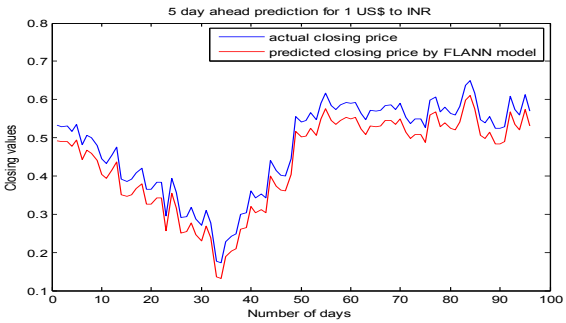
For 30 days ahead prediction



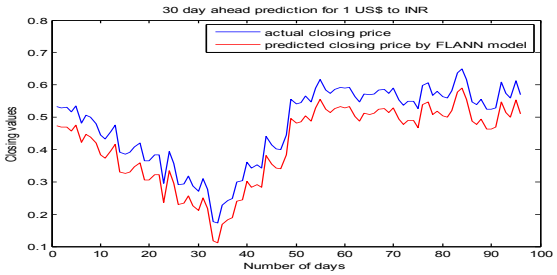
Testing for FLANN model:
For 1 days ahead prediction



For 5days ahead prediction

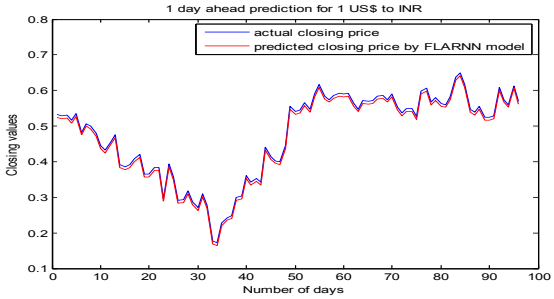


For 30 days ahead prediction

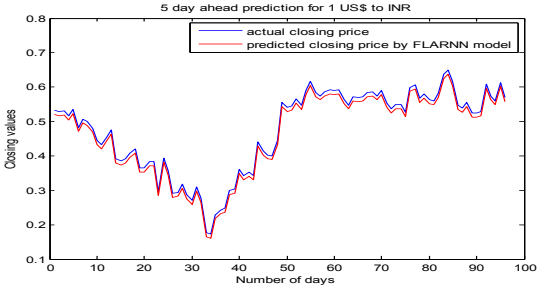


Testing of FLARNN model

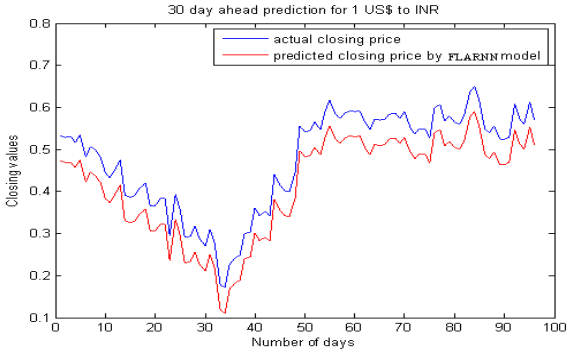
For 1 day ahead prediction



For 5 days ahead prediction



For 30 days ahead prediction



Model Comparison via MAPE for 1US $ to Rupees

Ahead prediction	RBF MAPE	FLANN MAPE	FLARNN MAPE	Training done for
1 day	3.7736	2.349	**1.991**	1000 day
5 day	4.992	3.878	**2.897**	1000 day
10 day	6.145	**5.678**	4.543	1000day
	5.987	3.998	**3.212**	2000 day
30 day	6.783	**5.198**	7.327	1000day
	6.342	**5.02**	6.789	2000 day

Model Comparison via MAPE for **1 US$ to Yen**

Ahead prediction	RBF MAPE	FLANN MAPE(%)	FLARNN MAPE	Training done for
1 day	1.24	1.349	**0.991**	1000 day
5 day	3.7390	3.878	**2.197**	1000 day
10 day	5.87	6.437	**3.543**	1000day
	4.861	5.498	**2.212**	2000 day
30 day	6.25	**5.498**	6.7327	1000day
	5.89	**4.5**	5.289	2000 day
60 day	9.4478	**6.22**	7.7321	1000day
	8.8178	**5.227**	6.1569	2000 day

VI. Discussion on simulation results

Starting from the calculation of various parameters associated with the exchange rate data, in this paper we have formulated a comparison between various models such as RBF, FLANN and FLARNN and results are compiled. In our lucid simulations, we tested our algorithms on three types of exchanges rates namely 1 US$ to Rupees, pound, Yen. The results are compiled along with the response plots. LMS has the advantage of faster convergence but the probability of getting stuck in local optima is high.

VII. Conclusion

The Recurrent Functional Link Artificial Neural Network and Radial basis function exchange rate prediction model is introduced. With the use of FLARNN, FLANN and RBF, the model for prediction of exchange rate indices becomes simpler and involves lesser computations compared to other such model reported earlier. Experiments show that in case of lower number of ahead prediction, FLARNN parameters updated with LMS algorithm along with technical indicator gives the best result. While for higher number of days ahead prediction, RBF parameters updated with LMS algorithm works the best.

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Filtering Schemes for Injected False Data in Wsn

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Abstract: *Wireless sensor networking is an emerging technology, which supports many emerging applications due to their low cost, small size and unethered communication over short distances. Sensor nodes are deployed in open hostile environment in WSN applications. An adversary can easily compromise sensor nodes due to their unattended nature. Adversaries can inject false data reports into the WSN through compromised nodes. The false data reports lead the en-route nodes and the base station to make false decision. False decision depletes the energy of en-route nodes and the base station. Hence create threat to the lifetime of the sensor nodes. To detect and drop false data, number of en-route filtering schemes have been developed. Bandwidth Efficient Cooperative Authentication scheme for injected false data(BECAN) is an efficient method for filtering false data. Here, implements the BECAN scheme by using NS2 and increases the security by adding Hybrid Authentication scheme (HAS).*

Keywords: *En-route filtering, Sensor node, false data.*

I. Introduction

In WSN applications sensor nodes are deployed in hostile environment. In such environment sensor nodes are subjected to various types of attacks such as eavesdropping, masquerade, false data injection, selective forwarding. Sensor nodes sense the events and generate event report for the sensed information and the event report has to be send to the base station through the en-route nodes. When event report is forwarded through en-route node, a compromised node can forge the report. False data contain false information from compromised nodes. The false data injection attack depletes the energy of the en-route nodes. One solution to reduce the impact of false data injection into the network through a compromised node is to filter the false data by the en-route node as early as possible before reaching the base station. Many enroute filtring schemes have been developed. Statistical en-route filtering is the first en-route filtering scheme (SEF) [1] to address the fabricated Report injection attacks in the presence of compromised nodes. Commutative Cipher based En-route Filtering scheme (CCEF)[2] drops fabricated reports en-route without symmetric key sharing. In Secure Ticket-Based Enroute Filtering Scheme (STEF)[3], ticket concept is introduced to drops false messages enroute. Dynamic En-route Filtering [4] is based on clustering. Finally BECAN [5] is band-width efficient co-operative authentication scheme for filtering injected false data.

II. Literature Survey

2.1 Sef

Statistical en-route filtering (SEF)[1] is the first en-route filtering scheme to address the fabricated report injection attacks in the presence of compromised nodes and introduce an en-route filtering framework. In SEF, there is a global key pool, which is divided into n non-overlapping partitions. Before deployment, each node stores a small number of authentication keys randomly selected from one partition of globe key pool.Once a stimulus appears in the field, multiple detecting nodes elect a CoS node that generates the report. Each detecting sensor produces a keyed MAC for the report using one of its stored keys.The CoS node collects the MACs and attaches them to the report in the form of a Bloom filter. These multiple MACs collectively act as the proof that a report is legitimate. A report with insufficient number of MACs will not be forwarded. When sink receives reports about an event, the sink verifies every MAC because it knows all the keys. Thus false reports with incorrect MACs that sneak through enroute filtering by chance are still detected. SEF cannot detect which nodes are compromised because reports are filtered en-route probabilistically, but it can prevent the false data injection attack with 80 - 90 percent probability within 10 hops.

2.2 Ccef

In Commutative Cipher Based En-route Filtering (CCEF)[2], each node is preloaded with a distinct authentication key. When a report is needed, the base station sends a session key to the cluster-head and a witness key to every forwarding node along the path from itself to the cluster-head. The report is appended with multiple MACs generated by sensing nodes and the cluster-head. When the report is delivered to the base station along the same path, each forwarding node can verify the cluster-heads MAC using the witness key. The MACs generated by sensing nodes can be verified by the base station only. CCEF has several drawbacks. First, it relies

on fixed paths as IHA does. Second, it needs expensive public key operations to implement commutative ciphers. Third, it can only filter the false reports generated by a malicious node without the session key.

2.3 Stef

Secure Ticket-Based En-route Filtering (STEF) [3],uses a ticket concept, where tickets are issued by the sink and packets are only forwarded if they contain a valid ticket. If a packet does not contain a valid ticket, it is immediately filtered out. STEF is similar nature to SEF and DEF[4]. The packets contain a MAC and cluster heads share keys with their immediate source sensor nodes in their vicinity and with the sink. The drawbacks of STEF are its one way communication in the downstream for the ticket traversal to the cluster head.

2.4 Def

In Dynamic En-route Filtering scheme (DEF) scheme, a legitimate report is endorsed by multiple sensing nodes using their own authentication keys. Before deployment, each node is preloaded with a seed authentication key and secret keys randomly chosen from a global key pool. Before sending re-ports, the cluster head disseminates the authentication keys to forwarding nodes encrypted with secret keys that will be used for endorsing. The forwarding nodes store the keys if they can decrypt them successfully. Each forwarding node validates the authenticity of the reports and drop the false ones. Later,cluster heads send authentication keys to validate the reports. The DEF[4] scheme involves the usage of authentication keys and secret keys to disseminate the authentication keys; hence, it uses many keys and is complicated for resource-limited sensors.

2.5 Becan

In Bandwidth efficient Cooperative Authentication (BECAN)[5] scheme, each node requires _xed (k)number of neighbors for co-operative neighbor router(CNR) based authentication. BECAN filter in-jected false data through cooperative authentication of the event report by k neighboring nodes of the source node.

BECAN distributes the authentication of en-routing to all sensor nodes along the routing path to avoid complexity. This scheme adopts bit compressed authentication technique to save bandwidth. The proposed technique is suitable to handle compromise and filter injected false data in wireless sensor networks. BECAN is not able to address attacks such as selective dropping and false routing information injected by compromised node.

III. Problem Definition

In the method BECAN (Bandwidth Efficient Cooperative Authentication), if sensor wants to send data to sink, it first finds path and then exchanges key with neighbor. If node is not adversary then only it can send data to neighbor. Finally MAC scheme is used for authentication. Here, injected false data identified earlier as possible. Over head of sink is reduced and energy consumption also very low compared to other methods. BECAN scheme only verifies the packets by using MAC and the keys generated by each node. Sharing pair-wise key with other sensor nodes may be vulnerable as an intermediate node can be compromised and hence keys will be disclosed. As a result, those compromised forwarding nodes can be easily manipulated to inject false data reports by the inside attacker. So security is less in the method.

IV. Prposed System

In order to increase the security of BECAN, can use a different Hybrid Authentication Scheme(HAS) based on RSA with CRT encryption instead of the verification of MAC. As the report is forwarded, each node along the way verifies the correctness of the RSAs probabilistically and drops those with invalid RSAs. As the infield compromised node is prevented from gathering enough RSAs, the report generated by it can be detected and dropped en-route and exclude the attacker node from the network so that injection of false data will be avoided in future. HAS prevents unauthorized access through injecting false data attack from mobile compromised sensor nodes through routing protocols.

V. Implementation Details

The simulation is in NS2 on Linux machine to authenticate the filtering of injected false data in Wireless sensor network. Mainly focus on the link stability and route lifetime, no route overhead was considered in the simulation. In 2500X1000 square meter area, nodes exist. Uses square area to increase average hop length of a route with relatively small nodes. The transmission range is fixed at 250 units. The number of nodes is set as 100. Nodes are assigned with unique ID and keys are generated for each node before deployment. The project includes the following modules:

- Architecture Model
- Power Management
- Key Management
- Security Analysis

VI. Experimental Results

BECAN method with HAS is implemented and the simulated output is obtained. Based on the values from the trace file, graphs are plotted. Compared with the existing method, the energy consumption is low and the throughput is high in this method

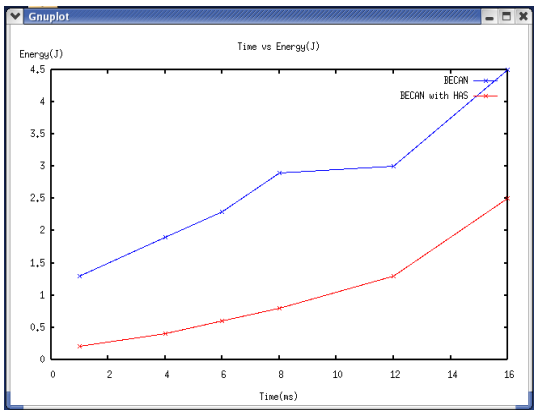

Figure 1: Energy Vs Time graph

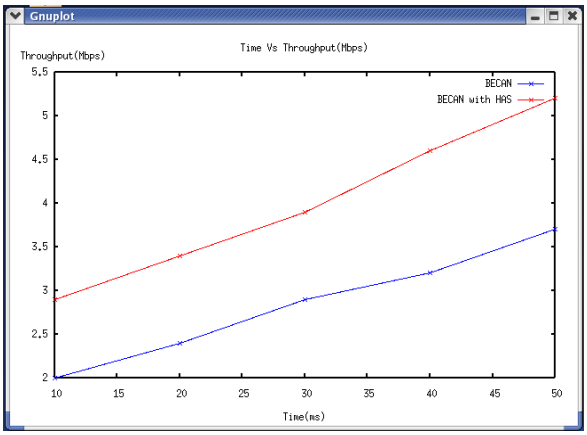

Figure 2: Throughput Vs Time graph

VII. Conclusion

Analyzed about false data injection by compromised node in WSN. En-route Filtering is an efficient way of dealing with false data injection attacks. A literature survey is done to analyzes about the en-route filtering schemes such as SEF, CCEF, STEF, DEF and BECAN. Implemented the BECAN with HAS and analyzed by comparing with existing methods. It shows BECAN with HAS model is efficient than older methods in case of energy consumption and throughput.

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Using Fuzzy Clustering and Software Metrics to Predict Faults in large Industrial Software Systems

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Abstract *: Faults are a key problem in software systems. Awareness of possible flaws from the initialization of a project could save money, time and work. Estimating the possible deficiency of software could help in executing software development activities. This paper proposes a model to predict the possibility of faults on a software system before testing. The model predicts possible faults during software development using Fuzzy Clustering and Software Metrics. This research is aimed at predicting faults in large software systems by creating clusters and then finding out the distance of each point in the data set with the clusters created to determine their degree of membership within each cluster*

Keywords*: Software, fault prediction, software metrics, fuzzy clustering*

I. INTRODUCTION

Reliance on software in our daily lives has increased so much in the last decade that in our day living without devices controlled by software is almost impossible. The Industrial domains such as medical applications, power plants, air traffic control and railway signaling have all integrated software as a fundamental part of their operation. Software engineers have to deal with a large number of quality requirements such as reliability, safety, availability, performance, maintainability and security which makes the development of these large software applications very challenging. The industrial reliance on software gives rise to the likelihood of gross crises in the case of a failure and the effect of these catastrophes ranges from economic damage to loss of lives. Therefore, there is an increasing necessity to ensure the steadfastness of software systems. Moreover, it is well known that the earlier a problem can be identified, the better and more cost effectively this problem can be fixed. Therefore, it is necessary to predict faults during the software development.

There are numerous techniques and metrics for investigating fault prone modules which may aid software developers in performing testing activities during development. It is almost impossible to produce software that is free of faults due to the rising complexity and the constraints under which the software is developed. Such faults may lead to an increment in development & maintenance cost and time, due to software failures and decrease customer's satisfaction [1].

Data Clustering is a basic technique in many modeling algorithms. The objective of clustering is to construct new collections of data from large data set. One of the most acceptable contributions to the field of data clustering is Fuzzy C-Means clustering. It has more benefits compared to other methods of data clustering, specifically the ability to split data for different size clusters with fuzzy logic. The Fuzzy C-Means can be seen as the modified version of the k-means algorithm. Which is a method of clustering that allows one piece of data to belong to two or more clusters. The degree of being in a certain cluster is related to the inverse of the distance to the cluster [2]. Fuzzy C-Means iteratively moves the cluster centers to the "right" location within a data set. This research is aimed at predicting faults in large industrial software systems by creating clusters and then finding out the distance of each point in the data set with the clusters created to determine their degree of membership within each cluster. The Factors like Mean Absolute Error, Accuracy and Root Mean Square Error help us in predicting the software system as faulty or fault-free.

The literature, [3]-[17] presents various types of Fault-Proneness Estimation Models. The results are also compared with [18] in which Hierarchical clustering based approach is used for Finding Fault Prone Classes in large software systems. The paper is organized as follows: section II exploits some literature on related works, section III explains the methodology followed in this research and section IV the result of the study. Finally conclusions of the research are presented in section V.

II. RELATED WORKS

Quite a number of efforts have been made in research for software fault prediction and assessment using various techniques [3] – [5]. Agresti and Evanco [6] worked on a model to predict defect density based on the product and process characteristics for Ada program. There are many papers advocating statistical models and software metrics [7, 8]. Gaffney and Davis [9, 10] of the Software Productivity Consortium developed the

phase-based model. It uses fault statistics obtained during the technical review of requirements, design, and the coding to predict the reliability during test and operation.

One of the earliest and well known efforts to predict software reliability in the earlier phase of the life cycle was the work initiated by the Air Force's Rome Laboratory [11]. For their model, they developed prediction of fault density which they could then transform into other reliability measures such as failure rates.

To do this the researchers selected a number of factors that they felt could be related to fault density at the earlier phases. Most of them are based on size and complexity metrics. In order to achieve high software reliability the number of faults in delivered code should be reduced. The faults are introduced in software in each phase of software life cycle and these faults pass through subsequent phases of software life cycle unless they are detected through testing or review process. Finally, undetected and uncorrected faults are delivered with software. In order to achieve the target software reliability efficiently and effectively, faults should be identified at early stages of software development process. During early phase of software development testing/field failure data is not available. Therefore, the prediction is carried out using various factors relevant to reliability.

A study was conducted by Zhang and Pham [12] to find the factors affecting software reliability. The study found 32 potential factors involved in various stages of the software life cycle. In another recent study conducted by Li and Smidt [13], reliability relevant software engineering measures have been identified. They have developed a set of ranking criteria and their levels for various reliability relevant software metrics, present in the first four phases of software life cycle. Recently, Kumar and Misra [14] made an effort for early software reliability prediction considering the six top ranked measures given by [13] and software operational profile. Sometimes, it may happen that some of these top ranked measures are not available, making the prediction result unrealistic. Also they have considered only product metrics and ignored process metrics that have a great impact on software reliability [15].

Software metrics can be classified in three categories: product metrics, process metrics, and resources metrics [16]. Product metrics describe characteristics of the product such as size, complexity, design features, performance and quality level etc. Process metrics can be used to improve software development process and maintenance. Resources metrics describe the project characteristics and execution. Approximately thirty software metrics exist, which can be associated with different phases of software development life cycle. Among these metrics some are significant predictor to reliability [13]. From the above literature we have observed that

1. Predicting faults early is very important for the entire software development process and reliability.
2. The reliability of software is a function of the number of the remaining faults.
3. Software metrics plays a vital role in early fault prediction in the absence of failure data.

Review of literature indicates that traditional models have not considered the both software metrics and development process maturity, for the early fault prediction. Therefore this paper proposes a model for early software fault prediction considering software metrics and process maturity together.

III. METHODOLOGY

There are several ways of identifying fault prone modules in a software application. First of all, find the structural code and design attributes of software systems. Thereafter, select the suitable metric values as representation of statement. Next step is to analyze, refine metrics and normalize the metric values. We used JEdit open source software in this study. JEdit is a programmer's text editor developed using Java language. JEdit combines the functionality of Window, UNIX, and Mac OS text editors. It was released as free software and the source code is available on [20]. JEdit includes 274 classes. The number of developers involved in this project was 144. The project was started in 1999. The number of bugs was computed using SVC repositories. The release point for the project was identified in 2009. The log data from that point to 2012 was collected. The header files in C++ were excluded in data collection. The word bug or fixed was counted. Details on bug collection process can be found in [19]. The following are the metrics used in the classification process:

1. Coupling between Objects
2. Lack of Cohesion
3. Number of Children
4. Depth of inheritance
5. Weighted Methods per Class
6. Response for a class
7. Number of Public Methods
8. Lines of Code

Using Fuzzy C Means Clustering algorithm we can group the software components into faulty and fault-free systems. Clustering can be a very effective technique to identify natural groupings in data from a large data set, thereby allowing concise representation of relationships embedded in the data. In our study, clustering allows us to group software modules into faulty and non-faulty categories hence allowing for easier understandability.

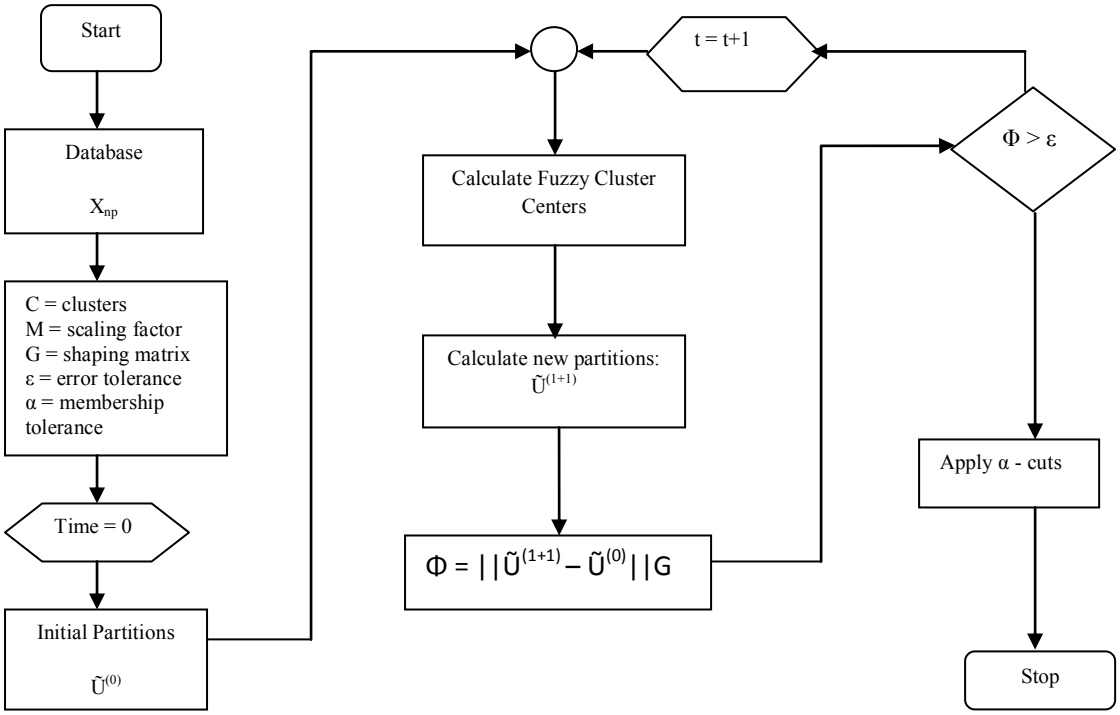

Fig.1 A flowchart depicting Fuzzy C - Means Clustering algorithm.

The Fuzzy C - Means Clustering algorithm attempts to partition a finite collection of n elements $X = \{x_1, ..., x_n\}$ into a collection of c fuzzy clusters with respect to some given criterion. Given a finite set of data, the algorithm returns a list of c cluster centres $C = \{c_1, ..., c_c\}$ and a partition matrix $W = w_{i,j} \in [0,1],\ i = 1, ..., n,\ j = 1, ..., c$, where each element $\mathbf{W_{ij}}$ tells the degree to which element $\mathbf{X_i}$ belongs to cluster $\mathbf{c_j}$. Like the k-means algorithm, the Fuzzy C - Means aims to minimize an objective function. The standard function is:

$$w_k(x) = \frac{1}{\sum_j \left(\frac{d(\text{center}_k, x)}{d(\text{center}_j, x)}\right)^{2/(m-1)}}.$$

Any point *x* has a set of coefficients giving the degree of being in the kth cluster $w_k(x)$. With Fuzzy C - Means, the centroid of a cluster is the mean of all points, weighted by their degree of belonging to the cluster:

$$c_k = \frac{\sum_x w_k(x)x}{\sum_x w_k(x)}.$$

The degree of belonging, $w_k(x)$, is related inversely to the distance from x to the cluster center as calculated on the previous pass. It also depends on a parameter m that controls how much weight is given to the closest center.

To predict the results, we have used confusion matrix as shown in Table I. The confusion matrix has four categories: True positives (TP) are the modules correctly classified as faulty modules. False positives (FP) refer to fault-free modules incorrectly labeled as faulty. True negatives (TN) are the fault-free modules correctly labeled as such. False negatives (FN) refer to faulty modules incorrectly classified as fault-free modules.

Table I
Matrix of Prediction

Prediction	Data		
		Fault	No Fault
	Fault	TP	FP
	No Fault	FN	TN

The following set of evaluation measures are being used to find the results:

1. **Mean Absolute Error** is a quantity used to measure how close forecasts or predictions are to the eventual outcomes.
2. **Root Mean Square Error** is a quadratic scoring rule which measures the average magnitude of the error. The difference between forecast and corresponding observed values are each squared and then averaged over the sample. Finally, the square root of the average is taken.
3. **Accuracy:** It indicates proximity of measurement results to the true value, precision to the repeatability or reproducibility of the measurement.

The accuracy is the proportion of true results (both true positives and true negatives) in the population. The Mean Absolute Error and the Root Mean Square Error can be used together to diagnose the variation in the errors in a set of forecasts. The Root Mean Square Error will always be larger or equal to the Mean Absolute Error; the greater difference between them, the greater the variance in the individual errors in the sample. If the Root Mean Square Error = Mean Absolute Error, then all the errors are of the same magnitude. Both the Mean Absolute Error and Root Mean Square Error can range from 0 to ∞. They are negatively-oriented scores: Lower values are better.

IV. RESULTS

During prediction the True positives (TP) is calculated as 18, means 18 modules are correctly classified as faulty modules. False positives (FP) calculated as 28, means 28 fault-free modules incorrectly labeled as faulty. True negatives (TN) is calculated as 228, means 228 modules are the fault-free modules correctly labeled as such and False negatives (FN) comes out to be 4, means 4 faulty modules incorrectly classified as fault-free modules. These values are recorded in confusion matrix as shown in Table II.

Table II
Recorded Matrix of Prediction

Prediction	Data		
		Fault	No Fault
	Fault	18	28
	No Fault	4	228

The Root Mean Square Error and Mean Absolute Error are thus calculated as 0.3393 and 0.1151 respectively while the accuracy of prediction is calculated as 88.49%.

V. CONCLUSION

This paper empirically evaluates performance of Fuzzy Clustering technique in predicting fault-prone classes in large industrial software. Here, the System generated from fault data using Fuzzy Clustering in MATLAB 7.4 environment is evaluated for the JEdit testing dataset. The proposed Fuzzy C Means Clustering based prediction technique shows the results are 88.49% percent Accuracy. This study confirms that construction of Fuzzy C Means Clustering based model is feasible and useful in predicting faulty prone classes. It is therefore concluded that, in case of large software systems, model is implemented using Fuzzy C Means Clustering based technique for classification of the software components into faulty/fault-free systems is found satisfactory. The contributions of the study can be summarized as follows: First large software systems analyzed. These systems are developed with different development methods than proprietary software. In previous studies mostly proprietary software were analyzed. Second, we examine Fuzzy clustering method to predict the faulty classes with better accuracy. The future work can be extended in following directions:

1. Most important attribute can be found for fault prediction and this work can be extended to further programming languages.
2. More algorithms can be evaluated and then we can find the best algorithm. We plan to replicate our study to predict model based on hybrid genetic algorithms or soft computing techniques.

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Design Test-bed for assessing load utilising using Multicast Forwarding Approach in Wireless Mesh Networks

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Abstract: *The challenges and complexities, coupled with the crucial importance of routing protocol in establishing communications among mobile nodes, build the routing space. In this kind of strategy, a node tries to forward the packet to one of its neighbours that are nearer to the destination than itself. If quite one nearer node exists, totally different selections area unit are attainable. A node selects ensuing hop for packet forwarding by mistreatment the physical position of its one-hop neighbours and therefore the physical position of the destination node. If the packet is retransmitted by some hop the most range of times and no receipt confirmation is received, this node returns a route error message to the original sender of the packet, characteristic the link over that the packet couldn't be forwarded. Due to common and unpredictable topology alterations in MANETs, the package consignment rate of multicast messages can be low. Their aim is to double-check that all multicast group constituents obtain, absolutely or with a high likelihood, the facts and figures multicast in this assembly, supplied they are reachable. This paper separately measures the Battery lifetime and load generated by AODV in WMNs because of node quality victimization a simulated test bed.*
Keywords*: APs, AODV, WMNs, Gateway, Load, Router.*

I. Introduction

Wireless networks take several forms. VHF radio, FM–AM radio, cellular phones, and CB radios are all styles of wireless technology however have terribly specific purposes (usually for the aim of communication verbal information). When one talks regarding wireless networking, it's a couple of breed of technology that's able to communicate information. Information may be voice, the net, or the other reasonably laptop information.

This sort of wireless technology may be accustomed supplement or maybe replace existing wireless systems. IEEE 802.11 is that the normal that outlines wireless Networks standards. Another normal, called wireless scientific discipline, permits mobile devices to stay connected, even after they go in associate wireless space that incorporates a totally different IP theme than the user has. Basically, this normal permits roaming while not losing property. The wireless network is capable of being isolated from the wired network and it may not be fascinating to possess these users plug into many networks. This will minimize the chance of a virus-infected laptop computer spreading a harmful virus to many networks. For this installation, you will wish to think about a visitors' space, however solely permitting visiting user's access to the web, not to other internal network resources.

A WMN comprises of multiple mesh routers (called nodes), which can ahead packets on behalf of other mesh routers through wireless connection. To further improve the performance, a mesh router may be equipped with more than one wireless interface. Mesh routers that are attached to the Internet are called Gateways. Mesh routers usually have negligible mobility and are generally repaired, such as being deployed on roofs or streetlight poles. Like any get access to point, a mesh router can serve localized mobile stations in its area. WMNs use symmetric connections between neighbouring nodes. It does not try to pursue routes between nodes when one of the nodes cannot discover the other one. Nodes do not lie on active paths; they neither sustain any routing data nor take part in any periodic routing table exchanges.

1.1. AODV

The AODV protocol keeps a route table to store the next-hop routing data for destination nodes. Every routing table will be used for an amount of your time. If a route is not requested at intervals that amount, it expires and a replacement route must be found once needed. Whenever a route is employed, its time period is updated. Once a sender node includes a packet to be sent to a given destination, it's for a route in its route table.

In case there is one, it uses it to transmit the packet. Otherwise, it initiates a route discovery procedure to search out a route by broadcasting a route request (RREQ) message to its neighbours. Upon receiving a RREQ message, a node performs the subsequent actions:

- It checks for duplicate messages and discards the duplicate ones.

- It creates a reverse route to the sender node (the node from that it received the RREQ is that the next hop to the source node), associated checks whether or not it's a valid and more modern route to the destination (compared to the one at the supply node).

Just in case those two conditions hold, the node replies to the sender node with a RREP message containing the last known route to the destination (shown in figure 1). Otherwise, it retransmits the RREQ message.

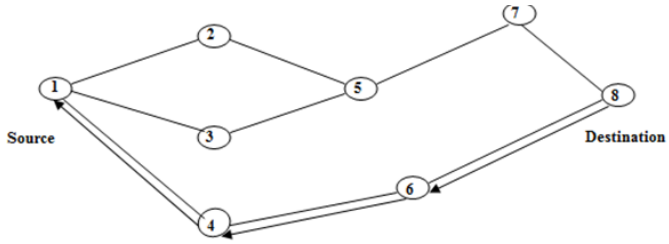

Fig.1: RREP in AODV Protocol

Route Maintenance is performed only when a node is attempting to forward a packet. If the packet cannot be successfully forwarded to the next-hop indicated in the packet's source route, Route Maintenance declares that next link in the source route to be broken, and notifies the packet's originator S with a ROUTE ERROR packet [1].

II. Methodology Used

The performance of an ad hoc network depends on the interaction among communication entities during a given neighbourhood. Thus, in general, before a node starts human activity, it should discover the set of nodes that are at intervals its direct communication vary. Once this info is gathered, the node keeps it in an indoor organisation thus it may be utilized in completely different networking activities like routing. The behaviour of an ad hoc node depends on the behaviour of its neighbouring nodes as a result of it should sense the medium before it starts sending packets to nodes in its intrusive vary, which may cause collisions at the opposite nodes.

The forwarding algorithmic program implements a forwarding goal that will be, as an example, the shortest average hop distance from source to destination. During this case, the set of potential nodes could embody solely those in direct communication vary from the present node or additionally the set of attainable nodes in the route to the destination. The forwarding goal might also embody some QoS parameters like the number of energy on the market at every node.

III. Experimental Test bed

Defining an experiment on any test bed involves several steps. Some of these steps, such as application and node configuration, are similar to an experiment setup in a wired testbed, while others, such as topology configuration and mobility configuration, are more specific to wireless experiment setup [2].

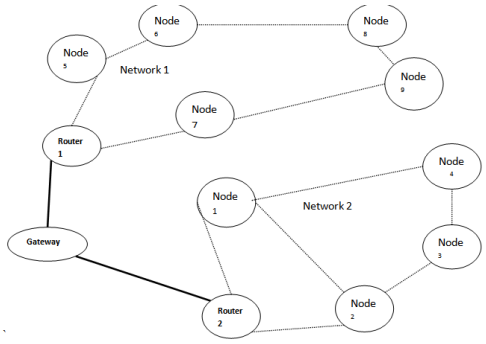

Fig. 2: Wired cum Wireless Multicast WMNs

Our implementation (see Network 2 from the fig.2) utilizes acknowledgments whenever possible, meaning that if a node 1 originating or forwarding a packet hears the next-hop node 2 forward the packet, Node 1 accepts this as evidence that the packet was successfully received by 2. If Node 1 fails to receive a passive acknowledgment for a particular packet it has transmitted to Node 2, Node 1 retransmits the packet to Node 2. When performing retransmissions at the Network layer, we also found it necessary to perform duplicate

detection so that when an acknowledgment is lost, a retransmitted packet is not needlessly forwarded through the network multiple times.

IV. Results and Discussion

All data traffic is either from mesh nodes to Routers or through gateways or from gateway to source node. This is because the scenario used in fig.2 for exchanging messages in between the different nodes and obtaining Load and battery lifetime results from the NS2[] Simulator and discussed in following subsections.

4.1. Battery Lifetime

When our test-bed network operated with the layer 3 acknowledgments and retransmission scheme, the average WMNs topologies are also expected to change frequently, as node mobility will move nodes in and out of other nodes' transmission ranges and under these circumstances we calculate the battery lifetime. Battery lifetime over a Mesh Nodes was measured as 19 % (Minimum) and maximum lifetime remains 100 % and fall in below 80%.This is due to fading, losses and wireless Propagation. The variability in propagation creates a significant level of inherent packet loss with which higher layers must be prepared to cope [1].

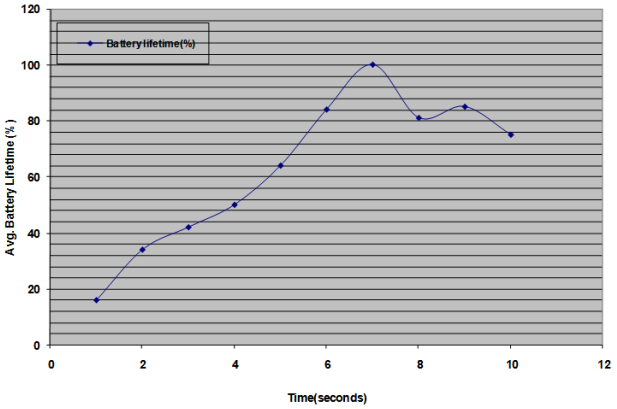

Fig.3: Battery Lifetime

4.2. Load

The experimental network under test used a fixed number of nodes. The experiment applied in mesh topologies for 0.1 seconds to 150 seconds. Since the load captures at every node that participates in the network and find that load of network is minimum against the previous work and shown in the figure.

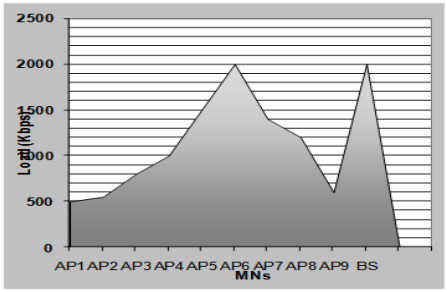

Fig.4: Load in between Mesh Nodes

V. Conclusion and Future Work

In this paper a test-bed for evaluating an 802.11 wireless mesh network. In preliminary analysis of information from runs of the test-bed, we've measured the Battery life introduced by the mesh nodes and located that even beneath a full load and with none special quality of service handling, the network will support an information or packet delivery with acknowledgment system. For WMNs, Battery life and load are major issues. AODV protocol conjointly provides reliable state synchronization in presence of load among the nodes in mesh networks. This approach is capable of configuring a minimum of various nodes with even distribution.

In the future, we might conjointly wish to enhance our security measure, to stop a malicious node from holding or exhausting the address area. Further, for wireless network with location-dependent contention, the Cross-layer support at the network and MAC layer ought to be adopted.

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Readability and Academic Communication: A Comparative Study of Undergraduate Students' and Handbook of Three Ghanaian Universities

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***Abstract**: Essentially, this study investigated the readability of handbooks of three reputable universities in Ghana, namely: University of Ghana, Kwame Nkrumah University of Science and Technology and University of Cape Coast. The study conducted an in-depth investigation into the readability of these handbooks, using seven readability indexes. These readability indexes include: Flesch-Kincaid Grade Level, Flesch Reading Ease, Gunning Fog Index, Coleman-Liau Index, SMOG Index, Automated Readability Index and Lisear Write Formula. The readability consensus for the 7 readability indexes showed that these handbooks are very difficult to comprehend when measured in terms of readability indexes and that they were generally written to be understood by university graduates and in some cases even above the reading level of university graduates. The study also established that there are no statistically significant differences across the mean scores of the readability of the three handbooks. It is therefore recommended that the hallmark of texts contained in students' handbooks should be sensitive to students' reading level. It is belief that this can be achieved through the use of plain language in writing students' handbooks.*

***Keywords:** text readability; readability index, Flesch-Kincaid Grade Level, Flesch Reading Ease, Gunning Fog, Coleman-Liau Index, SMOG Index, Automated Readability Index, Lisear Write Formula and Ghanaian Universities Students' Handbook.*

I. Introduction

As streetlight lights up the roadway in the night and a map provides guidance and direction to keep a traveller from straying, so is the university students' handbook (Matz, 2012). According to Webster's Collegiate Dictionary (9th edition), handbook is a concise reference book covering a particular subject. On the other hand, Oxford Online Dictionaries describes it as a book giving information such as facts on a particular subject or instructions on a variety of topics, ranging from private to public matters. Saxonis, a Medieval Latin Dictionary sees it as ***vade mecum*** (Latin, "go with me") or **pocket reference** that is intended to be carried at all times. It may also be referred to as an enchiridion (Late Latin term for a small manual or handbook).

There is no gainsaying that student's handbook is fundamental to an enjoyable and rewarding university education. While it is not a formal contract or agreement, the handbook is usually designed to assist students navigate, familiarize and acclimatize themselves with the university environment and live up to the institution's expectations and requirements (Pannekoek, 2012). Handbooks are a source of ready reference for school policies, procedures, services and other relevant information geared towards a fruitful course of study at the university (Drucker, 2012). For example, on page 11 of the handbook of the oldest and largest of the Ghanaian universities and tertiary institutions, the university of Ghana (founded in 1948), detailed information is provided in connection with the location of the institution. It is stated that the campus of the university lies about 13 kilometers north-east of Accra, the capital of Ghana, at an altitude of between 90 and 100 metres.

From the main university gate on the Dodowa Road, the University Avenue extends to Commonwealth Hall on Legon Hill. Providing detailed information on regulations for the conduct of university examination, the handbook of Kwame Nkrumah University of Science and Technology stipulates that all students, both males and females, are entreated to dress decently to the examination Hall. It further states that any candidate who does not dress decently would be refused entry into the Examination Hall. The University of Cape Coast Students' handbook on page 34 under the subheading, "Discipline" states that the University of Cape Coast is a community of Students, Lecturers and Administrators, hence it is required that as members of this diverse community each one should live by standards of proper conduct so that one member's freedom will not impinge on another member's right. In all cases of breach of discipline, punishment may involve fines, suspension or dismissal.

From the foregoing, it is clear that information contained in university handbook is invaluable and a pre-requisite to successful and rewarding university education. How can a student perform well if they don't understand the policies and regulations guiding examination, lecture theatres, cohabitation in the halls and other activities on campus? Emphasizing the important place of students' handbook in students academic life, Farmer et al. (2007) affirms that handbook constitute the most fundamental source of reference for students. Such

educational and instructional material comprise rich texts which have profound influence on the cognitive and perceptive capabilities of students when written to commensurate with students age and knowledge levels, prepared on the basis on which education programs are grounded so as to transfer the contained knowledge to students. In line with this statement, Unsal and Gunes (2008) stated that handbooks are important tools enabling students to work independently; being fully aware of what is required of them.

In order to aid understanding and comprehensibility of university students' handbook, authors of this document must ensure that it is written at a level that commensurate with students' reading ability. This should be of serious concern to university administration, because, Wellington and Osborne (2001) indicated that language use is the major barrier to most students in the learning process. Since English is the official language of Ghana, it is the medium of both verbal and non-verbal instruction in the university. This medium of instruction and its influence on learning has become an important issue (Yong, 2010). Lemke (1997) asserts that students encounter numerous problems due to learning English as a foreign language, of which they seldom use at home and other social settings. Several researchers have indicated that the language used in some instructional material exceeds the normal experience of many university students (Lynch, *et al*., 1972 cited in Letsoalo, 1996, p. 184) for whom they are written. Curtis and Millar (1988) argued that if the understanding of handbook language is difficult for English speakers, it is likely to be even more difficult for students who speak and read English as a second language. In the Ghanaian context, it has long been recognized that students encounter enormous problems reading and comprehending English as a second language (Heppner et al., 1997; Yong, 2003, Mohiddin, 2007; Romaizah, 2009 ;).

It is against this background that the present study will carry out an extensive comparison of the readability of students' handbook of three universities in Ghana: University of Ghana, Kwame Nkrumah University of Science and Technology, and University of Cape Coast by means of seven popular readability indexes: Flesch-Kincaid Grade Level, Flesch Reading Ease, Gunning Fog Index, Coleman-Liau Index, SMOG Index, Automated Readability Index and Lisear Write Formula.

II. Statement of the Problem

Studies have shown that truancy, examination malpractices, and poor performance persists despite guide and direction provided in students' handbook, suggesting that information contained in the handbook is not really influencing students' activities on university campuses (Atabong et al., 2010; Fordjour et. al., 2011; Bediako, 2013). In his book, *Ghanaian English: An exploratory survey*, Sey (1973:7) posits that in connection with language use and style, educated and learned Ghanaians have the tendency of using learned and archaic forms coupled with flamboyance of prose style and frequent cases of hyper-correctness. Little wonder public speakers, journalists and writers who are known for this flamboyant prose style and the use of learned forms in Ghana are those ascribed linguistic excellence.

As a result of the above stated tendency among writers in Ghana, several handbooks maybe produced without due consideration for its readability or whether the intended audience can comprehend its content. Since readability indexes measure comprehensibility of written text and comprehensibility is sine qua non to acting in harmony with what is read and understood, it would be pleasing to examine the readability of students' handbook of universities in Ghana. In doing this, the researcher uses the handbooks of University of Ghana, Kwame Nkrumah University of Science and Technology and University of Cape Coast for the study. The choice of these universities is as a result of the fact that they are generally perceived to be the three leading universities in Ghana. Also, the choice is as a result of the longstanding reputation of these three universities as icon of excellence. These universities also constitute a fair representation of universities in Ghana.

III. Objectives of the study

This study was intended to:

i. Establish the readability of Ghanaian universities students' handbook measured in terms of readability indexes.
ii. Ascertain if there is any significant difference between the readability of Ghanaian universities students' handbooks.
iii. Find out if there are variations in the scores of readability indexes.

IV. Research Questions

i. How readable are Ghanaian universities students' handbook measured in terms of readability indexes?
ii. Are there variations in the scores of readability indexes?
iii. Are there any significant differences in the readability of Ghanaian universities students' handbook?

V. Hypothesis

Ghanaian universities students' handbooks are difficult to comprehend when measured in terms of readability indexes.

VI. Literature Review And Theoritical Perspective

This section of the research has two parts, the first part focuses on the theory that underpins the study. Here, attention is given to social constructionism, a theory attributed to Vygotsky (1978). The second part of this section discusses readability indexes and reviews of some works done in the area. Attention is also given to the place of Ghana in World Englishes, drawing attention to the need for English Language, which has become the soul medium of instruction in secondary and tertiary institutions to be handled in a manner that will enhance academic communication.

i. Social Constructionism

Social constructionism as a theory, attributed to Vygotsky (1978), the theory refers to the development of phenomena relative to social contexts. According to Flamand (1999), the theory accounts for the ways in which phenomena are socially constructed. Social construction theory thus focuses on the ways we think about our experience and analysis of the world. Hackling (1999), also asserts that a major focus of social constructionism is to uncover the ways individuals and groups participate in the construction of their perceived social reality. It involves looking at the ways social phenomena are created, institutionalized, known and made into tradition by humans. He underscores that the social construction of reality is an ongoing, dynamic process that is (and must be) reproduced by people acting on their interpretation and their knowledge of it.

Social constructionism is associated with what is called social construct. Boghossian (2001) and Flamand (1999), underscore that social construct is anything that exists as a product of human social interaction instead of objective, human independent existence. It can be said that social constructionism is a concept or practice; that is, the creation of a particular group. Social constructs are generally understood to be the by-products of countless human choices rather than laws resulting from divine will or nature. Gergen (1985) had explained social constructionism: Social constructionist inquiry is principally concerned with explicating the process by which people come together to describe, explain, or otherwise account for the world (including themselves) in which they live. It attempts to articulate common forms of understanding as they now exist, as they have existed in prior historical periods, and as they might exist should creative attention be so directed (p. 266). The constructionist attempts to ascertain how people explain their existence as a group through what pertains now, was and will be if conscious effort are taken to enable the common forms of doing things in that group. Relating the theory of social constructionism to writing, writing is essentially a social act, in which the writer must construct meaning in a manner conventional in a particular community. This school of thought ascribes to the learner-writer a high level of awareness of its central tenant (be it cognitive strategies in the writing process, or writing as a social practice). It portrays the experience of writing from the point of view of awareness – either of the cognitive process/problem solving, or of social action. The view that knowledge is created through the discourses of social communities has its origin in the theory of social constructionism. Thus the ways we comprehend the world, the categories and concepts we use, are not 'truths' proven and fixed for all time but are specific to particular cultures and periods. In other words, our knowledge does not result from objective descriptions of what the world is really like, but emerges in part through our perceptions of that world during our interactions. No matter how careful our experiments or rigorous our armchair reasoning, they always involve interpretation, and interpretation always depends, at least in part, on the assumptions researchers bring to the problem they are studying. More simply, knowledge is 'the social justification of belief', and in academic contexts, this justification is accomplished through academic discourses (Rorty, 1979. p. 170). In sum, academics cannot step outside the beliefs of their social groups to tell us 'what the world is really like' but they have to draw on conventional ways of producing agreement.

Social constructionism focuses on the creation of meaning, on the existence, the development and the role of joint meaning (Katerm et al., 2004).

Since the theory of social constructionism dwells on the ways in which individuals and groups participate in the creation of their perceived social reality, it is found appropriate for the present research. Thus the way language is used in the writing of Ghanaian university students' handbooks resulting in the level of difficulty of the handbooks can be seen from the point of view the universities individually participating in the creation of realities of themselves to the outside world and even to members of the university community, in the practice of handbook writing, is what makes the theory to be useful in this present study. Indeed, Hyland (1999) asserts that academic knowledge is now perceived as a social accomplishment, the outcome of a cultural activity shaped by ideology and constituted by agreement between the writer and a potentially skeptical discourse community. Academic writing does not exist in vacuum; it is situated in a disciplinary community for it to be accepted as one of its kind.

ii. **Discussion of Readability Indexes**

Lively and Pressey (1923) were among the pioneers of readability formulas. In all, researchers have proposed more than 200 readability formulas (Klare, 1984). Almost without exception, readability formulas are based on syntactic and semantic complexity. Basically, the number of words per sentence determines syntactic complexity. The basis for measuring semantic complexity is either by word familiarity as defined by its inclusion on a word list or the number of syllables per word.

According to Fry (2002), readability of classroom materials or public documents, usually refers to a numerical or grade-level score that is obtained by applying a mathematical formula to a sample of text. The classic readability formulas predict comprehension (McLaughlin, 1974). Most do so by providing a numerical score representing the educational level necessary to read a document with ranges of 50% to 75% comprehension. However, Klare (1974) indicated that the SMOG formula predicts 100% comprehension. In connection with popular readability indexes, Burke and Greenberg (2010) intimated that the mathematical formula used to determine the difficulty of a given text typically takes into consideration issues such as sentence complexity (measured by sentence length) and vocabulary difficulty (measured by either the number of letters or syllables in words or by a comparison to lists of easy or difficult words). In effect, readability formulas measure the relationship between the difficulty experienced when reading a text and the linguistic features, specifically word meaning and sentence structure, of that text (McLaughlin, 1969) on the web and also the one found in a word processing program. Burke and Greenberg's (2010) findings also revealed that the SMOG readability scores for books written above the fourth-grade level were consistently high while Flesch-Kincaid scores for the same books were consistently low. Based on their finding, Burke and Greenberg (2010) summarized the comparison between the readability indexes as shown in Table 1 and recommended the use of two or more readability indexes to ascertain the readability of a given text, textbook or handbook in view of the varying scores obtainable from readability indexes.

Table 1: Comparison of Some Readability Indexes

Selection Criterion	Readability tool
100% comprehension	Always use SMOG
Material below fourth grade	Use Fry
Identify difficult words	Always use Dale-Chall
Easiest	Flesch-Kincaid Grade level – Can do straight from Microsoft Word
Cautions	Flesch-Kincaid often scores lower than other measures
	SMOG often scores higher than other measures

Source: Burke and Greenberg (2010)

According Brutt-Griffler (2002), World Englishes has been described as a phase in the history of the English language. This phase has witnessed the transformation of English from the mother tongue of a handful of nations to a language being used by far more speakers in non-mother tongue settings. The changes that have accompanied this spread-the multiplicity of varieties--result not from the faulty and imperfect learning of the non-mother tongue speakers, but from the nature of the process of micro acquisition, language spread and change.

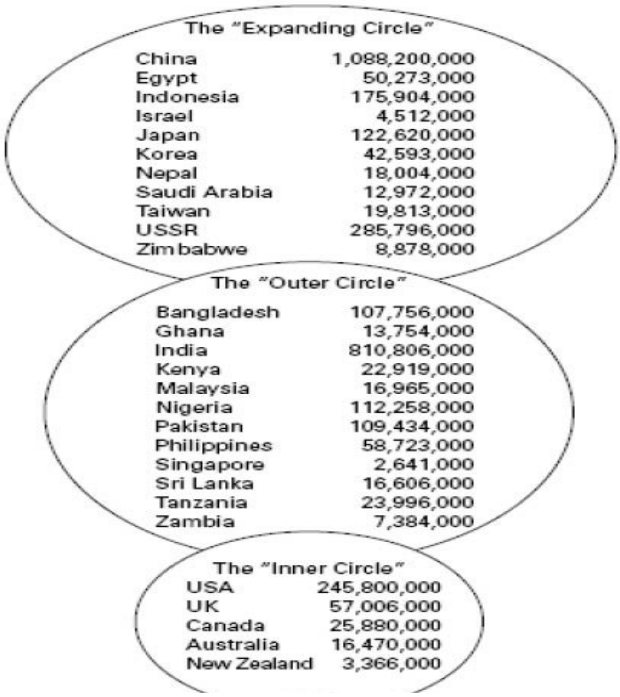
Due to the transformation the English language is presently undergoing, world English has produced certain varieties. Among these varieties, the term, 'New Englishes' is used to describe regional and national varieties of the English language used in places, such as Ghana, where it is not the mother-tongue of the majority of the population (Nordquist, 2013). Mollin (2006) indicated that Kachru coined the term non-native Englishes to refer to the variety of English which is not a native variety. This term has gained popularity that Platt, Weber and Ho (1984) designate an English variety with the following characteristics as non-native English:

i. It has developed through the education system (possibly even as a medium of education at a certain level), rather than as a first language of the home.
ii. It has developed in an area where a native variety of English was not spoken by a majority of the population.
iii. It is used for a range of functions (for example, letter-writing, government communications, literature, as a lingua franca within a country and in formal contexts).
iv. It has become nativised, by developing a subset of rules which mark it as different from American or British English.

Jenkins (2009) affirms that Kachru used his three-concentric model of world Englishes to represents the way in which English had been spread, the way people acquired the language, and the use of English. In

essence, *Kachru's concentric model is built on the historical context of English, the status of the language, its geographical distribution and its functions in various regions.*

Kachru's Three Concentric Model of World Englishes



Source: Kachru (1992)

iii. **Classification of World Englishes**

As depicted in the above diagram, Kachru proposes that the countries where English has traditionally been the native language, would belong to the Inner Circle; hence, they would be the "norm-providing". Countries where English has official status ("norm-developing") would be located in the Outer circle, of which Ghana is inclusive. And, countries where English has no official status would be in the Expanding circle; thus, they would be "norm-dependent".

However, irrespective of the wide publicity and acceptance of this model, it has some weaknesses in terms of uses and users of English, Jenkins (2009) indicated that the model is designed having in mind geography and genetics, so it does not consider users identification. An intermediate area may be located between the Inner and the Outer circle, because some people use English just at home, instead of using it for academic, social or political purposes. Another intermediate area may be located between the Outer Circle and the Expanding circle, because there are many countries in which English is not perceived as a Foreign Language anymore, but as a Second Language.

Nelson and Todd (1992) mentioned that in Ghana, English is perceived as a second language and probably as a result of their early exposure to, and intimacy with English, Ghanaians are known, in West Africa, to have developed a particularly positive attitude toward English. At the time when the return to the indigenous languages has virtually become the song of the day in other parts of the continent, Dseagu (1996) reports a sizable minority of middle-class Ghanaians who still give priority to English in their homes, and make their children acquire it as their first language. The attachment of Ghanaians to English, predictably, affects their attitude toward 'New Englishes' in the form of 'Ghanaian English', which is sometimes perceived as Pidgin by educated Ghanaians (Huber, 1998). Ghanaians are also reported to be very proud of their English (Nelson & Todd 1992:440, Sey(1973:7)

Gyasi (1991: 26), principal in English at the Kumasi branch of the Ghana Institute of Languages, confirms that 'Ghanaians generally boast that their pronunciation is nearer that of RP than that of other non-native users of English in the former British colonies in Africa, especially in West Africa'. They are also very sensitive to stigmatised forms and will promptly correct themselves if their attention is drawn to a mistake Sey, (1973:7)

This background probably explains why Ghana, despite a shared colonial experience with, and a similar sociolinguistic background to, countries like Nigeria, Cameroon, Sierra Leone, and Gambia, has the tendency to use learned and archaic forms and is also known for flamboyance of prose style and frequent cases

of hyper-correctness. Little wonder several public speakers, journalists and writers in Ghana who are known for this flamboyant prose style and the use of learned forms are those ascribed linguistic excellence. Confirming this notion are the following expression in Fante: "Brɔfo yɛ dur" (English is weighty, very powerful) "Otu brɔfo" (He digs up English) and "Tu bra [Dig it up (An exhortation to public speakers to utter more English expression of pleasing cadences)].

As earlier mentioned, due to the above stated tendency among educated Ghanaians, books, textbooks and other reading materials maybe produced without giving attention to the level of linguistic competence of the targeted audience. Giving credence to this unfortunate situation in Ghana, a recent study by Rubagumya et al. (2010) on Language of Instruction and Quality of Learning in Tanzania and Ghana, findings revealed that in "both Ghana and Tanzania, English textbooks were difficult for learners to read.Language used in most textbooks was above the level learners can understand.

It is pertinent to mention at this juncture that the aforementioned tendency of educated Ghanaians aroused a keen desire in the researcher to conduct in-depth investigation into the readability of University students' handbook of three most reputable Universities in Ghana: University of Ghana, Kwame Nkrumah University of Science and Technology and University of Cape Coast.

VI. Methodology

In this study, seven readability indexes were applied to sample sections of the university students' handbook in order to ascertain the readability of these handbooks. The study also investigated to ascertain whether there were variations in the readability scores of the seven readability indexes. In answering research question 2 and test the hypothesis, a one-way ANOVA was used at a significant level of 0.05 by means of Statistical Package for Social Sciences (SPSS) version 16.

The readability of the handbooks was determined as shown in Table 2 and 3 using the following readability formulas: Flesch-Reading Ease, Gunning Fog, Flesch-Kincaid Grade Level, Coleman-Liau, SMOG Index, Automated Readability Index and Lisear Write Formula. The seven readability formulas were used based on the recommendation of Burke and Greenberg (2010), that using two or more readability formulas is preferable because the formulas have certain limitations, for example, SMOG readability index often scores higher than other measures while Flesch-Kincaid often scores lower than other measures. When several readability indexes are used, a statistically balanced and accurate result is obtained.

VIII. Results and Findings

Table 2: Readability Consensus Score of Handbooks

Institution	Readability Consensus on Handbook (Based on 7 readability formulas in Table 1)		
	Grade Level	Reading Level	Reader's Age
University of Ghana, Legon	16	Very difficult to read	College Graduate
Kwame Nkrumah University of Science and Technology	16	Very difficult to read	College Graduate
University of Cape Coast	19	Very difficult to read	College Graduate

Source: Field Survey, 2013.

The selected portions from each of the students' handbook of the three universities were fed into a computer and subjected to readability test using the seven readability indexes. Various scores obtained coupled with appropriate remarks interpreting the meaning of readability scores are provided in Table 2 above. Inferences drawn based on information in Table 2 and 3 are presented below.

Table 3: Result of Readability Indexes Analysis on University Students' Handbook

Readability Index	University of Ghana, Legon	Kwame Nkrrumah University of Science	University of Cape Coast	Comment
Flesch Reading Ease	24.7	24.6	10.7	**Very difficult to read**
Gunning Fog	14.8	13.4	18.6	**Hard to read**
Flesch-Kincaid Grade Level	17.2	15.7	19	**University Graduate and above**
The Coleman-Liau Index	12	15	16	**Twelfth Grade/Graduate College**
The SMOG Index	14.1	14.7	16.1	**University**
Automated Readability Index	17.5	16.3	19.9	**University Graduate**
Lisear Write Formula	20.9	18.3	22.5	**University Graduate and above**

Source: Field Survey, 2013.

Findings from the readability consensus of the seven formulas in Table 3 revealed that on a general note, the handbooks of the three universities are very difficult to read. The handbook for the university of Ghana and Kwame Nkrumah University of Science and Technology scored 16 as the overall readability of all the indexes used for the study referred to as readability consensus, whereas University of Cape Coast scored 19, which showed a distinct difference from the other two universities. The results lend support to Rubagumya et al. (2010) and Sey (1973:7) that educated Ghanaians often write with complex grammatical structures to the detriment of the readers, who may have difficulty comprehending or getting the import of the text. Essentially, Table 2 has shown that Ghanaian university students' handbook measured in terms of readability indexes are very difficult to read and comprehend.

Findings from Table 3 revealed that for the Gunning Fog readability, the University of Ghana's handbook scored 14.8, Kwame Nkrumah University of Science and Technology scored 15.7 and University of Cape Coast scored 18.6. Flesch Reading Ease had the following: 24.7; 24.6 and 10.7, the SMOG Index has: 14.1; 14.7 and 16.1 and Lisear Write Formula has: 20.9; 18.3; 22.5. Though, the scores of the readability indexes vary, they all pointed to the fact that the handbooks are very difficult to read and comprehend. For example, Gunning Fog scores for the three handbooks revealed that they are hard to read, the implication of hard to read can be understood in the light of Ivan's (2010) statement that the ideal score for readability with the Fog index is 7 or 8. Anything above 12 is too hard for most people to read. For instance, The Bible, Shakespeare and Mark Twain have Fog Indexes of around 6. The leading magazines, like Times, Newsweek, and the Wall Street Journal average around 11. This means that the language use and style may be difficult for students to comprehend, left alone act in harmony with the requirement and information in the handbook. Table 3 showed that the handbooks were written beyond students' comprehension level making the handbooks suitable only for University graduates. This is in harmony with the result of Dzinyela et al. (2003) that writers in Ghana often write beyond students' reading level.

In summary, Table 3 has vividly shown that there is variation in the scores of readability indexes, with majority of the indexes showing that the handbooks are very difficult to read and could only be comprehended by university graduates and above.

Table 4: Means and Standard Deviation of Readability Indexes Analysis Scores

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimm	Maximum
UG	7	17.3143	4.32721	1.63553	13.3123	21.3163	12.00	24.70
KNUST	7	16.8571	3.73580	1.41200	13.4021	20.3122	13.40	24.60
UCC	7	17.5429	3.34629	1.36612	13.2049	20.2284	10.70	19.90
Total	21	16.9750	3.65180	.81657	15.2659	18.6841	10.70	24.70

Source: Field survey, 2013.

UG: University of Ghana, Legon KNUST: Kwame Nkrumah University of Science and Technology and UCC: University of Cape Coast

Table 4 reveals the mean scores of the various handbooks: University of Ghana = 17.31, Kwame Nkrumah University of Science and Technology = 16.86 and University of Cape Coast = 17.54. The lower and the upper bounds at 95% confidence interval of the university students' handbook were within the same range and used to measure if there is any significant difference in readability of the mean scores of the three handbooks.

Table 5: One Way ANOVA Showing Differences in the Mean Scores of the Three Handbooks

Readability					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.707	2	.853	.055	.947
Within Groups	280.743	18	15.597		
Total	282.450	20			

Source: Field survey, 2013. P< .05

One way Analysis of variance (ANOVA) between groups was computed to test whether statistically significant differences exist among the mean scores of the three handbooks of the universities. The results in Table 5 revealed that the readability of Ghanaian university students' handbook does not differ significantly across the three handbooks, F (2, 18) = 0.55, p = .947. The results provided answer to the third research question

indicating that there is no significant difference statistically in the readability of Ghanaian university students' handbook.

Hypothesis: Ghanaian university students' handbooks are difficult to comprehend when measured in terms of readability indexes.

The purpose of this hypothesis was to ascertain the relative ease or level of readability and comprehensibility Ghanaian university students' handbooks offer prospective readers. The information presented in Table 2 and 3 showed that the handbooks are very difficult to read. The readability consensus of seven readability indexes revealed that the content of the handbooks are only suitable for university graduates and those with higher educational qualification. By virtue of the results, readability indexes the researcher fails to reject the null hypothesis: Ghanaian university students' handbooks are difficult to comprehend when measured in terms of readability indexes.

IX. Conclusion and Recommendation

The investigative and analytical approach adopted for this study have vividly shown that Ghanaian university students' handbooks are very difficult to comprehend when measured in terms of readability indexes. The seven readability indexes used in ascertaining or testing the readability of the three handbooks revealed that they are very difficult to read, with result indicating that they were written to meet the level of university graduates and those with higher educational qualification as depicted in Table 2. The study also discovered that there are variations in the scores of readability indexes. Table 3 vividly portrays these variations, though the variations are little, results thus show that the handbooks are altogether difficult to read and comprehend.

The result of the One Way ANOVA in Table 5 vividly revealed that there are no significant differences statistically across the three handbooks. The study also failed to reject the hypothesis that Ghanaian university students' handbooks are difficult to comprehend when measured in terms of readability indexes. Tables 2 and 3 lend support to this conclusion.

It is pertinent to state that while readability is only one element in text selection, it is important, and should not be ignored or handled with laxity. Appropriate readability check should be done so as to adequately provide students with useful and functional information. In line with Sey (1973:7), complex grammatical structures and learned forms as well as unnecessary display of flamboyant prose style should be avoided in producing students' handbook. The hallmark of text contained in students' handbook should be sensitive to students' reading level. Attainment of these qualities in the production of students' handbook undoubtedly will go a long way to awaken the dying embers of handbook readability and comprehensibility.

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Sample Texts from University of Ghana Students' Handbook

The campus of the University lies about 13 kilometres north-east of Accra, the capital of Ghana, at an altitude of between 90 and 100 metres. From the Main University Gate on the Dodowa Road, the University Avenue extends to Commonwealth Hall on Legon Hill. Along it are grouped other Halls of Residence, Departments, lecture theatres and laboratories. Mid-way, an open space - the University Square - with an ornamental pool is over-looked by the Balme Library (named after David Mowbray Balme, the first Principal of the University College). Across from the University Square are sports fields, a Central Cafeteria and halls of residence. Behind Commonwealth Hall is an open-air theatre with a Grecian style auditorium build into the slope of Legon Hill. On the summit of Legon Hill is the Convocation Group of Buildings which houses the University's administration offices, The Great Hall, with a seating capacity of 1,500 and a Tower donated by the Government of Ghana in 1959 to commemorate Ghana's Independence. On the southern side of the campus are residential accommodation for staff, the University Basic Schools, the Noguchi Memorial Institute for Medical Research, School of Public Health, Sports Stadium, a night market, supermarket and student hostels; while on the Northern side are more teaching departments, lecture theatres and laboratories, Across the Accra-Dodowa road from the Main University Gate is a Police Station, a university Hospital and housing for Junior Staff of the University.

Result:
Flesch Reading Ease score: 24.7 (text scale)
Flesch Reading Ease scored your text: very difficult to read.
Gunning Fog: 14.8 (text scale)
Gunning Fog scored your text: hard to read.
Flesch-Kincaid Grade Level: 17.2
Grade level: College Graduate and above.
The Coleman-Liau Index: 12
Grade level: Twelfth Grade
The SMOG Index: 14.1
Grade level: college
Automated Readability Index: 17.5
Grade level: College graduate
Linsear Write Formula : 20.9
Grade level: College Graduate and above.

Sample texts from of Kwame Nkrumah University of Science and Technology Students' Handbook
The University Hospital is part of the University Health Services. It is under the supervision of the Director, University Health Services, the Hospital is a 24-Hour General Hospital, established and managed by the KNUST. It is located in the Northeastern part of KNUST campus, along the Kumasi-Accra Highway. The Hospital consists of 100 beds and cots, an out-patient Department (OPD), Four Wards, Operation Theatre, Laboratory, X-Ray, Maternity, Maternal and Child Health units, Dispensary, Medical Records Unit, a Dental Clinic and Eye Clinic. The services provided include Out-Patient Services, in-Patient Services, Maternal Care, Radiography, Ultra Sound, Surgery, Laboratory, Dental Care and Ambulance Services, Medical attention is given free of charge to students, members of staff and their registered dependants. Arrangements are usually made for specific cases to receive specialist attention where necessary, outside the university Hospital.
Flesch Reading Ease score: 24.6 (text scale)
Flesch Reading Ease scored your text: very difficult to read.
Gunning Fog: 13.4 (text scale)
Gunning Fog scored your text: hard to read.
Flesch-Kincaid Grade Level: 15.7
Grade level: College Graduate and above.
The Coleman-Liau Index: 15
Grade level: college
The SMOG Index: 14.7
Grade level: college
Automated Readability Index: 16.3
Grade level: College graduate

Linsear Write Formula : 18.3
Grade level: College Graduate and above.

Sample texts from University of Cape Coast Students' Handbook

The Vice-Chancellor is the academic and administrative head of the University, and chief disciplinary officer is responsible to the University Council for the overall administration of the University. He has to be informed of all important developments and problems in the University, in particular those relating to academic activities, finance, physical developments and student affairs. Apart from his/her functions within the University, the Vice-Chancellor also serves as spokesperson in relation to the government and external bodies including the international community. In the actual execution of his/her duties, the Vice-Chancellor works mainly through the various Boards/Communities which are responsible for policy-making, some of which he/she serves on as Chairperson. Even when he/she does not serve as Chairperson of some Committees/Boards, the Statues provide that he/she should have unrestricted rights of attendance and speech at all meetings of University bodies and he/she either receives or has access to minutes of all University bodies. The Pro-Vice-Chancellor, who is assigned special responsibilities by the Statues, acts for the Vice-Chancellor when the latter is absent.

Flesch Reading Ease score: 10.7 (text scale)
Flesch Reading Ease scored your text: very difficult to read.
Gunning Fog: 18.6 (text scale)
Gunning Fog scored your text: difficult to read.
Flesch-Kincaid Grade Level: 19
Grade level: College Graduate and above.
The Coleman-Liau Index: 16
Grade level: graduate college
The SMOG Index: 16.1
Grade level: graduate college
Automated Readability Index: 19.9
Grade level: College graduate
Linsear Write Formula: 22.5
Grade level: College Graduate and above.

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Chaos Based Direct Public Verifiable Signcryption Scheme

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Abstract: *Chaos is one type of complex dynamic behaviour generated by determined nonlinear dynamic systems.Chaos functions have mainly used to develop mathematical models of non linear systems .Chaotic systems have many important properties, such as sensitive dependence on initial conditions, system parameters, density of point set topology of all cycles passed. Most properties such as mixing and diffusion are related to some requirement in the sense of cryptography. Therefore, provide more useful and practical applications of chaotic cryptosystems. In this paper, we investigate the utility of such functions in signcryption scheme for secure communication. An algorithm using a simple chaotic function* $f(x) = 3*x *(1 - x^2)$ *is proposed .The proposed scheme is highly sensitive to the initial conditions. This paper presents chaos based Multi message signcryption scheme with public verifiability concept. The proposed scheme works for both single recipient and multiple recipients. The proposed scheme uses a chaos based multi key generator to generate multiple keys for signcryption scheme, and provides high security due to its chaotic nature. This represents important improvements over the chaotic key multi-message multi-recipient signcryption (CPK-MM-MRS) scheme proposed earlier.*

Keywords: *Chaos, Signcryption, Choatic function, Hash function, Keyed Hash Function, Encryption, Signature.*

I. Introduction

Chaos is one type of complex dynamic behaviour generated by determined nonlinear dynamic systems, which is greatly sensitive to initial conditions and parameters, and accurate duplication of it is impossible.

Generally, in a typical communication system the communication channel is considered to be insecure. Confidentiality, integrity and non-repudiation are the most desirable features of cryptographic system. To achieve these goals, in traditional approaches, the information is digitally signed and then encrypted before transmitting over an unsecure network. The sender signs the message using digital signature scheme and then encrypts the message (and the signature) using a private key encryption algorithm under an encryption key, chosen randomly. The randomly chosen encryption key is then encrypted using the recipient's public key. This two-step approach is called "signature then encryption".

Yuliang Zheng in 1997 [2], presented a positive answer to the following question: "Is it possible to transmit the message of arbitrary length in the way of security and authentication with costs below the required signature –then- encryption scheme?" This is the first time, since the public key encryption technology has been invented, that the problem is addressed in the literature. He found a new cryptographic primitive called signcryption which meets the functions of digital signature and public key encryption in a logical single step and cost significantly less than the required signatures-then-encryption scheme [3] . The proposed cryptography primitive is more efficient for both type of cost involved: Computation cost and communication overhead. The computational cost represents how much computing effort investment by the sender and the receiver of the message. It is by a quantity related to the dominant operation count. The communication overhead represents the extra bits which are appended to a message in case of a digital signature or encryption based on public key cryptography . Encryption and digital signatures are two basic encryption tool, that can guarantee the confidentiality, integrity and non-repudiation. Until signcryption, they are seen as important, but distinct building blocks of different encryption systems.

In many applications, the confidentiality and authenticity are needed together. These applications include secure mail (S / MIME), Secure Shell (SSH), and secure web browser (HTTPS). In order to achieve these two objectives, many cryptography schemes have been created : Schnorr signature-then-ElGamal encryption, DSS-then-ElGamal encryption, RSA signature-then-RSA encryption. Any signcryption scheme should have the following properties:

1. Correctness: Any signcryption scheme should be correct verifiable.
2. Efficiency: The computational cost and communication overhead of the signcryption scheme should be less than the best known signature –then- encryption scheme.
3. Security: A signcryption scheme should also meet the security attributes of an encryption scheme and digital signatures. This additional properties mainly include:

a) Confidentiality: It should be computationally infeasible for an attacker to observe any partial information of a signcrypted text, without knowledge of the sender's or designated recipient's private key.
b) Unforgeability: It should be computationally infeasible for an attacker to masquerade a sender to create an authentic signcrypted text that can be accepted by an unsigncryption algorithm.
c) Non-repudiation: The recipient should be able to prove to a third party that the sender has sent the signcrypted text. This ensures that the sender cannot deny his signcrypted texts.
d) Integrity: The recipient should have the ability to verify that the received message is the original one, sent by the sender.
e) Public verifiability: Any third-party without any practice on the private key of the sender or the recipient can verify that the signcrypted text message is a valid signcryption of its corresponding message.

Some signcryption scheme provide further properties, such as public verifiability and forward secrecy of message confidentiality, while others do not provide them .

A secure signcryption scheme should satisfy public verifiability (including non-repudiation). If Receiver doesn't compromise his secret key and the plaintext to any- one, we say that the signcryption scheme satisfy public verifi bility. Furthermore, we note that public verifiability should not affect the confidentiality and unforgeability of the scheme. However, public verifiability was not be provided in Zheng's scheme [2]. When a signer denies her signature, a receiver has to show his secret key to a judge if the scheme doesn't use complicated zero-knowledge proof. To overcome the disadvantage, Boo and Deng[18] proposed an improvement to avoid compromising the receiver's secret key to the judge. Yet, the scheme requires the receiver to send the plaintext of the message to the judge during the public verification. Hence, Bao-Deng's scheme [18] evidently violates the rule of confidentiality. In order to achieve the public verifiability , In 2006 LEI Feiyu , CHEN Wen , CHEN Kefei [17] analyzed the structure of signcryption and develop a generic solution based on quadratic residue. And the proposed solution is shown to be straightforward and efficient. It provides public verifiability.

Chaos is one kind of complex dynamic behavior generated by determined nonlinear dynamic system, which is greatly sensitive to initial conditions and parameters, to repeat that it is impossible. This is a complex and dynamic activities, widely represent in the non-linear system. Its properties, such as the initial conditions and parameters, similar to the statistical properties of the noise make it difficult to predict. It is widely used in cryptography. The appearance of the enigmatic and random nature is the most attractive features of deterministic chaotic system signals lead to new (engineering) applications due to the sensitivity and unpredictability of the chaos.

Dependency on initial conditions and highly unpredictable nature of chaotic signals is the most attractive feature of chaotic systems that leads to novel cryptographic applications. Cryptography and chaos have some common features, the most prominent being sensitivity to parameters' and variables' changes. In 2008 H.

Elkamchouchi [5] proposed chaos based signcryption scheme for multi messages multi recipient, no significant research has been carried out on chaos based signcryption schemes. In this paper, Chaos based signcryption schemes for multi messages single receipt and multi message multi receipt is proposed. The scheme also provides the public verifiablity. The main idea, behind the proposed scheme, is to achieve very high security by using chaotic keys for the encryption algorithm, generated by chaotic key generator.

Use of mathematical functions to generate multiple keys or a time slice has been largely unexplored ideas. This function is recommended in [1]. However, a simple mathematical function is not enough. Always assumed that the encryption algorithm is public, and this means that the function to generate multiple keys is known to the hacker as well. This means that, once the hacker is able to find a key, he immediately access other keys. Here a chaotic function can play an important role. This paper presents an algorithm, the use of the chaotic function $f(x) = 3*x*(1-x^2)$ explore signcryption scheme to generate multiple keys.

This paper is structured as follows. Chaotic function i.e $f(x) = 3*x*(1-x^2)$ is discussed in Section II. The third section describes the proposed scheme which includes description of parameters, the key generation phase, dynamic chaotic key generator, and multi message signcryption schemes for single recipient and multiple recipients. In the third section analysis of the purposed scheme for the proof of correctness and for the assessment of algorithm. Section V presents the conclusions and scope for futhur work in this area.

II. Chaos function for Signcryption scheme

Chaotic functions were first studied in the 1960's and show numerous interesting properties. Chaos is greatly sensitive to initial conditions and parameters and accurate duplication of it is impossible. Therefore, chaotic systems have more useful and practical applications. Cryptography and chaos have some common features, the most prominent being sensitivity to parameters' and variables' changes.

One of the simple chaotic function $f(x) = r*x*(1 -x^2)$ is used here, where r is the control parameter and this function is bounded to $0 < r < 3$. This function can be written for the iterative form $x_{n+1}=r*x_n*(1-x_n^n)$ where

x_0 is used as a starting point. In this paper some of the important properties of this function that are of relevance are described.

Figure 1 shows a bifurcation diagram [3] of this function. This is a plot of the parameter 'r' with the values that are obtained after some number of iterations i.e f(x). For 0<r<2, the function is seen to converge to a particular value after some number of iterations. As 'r' increases to just greater than 2 the graph is divided into two branches. Now the value of this function takes oscillation between two different values.

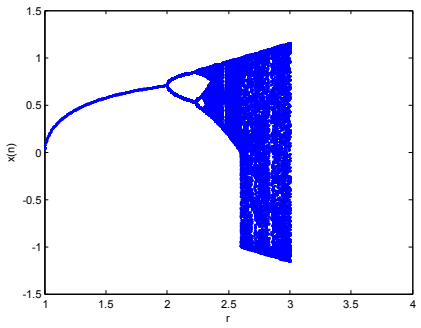


Fig 1. The bifurcation diagram for the function f(x) =r*x*(1-x^2)

The x-axis gives the 'r' value and corresponding y-axis denotes the f(x) value. When the parameter 'r' further increases, the curve again bifurcate and now the value of the current oscillations are seen in between 4 values. For the 'r' in the current situation, the increase in branch becomes faster and faster, 8,16 then 32. Periodicity of 'r' is called "point of accumulation" exceeds a certain value gives a chaos to complete. It is found when (r > 2.37), the chaos generated values are considered to be restricted to two different boundary. As the value of the 'r' increases, the two boundaries gave way to a single way. Also the range between which chaos values are yielded increases constantly as the value of 'r' is increased. Finally when r = 3, we observed that the chaos generating the full range of (-1.3 to 1.25). Precisely at this point, we are interested in the chaos function. Therefore the chaos function that we investigate for applications in generation of multiple keys for Signcryption scheme in this paper is f(x)= 3*x*(1-x^2).

We are using this function for generation of multiple keys for the Signcryption scheme as it is simple to use, one Dimensional in nature and it also provides a high range for key generation which provides more security to the scheme proposed before. Hence we can also experiment with some complex chaotic functions for generation of chaotic keys in near future.

Mathematical Preliminary

Quadratic residue: Let N be an integer, and $Z_n^+ = \{k \in Z_n \mid (k,N)=1 \}$, $a \in Z_n^+$ is said to be quadratic residue modulo N, if there exist an $x \in Z_n^+$ such that $x^2 \equiv a \bmod N$. It is infeasible to compute x from $x^2 \equiv a \bmod N$. if modulo N cannot be factorised[17].

III. Proposed Scheme

The purposed signcryption scheme consists of four algorithm namely, key generation algorithm, chaotic multi-key generator, signcryption algorithm and unsigncryption algorithm. The parameters used in the purposed scheme are:

p: a large prime number.
q: a prime factor of p-1.
g: a integer with order $q \bmod p$in [1,…,p-1]
n: total numbers of messages.
w: total no of receivers.
Npublic :a public parameter and assume that it is infeasible to factorize Npublic.

3.1 Key Generation

The private and public keys of sender and receiver are generated in the following manner:

Pair of sender's key (x_a, y_a) is computed as follow:

x_a: Sender's private key chosen randomly from [1,...,q-1]

y_a: Sender's public key computed as:

$$y_a = g^{x_a} \bmod p$$

Pair of sender's keys (x_b, y_b) is computed as follow:

x_b: Receiver's private key chosen randomly from [1,...,q-1]

y_b: Receiver's public key computed as:

$$y_b = g^{x_b} \bmod p$$

3.2 Chaotic multi- Key Generator (CMKG)

The chaotic multi- key generator CMKG

$$CMKG(k, n)$$

proposed here is two tuple, where k is generated using receiver's public key (y_b) or sender's public key (y_a) and receiver's private key (x_b) (as shown below), and n is the total number of messages.

1) Calculate a message encryption key " k" for every receiver which is called the master key and Pick a random number x from [1,…, q].

$$k = y_b^x \bmod p \quad (1)$$

$$t = \text{hash}(k) \quad (2)$$

2)Compute the secret multi-keys for block cipher algorithm using the CMKG . Suppose sender A wants to send n messages $(m_1, m_2, \dots, m_n)$ to receiver B, he will generate n chaotic keys ($k_1, k_2 \dots k_n$) for encryption as follow:

$(K_1, K_2, \dots K_n) = CMKG(k,n)$ (3)

By using Chaotic function ,i.e $K_i = r * k_{i-1} * (1 - k_{i-1})$,we will find multiple keys. For i=1…n.

3.3 Signcryption Schemes

This section defines two multi messages signcryption schemes. First scheme is defined for the single recipient and the second is defined for the multi recipient. In describing the schemes, we use *hash* to denote the one way hash function, KH to denote keyed one way hash function, CMKG to denote chaotic multi- key generator and (E, D) to denote private key encryption and decryption algorithm.

3.3.1 Multi Message Single Recipient Signcryption Scheme

The Graphic representation of the scheme is shown in Fig.2. To signcrypt the n messages, a user calculates n chaotic keys ($k_1, k_2 \dots k_n$) used to encrypt the n messages $(m_1, m_2, \dots, m_n)$ and then creates signature on n messages using his private key(x_b).

Signcryption algorithm:

1. Compute $k = y_b^x \bmod p$ (4)
2. Compute $v = k^4 \bmod N_{public}$. (5)
3. $z = \text{Hash}(v)$ (6)
4. For n messages compute n chaotic keys using:
   $(k_1, k_2 \dots k_n) = CMKG(k, n)$ (7)
5. Compute cipher text $(c_1, c_2, \dots, c_n)$using encryption algorithm under chaotic keys ($k_1, k_2 \dots k_n$) as follow:
   $c_i = E_{ki}(m_i)$ for i = 1,...,n (8)
6. Compute keyed hash values (r1, r2,…,rn) for n messages using c as follow:
   $r_i = KH_z(c_i)$ for i = 1,...,n (9)
7. Compute multi message signature using:
   $s = x(x_a + \sum_{i=1}^{n} r_i)^{-1} \bmod q$ (10)

Sender sends signcrypted text $(c_i, r_i, s)$to receiver

On the receiver side, receiver can recover k and c successfully by using sender's public key and his private key . Receiver then computes the chaotic keys to decrypt the messages and recover the plain messages. He then checks the integrity of the messages by computing keyed hash values of decrypted messages under c and comparing it to the received keyed hash values ($(r_1, r_2, \dots, r_n)$.The unsigncryption algorithm is as follow:

Unsigncryption algorithm:

1. Calculate $d = (y_a . g^{\sum_{i=1}^{n} r_i})^s \bmod p$ (11)
2. Calculate $k = d^{x_b} \bmod p$ (12)

3. $v=k^4 \text{mod} Npublic$ (13)
4. $o=hash(v)$ (14)
5. For n messages compute n chaotic keys using
   $(k1,k2,...kn) = CMKG(k,n)$ (15)
6. Recover messages using
   a) $m_i = D_{ki}(c_i)$ for i = 1,...,n (16)
   b) Accept if $KH_o(c_i) = r_i$ for i = 1,...,n (17)

If Alice denies her signcryption, BOb computes $V1 = k^2$ mod Npublic, then forwards (c_1, r_1, V1) to a judge (or anyone). The judge computes $v=V1^2$ mod Npublic , then calculate f=hash(v) and verifies $r_1=KH_f(c_1)$. If the equation holds, the judge says that Alice tells a lie.This shows Public Verifiability concept.

3.3.2 Multi Message Multi Recipient Signcryption Scheme

Let the total numbers of receivers be w. For a receiver b_j, his key pair is (x_b^j, y_b^j) for j=1,…,w the sender calculates k^i using the jth user public key y_b^j and t^j using the one way hash function . He then computes n chaotic keys(k_1^j,k_2^j…k_n^j) to encrypt n messages $(m_1, m_2, \dots, m_n)$for the jth receiver. The sender then signs the n messages using his private key (x_a) and sends the signcrypted text to receiver j. The signcryption algorithm is as follow:

Signcryption algorithm:

1. Calculate $k^j = (y_b^j)^x \text{mod} p$ (18)
2. Calculate $v^j = (k^j)^4$ mod Npublic (19)
3. $Z^j=hash(v^j)$ (20)
4. for i =1,…,n
   a) $k_i^j=CMKG(k_i^j,n)$ (21)
   b) $c_i^j = E_{k_i^j}(m_i)$ (22)
   c) $r^j = KH_z^j(c_i^j)$ (23)
5. $s = x(x_a + \sum_{i=1}^{n} r_i)^{-1} \text{mod} q$ (24)

Sender sends signcrypted text (c_i^j,r_i^j,s) receiver j.

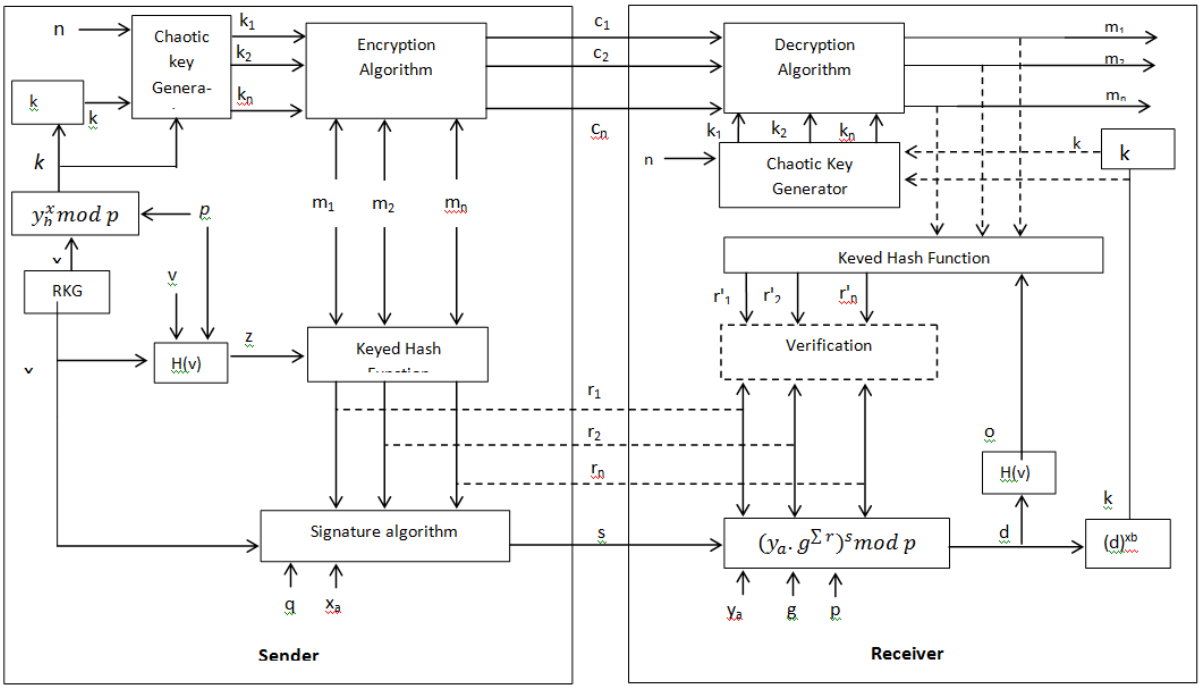
The jth receiver recovers the parameters k^j ,t^j using his private key (x_b^j) and sender's public key (y_a)and computes chaotic keys (k_1^j,k_2^j,….k_n^j) to decrypt the messages. After decrypting the messages, he then checks the integrity of the messages by computing keyed hash values of decrypted messages under t^j and comparing it to the received keyed hash values$(r_1, r_2, \dots, r_n)$. The unsigncryption algorithm is as follow:

Unsigncryption algorithm:

1. Calculate $k = (y_a . g^{\sum_{i=1}^{n} r_i})^s \text{mod} p$ (25)
2. Calculate $t^j = k^{x_b^j} \text{mod} p$ (26)
3. Calculate $v^j = (k^j)^4$ mod Npublic (27)
4. $Z^j=hash(v^j)$ (28)
   a)For i = 1,…n
      i. $(_{t1}^{\ j})=CMKG(t^j)$ (29)
      ii. $m_{i=} D_{t_i^j}(c_i)$ (30)
      iii. $KH_z^j(c_i) = r_i$ (31)

If Alice denies her signcryption, BOb computes $V1 = k^2$ mod Npublic, then forwards (c_1, r_1, V1) to a judge (or anyone). The judge computes $v=V1^2$ mod Npublic , then calculate f=hash(v) and verifies $r_1=KH_f(c_1)$. If the equation holds, the judge says that Alice tells a lie.This shows Public Verifiability concept.

IV. Analysis of Proposed Scheme



4.1 Correctness of the Proposed Scheme

Messages $(m_1, m_2, \ldots, m_n)$can be recovered on receiver's b_j side, for j=1,…,*w*, if the signcrypted text is generated by the sender, as the jth receiver can recover the parameters (k^j, t^j) by using his private key (x_b^j) and sender's public key (y_a) and can compute chaotic keys $(k_1.k_2 \ldots k_n)$ are used to decrypt the encrypted messages.

Evaluation

The chief merit of the above algorithm that the multiple keys generated by the algorithm are expected to be completely random and non deterministic in nature. In determining the keys for the Signcryption scheme, we would like to ensure that even if a potential hacker can get an idea of a key, he should not be able to calculate the other keys with the knowledge of the chaos functions.

The proposed scheme is analysed for its correctness and the public verifiability as follow:

$$k^j = d^{x_b^j} \bmod p$$
$$= (y_a . g^{\sum_{i=1}^{n} r_i})^{s.x_b^j} \bmod p$$

Since, $d = (y_a . g^{\sum_{i=1}^{n} r_i})^{s} \bmod p$

$$= (g^{x_a} . g^{\sum_{i=1}^{n} r_i})^{s.x_b^j} \bmod p$$
$$= (g^{x_a + \sum_{i=1}^{n} r_i})^{s.x_b^j} \bmod p$$
$$= (g^{x_b^j . (x_a + \sum_{i=1}^{n} r_i)})^{s} \bmod p$$
$$= \left(y_b^j\right)^{(x_a + \sum_{i=1}^{n} r_i).s} \bmod p$$
$$= \left(y_b^j\right)^{x} \bmod p$$
$$= \text{value generated on sender's side}$$

Since, $s = x(x_a + \sum_{i=1}^{n} r_i)^{-1} \bmod q$

V. Conclusion

In this paper, new multi message chaos based signcryption schemes are proposed for both single recipient and multi recipient. The proposed schemes achieve the public verifiability. This signifies that the signature of the sender can be verified publicly without the knowledge of sender's or receiver's private key and the message. In the proposed scheme chaotic keys are used to encrypt the messages. The main idea behind the proposed

scheme is to develop a chaotic key generator which generates chaotic keys for encryption algorithm. Due to chaotic nature of the keys, the proposed scheme provides very high security. it increases the strength of chaotic keys and therefore the strength of signcrypted text which is highly desirable when the high computational power systems are being used.

Acknowledgement

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A Novel Methodology for Traffic Monitoring and Efficient Data Propagation in Vehicular Ad-Hoc Networks

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Abstract: *A vehicular ad hoc network is an emerging technology, however some challenging issues need to be resolved. In recent years, road congestion and traffic related pollution have a large negative social and economic impact worldwide. For better public transport, strategic planning, traffic monitoring is required to cut pollution and congestion. One of the important attributes of traffic data is the interval between the time that the data are generated by a vehicle on a particular road and the time that the data is made available to the user as a query response and also to select the fastest route to a destination in a reliable manner. To address these issues, this work focuses on two routing algorithms for VANETS 1) Delay bounded greedy forwarding(D-Greedy) 2)Delay bounded minimum cost forwarding (D-MinCost). The first proposed algorithm (D-Greedy) exploits local traffic conditions, i.e., information about the speed and density of cars at the road segment that it currently traverses. The second algorithm (D-MinCost) assumes knowledge of global traffic conditions, i.e., statistical information about the speed and density of cars on every road segment of the city. This work explores on the current traffic conditions on that road segment. Also a framework is proposed for vehicular networks that jointly optimizes the two key processes associated with monitoring traffic i.e. data acquisition and data delivery.*
Keywords: *Ad hoc network, data muling (DM), multihop (MH) communication, routing, sensor participation, traffic monitoring, vehicular ad hoc networks (VANETs), vehicular networks.*

I. Introduction

Recent years have witnessed a growing interest in the applications of Vehicular Ad Hoc Networks (VANETS). Of particular interest are the applications in the deployment of *ambient traffic monitoring* conditions, wherein vehicles equipped with the Global Positioning System (GPS) detect local traffic and periodically report it to one of the stationary roadside units dispersed throughout the city. These units are referred to as access points (APs) and act as gateways to the city's traffic-monitoring center (TMC) and the outside world.

One of the most important attributes of traffic data is *freshness*, i.e., the interval between the time that the data are generated by a vehicle on a particular road and the time that the data is made available to the user as a query response. Informally, data freshness indicates how stale the data are and to what extent they can be used to estimate trip times or to select the fastest route to a destination in a reliable manner.

We aim at minimizing the bandwidth utilization of a traffic monitoring system while adhering to user defined data freshness requirements. Applications could widely vary in their requirements for data freshness; for example, an emergency response application, e.g., an ambulance coordination service, has stringent constraints on data freshness in the order of a few minutes. On the other hand, a road maintenance company that works overnight could tolerate data staleness of tens of minutes to decide how to plan
road repair work.

Thus, our high-level goal is to design an *ambient traffic monitoring* system that minimizes bandwidth utilization while adhering to user-defined data freshness requirements and also it focuses on undesirable communication overhead. Because our main goal is to reduce the communication cost associated with traffic-monitoring. To achieve this goal, the two system aspects that significantly impact both data freshness and bandwidth utilization: 1) data acquisition and 2) data delivery. The list is as follows

1) A novel problem is formulated in the context of ambient traffic monitoring, i.e., minimizing the communication cost required to monitor traffic while providing deterministic guarantees of data freshness.
2) Two novel delay-tolerant routing algorithms for vehicular networks are proposed i.e., ***delay-bounded greedy forwarding (D-Greedy)*** and ***delay-bounded minimum-cost forwarding (D-MinCost)***, which leverages locally available information about traffic and global traffic statistics to reach forwarding strategy decisions that, minimize communication.
3) A framework is prepared for a vehicular network that jointly optimizes the two key processes associated with monitoring traffic, i.e., data acquisition and data delivery.

4) The evaluation is done using MATLAB tool.

The figure 1 shows the VANET architecture which consists of GPS, RSU and vehicles.

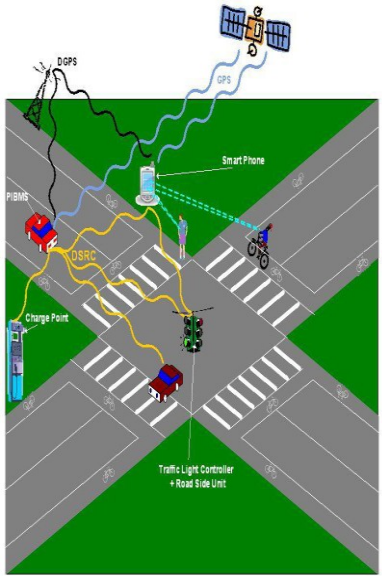

Figure 1: VANET Architecture

II. Related Work

Data dissemination in VANETs can be used to inform drivers or vehicles for traffic jams and to propagate emergency warning among the vehicles (incident or accident) to avoid collisions. In India alone, there are around 400,000 road accidents with 90,000 fatal accidents. Indian roads struggle with problems of traffic flow and instability.

We can save lots of lives, money, and time by forewarning appropriate information to the driver or vehicle regarding congestion and traffic management. Number of innovations in safety, comfort, and convenience have already made today's vehicle a very different machine than it was in the past days. Now a new technology characterized by proliferation of low-cost wireless connectivity and distributed peer-to-peer cooperative systems, is changing the way in which next generation vehicle will evolve. So data dissemination in VANETs plays important role for safety and non-safety applications.

VANETs are based on short-range wireless communication. The Federal Communications Commission (FCC) has recently allocated 75 MHz in the 5.9GHz band for licensed Dedicated Short Range Communication (DSRC).VANETs can be divided into two main areas: Safety applications (e.g. collision warning and work zone warning) and non-safety applications (e.g. traffic condition application and comfort application). For an example, if the vehicle has crashed on the highway, the emergency information can be propagated as soon as possible to inform the vehicles behind the accident for the purpose of safety of other vehicles, might be caused due to this accident.

The second area receiving direct benefit is relevant to transportation traffic control. The immediate benefit from VANET is to improve the efficiency of traffic system. Information about traffic jam can be acquired in real-time so that drivers heading towards the congested area can receive it with sufficient time to choose alternate routes. Toll roads can be automatically paid without the installation of additional hardware to a vehicle. Traffic signals equipped with communication equipment can be used to more accurately control intersection traffic.

Now non-safety applications, for example if a gourmand can easily find some suitable restaurants by using the location based service through VANETs and also useful local advertisements and announcements can be delivered to travelers, such as sale information at a departmental store, the available parking lot at a parking place, the room availability and price at a hotel, the menu at a restaurant. With the rapid applications of VANETs, especially for the safety applications, it may be time dependent. Thus, the information must be sent to other vehicle quickly. For the information dissemination in VANETs, we have to consider the different scenarios or different communication patterns. Node mobility, extreme network density and changing topology from urban gridlock to rural traffic and the rapidly changing information needs moving vehicles make VANETs harsh and demanding networks.

We consider the problem of data dissemination in VANETs, where (1) the vehicular network consists of multitude of data sources and data users; each vehicle is potentially a data source and user at the same time

and (2) diverse types of applications, such as traffic management, situational awareness, and commercial services share the same networking infrastructure (RSUs etc.). The aim of data dissemination is to utilize maximum network resources to serve the data needs of all users. Each vehicle participating in the VANET periodically produces reports regarding the traffic condition.

Researchers and automotive industries are envisioning the deployment of *ambient traffic-monitoring applications*, where vehicles equipped with the Global Positioning System (GPS) detect local traffic and periodically report it to one of the stationary roadside units dispersed throughout the city. These units are referred to as access points (APs) and act as gateways to the city's traffic-monitoring center (TMC) and the outside world.

Important attributes of traffic data is *freshness*, i.e., the time that the data are generated by a vehicle on a road and the time that the data is made available to the user as a query response. Depending on the expected rate of change in traffic conditions, users may have different freshness requirements for different parts of the city or for different times of the day. It is crucial that the ambient traffic-monitoring application provides deterministic guarantees that the available traffic data satisfy the specified freshness requirements.

At the same time, the ambient traffic-monitoring application will share bandwidth resources with various applications that run on the same vehicular ad hoc network (VANET), e.g., applications that provide Internet access to passengers, commercial applications that flood advertisements about nearby stores, and safety applications that provide drivers with emergency braking services. Thus, our goal is to design an ambient traffic monitoring system that minimizes bandwidth utilization and also takes care of data freshness. To achieve this goal, we investigate the following two aspects of traffic monitoring, both of which significantly impact both data freshness and bandwidth utilization: 1) data acquisition and 2) data delivery.

VANETs have some unique characteristics not shared by other types of MANETs:
1. VANETs track position of vehicles moving at high speed.
2. Mobility patterns are somehow predictable as movement is constrained by road infrastructure. In some situations such as highway traffic, the mobility patterns become highly predictable.
3. Large coverage area. Vehicles travel over long distances and traffic information may be useful to vehicles hundreds of miles away.
4. Power consumption is not a major concern. Vehicles are mobile power plants.
5. Vehicles have a high cost and therefore can be equipped with additional sensors without significantly impacting the total cost.
6. VANET's topology is extremely dynamic as vehicles go in and out transmission range quite rapidly.
7. Vehicles travel long distances in a small amount of time when compared to other mobile networks.

III. Proposed System Design

Our motivating example is the ***ambient traffic sensor application*** wherein vehicles are equipped with sensors that detect accidents, road faults and traffic congestion. On detection of an interesting event, vehicles attempt to notify the city's traffic monitoring center, by sending the information to one of the stationary roadside units dispersed in the city. These are referred to as *access points (APs)* and act as gateways to stream traffic information through a fixed network to the outside world.

We note that messages may have very different priorities, and thus delay thresholds until they are delivered to one of the APs. For example, information about a serious accident has higher priority than information about a road fault. The former must be delivered to one of the APs much faster than the latter, since it calls for immediate assistance from fire, hospital or police departments. It is therefore vital that packet forwarding algorithms are designed to prioritize packets based on their urgency and deliver them within user defined delays.

The goal is to design algorithms that try to optimize bandwidth utilization, by being frugal in wireless packet transmissions. To do so, we plan to leverage knowledge of traffic information on different parts of the city. Our proposed algorithms are traffic-informed and they adapt their behavior depending on the traffic density and the average vehicle speed on different road segments.

The key to achieve this goal is to take into consideration statistics of vehicle density and speed in various parts of the city. We carefully study the tradeoff between the competing requirements for timely data delivery and low bandwidth utilization.

We propose two novel algorithms, D-Greedy and D-MinCost that exploit traffic information to forward packets to the most convenient access point. D-Greedy exploits only local traffic information, whereas D-MinCost leverages traffic information about the entire city. Unlike existing vehicular-assisted forwarding algorithms [16], D-Greedy and D-MinCost do not try to minimize delay of packet delivery. Their goal is to minimize the number of packet transmissions required to satisfy packet-specific delay thresholds.

The proposed work consists of two system aspects which impact on both data freshness and bandwidth utilization they are-data acquisition and data delivery which are as follows:

3.1 *Data Acquisition*

Data acquisition refers to the sampling of road traffic information by passing vehicles. High sampling rates can be achieved by having vehicles participate in the sampling process and generate traffic information messages with high frequency. The lower the data acquisition period (DAP) is, the fresher the traffic data that become available for each road, but the larger the number of traffic messages propagated through the network.

3.2 *Data Delivery*

Data delivery refers to the propagation of traffic messages from the originating vehicle to one of the APs dispersed in the city. Traffic messages can be delivered either by wireless multihop forwarding (MF) or by physically carrying messages at the vehicle's speed towards an AP. We propose hybrid algorithms that carefully combine MF and data muling (DM) to achieve a desirable delivery delay. Clearly, the lower the data delivery delay (DDD), the fresher the traffic data available at the APs, but the higher the use of MF, and thus, the higher the communication cost. The block diagram of system is shown in figure 2.

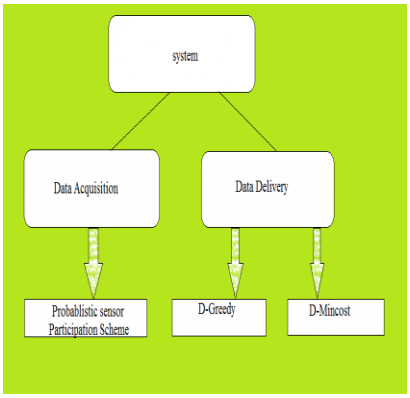

Figure 2: Block diagram of proposed system

IV. Proposed System Algorithms

The proposed algorithms leverage local or global knowledge of traffic statistics to carefully alternate between the Data Muling and Multihop Forwarding strategies, in order to minimize communication overhead while adhering to delay constraints imposed by the application.

We present two novel routing algorithms for VANETs, *Delay-bounded Greedy Forwarding (D-Greedy)* and *Delay-bounded Min-Cost Forwarding (D-MinCost)***.** The goal of algorithms is to deliver messages originating in vehicles to an access point with bounded delay while minimizing the number of wireless transmissions.

D-MinCost requires knowledge of *global traffic conditions*, i.e. statistical information about the speed and density of cars on every road segment of the city. In this work we do not study the precise process of maintaining a fairly accurate set of urban traffic statistics but rather assume that, when in the vicinity of access point, vehicles can update the preloaded street map with the latest statistical information. D-Greedy, on the other hand, requires no such knowledge. It only relies on local information, i.e. vehicle speed, to make forwarding decisions.

Our algorithms intend to minimize the number of transmissions while forwarding a message to an access point within the message-specific delay threshold. Two forwarding strategies used are:

a) Multihop Forwarding, which refers to the aggressive forwarding of messages to vehicles that are better positioned to deliver them to an access point.

b) Data Muling, which refers to buffering messages in local memory and carrying them at the vehicle's speed.

4.1 *Delay-bounded Greedy Forwarding (D-Greedy):*

The D-Greedy algorithm defines a forwarding strategy that assumes no knowledge of traffic information beyond node speed, which can be derived locally from the available location information. D-Greedy assumes that the best path to an access point is the shortest one. i.e, the path that minimizes the sum of the lengths of the edges on the directed graph *G* that abstracts the street map.

When multiple APs exist, the algorithm selects the closest one, i.e. the one on the shortest path beginning at the vehicle's location. Each vehicle maintains a neighbor list by periodically broadcasting beacons. A beacon message contains the unique vehicle identifier (*id*) and the length of the shortest path between the vehicle's current location and the location of the closest access point
(*distToAP*). *distToAP* is computed by running a single invocation of Dijkstra on *G* just before broadcasting a beacon. As soon as a vehicle senses an event and generates a new message, the message is assigned a delay threshold value (*TTL*) and is considered to be useful only if delivered before *TTL* has elapsed.

A. Greedy Strategy Selection

Vehicles periodically iterate through their buffers and make greedy decisions about the strategy that will be used for forwarding each message to the closest AP. The decision depends on the remaining delay budget (*TTL*) until the message expires as well as on the distance to the closest AP (*distToAP*). Since global traffic information is not available, D-Greedy assumes that the remaining message delay budget can be uniformly distributed among the edges that compose the shortest path to the AP. Each edge on the path is allocated a delay budget that is proportional to its length. The algorithm periodically monitors the forwarding progress of each message; as long as the actual time spent by the carrying vehicle that travels along an edge does not exceed the delay allocated to that edge, the Data Muling strategy is selected for the message. Otherwise, the algorithm assigns the Multihop Forwarding strategy to the message.

The figure 3 shows that there is a source vehicle and a access point.

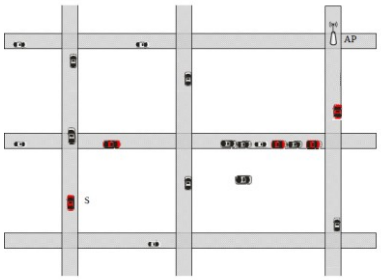

Figure3: D-Greedy strategy

Let *distToInt* be the remaining length, until the next intersection, of the current street segment on which the vehicle is traveling. *distToAP* denotes the current shortest path distance from the closest AP. *U* the average speed of the vehicle calculated during a *k*-second historical window. D-Greedy computes the available delay budget *Del* for forwarding the message along the current edge up to the next intersection as follows:

$$Del = TTL \times \frac{distToInt}{distToAP}$$

D-Greedy calculates the expected delay if the Data Muling strategy were to be used to carry the message to the next intersection

$$Del_{DM} = \frac{distToInt}{u}$$

If $Del_{DM} \leq Del$ then the algorithm opts for the Data Muling strategy. Otherwise, the Multihop Forwarding strategy is chosen. In this case, the message is forwarded to the neighboring vehicle in range that is closest to the AP and it is deleted from the node's buffer. There are two extreme cases in which a vehicle does not apply the selected forwarding strategy for the message. When there is no better-positioned neighbor node to forward the message than the current node, messages that were originally assigned to use the Multihop Forwarding strategy switch to Data Muling. Similarly, if the carrying vehicle is moving away from the closest AP, messages that were originally assigned to use the Data Muling strategy switch to the Multihop Forwarding strategy until a vehicle traveling towards the AP is found.

Figure 4 indicates the D-min cost strategy which shows delay and cost in terms of Data Muling and Multihop forwarding. Also it shows the shortest path to reach the access point and minimum cost required to reach AP.

4.2 Delay-Bounded Minimum Cost Forwarding (D-MinCost)

Our second proposed algorithm leverages the knowledge of global traffic statistics, i.e. estimated values of average vehicle speed *u* and density *d* for all edges of the street graph *G*. Based on this information, D-MinCost computes bandwidth-efficient delay-constrained paths for every message in the node's buffer. In the graph that abstracts the street map, edges represent road segments and vertices represent road intersections. We would like to annotate each edge with two metrics:

1) Cost (C), representing the number of message transmissions along the edge.
2) Delay (*Del*), denoting the time required to forward a message along the edge.

However, the cost and delay of forwarding a message along an edge depends on whether we are using the Data Muling strategy or the Multihop Forwarding strategy. For edges associated with the Data Muling strategy:

$$Del_{DM} = \frac{\ell}{\overline{u}}, C_{DM} = 1$$

Where ***l*** denotes the length of the edge and the $\overline{u}$ average vehicle speed along that edge. We fix the communication cost of the Data Muling strategy to 1 message transmission regardless of the segment length. The reason is simple: the vehicle carries the message along the entire road segment, and in the worst case, transmits it only once upon reaching the intersection. For edges associated with the Multihop Forwarding strategy, we must first check whether Multihop is feasible on the road segment. For wireless communication range *R*, Multihop Forwarding is an available option if $\ell > R$ and, $\overline{d} \geq \frac{\ell}{R}$ where *d* is the average vehicle density for the edge in question.

$$C_{MH} = \frac{\ell}{R}, Del_{MH} = C_{MH} \times q$$

q denotes the time required for the node to check its neighbor list and identify the best next hop.

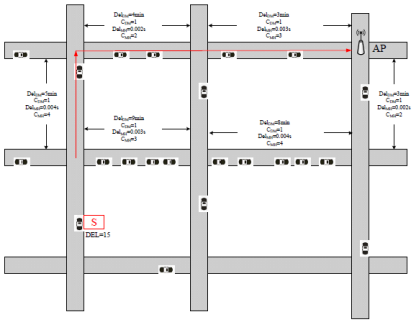

Figure 4: D-MinCost Strategy

V. Simulation & Results

Simulations are compiled with MATLAB tool version 7.10.0.499(R2010a) .

Figure 5

Figure 5 shows the shortest path from source to destination. Here the source is node 1 and destination node 7.The total numbers of nodes are 30.After performing the dijkstra's shortest path algorithm we got the total cost as 4.

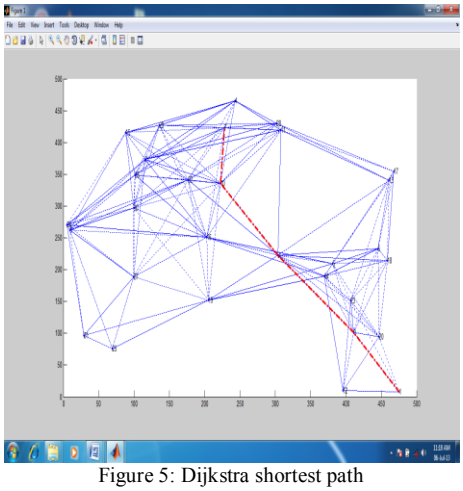

Figure 5: Dijkstra shortest path

path =1 9 3 10
total Cost =4

Figure 6

Figure 6 shows the situation of multiple paths. The numbers of nodes present in the graph are 70.Graph shows the two best possible paths from node 1 as source and node 15 as destination.

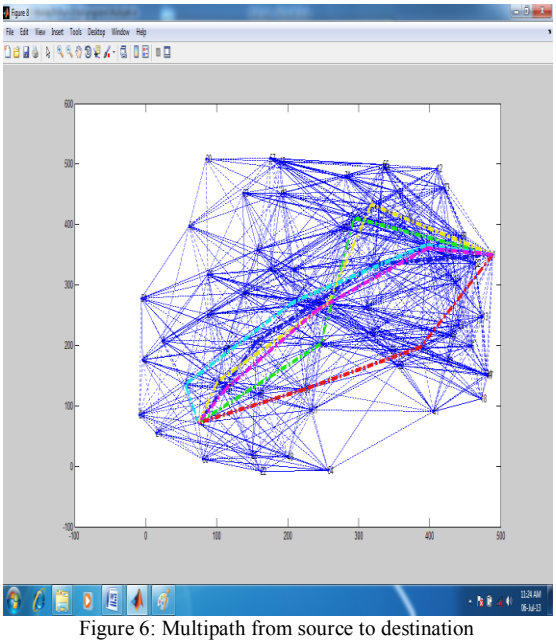

Figure 6: Multipath from source to destination

Figure 7:

Figure 7 shows the best path from source as node 1 and destination as node 15 is path= 1 9 7 27 15 and the cost is 4

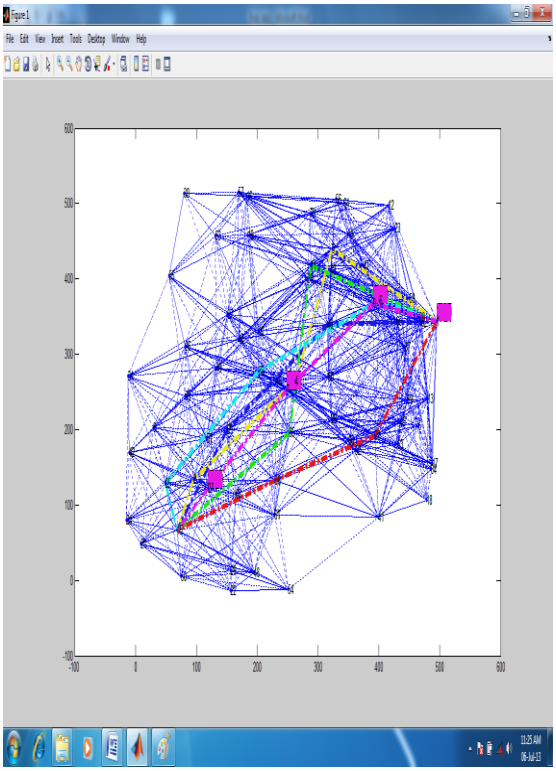

Figure 7: Highlighted multipath from source to destination

Figure 8:

Figure 8 shows the shortest path from node 1 and node 12.Also the result shows the total distance from source to destination and the number of iterations performed. Here total distance=1947.3766 and number of iterations performed are 1740.

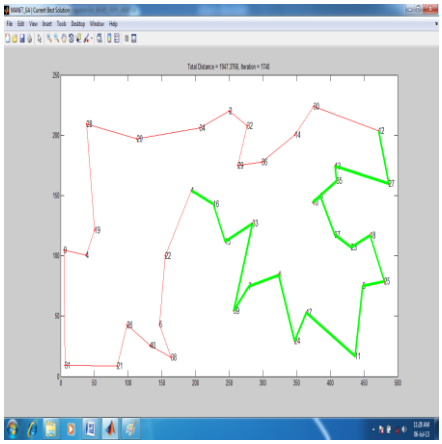

Figure 8: Shortest Path

Figure 9:

Figure 9 shows the node locations after the simulation and also it shows distance matrix, total distance and the best solution history.

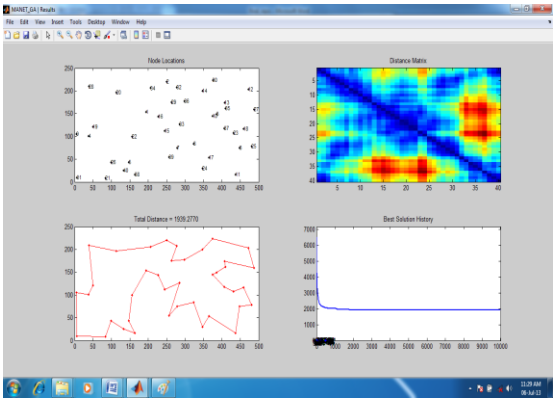

Figure 9: Node location, total distance, best solution, distance matrix

Figure 10:

Figure 10 shows the path from source=1 and destination=12.

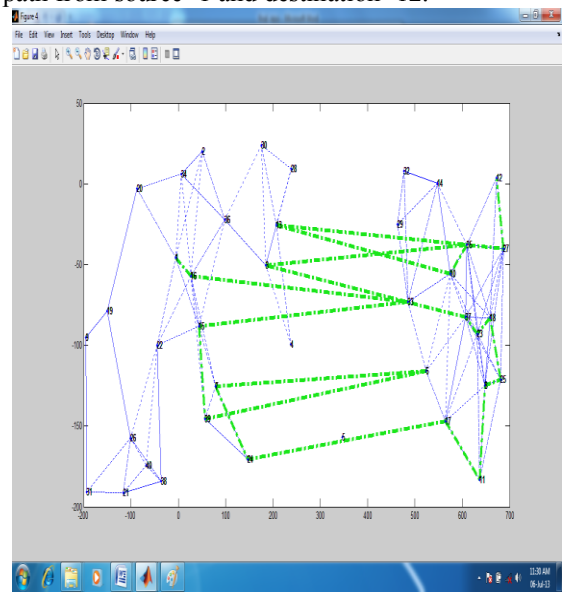

Fig10: Path formed

VI. Conclusion and Future Scope

In this work the problem of minimizing the communication incurred by traffic monitoring systems while providing deterministic guarantees of information freshness is defined. The proposed algorithms ensure that it will be utilized in both key processes associated with monitoring traffic i.e., data acquisition and data delivery. For data delivery, the following two novel packet-forwarding schemes for vehicular network scenarios are proposed, which route messages towards fixed infrastructure nodes: 1) D-Greedy and 2) D-MinCost. A framework is proposed that jointly optimizes the data acquisition and data delivery stages in the traffic-monitoring system. In this work, a busy urban scenario is considered, where the wireless medium is expected to be congested throughout.

Because of limited time constraint we are unable to include all the features of VANETS and also we are not providing up to date information. The framework for weather information can be incorporated in future using this work. Vehicle-to-Vehicle(V2V) and Vehicle-to-Roadside(V2R) Communication can bring out the following achievements in future like presence of obstacles on road, emergency braking of a preceding vehicle, information about blind crossing, school proximity, railway crossing, entries to highways, high speed internet access, electronic toll collection, parking space locater in cities, information about nearest petrol pump etc..

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Routing Algorithm for Heterogeneous Wireless Network in VANET

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Abstract : *Today, Vehicular Ad Hoc Network (VANET) is an emerging technology. With the progress of wireless radio technology, telecommunication, various wireless specifications and protocols, the routing problems in heterogeneous wireless network become popular research area in the field of VANET for supporting different aspects of Intelligent Transportation System (ITS) applications. In this paper, we integrate cellular (3G) network and Vehicular Ad-Hoc Network (VANET) into a hybrid network. This hybrid network is called heterogeneous wireless network (HWN) with multi-cells architecture to overcome the weakness of cellular network and Ad-Hoc network. We also, propose a routing algorithm for HWN. The simulation results show that HWN with the proposed routing algorithm has minimum request block rate and transmission time.*
Keywords: *Heterogeneous Wireless Network, VANET, Routing Algorithm*

I. Introduction

In recent years, the progress of wireless communication technology brings convenience to our daily life. Moreover, various wireless personal communication systems have been deployed globally across different geographical location so that, mobile users can communicate with others and access the Internet anytime and anywhere. Therefore, wireless network must provide ubiquitous communication capability and information access regardless of user's location.

There are many wireless devices deployed according to the requirements and the characteristics of networks. Most of them can be classified according to their transmission rate and coverage range. A satellite system provides global coverage with low transmission rate (typically 10kb/s or lower). The Wireless Local Area Network (WLAN) operate at Mbps rate (typically 1~2Mb/s) over a range of hundreds meters (typically 150~250 meter using IEEE 802.11b protocol). Also, the popular 3G system has the coverage in the range of several kilometers with the transmission rate of about 200~300 kb/s or higher.

Furthermore, the Vehicular Ad-Hoc Network (VANET) is another wireless network without communication infrastructure. It is characterized by dynamic topology with vehicular node mobility and limited bandwidth. Each Vehicular Node (VN) operates not only as a host but also a router. It forwards the packet to other nodes using peer-to-peer communication. A lot of work has been discussed about efficiently finding the "multi-hop" routing paths [3,4] and some resource factors that need to be considered in "homogeneous" environment are discussed in [5,6]. These routing algorithms can be mainly classified into two categories:

(a) One is *proactive* protocol, in which all VNs *proactively* maintain the information of their neighbors in information table. The information stored in the table of VNs includes number of hopes, TTL, transmit rate, etc. When some VN initiate route request message, this protocol can be aware of the neighboring VNs' state without any extra detection and delay. Therefore, neighboring VNs must periodically exchange the information to get the timely update of their information table. The period of updating-table time *T* in *proactive* routing protocol relies on the routing table update mechanism. When *T* is low, out-of-date routing table information in VN is unavoidable. When *T* is high, there will be unnecessary overhead of updating routing table. Furthermore, not all of VNs deliver and receive data in each time cycle. Therefore, some updating messages in *proactive* routing protocol are unnecessary, and the implement of such protocol is not included in the proposed algorithm.

(b) The other category is *reactive* protocol, which couples with the *on-demand* nature. This protocol eliminates the need of updating table information among neighboring VNs. When a VN uses this protocol, it takes some waiting time during the process of route discovery. The *proposed routing algorithm* in this chapter uses *reactive routing protocol* as it eliminates the need of updating table information so that unnecessary use of bandwidth can be avoided.

II. Related Work

Considering the various features and limitations of wireless communication technology, a variety of heterogeneous wireless networks are formed, but most of them are not implementable. Currently, many researchers are working on the project of 4G also known as Beyond Third generation (B3G). The main goal of 4G project is to integrate all kind of heterogeneous networks [9]. However, the project poses many research challenges and issues, such as handoff and location coordination [7,8]. Also many researches only offer the conceptual model or provision toward the 4G [9,10]. After that, the integration of the popular 3G cellular network and Ad-Hoc network to form Heterogeneous Wireless Network (HWN) architecture is introduced by many researches. The 4G (B3G) is a project integrating all types of the heterogeneous wireless network. There is a lot of work carried to develop the routing protocol and algorithm in HWN toward 4G [13, 14]. However, most of the work only focus on the conceptual network architecture of 4G without details or just consider only single base station (BS) assumption without considering the congestion issues [13,15]. Moreover, these researches only discussed about the routing algorithm of original cellular network [16] or original Ad-Hoc network [14].

In this paper, we propose heterogeneous wireless network (HWN) which is the hybrid network of popular 3G cellular network and Vehicular Ad-Hoc network. It takes the advantages of the large-scale 3G system and the high transmission rate in Vehicular Ad-Hoc network. The proposed HWN can reduce the block rate of the Internet access and support larger coverage of Vehicular Ad-Hoc network. We also introduce a new routing algorithm for HWN without additional hardware cost.

III. Proposed Heterogeneous Wireless Network Architecture

The proposed heterogeneous wireless network, integrates the feature of the cellular network (e.g. 3G system) and Vehicular Ad-Hoc network as shown in Figure 1. It is assumed that each Vehicular Node (VN) equips with the Mobile Router (MR) and cellular interface (e.g.CDMA2000 1xEV-DO) and Ad-Hoc interface (e.g. IEEE 802.11b).There are many companies offering dual-mode integrated interface recently. Therefore, the routing protocol can make a decision of selecting the correct mode or interface to deliver the packets. In order to form HWN environment, we distribute the BS along road side. We also assume that the coverage of each BS is 1000*1000 square meters. It is also assumed that, it is an all-IP environment which each VN and BS has unique IP as ID.

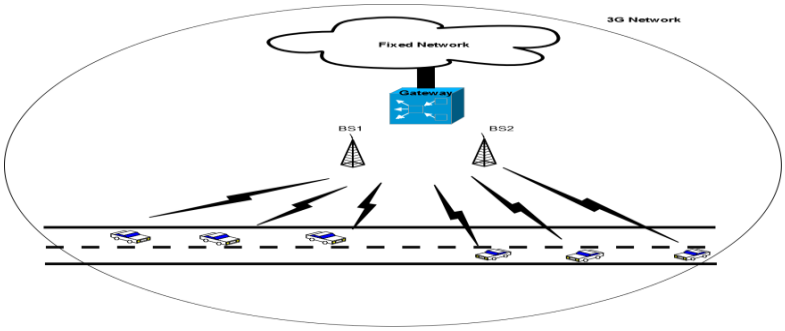

Fig1. Proposed heterogeneous wireless network architecture for VANETs

The HWN architecture that we proposed is used for the vehicular applications. There are many factors in vehicular network applications such as availability assurance, reliability, and throughput that need to be considered to improve the routing algorithm performance for transmitting data.

To improve the routing algorithm performance, we resolve two issues rose in the existing HWN.

(i) The drawback of existing HWN is that it only supports the data transmission between the specific source and destination in VANET. When specific source node has multiple routing paths to send data packets to destination, an effective routing path is selected based on the above considered factors.

(ii) Due to the multi-cells architecture of HWN there may be data traffic load in HWN is an effective method of distributing the data traffic is needed to enhance the total data throughput or distribute data traffic load and provide better services to number of vehicular nodes.

The proposed routing algorithm solves these two issues (problems) that we discussed later in this chapter. Now, we introduce the architecture of our proposed HWN.

The HWN is composed of Base Station (BS), vehicular node that equips with Mobile Router (MR), 3G network and gateways. The architecture of proposed HWN is shown in Figure 1. Vehicular node can access the internet through different cellular cells or communicate with other vehicular nodes directly or via Base Station (BS). Hence the vehicular device in HWN can have different behavior in the homogeneous network. To

understand the different behavior of HWN, let us consider an example shown in Figure 2.
In Figure 2 there are two types of communication possible for vehicular network

(a) Communication between specific source to specific destination
The communication between specific source to destination can further divided into three sub-categories:
(i) Source and destination are in under in same BS
If a source (Source1) wants to deliver data packets to destination (Destination1), Source1 deliver the packets to Destination1 by multi-hop routing through intermediate nodes *without any assistance* from the cellular network (Source1 can deliver packets to Destination1 by using its own Ad-Hoc network). The arrow marked (1) in Figure 2 shows this communication scenario.
(ii) Source and destination are in under different BS, but form a Ad-hoc region
If Source2 and Destination2 are in *different* cells (BS) but sufficiently close to each other so as to form their Ad-Hoc region, then Source2 can deliver packets to Destination2 through their Ad-Hoc network without using the of the Base Station (BS). The arrow marked (2) in Figure 2 shows this type of communication.
(iii) Source and destination are in under different BS
When Source3 under BS1 wants to deliver packets to Destination3 which is under BS2 then, Source3 will use the cellular network to deliver data packets. The Source3 will first send the data packets to the BS1 (as shown by arrow marked (3)). Then, packets are subsequently by BS1 (arrow marked (3)) delivered through the fixed network to BS2. Finally, BS2 will deliver the data packets to Destination3 (arrow marked (3) in Figure 2).

(b) Communication between specific source to Internet
In addition, VN can connect to the Internet (fixed network) through the cellular network to access internet applications rather than making any communication to other VNs.

The proposed HWN incorporates both types of communication possibilities explained above. The detail of these communication categories are explained in next section.

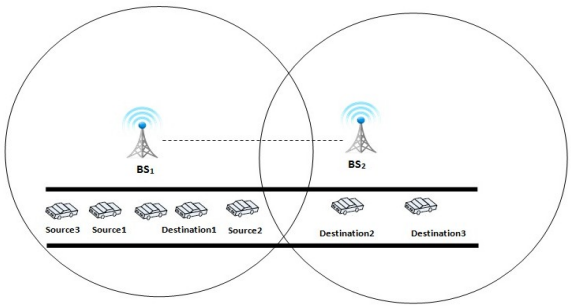

Fig2. Various Source & Destinations in heterogeneous wireless network architecture

IV. Proposed Road Based Routing Algorithm

The integration of VANET and cellular network is used to form the heterogeneous wireless network. In this section a new routing algorithm, named Road Based Routing Algorithm (RBRA) is proposed for our heterogeneous wireless network. The two major processes of the *RBRA* (Road Based Routing Algorithm) are:
(a) Road Based Routing Discovery Process (RBRDP) and
(b) Load Distribution Process *(LDP)*.

The flowchart of RBRA (Road Based Routing Algorithm) is shown in Figure. 3. We also consider and describe the network interface used by VN as mentioned in section 4.2. We already classify the requirements of traffic load into two parts: *(i)* the routing path from the specific source and destination traffic and, *(ii)* the routing path from VN to Internet. The difference between these two traffic loads is the destination of the request. The destination can be VN or the server connected to Internet by fixed network.

If the application of VN can decide the requirement of the Internet access, the VN can send the Route Request message (RREQ) messages by using cellular interface to the cell (BS) in which it is registered, without flooding the RREQ messages by dual-mode interface.

However, if the application of VN is not able to decide the type of data traffic for the Route Request message (RREQ), it can send the RREQ message to its BS. BS can check the destination in VLR (Visitor Location Register) or HLR (Home Location Register).

- If the check successes (i.e. destination exists in VLR or in HLR), the specific source and destination traffic

is preferred.

- Otherwise, the destination is the server connected to fixed network. Thus VN must transmit data to destination through BS and fixed network. We call such kind of data traffic as "Internet Access", and the internet access traffic is preferred.

(i) Routing path for specific source and destination

If VN (specific source) initiates the routing path to specific destination in HWN, the Road Based Routing Discovery process (RBRDP) starts to find the specific destination by using dual-mode (Ad-Hoc and cellular) interface. If a reachable routing path is found, the proposed routing algorithm evaluates the route metric for each reachable route and selects one routing path with minimum route metric to transmit data as shown through path (1b) → (9) → (11) → (12) → (13) in Figure 3. If no such reachable path exists, then the request is blocked as shown through path (1) → (1b) → (9) → (10) in Figure 3.

(ii) Routing path for Internet Access

When VN wants to access the internet, it connects itself to the registered cell by using cellular interface. Then, BS runs the bandwidth capacity test to check whether it has enough bandwidth for this request. If the capacity test is succeeded, then the BS sends ACK message back to VN. The ACK message indicates that the bandwidth is reserved by BS for requesting VN. Next, the VN establishes the routing path to BS for data transmission. Finally, the VN accesses the Internet through fixed network via BS. These steps are shown in Figure 3 with route (1a) → (2) → (3) → (4) → (5).

If the capacity test fails, the BS starts a "Load Distribution Process" to find a reachable routing path from the neighboring BS. VN receives a Route Ack (RACK) message from registered BS. The RACK message indicates to requesting VN that registered BS does not have sufficient bandwidth to access Internet. The RACK message sent by BS also includes cell IDs of its neighboring BS. Thus, VN triggers Road Based Route Discovery process (RBRDP) for specific available cells ID's sent by its BS. Now, VN can use a dual mode interface to flood RREQ message to find the destination by using communication between specific source and destination in heterogeneous wireless network. If VN find a reachable path with in a limited time, than it evaluates the route metric for the reachable path. Next, the VN select the path with the minimum route metric to forward the data. The above steps are indicated by path (1a) → (2) → (6) → (7) → (8) → (9) → (11) → (12) → (13) in Figure 3. If VN does not find any reachable path within a limited time, the route request (RREQ) message is blocked. These steps are indicated by path (1a) → (2) → (6) → (7) → (8) → (9) → (10) in Figure 3. In next section, we will describe the RBRDP and LDP processes in detail.

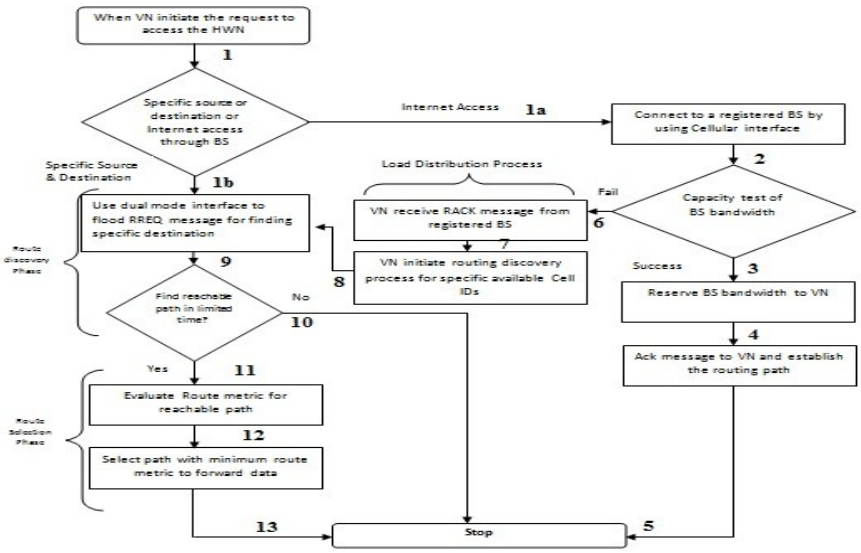

Fig.3. *Road Based Routing Algorithm in Heterogeneous Wireless Network*

V. Road Based Routing discovery process

Based on proposed HWN mentioned earlier, the proposed routing algorithm is used to find out the path to send or deliver data packets in the network. We have already discussed that our proposed routing algorithm is based on reactive routing protocol.

It is not necessary that every VN require accessing the cellular interface (i.e BS). But some of the VNs

that do not access the cellular interface also have the ability to forward or deliver data packets to other VNs through the Ad-hoc region they formed. VNs that really require accessing the cellular interface can send the route request messages (RREQ) to BS. During route discovery process, the RREQ message will be broadcasted to all the VNs that are in the Ad-Hoc region of initiating VN as well as to the BS in which initiating VN is registered.

The RREQ message received by VNs and BS can also broadcast the same RREQ message to their neighboring VNs and BS. This broadcasting continuous until destination node is found. This continues broadcasting in Route Discovery process increases the Route Reply Packet Overhead.

However, if we limit the number of the forward hops in our routing protocol, the on-demand flooding RREQ message overhead may be reduced. The TTL (Time to Live) in the RREQ message also limits the delay time of whole routing process. The Road Based Routing algorithm (RBRA) uses reactive routing which is more suitable and better fit in HWN. Also, the route discovery process is divided into two phases: (a) *route discovery phase* and (b) *route selection phase*.

(a) Route Discovery Phase

Our RBRDP (road based routing discovery process) is designed for heterogeneous wireless network and it is the modification of the reactive DSR (Dynamic Source Routing) routing protocol which is designed for homogeneous network. In route discovery phase, we assume that BS (Base Station) will act as a VN during routing discovery process. The bandwidth usage, delay of transmission and the mobility of every VN may be different. However, the transmission range and frequency band is same for all VNs as it follow the IEEE802.11 specification. Similarly, the transmission range, and frequency band is same for all BS as it follow the cellular standards. But, all BS differs in bandwidth usage and delay of transmission. We already assumed that each node (VN or BS) has a unique IP, then, the "Source ID" field and "Destination ID" field in RREQ message can be filled with specific IP s

The RREQ message format and their field are shown in Fig. 4.

Source ID	Request ID	Destination ID	TTL / HOP	Complete Route	Bandwidth Requested

Fig.4. The RREQ Message Format

When some VNs initiate to access the HWN (i.e. cellular interface or Ad-Hoc region), then BS as well as vehicular node (VN) participate in the routing discovery process. Therefore, when node (VN or BS) receives the RREQ message, it checks all the route field of RREQ to determine that whether all fields contain information. If the incomplete routing path exists in routing table of node, then node will discard the RREQ message. Otherwise, it re-floods the packet to reachable neighbors and appends the host id (neighboring id) as destination in the *complete route* field. The process of re-flooding of packets continues until destination is found. If the destination is reachable, the RREP message contains the complete routing path information toward the source. Hence, the routing path is established.

Through the use of BS, the original source and unreachable destination pair in heterogeneous Ad-Hoc network can find alternate path to deliver packets. If there exists an alternate path, then the request block rate can be reduced. The request block rate is defined:

$$Request\ block\ rate = \frac{number\ of\ blocked\ request\ to\ access\ the\ network}{Total\ number\ of\ request\ to\ access\ the\ network}$$

When BS receives the RREQ message, it can check the VLR (Visitor Location Register) to find the reachable destination (VN) to avoid re-flooding of RREQ message. If the destination VN is found in its VLR or in HLR, then it can send the RREQ message to the reachable VN. Otherwise it forwards the RREQ message to other BS through cellular network. The same process continues till destination is found.

The steps of modified routing discovery phase are shown in Fig. 5(a) & (b). The source node can be any VN in the HWN. When the source node initiates the route request, it checks the route cache. If there is a route in route cache that contains the destination ID, the destination is reachable. Then, the source node writes the routing path in the packet header and forwards the packet to next-hop node. If the route in route cache does not exist, the source node buffers the forwarded data and floods RREQ messages to reachable neighboring nodes (VNs or BS) until receiving the RREP(Route Request Reply) messages in a limited time(message TTL).

Here, we assume that the requests initiated by the source node have queuing property. In other words, the request of data transmission that is initiated earlier by the source node is processed first. The intermediate node can be either a VN or BS.

(a) When the intermediate node (VN) receives the RREQ message, it checks the "TTL" and "Hop" fields in RREQ message to decide whether the message will be discarded or not. If the incomplete route is recorded in "Complete Route" field or host ID is not a destination ID, then the host discards the RREQ message. When the intermediate node that receives the duplicate RREQ message from the same source ID, then it discards the RREQ message to minimize Route Request Packet Overhead. Thus the traffic of flooding RREQ message received by intermediate node can be removed if they are originated from of the same source ID. If the host ID is same as the destination node for the request, the host sends the RREP message backward to the source node. Otherwise, the VN appends host id and available bandwidth in "Complete Route" field in RREQ message and forward to reachable next-hop by dual-mode interface. When the intermediate node receives the RREP message, it updates its available bandwidth and forwards the RREP message to next-hop recorded in the RREP message.

(b) If the intermediate node is BS, it checks:

(i) The VLR (Visitor Location Register) database to find the reachable VNs in its record as well as it also checks the bandwidth request to serve the RREQ initiated by source. If the destination is reachable, then BS updates a host ID and available bandwidth in the source ID and bandwidth request field respectively in the RREQ message. The updated RREQ message is then sent to destination VNs.

(ii) The HLR (Home Location Register) to find whether the VN is registered in it or not. If VN is registered in its HLR, then it sends the RREQ message to reachable destination VN. For sending the message, it appends the host ID and available bandwidth in "Complete Route" field in RREQ message. Otherwise, BS check the neighboring BS to forward the RREQ message through fixed network to find the destination node, such as Source3-BS1-BS2-Destination3 path shown in Figure 2.

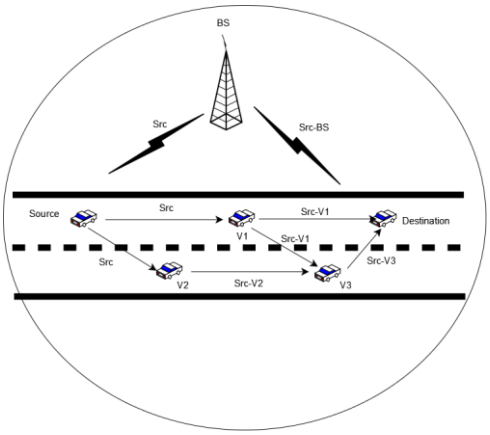

Fig. (a)

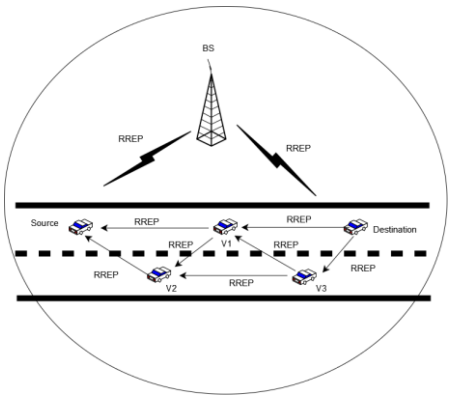

Fig. (b)

Fig.5. Route Discovery steps

(b) Route Selection phase

We design the routing metric function for considering the transmission time and number of intermediate nodes in our RBRDP. The routing metric and routing selection functions of RBRDP is describe as.

Assume that all the nodes (VN and BS) in HWN belong to set of nodes N.
Let set N = {N1, N2, N3……Ni |i is the number of nodes in Heterogeneous Network}
After completing the route discovery process (RD), there may be an existence of multiple paths. Thus the routing path discovered between any source and destination can be defined as:
RD (N_S, N_D) = {R_1, R_2 ……Rj | j is a route number, N_S, $N_D \in N$ & $N_S \neq N_D$}
where N_S and N_D represent source and destination node respectively and
Rj = {N_S, N_1, N_2 …….. N_D} with the
constraint such that: $2 \leq |Rj| \leq Nmax$
N_{max} = the maximum number of intermediate node in R_j
| R_j | = no. of nodes in R_j
$\forall$ R_j satisfy the following condition
$d(N_K, N_{K+1}) \leq T(N_K)$, $\forall N_K, N_{K+1} \in R_j$, $1 \leq K \leq |R_j| - 1$
where $T(N_K)$ is transmission range of N_K and
$d(N_K, N_{K+1})$ is the distance between N_K and N_{K+1}.
Each pair of (R_i, R_j) is disjoint in intermediate node $1 \leq i \leq n$, $1 \leq j \leq n$. n → number of path in route discovery phase.
Within few numbers of intermediate nodes to minimize the transmission time we design RM function of RBRDP as follows-
$RM_{RBRDP}(R_i) = \{(\lambda_{reg} - \min\_ \lambda(R_i)) / \lambda_{reg}\} + |R_j|$ where $1 \leq j \leq n$
λ_{reg} - request bandwidth of N_S
$\min\_ \lambda(R_i) = \min\{ \lambda(N_1), \lambda(N_2)……. \lambda(N_K) \mid \forall N_K \in R_i \mid \leq K \leq |R_i| \}$
So the proposed Route Selection (RS) function of RBRDP is defined as
$RS_{RBRDP}(RD(N_S, N_D)) = \min \{RM_{RBRDP}(R_1), RM_{RBRDP}(R_2)…..... RM_{RBRDP}(R_n) \mid n$ is the number of path found}.
More specifically if $RM_{RBRDP}(R_i)$ and $RM_{RBRDP}(R_j)$ are the same.
We select the route with higher average value of available to the bandwidth.

(c) Load Distribution Process

In this section, we describe the Load distribution in detail. The capacity of BS is usually limited. In this section, we formally describe the meaning of capacity test of BS. The capacity check of BS refers to the available bandwidth of BS to fulfill the incoming request. The capacity test of BS mentioned above can be written as follows.

Total bandwidth – reserved bandwidth >= bandwidth request by VN

If the capacity test of reachable BS is failed, this BS becomes the "Hot Spot" (congestion spot). When VN wants to access the Internet through the "Hot Spot" BS (original cellular network requirement), but the request is not fulfilled, then the load distribution process initiates. The goal of the process is to find out another available routing path to access the Internet through some other available BS as the registered BS of VN becomes "Hot Spot".

The existing cellular network supports only their registered VNs. If the BS is overloaded, then the request sent by their registered VNs could not process. In this section, we propose an extension of cellular network that eliminates the above problem and also supports multi cells services through the Vehicular Ad-Hoc Network. In addition, the goal of this process is to reduce the block rate of original cellular network.
There are 4 steps in the load distribution process:
Step 1. When BS becomes "Hot Spot" (congestion spot), it checks the routing table information collected by the fixed network to find neighboring BS which is available to fulfill the request.
Step 2. The "Hot Spot" BS fills the neighboring cells ID in RACK (Route ACK)
message. Then it sends RACK message to the source node.
Step 3. The source node initiates the routing discovery process through Vehicular Ad-Hoc network to find the other path that can access the neighboring cells ID recorded in the RACK message.
Step 4. If step 3 success, the routing path selected by routing metric of proposed RBRDP to the neighboring cells is established. Otherwise, the request will be blocked.

For example, in Figure 2 if the BS1 becomes "Hot Spot", the request initiated by Source2 will access the network through the routing path Source2- BS2- Destination2. Hence, the request of Source2 may access the network from being blocked by BS1 with the help of proposed Load Distribution Process. Through the use of load distribution process, the request block rate can be reduced as compared to the original cellular network.

VI. Simulation parameter and performance Analysis

In this section, we present the performance evaluation of the proposed RBRA (Road Based Routing Algorithm) in HWN (Heterogeneous Wireless Network). The distributed position of VNs in the HWN is the

high way scenario and located. All VNs are registered to BS. The registered BS of VN is depended on the position of the VN. The handoff scheme of HWN is based on the "hard handoff". When VN moves to neighboring cells, it triggers the routing discovery process to establish the new route toward the new cell and it drops the previous connection immediately. Moreover, we give some definitions in HWN because that HWN must satisfy the Vehicular Ad-Hoc network and cellular network requirements. We define the overall Service Rate (SR) as follows:

$$\text{SR(Service Rate)} = \frac{\textit{Number of Vehicular Nodes request to access the HWN}}{\textit{Total Number of VNs in HWN}} * 100\%$$

SR represents the ratio of VNs which really initiate the routing requests (RREQ) in HWN. The routing requests contain the requests of each homogeneous network. Therefore, the RREQ message may request to find out the route to specific VN (original Vehicular Ad-Hoc Network) or the BS (original cellular network). In the following, we define the request ratio of the original Vehicular Ad-Hoc network and cellular network

Table 1. Simulation Parameter

Parameters	Value
Number of BS	6
Coverage of BS	1000*1000 square meters
Dual-mode interface Specification	CDMA2000 1xEVDO IEEE 802.11
Max hops of each route	10
AdHoc_ServiceRate	SR(Service Rate)/2
Cellular_ServiceRate	SR(Service Rate)/2
Pausing Time	1s
Request bandwidth	Class 1 to Class 4 50~600 kbps
Mobility Model	Highway Scenario
Pausing time	1 second
VN Mobility	Class 1to Class 4 0- 120 km/h

Performance Analysis Block Rate

The curve in Figure 7 represents the architecture comparison homogeneous Ad-Hoc network and proposed HWN with RBRA (Road Based Routing Algorithm).Because of the requirements in the homogeneous environment DSR don't involve the cellular network. We set the Vehicular AdHoc Service Rate as 0.20 which is the same as homogeneous Ad-Hoc network with DSR algorithm, and the Cellular Service Rate is 0. However, we also give the definition of request block rate as follows.

$$\textit{Request block rate} = \frac{\textit{number of blocked request to access the network}}{\textit{Total number of request to access the network}}$$

As Fig. 7 shows, the request block rate in HWN with RBARP can be greatly reduced about 40~60% compared with DSR.

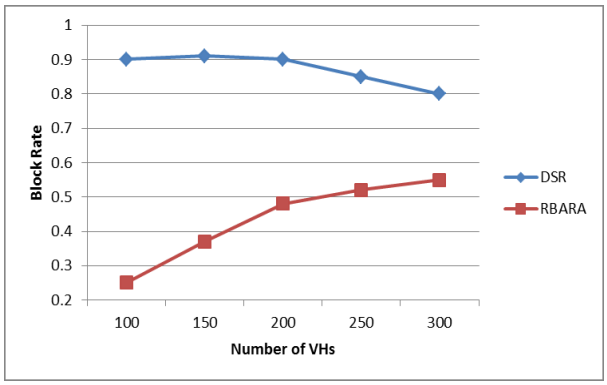

Fig. 7.Request block rate in homogeneous Ad-Hoc network with DSR vs. request block rate of RBRA (Road Based Routing Algorithm) in HWN

Transmission Time

Fig.8 presents the transmission time mentioned earlier. We compare the transmission time between the DSR and proposed RBRA. In Fig. 8, the transmission time of the proposed RBRA is about 10~30% lower than that of DSR. The size of deliver data is set to 1Mb. The SR is set as 0.4. The Vehicular AdHoc Service Rate and Cellular Service Rate are set as 0.20.

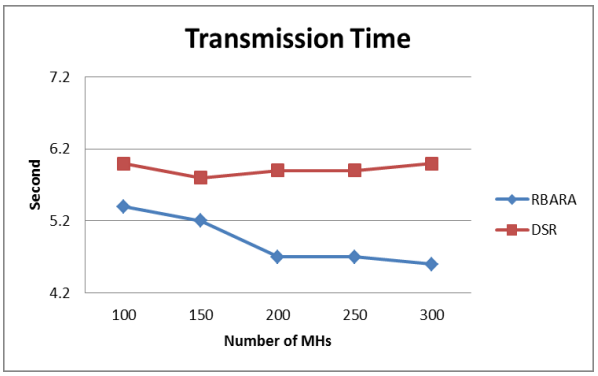

Fig. 8. Transmission time of DSR vs. transmission time of RBRA

Request Block Ratio

The comparison of *request block rate* in HWN is shown in Fig.9. The block rate of proposed RBRA is about 20~40% lower than the *DSR*. In other words, the proposed *RBRA* services more connections in HWN. The SR is set as 0.4. The Vehicular AdHoc Service Rate and Cellular Service Rate are set as 0.20 .

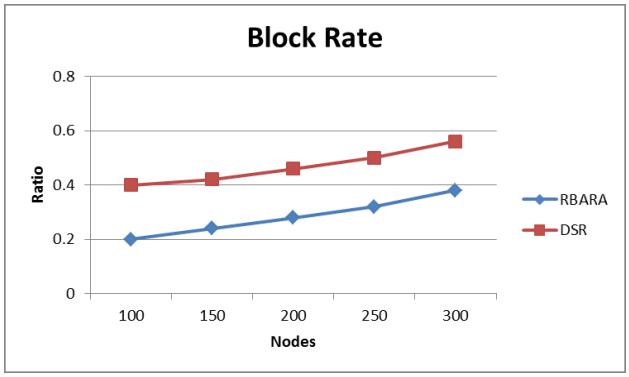

Fig. 9. Request block rate of DSR vs. Request block rate of RBRA

Request block rate with and without LDP (Load distribution process)

In Fig. 10, the comparison of *request block rate* of RBRA without *load distribution process* and RBRA with *load distribution process* in multi-cells environment is presented. The proposed RBRA with *load distribution process* reduces the block rate of request. In other words, we serve more than 10% VHs to access the HWN through the *load distribution process*. For the convenience of observing the result that *load distribution process* caused, the SR is set as 0.4. Moreover, the Cellular Service Rate is set to the same as SR to increase the cellular network traffic.

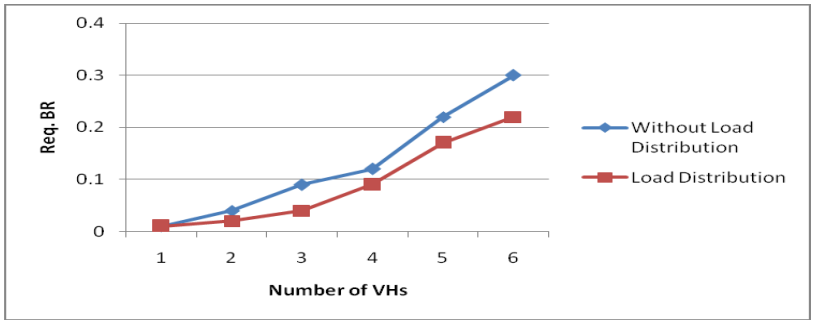

Figure 10. Request block rate without LDP vs. request block rate with LBP

VII. Conclusion

In this paper, we have considered a HWN consist of Vehicular Ad-Hoc network and cellular network with multi-cells. Taking the advantages of homogeneous network in HWN, we have also proposed the RBRA (road based routing algorithm) which consists of two processes: road based routing discovery process and load distribution process. The HWN architecture and the proposed routing algorithm can reduce block rate. Moreover, the load distribution process uses the simple scheme (capacity test) to check whether BS is congested or not. The simulation process show that the proposed routing algorithm perform better than the homogeneous routing algorithm.

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MAPS-A Survey on Mobile Agents Platform for Sunspot Java in WSN

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Abstract : *A major challenge in wireless sensor networks (WSN) research field is to find flexible and effective strategies and energy to perform the network setup and configuration to accomplish described sensing missions. Mobile agents have been proposed as a means to address two important issues in the design of wireless sensor networks (WSN): the need for reprogramming the network and decreasing energy expenditure. However, few mobile agent systems have been developed for WSN so far. In this paper, we describe MASPOT, a mobile agent system for Sun SPOT, a WSN platform developed by Sun Microsystems. MASPOT provides a solution to the above problems and extends the range of Sun SPOT applications. The design and implementation of MAPS (Mobile Agent platform of sunspots), an innovative Java-based framework for wireless sensor networks based on Sun SPOT wireless technology that enables agent oriented programming of WSN applications.*
Keywords- *AFME, MASPOT, MAPS, SUNSPOT, WSN*

I. Introduction

Wireless Sensor Networks (WSN) are emerging as powerful platforms for distributed embedded computing supporting a variety of high-impact applications. Due to recent advances in electronics and communication technologies, wireless sensor networks (WSN) have been introduced and are now becoming one of the most disruptive technologies enable and support the next generation of universal and pervasive computing scenarios. Wireless sensor networks (WSN) are the collection of small devices with low cost sensing, computing, storage, possibly operating capacity and communication. Each sensor node is programmed to interact with each other and with their environment, which is a distributed system only to achieve a global behavior and result. Sensor networks are a powerful technology to support a large number of different real-world applications, and a demonstration, it is interesting to note that in the last decade, this new technology has appeared in a wide range of different areas such as health, environment and infrastructure monitoring, smart home automation, management of the emergency and military support, showing great potential for many other applications. For many WSN applications, human access to nodes after network deployment is not possible or desirable. This has at least two consequences: the life of the nodes should be extended as much as possible, because it will not be possible to replace or recharge their batteries and the network and the applications running on it must be managed remotely. In particular, network and applications should be reconfigured remotely. More generally, the sensor network must be reprogrammable [1], [2], [3]. That means it should be possible to modify and add software components running on each node and dynamically add new forms of treatment or requests captured by the network.

The mobile agent (MA) paradigm is a mechanism for distributed computing used to address problems of dynamically changing environments, such as sensor networks. The mobile agent is a software process that can operate autonomously and can migrate its code and state. Mobile agents provide a means of dynamic reprogramming and makes a powerful and flexible mechanism for the problems of complex distributed WSN systems [4] [5]. Mobile agents are a distributed computing paradigm based on code mobility that has already demonstrated effectiveness and efficiency in IP-based highly dynamic distributed environments. Due to their intrinsic characteristics, mobile agents can provide more benefits in the context of sensor networks than in conventional distributed environments. A mobile agent is a software component that is able to migrate from node to node in a network. When it moves, the agent execution is interrupted, its code, state and possibly execution of its state data are transferred to another node, and after being installed on that node, it resumes execution. Mobile agents can contribute to the reprogramming a WSN because they carry the code that is automatically installed along their tracks. Mobile agents can also help to reduce the amount of energy expended by a WSN as they can locally (at each node) read data from sensors, processing aggregate data (or fusion) of different nodes on their way through the network. The potential benefits of mobile agents have already been highlighted in the context of traditional distributed systems and their applicability can be naturally extended to sensor networks. Different platforms and middleware have been developed to support the implementation of a sort of code migration on WSN [6], [7], [8]. MAPS (Mobile Agent platform sunspot) is an innovative Java-based sensor networks for wireless frame based Sun SPOT that allows the agent oriented programming of WSN

applications. Mobile agents have been proposed as a way to answer these issues. [9] In this paper, we describe MASPOT, a mobile agent system for Sun SPOT (Sun Small Programmable Object Technology) platform. Our interest in the development of a mobile agent system for this platform arose from the fact that the Sun SPOT nodes have many more resources (memory and processing) than other typical sensor nodes. Thus, this platform allows us to develop more complex applications. In addition, the Sun SPOT applications are written in Java. This allows us to write applications for mobile agents using a general purpose language and high-level programming. Many projects are being developed based on sunspots. [10] Adding the mobile agent functionality to the Sun SPOT extends the range of applications of this platform, as pointed out by the Sun SPOT developers. Beyond MASPOT and native form of process migration in Sun SPOT, there are only two other systems for this platform that implements some form of process migration, MAPS (Mobile Agent platform of sunspots) and AFME (Agent Factory Micro Edition). [11]

II. Related Work

Many mobile agent systems have been proposed, particularly for traditional distributed systems (Internet). Since the advent of Java, it has become the main programming language used for the implementation of mobile agent systems, as it provides built-in functions useful for the implementation of these systems, such as dynamic loading classes and serialization. One of the major mobile agent systems developed in Java for the Internet was Aglets. In the context of sensor networks, mobile agents have been proposed as a way to meet the needs of WSN (re) programming and extend the lifetime of the network (by conserving energy of nodes) (eg, [1], [2], [3]). A number of mobile agent systems have been proposed and implemented so far [2], [6], [7]. Agilla [2] and the system described have been developed for the TinyOS operating system. Agilla is a multi-agent where each node supports multiple agents and maintains a tuple space and neighbor list middleware. The tuple space is local and shared by agents residing on the node. Special instructions allow agents to remotely access the tuple space to another node. The neighbor list contains the address of all nodes in a single jump. Agents can migrate with their code and state, but do not carry their own tuple spaces. Sensor ware is a general framework based on the middleware agent technology, where the concept of mobile agent is exploited. Mobile control scripts in Tcl model network participants' functionalities and behaviors, and routing mechanisms to destination areas. Agents migrate to areas of destination carrying aggregation reliable data. The representation of the detailed program and node Tcl interpreter overhead may be acceptable, but they are not yet on a sensor node. Although both Agilla and Sensor ware are based on mobile agents to use a different model of communication: interaction agent Agilla is based on the local tuple spaces, whereas the interaction of the agent Sensor ware is based on direct communication, message-based network. The script can be very complex and the diffusion becomes slower when it reaches the destination areas. Ware sensor [11] is based on mobile control scripts. Smart messages implements the migration of Java code in the form of messages that traverse a network and run on the nodes. It is based on a modification of the Java virtual KVM machine. The mobile agents only for the Sun SPOT platform systems that we are aware of are AFME (Agent Factory Micro Edition) [6] and maps (Platform for Mobile Agent sunspots) [7]. These systems are based on Java. The maps are based on components that interact via events and each component provides services to mobile agents, including services for the creation of the agent, the cloning of the agent, the agent migration, the manipulation of the timer and the message transmission. MAPS do not apply the code migration. As stated in, an agent can only migrate to nodes where the agent code has been previously installed. This restriction comes from the fact that the migration of the agent in MAPS is based on the migration of isolates (not including the migration of code). AFME is a part of the originally developed for 3G cell phones agent, but it was revised to Sun SPOT. AFME platform consists of a controller and platform services, which include the transport of wireless messages and migration services. AFME [12] is a light source J2ME MIDP compliance officer opened based on the framework of the existing plant and pervasive systems for wireless agent. AFME and was not specifically designed for sensor networks, but thanks to a recent support on J2ME platform Sunspot sensor, it can be adopted to develop WSN applications based agents. The wireless message transport service provides datagram-based communication between two nodes. There is no message delivery ordering guarantee. The migration service can transfer the execution state of an agent. However, it does not provide code migration. All classes required by the agent must already be present at the destination. MOBILE-C is an agent platform for mobile C / C + + agents. This platform is compatible with the IEEE Foundation for Intelligent Physical Agents (FIPA) [13]. It extends FIPA standards to support MAs. It incorporates an integrated C / C + + interpreter for the platform as a runtime MA and defines a mobility protocol officer to lead the migration process of the agent. For agent migration, it uses FIPA agent communication language (ACL) encoded in XML. This provides a good solution for inter-platform agent migration in FIPA compliant agent systems. In this context, scriptable C / C + + language is chosen as MA. It is written in C with a small footprint, and it uses an embeddable C / C + + interpreter named Ch [14] to support the implementation of MA C / C + + source code.

III. Architecture of MAPS

The MAPS sensor node architecture is shown in Fig1. It is based on components that interact through events. Each component offers a minimal set of services to mobile agents including message transmission, agent creation, agent cloning, agent migration, timer handling, and easy access to the sensor node resources.

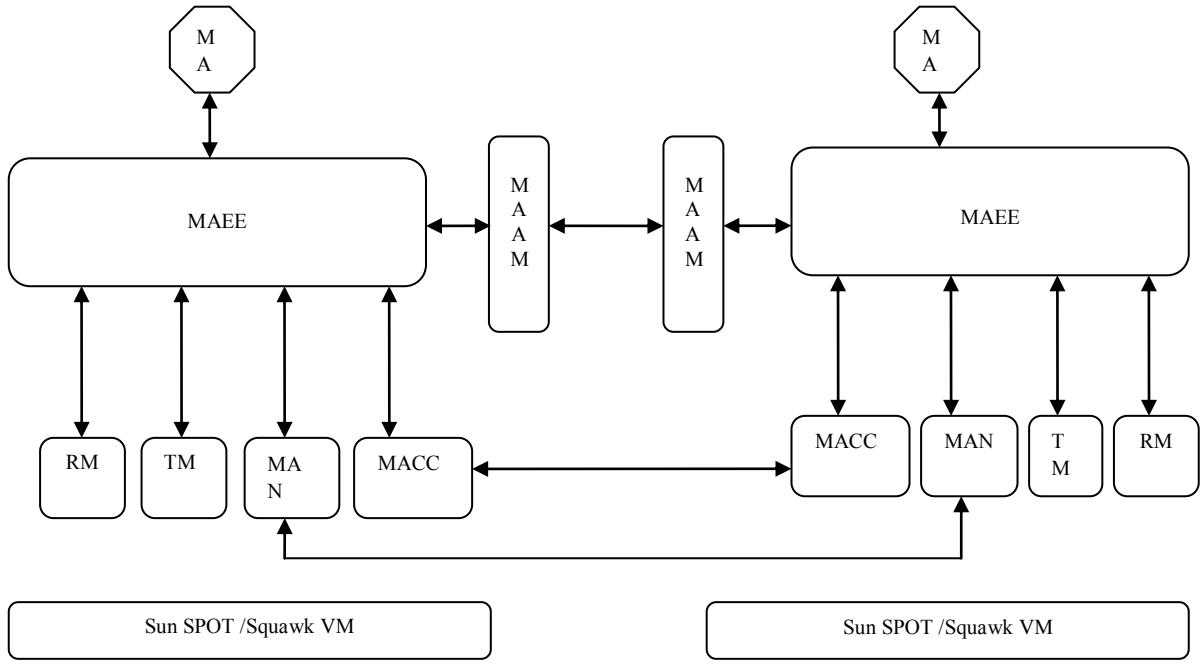

Fig 1. MAPS sensor node architecture

3.1. MAPS

The main MAPS components are:

• Mobile Agent (MA). Each agent behavior is modeled as multi-plane state machines driven by ECA rules. MAs may be differentiated on the basis of the layer (application, middleware and network) at which they perform tasks. Application layer MAs (or MAAPP) incorporate application-level logic performing sensor monitoring, actuator control, data filtering/aggregation, high-level event detection, application-level protocols, etc. Middleware layer MAs (or MAMW) perform middleware-level tasks such as distributed data fusion, discovery protocols for agents, data and sensors, scope management, etc. Network layer MAs (or MANET) mainly implement transport (e.g. data dissemination) and network (e.g. multi-hop routing) protocols. MAAPP, MAMW, and MANET can locally interact to implement cross-layering.

• Mobile Agent Execution Engine (MAEE). The MAEE is the component which supports the execution of agents by means of an event-based scheduler enabling cooperative concurrency. The MAEE handles each event emitted by or to be delivered to MAs through decoupling event queues. The MAEE interacts with the other core components to fulfill service requests (message transmission, sensor reading, timer setting, etc.) issued by the MAs.

• Mobile Agent Migration Manager (MAMM). The MAMM component supports the migration of agents from one sensor node to another. In particular, the MAMM is able to: (i) serialize an MA into a message and send it to the target sensor node; (ii) receive a message containing a serialized MA, deserialize and activate it. The agent serialization format includes code, data and execution state.

•Mobile Agent Communication Channel (MACC). The MACC component enables interagent communications based on asynchronous messages. Messages can be unicast, multicast or broadcast.

• Mobile Agent Naming (MAN). The MAN component provides agent naming based on proxies and regions to support the MAMM and MACC components in their operations. The MAN also manages the (dynamic) list of the neighbor sensor nodes.

• Timer manager (TM). The TM component provides the timer service which allows for the management of timers to be used for timing MA operations.

• Resource manager (RM). The RM component provides access to the sensor node resources: sensors/actuators, battery, and flash memory.

IV. MAPS Agent

The behavior of MAPS mobile agent is modeled through a multi-plane state machine (MPSM) depicted in Fig *2*.

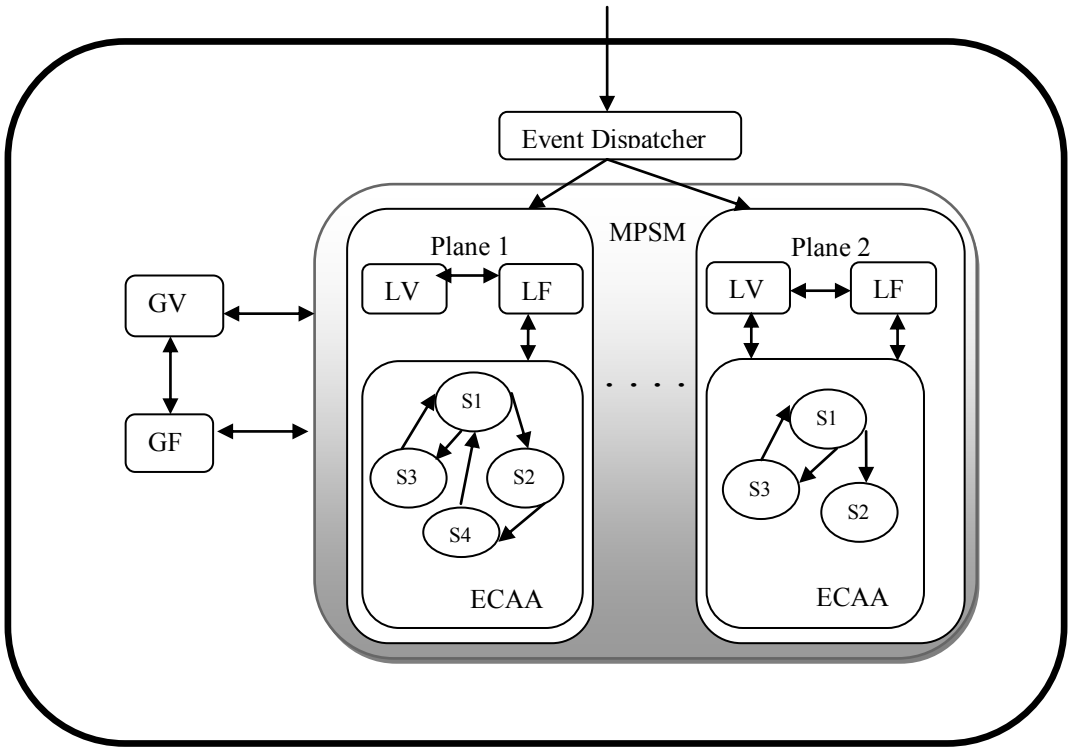

Fig 2. MAPS agent model

In particular the architecture consists of:
• Global variables (GV). The GV component represents the data of the MA including the MA identity.
• Global functions (GF). The GF component consists of a set of supporting functions which can access GV but cannot invoke neither core primitives nor other functions.
• Multi-plane State Machine (MPSM). The MPSM component consists of a set of planes. Each plane may represent the behavior of the MA in a specific role. In particular a plane is composed of:
• Local variables (LV). The LV component represents the local data of a plane.
• Local functions (LF). The LF component consists of a set of local plane supporting neither functions which can access LV but can invoke neither core primitives nor other functions.
• ECA-based Automata (ECAA). The ECAA component which represents the dynamic behavior of the MA in that plane and is composed of states and mutually exclusive transitions among states. Transitions are labeled by ECA rules: E[C]/A, where E is the event name, [C] is a Boolean expression based on the GV and LV variables, and A is the atomic action. A transition t is triggered if t originates from the current state (i.e. the state in which the ECAA is), the event with the event name E occurs and [C] holds. When the transition fires, A is first executed and, then, the state transition takes place. In particular, the atomic action can use GV, GF, LV, and LF for performing computations, and, particularly, invoking the core primitives to asynchronously emit one or more events. The delivery of an event is asynchronous and can occur only when the ECAA is idle, i.e. the handling of the last delivered event (ED) is completed.

V. MASPOT

5.1. System Overview

MASPOT [15] is a MA-based system developed for Sun SPOT sensor devices. The authors claim that this is the only Java-based MA system for sensor networks that currently provides the code migration. Lifecycles MA basis of creation, initialization, cloning and migration services are implemented within this

framework. MASPOT communication service provides communication primitives agent- agent using tuple spaces and communications base station agents by passing messages. In addition, it uses only about 1.5% of the available flash memory and spends around 0.02% of the battery power of sensor devices travel agent. It also extends the scope of network applications based on Java sensors that can be built using current technology. MAPS (Mobile Agent Platform for Sun SPOT) is a platform based on MA for Sun SPOT sensor devices. It is built on the paradigm of the agent and provides the programming of WSN applications using Java. The architecture of the card is based on components and provides basic services to agents. Event-based, approaches based on the state and based agents are grouped in this platform. Since squawk virtual machine operations are relatively slow, time migration MA is quite high. Serialization of agents in a message is a very time-consuming operation. The radio communication flows between detection devices is quite slow. MAPS [7] and MASPOT [15] are some studies on the integration of MAS in WSNs, but very few of them have been developed for detection devices sunspots [16]. They are compatible with Java 2 Micro Edition, and are supported by the transponder on Java Virtual Machine. MASPOT system is composed of a set of sensor nodes, a base station and a user station. The base station is connected to the user station. The user station is a computer through which users interact with the MASPOT WSN. MASPOT a software component running on each node and the user workstation. The application of management MASPOT runs on the user's machine. This application is used to create, configure and manage remote workers. A MASPOT agency is running on each node. Agency represents all software components that are needed to support: the cycle of the agent's life, ie, the receiving agent, instantiation, implementation, migration, destruction, controls the execution of agents (interrupting, recovery and off), and communication between agents and between agents and the base station.

An agency is composed of the following main components
1) Mobile Agent Manager: responsible for controlling the execution of agents;
2) Mobile Agent Transport Service: responsible for receiving (receiving, deserializing) and sending (serializing, transmitting) agents;
3) Tuple Space Manager: responsible for managing a local tuple space;
4) Communication Service: responsible for executing the communication protocol between the base station and mobile agents.

5.2. Agent Implementation

In MASPOT, an agent is a standalone application. MASPOT requires an agent inherits a predefined class called Agent, which provides methods for communication connections migration, cloning and openness to the base station. Users create MASPOT agents applying MASPOT management (on the user's computer). Once created and started, an agent is introduced into the network by the base station. Upon execution, an agent can create other agents, called its child agents. Child agents migrate and run independently of its parent agent. Each agent has an identifier. Agents created directly by users MASPOT have IDs assigned by the application MASPOT management. The identifier of an agent of the child is created by adding suffixes to the ID of the parent, so it is unique in the whole system. An agent is structurally composed of: its code, internal data, namely the application of agent data, metadata, ie, data that represents information about the agent itself, such as the ID of the Agent, and the executing State, namely, data on its execution context (s), including the state of the execution stack. MASPOT support the migration of both high and low. In high migration, the execution state of the agent (execution stack) is transferred during the migration agent with the state of data; metadata and code, low migration, only code, state data and metadata are transferred. In low migration, the information necessary for the agent to resume execution after migration (at the destination node) must be represented in the data state. In this case, an agent always takes performance since the beginning of the code (Main method). In MASPOT, the type of migration is associated with each agent at the time of creation, and the type of migration does not change during the life cycle of the agent.

VI. Implementation Of A Sample Application

The aim of the application is to retrieve the data on a node *x* and, at specific instants, send them to another node *y*. The receiving node is connected by USB cable to the PC and prints the retrieved data on the command prompt window.

The described application is designed by using three agents:
1. Data collector agent
2. Data carrier agent
3. Data viewer agent

The data collector agent runs on the *x* node, whereas the data viewer agent on the *y* node. The data collector creates the data carrier agent during its lifecycle. The data viewer waits for a click on one of the two Sun SPOT switches, and then sends a start message to the data collector, which starts to collect sensor data. In particular, the data collector creates three permanent timers, one for each sensor of the node, so that when a timer expires, the agent sends a request to retrieve a new instant value from the related sensor. During sensor data collection, the agent waits for a click on one of the two switches. When this happens the agent creates the data carrier agent, which is in charge of forwarding the collected data to the data viewer agent. In particular, the carrier agent asks for its migration towards the node where the data viewer agent is running. When the migration is completed, the data carrier sends the collected data to the data viewer agent, which in turn prints them on the command prompt window. The agents stop their activity when the user click on one of the two switches on the SunSPOT connected to the PC.

6.1. Data Collector Agent

In Fig 3 the automation related to the plane necessary for modeling the agent behavior is shown.

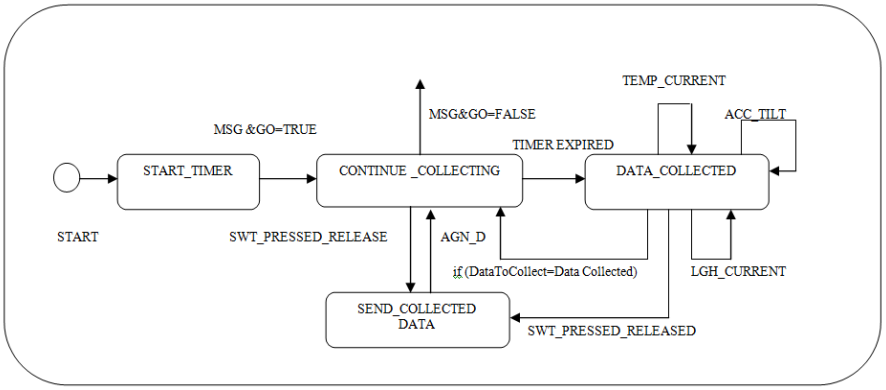

Fig 3. Data Collector plane diagram

START

MAPS allow to save byte arrays into the Sun SPOT flash memory. So, any object that can be serialized in a byte array can be also saved. In this example a simple static byte array (2) is stored by creating the FLS_ADD event (3) and invoking the flash method. The current state change to START_TIMER.

```
1. if (event.getName() == Event.AGN_START) {
2. byte[] byte_dati = new byte[]{12,13,14,15,16};
3. Event flsAdd = new Event(this.agent.getId(), this.agent.getId(),
4. Event.FLS_ADD, Event.NOW);
5. this.agent.flash(flsAdd, byte_dati);
6. this.currentState = START_TIMER;
7. }
```

START_TIMER

If the received event is of type MSG with parameter value “true” (8), which means that the message coming from the viewer agent has been received, the current state turns into CONTINUE_COLLECTING and a permanent 3 seconds timer is instantiated. The instructions from (12) to (15) are for the creation of a LED_BLINK event related to the first LED and using the blue color. From (16) to (20) a SWT_PRESSED_RELEASED event is created. Such event is then triggered when the user releases the switch indexed with 2.

```
8. if (event.getName() == Event.MSG && event.getParam("go").equals("true")) {
9. this.currentState = CONTINUE_COLLECTING;
10. Event timer = new Event(this.agent.getId(), this.agent.getId(),
Event.TMR_EXPIRED, Event.NOW );
11. timerID = this.agent.setTimer(true, 3000, timer);
12. Event blink = new Event(this.agent.getId(), this.agent.getId(),
Event.LED_BLINK, Event.NOW);
13. blink.setParam(ParamsLabel.LED_INDEX, "0");
14. blink.setParam(ParamsLabel.LED_COLOR, "blue");
```

```
15. this.agent.actuate(blink);
16. Event switch2Pressed = new Event(this.agent.getId(), this.agent.getId(),
Event.SWT_PRESSED_RELEASED, Event.PERMANENT);
17. switch2Pressed.setParam(ParamsLabel.SWT_PRESSED, "false");
18. switch2Pressed.setParam(ParamsLabel.SWT_RELEASED, "true");
19. switch2Pressed.setParam(ParamsLabel.SWT_INDEX, "2");
20. this.agent.input(switch2Pressed);
21. }
```

Continue_Collecting

When the agent receives the TMR_EXPIRED event, it makes a reading from the three onboard sensor temperature (24), acceleration (27), light (29) and from the battery (31). If the agent receives the SWT_PRESSED_RELEASED event, the related action is the creation of the Data carrier agent (37). The create method needs the class of the agent and its related package, an optional set of parameters and the address of the node where the agent have to start. If the received event is of MSG type, with the parameter equal to false, the agent terminates itself (41). This means that the sensing operation is stopped.

```
22. if (event.getName() == Event.TMR_EXPIRED) {
23. this.currentState = DATA_COLLECTED;
24. Event temperature = new Event(this.agent.getId(), this.agent.getId(),
Event.TMP_CURRENT, Event.NOW);
25. temperature.setParam(ParamsLabel.TMP_CELSIUS, "true");
26. this.agent.sense(temperature);
27. Event accel = new Event(this.agent.getId(), this.agent.getId(),
Event.ACC_TILT, Event.NOW);
28. this.agent.sense(accel);
29. Event light = new Event(this.agent.getId(), this.agent.getId(),
Event.LGH_CURRENT, Event.NOW);
30. this.agent.sense(light);
31. Event battery = new Event(this.agent.getId(), this.agent.getId(),
Event.BTR_CURRENT_LEVEL, Event.NOW);
32. this.agent.actuate(battery);
33. }
34. if (event.getName() == Event.SWT_PRESSED_RELEASED) {
35. if (event.getParam(ParamsLabel.SWT_ACTION).equals("released")) {
36. this.currentState = SEND_COLLECTED_DATA;
37. this.agent.create("applications.demo.DataCarrier", null,
this.agent.getMyIEEEAddress().asDottedHex());
38. }
39. }
40. if (event.getName() == Event.MSG && event.getParam("go").equals("false")) {
41. this.terminateAgent();
42. }
```

DATA_COLLECTED

When the agent receives an event related to a sensor reading completion, it retrieves and saves the values in a simple String. If the sensor data collection is completed (53), the agent blinks the first LED and continues to wait for the next timer expiration.

```
43. if (event.getName() == Event.TMP_CURRENT) {
this.collectedData +=event.getParam(ParamsLabel.TMP_TEMPERATURE_VALUE)+"-";
44. }
45. else if (event.getName() == Event.ACC_TILT) {
46. this.collectedData += event.getParam(ParamsLabel.ACC_TILT_X_VALUE) + "-";
47. }
48. else if (event.getName() == Event.LGH_CURRENT) {
49. this.collectedData += event.getParam(ParamsLabel.LGH_LIGHT_VALUE) + "-";
50. else if (event.getName() == Event.BTR_CURRENT_LEVEL){
51. this.collectedData += event.getParam(ParamsLabel.BTR_CURRENT_LEVEL);
52. }
```

```
53. if (++this.nDataCollected == this.totalDataCollecting) {
54. this.collectedData += "|";
55. Event blink = new Event(this.agent.getId(), this.agent.getId(),
Event.LED_BLINK, Event.NOW);
56. blink.setParam(ParamsLabel.LED_INDEX, "0");
57. blink.setParam(ParamsLabel.LED_COLOR, "blue");
58. this.agent.actuate(blink);
59. this.nDataCollected = 0;
60. this.currentState = CONTINUE_COLLECTING;
61. }
```

SEND_COLLECTED_DATA If the received event is related to the correct creation of the carrier agent (AGN_ID event type); the agent sets the data in a new message and forwards it to the created agent (66). Moreover the data collector agent state returns to CONTINUE_COLLECTING.

```
62. if (event.getName() == Event.AGN_ID) {
63. String carrierAgentID = event.getParam(ParamsLabel.AGT_ID);
64. Event msg = new Event(this.agent.getId(), messengerAgentID, Event.MSG, Event.NOW);
65. msg.setParam("collectedData", this.collectedData);
66. this.agent.send(this.agent.getId(), carrierAgentID, msg, true);
67. this.collectedData = "";
68. this.currentState = CONTINUE_COLLECTING;
69. }
```

6.2. Data Carrier Agent

The Data Carrier Agent's aim is to carry the collected data (sent by the data collector agent) to the remote node and forward them to the Data Viewer Agent. Its plane diagram is depicted in Fig 4.

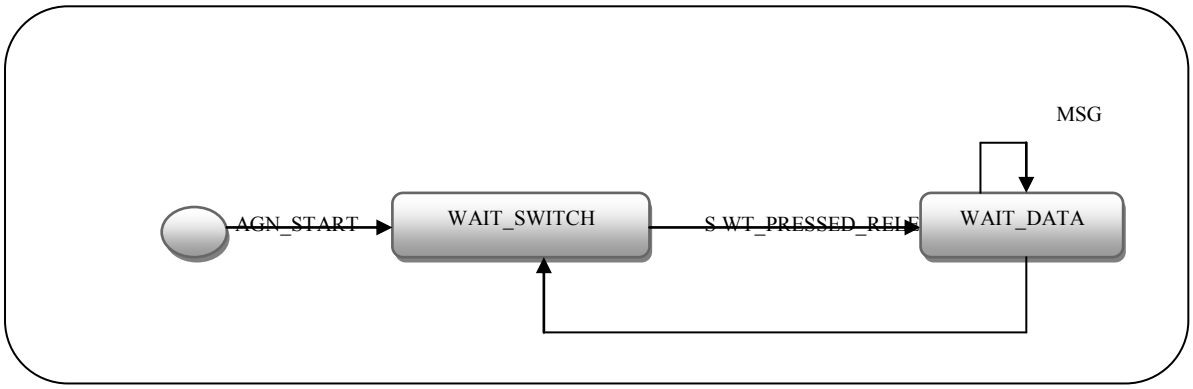

Fig 4. Data Carrier plane diagram

START

If the received event is a message (coming from the Data Collector Agent), the agent reads the carried sensor data values (3), gets the address of the neighbor Sun SPOT nodes (4) and request the migration to the first node of the list (6). Moreover, the agent state changes to MIGRATION.

```
1. if (event.getName() == Event.MSG) {
2. this.currentState = MIGRATION;
3. this.collectedData = event.getParam("collectedData");
4. Vector neighbors = this.agent.getNeighbors();
5. String address = (String)neighbors.elementAt(0);
6. this.agent.askForMigration(address);
7. }
```

MIGRATION

If the agent receives the event related to its migration completion (8), it means that the agent is now running on the destination node. Upon that, it creates a new message event having the retrieved data (9, 10) and forwards it to every local agent (11). At th end, the agent terminates itself (12).

```
8. if (event.getName() == Event.MGR_EXECUTED) {
9. Event broadcastMsg = new Event (this.agent.getId(), Constants.BROADCAST,
Event.MSG, Event.NOW);
10. broadcastMsg.setParam("collectedData", this.collectedData);
11. this.agent.send(this.agent.getId(), Constants.BROADCAST, broadcastMsg,true);
12. this.agent.terminateAgent();
13. }
```

6.3. Data Viewer Agent

The Data Viewer behavior consists in sending the starting message to the Data Collector on the remote node for starting sensor data collection, and waiting for data sent by the migrated Data Carrier Agent.

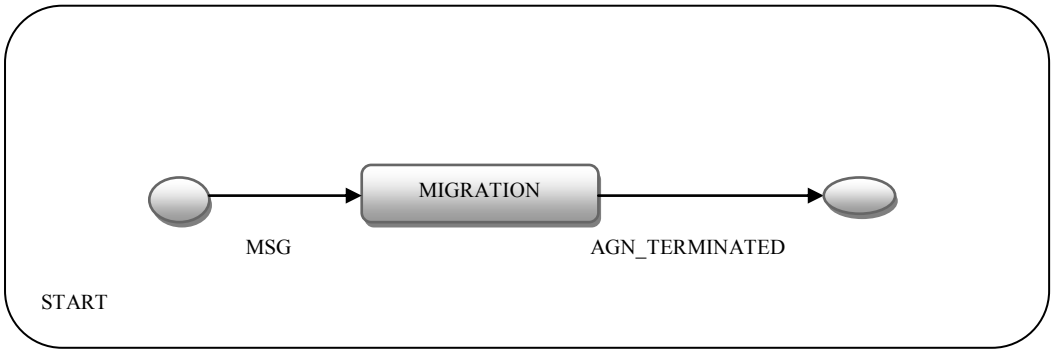

Fig 5. Data Viewer plane diagram

START

Upon the starting event, the agent turns on the first LED (2-5), waits for the switch 0 to be released (7-11) and go to the WAIT_SWITCH state.

```
1. if (event.getName() == Event.AGN_START) {
2. Event ledOn = new Event(this.agent.getId(), this.agent.getId(), Event.LED_ON,
Event.NOW);
3. ledOn.setParam(ParamsLabel.LED_INDEX, "1");
4. ledOn.setParam(ParamsLabel.LED_COLOR, "green");
5. this.agent.actuate(ledOn);
6. this.currentState = WAIT_SWITCH;
7. Event switch0Pressed = new Event(this.agent.getId(), this.agent.getId(),
Event.SWT_PRESSED_RELEASED, Event.PERMANENT);
8. switch0Pressed.setParam(ParamsLabel.SWT_PRESSED, "false");
9. switch0Pressed.setParam(ParamsLabel.SWT_RELEASED, "true");
10. switch0Pressed.setParam(ParamsLabel.SWT_INDEX, "0");
11. this.agent.input(switch0Pressed);
12. }
```

WAIT_SWITCH

If the received event is SWT_PRESSED_RELEASED (13), the agent gets the IDs of the neighbor nodes (15-19), gets the first one (20) and sends a message to the Data Collector agent residing on it (21-23). Moreover, the agent state changes to WAIT_DATA.

```
13. if (event.getName() == Event.SWT_PRESSED_RELEASED) {
14. this.currentState = WAIT_DATA;
15. Vector remoteAgents = this.agent.getRemoteAgentsID();
16. while (remoteAgents.size() == 0) {
17. Thread.sleep(1000);
```

```
18. remoteAgents = this.agent.getRemoteAgentsID();
19. }
20. this.remoteID = (String)remoteAgents.elementAt(0);
21. Event msg = new Event(this.agent.getId(), this.remoteID, Event.MSG,
Event.NOW);
22. msg.setParam("go", "true");
23. this.agent.send(this.agent.getId(), this.remoteID, msg, true);
24. }
```

WAIT_DATA

If the agent receives a message coming from the Data Carrier (26), the agent parses the collected data and prints them on command prompt window (26-34). Otherwise, if the switch is released (37) the agent sends a message to the Data Collector for terminating sensor data collection (39-41), whereas the agent goes to the WAIT_SWITCH state.

```
25. if (event.getName() == Event.MSG) {
26. StringTokenizer collectedData = new
StringTokenizer(event.getParam("collectedData"), "|-");
27. while (collectedData.hasMoreTokens()) {
28. System.out.print("\nTemperature: " + collectedData.nextToken());
29. if (collectedData.hasMoreTokens())
30. System.out.print("\nAcceleration: " + collectedData.nextToken());
31. if (collectedData.hasMoreTokens())
32. System.out.print("\nLight: " + collectedData.nextToken());
33. if (collectedData.hasMoreTokens())
34. System.out.println("\nBattery: " + collectedData.nextToken());
35. }
36. }
37. if (event.getName() == Event.SWT_PRESSED_RELEASED) {
38. this.currentState = WAIT_SWITCH;
39. Event msg = new Event(this.agent.getId(), this.remoteID, Event.MSG,
Event.NOW);
40. msg.setParam("go", "false");
41. this.agent.send(this.agent.getId(), this.remoteID, msg, true);
42. }
```

VII. Conclusion

This paper describes MASPOT a system of mobile agents for the Sun SPOT platform. To the best of our knowledge, MASPOT is the first mobile agent system for this platform that supports code migration. Supporting code migration is a fundamental issue when considering the use of mobile agents to support WSN reprogramming. The ability to run mobile agents on sunspots significantly extends the range of possible applications for this platform. Given the use of mobile agents on WSN raises immediate questions about the implicit costs. By using MAPS, a WSN application can be structured as a set of stationary and mobile agents distributed on sensor nodes supported by a component-based agent execution engine which provides basic services such as message transmission, agent creation, agent cloning, agent migration, timer handling, and easy access to the sensor node resources. MAPS programming has been exemplified through a simple yet effective example which shows how to program the dynamic behavior of agents in terms of state machines on the basis of the MAPS library. We plan to explore the use of mobile agents in WSN further to check the situations in which the use is beneficial.

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Image Processing for Automated Flaw Detection and CMYK model for Color Image Segmentation using Type 2 Fuzzy Sets

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Abstract : *Infrared (IR) thermography has evolved in recent years from being an emerging nondestructive testing (NDT) technique to a viable approach for both aerospace manufacturing and in-service inspections. One of the drawbacks of thermography techniques is that no standard signal processing has been universally adopted and that different algorithms yield different sizing results. Additionally, the data interpretation is not as simple as with other NDT techniques. In this paper the most common signal processing techniques applied to pulsed thermography, which include derivative processing, pulsed phase thermography and principal component analysis, are applied in an attempt to simplify the damage detection and sizing process. The pulsed thermography experiments were carried out on 25 impacted panels made of carbon fiber epoxy material. Despite using similar panels and the same experiment parameters, the damage detection and sizing processes are not straight forward. It is concluded that some algorithms provide easier detection capability than others. However, on their own, the different algorithms lack the robustness to make the damage detection and sizing processes reliable and fully automated. And Optimization of the similarity measure is an essential theme in medical image registration. In this paper, a novel continuous medical image registration approach (CMIR) is proposed. This is our extension work of the previous one where we did a segmentation part of any particular image with a custom algorithm .The CMIR, considering the feedback from users and their preferences on the trade-off between global registration and local registration, extracts the concerned region by user interaction and continuously optimizing the registration result. Experiment results show that CMIR is robust, and more effective compared with the basic optimization algorithm. Image registration, as a precondition of image fusion, has been a critical technique in clinical diagnosis. It can be classified into global registration and local registration. Global registration is used most frequently, which could give a good approximation in most cases and do not need to determine many parameters. Local registration can give detailed information about the concerned regions, which is the critical region in the image. Finding the maximum of the similarity measure is an essential problem in medical image registration. Our work is concentrating on that particular section with the synergy of Tpe-2 fuzzy logic invoked in it.*

Keywords; *Extrinsic method, Fuzzy sets, image possessing, intrinsic method Introduction, Multi-model image alignment.*

I. INTRODUCTION

In pulsed thermography (PT) energy is applied to the specimen using a pulsed excitation. Typically, the energy sources are flash lamps whose flash duration varies from a few milliseconds for good thermal conductors to a few seconds for low-conductivity materials. The applied energy creates a thermal front that propagates from the specimen's surface throughout the specimen. During the cool down process the surface temperature decreases uniformly for a sample without internal flaws. When the thermal front intersects an interface from a high to low conductivity layer, like in the case of delamination, disband and porosity, the cooling rate is locally disrupted. This results in an accumulation of heat above the flaw that is also manifested at the specimen's surface and can be detected by an IR camera. Thus, allowing defective areas to be distinguished from sound areas. Image processing is commonly used for two purposes. Its first use is to improve the visual appearance of images to a human viewer. Filtering and color map adjustments are commonly applied to make an image more pleasant to look at. Its second purpose is to prepare the images or data for the measurement of features present. This can include applying a threshold to create a binary image, applying morphologic filters, etc. The processed image allows the operator to measure the size of the features of interest and could also be used for automated flaw detection and measurements. Although NDT inspections are more and more automated, thanks to automated scanning systems, the inspector is still required to identify the presence of flaw and to perform the measurement of the features of interest. The following paragraphs review the most common signal processing techniques applied to pulsed thermography data. In the open literature these algorithms are usually applied and demonstrated on laboratory samples that contain artificial and simple geometry flaws. In this paper, solid laminate samples that have been damaged by impact are used to investigate the capability of these algorithms for the development of robust and automated flaw detection and measurements. And Information systems are

often poorly defined, creating difficulty in representing concepts and selecting important features used to solve the problems. Type-1 (T1) fuzzy set (FS) has been around for more than four decades and yet not able to handle all kinds of uncertainties appearing in real life. The above statement sounds paradoxical because the word fuzzy has the connotation of uncertainty. The extension of T1 fuzzy systems, in particular type-2 (T2) accommodates the system uncertainties and minimizes its effect considerably in decision making. However, T2 FS is difficult to understand and explain. Application of T1 fuzzy logic to rule-based systems is most significant that demonstrates its importance as a powerful design methodology to tackle uncertainties. A fuzzy logic system (FLS) is described completely in terms of T1 fuzzy sets, called type-1 fuzzy logic system (T1FLS), whereas a FLS with at least one T2 fuzzy set is called T2 fuzzy logic system (T2FLS). T1FLSs cannot directly handle rule uncertainties because T1 fuzzy sets are certain. On the other hand, T2FLS is very useful in circumstances where it is difficult to determine an exact membership function of a fuzzy set. Such cases are handled by rule uncertainties and measurement uncertainties. Like T1FLS, T2 has wide applications and the potential of T2 systems outperforms T1 in most of the cases. The aim of the paper is to describe T2 fuzzy systems for managing uncertainties, identifying the frontier research areas where T2 fuzzy logic is applied and proposes an algorithm on application of type-2 fuzzy sets in color image segmentation.

II. THERMAL CONTRASTS

The most basic data processing performed on pulsed thermographic data is the computation of thermal contrasts. Thermal contrasts have the advantages of being less sensitive to noise and to the surface optical properties1. The main problem with thermal contrast computation is that it requires a priori knowledge of a sound area. Although more recently new contrast methods have been developed to overcome this problem

III. PULSED PHASE THERMOGRAPHY

Pulsed phase thermography (PPT) is a processing method in which the thermal images are transformed from the time domain to the frequency domain5. This can be performed by processing a sequence of thermal images (thermogram) with discrete Fourier transform (DFT):

$$F_n = \sum_{k=0}^{N-1} T(k) e^{-2\pi i k n / N} = \mathrm{Re}_n + i\,\mathrm{Im}_n$$

……(1)

Where n designates the frequency increments (n=0,1,…N- 1), and Re and Im are the real and the imaginary parts of
the DFT, respectively. For convenience, fast Fourier transform (FFT) a computationally efficient version of the DFT is generally used. Once the data has been converted into the Fourier domain, the phase (□) and amplitude (A) images of the different frequencies can be calculated using:

$$A_n = \sqrt{\mathrm{Re}_n^{\,2} + \mathrm{Im}_n^{\,2}}$$

and

$$\phi_n = tan^{-1}\left(\frac{\mathrm{Im}_n}{\mathrm{Re}_n}\right)$$

……(2)

The phase is particularly advantageous since it is less affected by environmental reflections, emissivity variations, non-uniform heating, surface geometry and orientation. The phase characteristics are very attractive not only for qualitative inspections but also for quantitative ones [6].

IV. THERMOGRAPHIC SIGNAL RECONSTRUCTION

Thermographic signal reconstruction (TSR)8 is a processing technique that uses polynomial interpolation to allow increasing the spatial and the temporal resolution of a thermogram sequence, while reducing the amount of data to be analyzed. TSR is based on the assumption that temperature profiles for non-defective areas follow the decay curve given by the one-dimensional solution of the Fourier diffusion equation for an ideal pulse uniformly applied to the surface of a semi-infinite body9, which is given by:

$$T(t) = \frac{Q}{e\sqrt{\pi \cdot t}}$$

……..(3)

Where T(t) is the temperature evolution, Q is the energy applied at the surface and *e* is the thermal effusively of the sample, which is defined as: $e = k\rho c$; where *k*, *ρ*, and *c* are the thermal conductivity, the mass density and the specific heat, respectively. Equation 3 may be rewritten in a logarithmic notation and expanded into a polynomial series.

$$\ln(\Delta T) = \ln(\frac{Q}{e}) - \frac{1}{2}\ln(\pi t)$$

$$= a_0 + a_1 \ln(t) + a_2 \ln^2(t) + \ldots + a_n \ln^n(t)$$

……(4)

The noise reduction resulting from this polynomial interpolation [11,][12] enables the use of derivate processing to enhance the contrast created by the presence of defects. The first and second derivatives of the thermogram sequence provide information on the rate of temperature variation. These measurements are analogous to the relations between position, velocity and acceleration in mechanics. The original thermogram corresponds to the surface temperature of the inspected object (position). The first derivative gives information on the cooling rate of the surface temperature (velocity), while the second derivative provides information on the acceleration or deceleration of this cooling rate (acceleration).

V. PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) 13, also known as principal component thermography (PCT)14, is an orthogonal linear transformation that transforms the thermogram sequence into a new coordinate system. The idea behind PCA is to remove possible correlation in the data by creating a new uncorrelated dataset called principal components. It has been applied in thermal NDT for data reduction and flaw contrast enhancement. The algorithm is based on the decomposition of the thermogram into its principal components using singular value decomposition (SVD). The first step of the PCA algorithm is to reshape the three-dimensional thermogram into a two dimensional array where the columns and rows contain the spatial and temporal information, respectively. Thus, the original thermogram T(x,y,t) becomes A(n,m) where n = Nx Ny , m = Nt, Nx and Ny are the number of pixels per row and column of the IR camera and Nt is the number of thermal images in the thermogram sequence. The two-dimensional array A is then adjusted by subtracting the mean along the time dimension, and decomposed into eigenvectors and eigenvalues.

$$A = U \Gamma V^T$$

……..(5)

Where U and V are orthogonal matrices which columns form the eigenvectors of AAT and ATA respectively, and Γ is a diagonal matrix that contains the singular values of ATA. Since the thermal images in the thermogram are non-erratic and vary slowly in time, the principal temporal variations of the dataset are usually contained within the first few eigenvectors. The principal component images are formed by calculating the dot product of the eigenvector and the measured temperature.

VI. MODELING UNCERTAINTY USING OF FUZZY LOGIC

Uncertainty appears in many forms and independent of the kind of fuzzy logic (FL) or any kind of methodology one uses to handle it . Uncertainty involves in real life, due to deficiency of information in various forms. One of the best sources for general discussions about uncertainty is found in. Two types of uncertainties, randomness and fuzziness exist, where probability theory is associated with the former and FS with the latter. Fuzziness (or vagueness) generally recognizes uncertainty resulting from the imprecise boundaries of fuzzy sets, nonspecificity connected with sizes (cardinalities) of relevant sets and strife (or discord), which expresses conflicts among the various sets of alternatives. T1 fuzzy sets are certain and not able to handle all kinds of uncertainties using a single membership value, which is crisp. A FLS needs some measure to capture uncertainties than just a single number. The extended FL, named as T2FL able to handle uncertainties by modeling and subsequently minimizing their effects. T2 fuzzy logic provides the measure of dispersion, fundamental to the design of systems that includes linguistic or numerical uncertainties translating into rules. T2 fuzzy set is a natural framework for handling both randomness and fuzziness. It is the third dimension of T2 membership function (MF) that allows us to evaluate the model uncertainties. A T2FLS has more design

degrees of freedom than a T1FLS because T2 fuzzy sets are described by more parameters compare to T1 fuzzy sets. Linguistic and random uncertainties are evaluated using the defuzzified and type-reduced outputs of the T2FLS. The type-reduced output can be interpreted as a measure of dispersion about the defuzzified output.

VII. SCOPE OF WORK

Image segmentation is one of the most difficult image processing tasks because the segmented images are not always precise rather vague. In earlier works, image segmentation was applied in monochrome color images, later applied on red, green, blue (RGB) color space. Two main image segmentation techniques are described in the literature; region reconstruction where image plane is analyzed using region growing process and color space analysis where the color of each pixel is represented in the designated color space. Many authors have tried to determine the best color space for some specific color image segmentation problems, however, there does not exist a unique color space for all segmentation problems. Computational complexity may increase significantly with reference to C(Cyan), M(Magenta),Y(Yellow), K(contrast) (CMYK) color space in comparison with gray scale image segmentation. Classically, the RGB color space has been chosen for color image segmentation where a point in the image is defined by the color component levels of the corresponding R, G and B pixels. However, while the region growing techniques tend to over-segment the images, on the other hand the color space analysis methods are not robust enough to significance appearance changes because of not including any spatial information. Fuzzy logic is considered to be an appropriate tool for image analysis, applicable in CMYK and particularly for gray scale segmentation. Recently, fuzzy region oriented techniques and fuzzy entropy based techniques are applied for color image segmentation. The major concern of these techniques is spatial ambiguity among the pixels, representing inherent vagueness. However, there still remain some sources of uncertainties with the meanings of the words used for noisy measurements and the data used to tune the parameters of T1 fuzzy sets may be noisy too. The new concept of evidence theory allows to tackling imprecision in model uncertainty used in pattern classification, and produces good results in segmentation, although this technique based on CMYK model is not often used.

The amount of uncertainty is evaluated using the approach proposed by Klir where he generalizes the Shannon entropy to belief functions using two uncertainty measures, mainly the non-specificity and the discord. The robust method using T2 fuzzy set is another approach for handling uncertainty in image analysis. It can take into account three kinds of uncertainty, namely fuzziness, discord and nonspecificity. T2 fuzzy sets have grade of membership value, which are themselves fuzzy. Hence, the membership function of a T2 fuzzy set has three dimensions and it is the new third dimension that

VIII. PRELIMINARIES OF TYPE-2 FUZZY SYSTEM

The term "fuzzy set" is general that include T1 and T2 fuzzy sets (and even higher-type fuzzy sets). All fuzzy sets are characterized by MFs. A T1 fuzzy set is characterized by a two-dimensional MF, whereas a T2 fuzzy set is characterized by a three-dimensional MF. Let us take an example of linguistic variable “speed”. Different values of the variable like “very high speed” , “high speed” , “low speed” signify the crisp value. One approach to using the 100 sets of two endpoints is to average the endpoint data and use the average values for the interval associated with "speed". A triangular (or other shape) MF has been constructed whose base endpoints (on the x-axis) are at the two average values and whose apex is midway between the two endpoints. The T1 triangular MF has been represented in two dimensions and expressed mathematically in equation (1)

$\{(x, MF(x))| x \in X\}$ ……(1)

However, the MF completely ignores the uncertainties associated with the two endpoints. A second approach calculates the average values and the standard deviations for the two endpoints. The approach blurs the location in between the two endpoints along the x-axis. Now the triangles are located in such a way so that their base endpoints can be anywhere in the intervals along the x-axis associated with the blurred average endpoints, which leads to a continuum of triangular MFs on the x-axis. Thus whole bunch of triangles, all having the same apex point but different base points are obtained as shown in figure 5. Suppose, there are exactly N such triangles, and at each value of x, MFs are: MF1(x), MF2(x), …, MFN(x). Weight is assigned to each membership value, say wx1, wx2, …, wxN, representing the possibilities associated with each triangle at a particular value of x.

The resulting T2 MF is expressed using (2)

$(x, \{(MFi(x), wxi)| i = 1, …, N\}| x \in X\}$ ….. (2)

Another way to represent the membership value: $\{(x, MF(x, w)| x \in X$ and $w \in Jx\}$ where MF(x, w) is the three-dimensional T2 MF, shown in figure 1.

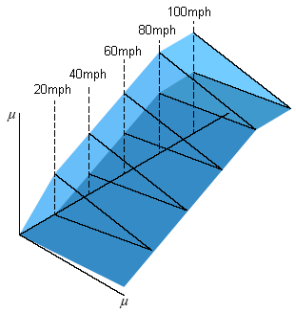


Fig. 1 3-D Representation of T2 FS "Speed"

Another way to visualize T2 fuzzy sets is to plot their footprint of uncertainty (FOU).

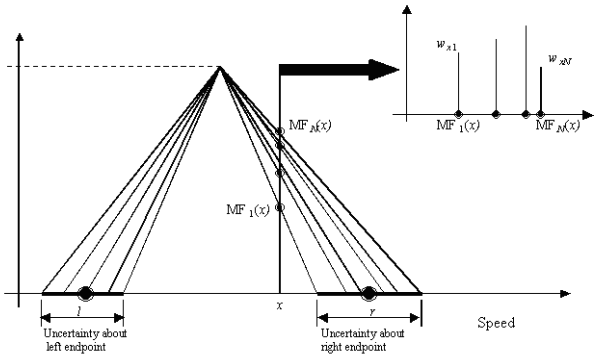


Fig. 2 Triangular MFs (base endpoints l and r) with Uncertain Intervals

IX. FOOTPRINT OF UNCERTAINTY

In T2, MF(x, w) can be represented in a two-dimensional x-w plane, consisting of only the permissible (sometimes called "admissible") values of x and w. It implies that x is defined over a range of values (its domain), say, X while w is defined over its range of values (its domain), say, W. An example of FOU for a Gaussian MF is shown. The standard deviation of the MF is certain while mean, m, is uncertain and varies anywhere in the interval from m1 to m2. Uncertainty in the primary memberships of a T2 fuzzy set, Ã, consists of a bounded region, called the footprint of uncertainty (FOU). FOU is the union of all primary memberships (Jx), given in (3).

$$\text{FOU}(\tilde{A}) = \bigcup_{x \in X} Jx \quad \text{.....(3)}$$

FOU focuses our attention on the uncertainties inherent in a specific T2 membership function, whose shape is a direct consequence of the nature of the uncertainty. The region of FOU indicates that there is a distribution that sits on top of it—the new third dimension of T2 fuzzy sets. Shape of the distribution depends on the specific choice made for the secondary grades. When the secondary grade is equal to one, the resulting T2 fuzzy set is called interval T2 fuzzy sets (IT2FS), representing uniform weighting (possibilities).

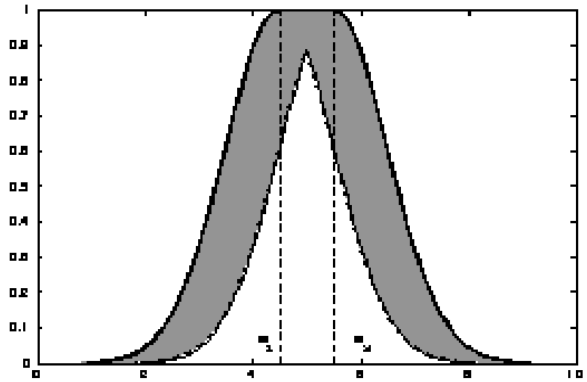


Fig. 3 OU of Gaussian (primary) MF with Uncertain mean

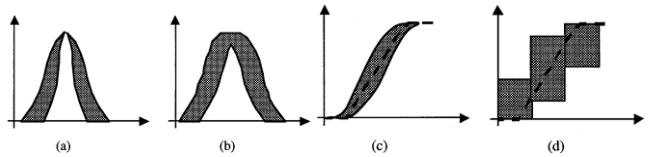


Fig. 4 OU: (a) Gaussian MF with Uncertain Standard Deviation (b) Gaussian MF with uncertain mean (c) Sigmoidal MF with Inflection Uncertainties (d) Granulated Sigmoidal MF with Granulation Uncertainties.

X. TYPE-2 FUZZY SET ENTROPY

The process of obtaining necessary information to perform segmentation leads to the correct selection of the regions of interest of the color image. The proposed work applied theory of fuzzy set to evaluate the regions of interest with fixed accuracy. Fuzziness index [12] and entropy [13] provide the measurement of degree of uncertainty [14] of the segmentation process. To measure the fuzziness of images, a few formal definitions are discussed below. An ordinary fuzzy set A of the universe of discourse X is classically defined by its membership function μA(x): X → [0, 1], x∈X.

A point x for which μA(x) = 0.5 is said a crossover point of fuzzy set $A \subseteq X$. The uncertainty is represented by the "α-cut" of fuzzy set A, whose membership function μαA(x): X→{0,1} is defined in (4).

μαA(x) = 1 if ∀x ≥ α

= 0 if ∀x < α …. (4)

Where α∈ [0, 1] and x ∈ X

The fuzziness index γ(A) of a fuzzy set A reflects the degree of ambiguity by measuring the distance d(A, A0.5) between A and its nearest set A0.5 (α=0.5) as described in (5).

γ(A) = 2×d(A, A0.5) / n1/p …. (5)

A positive scalar p is introduced to keep γ(A) in between zero and one depending on the type of distance function used. In the proposed algorithm with the help "α-cut" "n-cut" fuzzy set is described, where n is the number of elements of n-cut vector. This measure represents the area between two membership functions μA(x) and μαA(x), described in (6).

$$\gamma(A) = \lim_{\Omega \to X} \left(\frac{1}{\|\Omega\|} * \int_{\Omega} | \mu_A(x) - \mu_A^{0.5}(x) | \, dx \right) \quad \ldots. \quad (6)$$

where $\|\Omega\|$ represents the size of the set Ω (linear index values) and in practice we can use the discrete formula, given in (7)

$$\gamma_A^p = \left[\frac{1}{\|X\|} * \sum_{x \in X} | \mu_A(x) - \mu_A^{0.5}(x) |^p \right]^{\frac{1}{p}} \quad \ldots. \quad (7)$$

γpA is a monotonic function, where p $\in [1, +\infty]$ and $\|X\|$ represents the cardinality of the set X.

The term entropy of fuzzy set A, denoted by H(A) (monotonic increasing function) was first introduced by De Luca and Termini, expressed in (8).

$$H(A) = \left(\sum S_n(\mu_A(x)) \right) / n.\ln 2 \quad \ldots. \quad (8)$$

Where $S_n(\mu_A(x))$ = -μA(x)ln(μA(x))-(1-(μA(x))ln(1-μA(x)))

In this work, we use the extension of the "De Luca and Termini" measure to discrete images, proposed by Pal [53]. The (linear) index of fuzziness of an M×N image subset A ⊆ X with L gray levels g∈[0, L−1] is defined in (9) and shown in figure 5.

$$\gamma(A) = \frac{1}{MN} \sum_{g=0}^{L-1} h(g) * [\mu_u(g) - \mu_l(g)] \quad \ldots. \quad (9)$$

Where h(g) represents the histogram of the image and μX(g), the membership function consists of μu(g) and μl(g). Entropies are used in with T2 fuzzy sets in gray scale image segmentation by extending the works proposed by Tizhoosh. Tizhoosh applied T2 fuzzy sets for gray scale image thresholding and obtained good results even in case of very noisy images. As proposed in , he used interval T2 fuzzy sets with the FOU, described below:

Upper Limit: $\mu_u(x)$: $\mu_u(x)$=[μ(x)]0.5

Lower Limit: $\mu_l(x)$: $\mu_l(x)$=[μ(x)]2

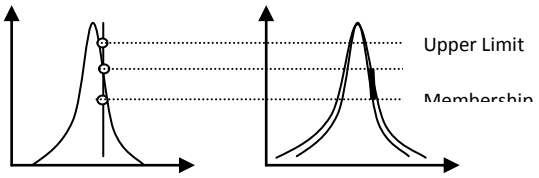


Fig. 5 Membership functions representing FOU

Here for the CMYK color model, the same functions are used for image segmentation. To overcome the drawback of gray scale imaging, various correctional measures are considered in the proposed algorithm.

XI. ALGORITHM FOR COLOR IMAGE SEGMENTATION

Begin
Step1:Read the JPEG file to be segmented
Step2:Select the proper shape of the interval base T2 fuzzy set MF as

$$A = \int_{x \in X} \int_{u \in Jx} \mu A(x, u) / (x, u) \quad Jx \subseteq [0, 1]$$

Step3:Fix the image size of M × N matrix;
Step4:Calculate h(g) for each color component of the color space;
//For linear index calculation
Step5:Calculate n – cut of the total image //for color pattern possibility matching with CMYK;
Step6:Initialize the position of the T2 MF;
Step7:Shift the MF with gray level ranges;
Step8: Mapping the picture colors into gray scale format;//For contour detection
Step 9: calculate the values of MF $\mu_u(g)$
and $\mu_l(g)$ (where μu(g) , μl(g)⊆ μX(g));
Step10: Compute edge of the image based on
contour formation;
Step11: Compute similarity matrix say 'W' based on inverting contours;
Step12: Find mid, max and min of fuzzy index;
Step13: Compute the n – cut eigenvectors;//possible
combination of colors for the input picture
Step14: Threshold the image with γ max value; //Unwanted pixel elimination based on Median filter
Step15: Masking of segmented image using msk matrix is defined by

$$msk = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Step16: Median filtering on the segmented image to remove noise;
Step17: Apply the region merging process using the obtained classes of pixels;
//Segmented portion of images are merged.
Step18: Smoothing of image to reduce the number of connected components;
Step19: Calculate the connected components;//n-Cut Eigen vector
Step20: Calculate the number of pixels in the final image;
End.

XII. EXPERIMENTAL RESULTS

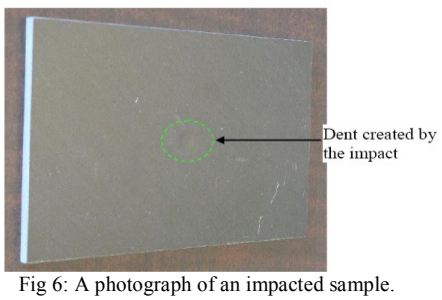


Fig 6: A photograph of an impacted sample.

In most papers available in the open literature, signal processing is applied to simple geometry simulated flaws such as square Teflon® inserts or flat bottom holes. Example of typical results obtained by processing PT inspection results of a composite sample that contains flat bottom holes are shown in Figure 7.

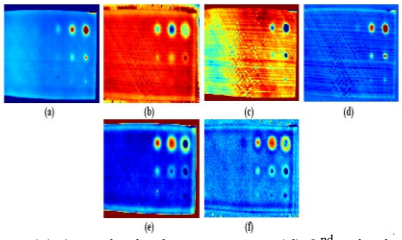


Fig 7: Typical images of (a) amplitude, (b) phase, (c) 1st principal component, (d) 2nd principal component (e) first derivative and (f) second derivative of a sample containing flat bottom holes.

As seen in the images presented in Figure 2, typically, except for the edge effect18, the flaws exhibit a uniform feature. The reason being that artificial flaws used in laboratory samples are usually at one specific depth. The reality is that a flaw can occur at different depths. For example an impact can cause fiber and matrix breakage resulting in a surface dent while creating delamination damage in several deeper layers. In addition, real components might be painted, be covered by a label or have information written on them that can affect the thermogram and make automated detection challenging. Examples of processed pulsed thermography results of impact-induced damage are presented in Figures 8 and 9.

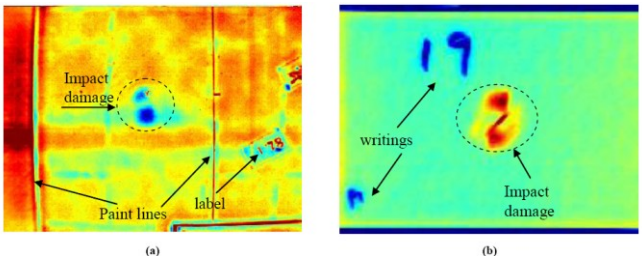


Fig 8: Pulsed thermography images of different samples containing impact damage, paint lines, sticker and marker writings.

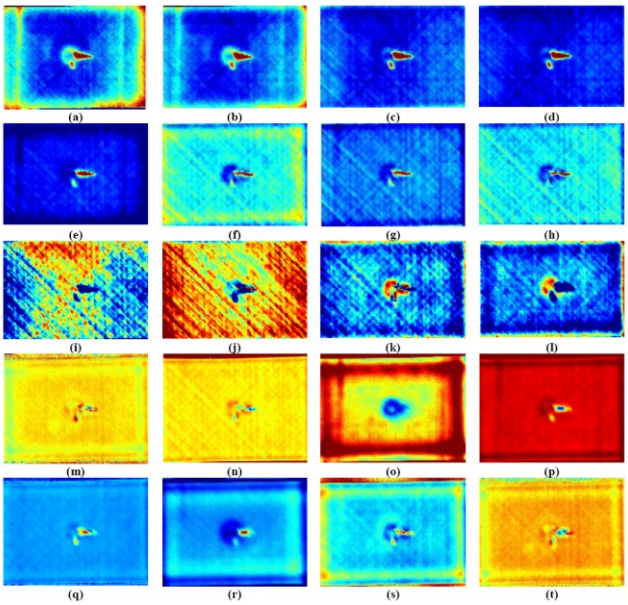


Fig 9: First four non-null images from (a-d) amplitude; (e-h) phase; and (i-l) principal components; and examples of 1st (m-p) and 2nd (q-t) derivative images of the same sample.

Although simply applying a threshold on the data obtained on laboratory samples can yield good results for automated detection, it lacks the robustness required to deal with real damage. Besides, due to the edge effect it can either underestimate or overestimate the flaw size. In addition, real damage does not behave like simulated flaws and sizing techniques such as the full-width half-maximum cannot be applied easily to estimate the flaw size. As it can be seen in Figure 4, amplitude, phase and principal component images provide different information and flaw sizes. One of the challenges is to select the proper images to accurately estimate the flaw size. The amplitude, phase and principal component images tend to show the flaw within the first few images;

while derivative processing algorithms require browsing through more images in the sequence to see the entire flaw. Therefore the former techniques were selected to develop the proposed algorithm. The first step of the algorithm proposed is to compute the amplitude, phase and principal component images. Then, the marking and writing are automatically detected and removed from the images by creating a mask. For the samples used, it was found that the writing of the last amplitude image had values less than two times the standard deviation (STD) compared to the average of the panel.

Then the selected images: amplitude images 2 to 6, phase images 2 to 10, and PCA images 1 to 6 were further processed. For each of the selected amplitude images, each pixel that had a value of one STD above the average was considered being part of a flaw. Similarly, for the selected phase and PCA images each pixel that had a value of one STD above or below the average of the sample was considered to be a flaw. This resulted into several binary images that were summed up to give a "flaw likelihood" image as shown in Figure 10(a). After summation, each pixel that had a value superior to 4 was considered a flaw. An example of a binary image obtained after applying the threshold to the flaw likelihood image is presented in Figures 10(b). A series of morphological filters were then applied to remove what is considered to be noise and filling holes in such a way that only the large connected components of binary image were kept, as shown in Figure 11 (a). The agglomeration of pixels corresponding to the damage area was identified to be the one which had the highest pixel value in the second amplitude image (Figure 11 (b)).

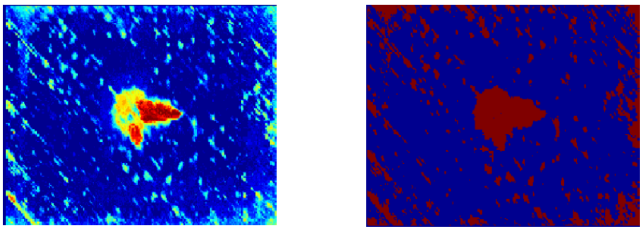


Fig 10: An example of a (a) damage likelihood image (b) flaw image after applying threshold.

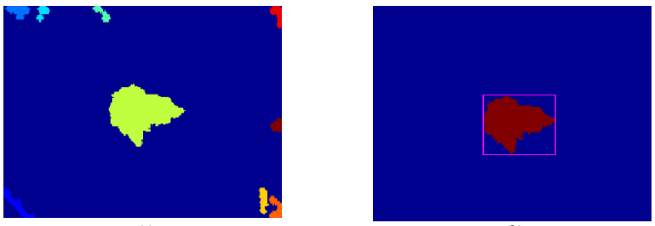


Figure 11: An example of a (a) flaw image after applying morphological operations (b) flaw image after identifying the image blob corresponding to the damage area.

The inspection results from both the front and the back of the samples were processed using this algorithm. In each case the algorithm successfully identified the damaged area and the false calls rate was zero. The final flaw image obtained (Figure 11 (b)) was used to calculate the flaw size and area. These measurements were similar to those obtained by an inspector measuring the flaw based on the regular processing techniques presented in section 2. The measurements obtained were then compared to those obtained by pulse-echo ultrasonic. It was found that on average the measurements by thermography underestimate the flaw width and length by 15% and 10% respectively. Since the measurements obtained by the automated algorithm are similar to those obtained by an inspector, the differences may be caused by the samples geometries and its material characteristic. Further trial of the algorithm on different sample geometries should be carried out to better explain these differences.
Although the process of creating this image is more computation intensive than other techniques used individually, it allows simplifying an entire thermogram sequence into a single image. Pulsed phase thermography and PCA significantly reduces the number of images to analysis, but combining these techniques reduces it even further.

And in order to test the performance of the algorithm, the samples (figure 12 onwards) are taken in JPEG image format having a size of 163×147 pixels in RGB color mode. Results of execution of the algorithm are shown from figure 12.

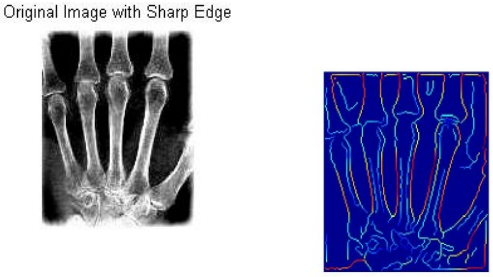


Fig. 12 Original image

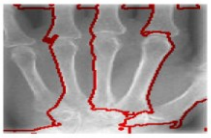


Fig. 13 Segmented Image

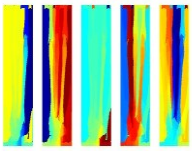


Fig. 14 Contour Detection

Fig. 15 n-cut eigenvectors

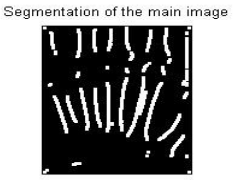
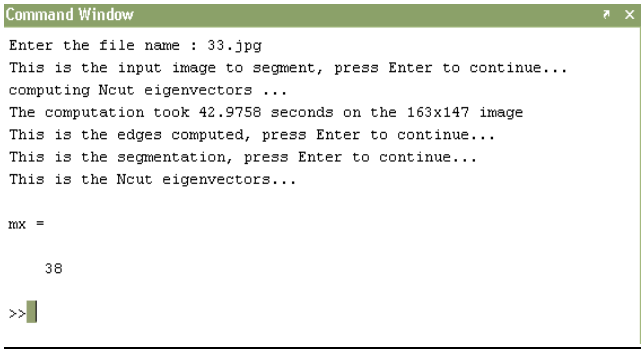


Fig. 16 Complement of the Enhanced Image

*A. **Screenshot of matlab***



XIII. CONCLUSION

An algorithm was developed for automated flaw detection and measurement of pulsed thermography inspection data. The algorithm was based on the combination of information from typical signal processing techniques used in pulsed thermography. The statistical divergence of the pixel value compared to the sample allowed identifying the damaged area. The algorithm provided measurements similar to that of a human eye.

Moreover, the image obtained during the processing was easier to interpret by the inspector, provided the damage area with stronger contrast compared to other processing techniques used individually.
Also Medical image registration has been an important area of research in the medical application of computer vision's techniques for the past several years. It can be defined as a task of finding the transformation that will optimally superimposes features from one imaging study over those of another study. The rules were applied to predict the transient flow and pressure distributions in the brain vasculature comprising a patient specific circle of Willis geometry and fractal models of peripheral vascular networks. The rules were shown to be able to efficiently provide detailed descriptions of the flow and pressure distributions at different levels of blood vessel sizes and simulate the variations of the blood flow in the major cerebral arteries when the peripheral vasculatures are subjected to various physiological and pathological conditions. In order to improve the prediction, the mechanisms of active regulation of blood flow need to be defined and implemented in the future model development.

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