

# **BETC (BLACK-HOLE ERADICATION TECHNIQUE BASED ON CLUSTERING) FOR SECURING MANET BASED AODV**

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## **ABSTRACT**

*Securing Mobile Ad-hoc network against various kinds of attacks has become a crucial agenda now days because mobile ad-hoc network covers a wide range of application and overall cost of establishing an ad-hoc network and implementing security algorithm is still lesser than establishing an infrastructure based network. Therefore numerous security solutions have been proposed so far. In this paper we are implementing the BETC technique based on clustering for securing Routing protocol AODV against black hole attack. Our proposed algorithm works as a hierarchal intrusion detection system in mobile ad-hoc network.*

**Keywords:** *AODV, Black-hole node, Cluster, IDS.*

## **I. INTRODUCTION**

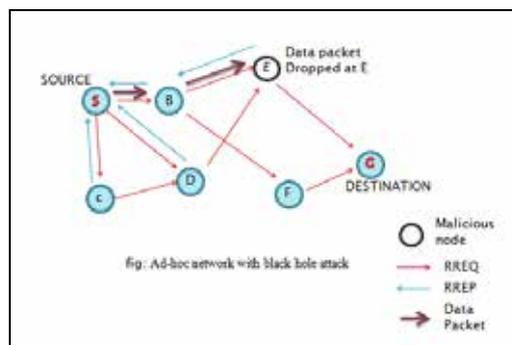
Computing world has been changed to a large extent in last decade. Along with various useful researches, malicious activities have also grown up as weeds. Mobile ad-hoc network has proved itself as an efficient tool to establish communication in areas where infrastructure cannot be build.

Mobile ad-hoc network can be seen as an autonomous ,dynamic system in which wireless devices are capable of communicating with each other within a radio range without any pre defined infrastructure.[5] has defined that topologies of ad-hoc network is mainly interdependent on two factors: transmission power and location of nodes.

The Ad-hoc On Demand Distance Vector (AODV) routing protocol establishes path between two nodes only when need arises. AODV is capable of both unicast and multicast routing. AODV acts as a reactive protocol, which search for path, only when two nodes intend to communicate with each other. AODV works on route request and route reply packets. When a node intends to establish path with other node for which source node does not have a route, it broadcasts a route request (RREQ) packet across the network. Intermediate nodes receiving this packet update their information for the source node and set up backward pointers to the source node in the routing tables. RREQ packet contains source node's IP address, current sequence number, and broadcast ID, and most recent sequence number for the destination of which the source node is aware. Intermediate node receiving the RREQ may unicast a route reply (RREP) in two cases: if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the RREQ. Otherwise, RREQ is rebroadcasted. In case of some error, route error (RRER) packet is generated and forwarded.

Attackers can access mobile ad-hoc network in similar manner as legitimate users do because since there is no infrastructure, so no security parameters are implemented. Attacks can be classified into two categories, active attacks and passive attacks. When attacker just snoops the information without disrupting network operation it comes under passive attack. Whereas when network operations are disrupted by directing data packets to false routes or by modifying routing parameters like hop count or sequence number, it is called as active attack.

Black hole attack is a kind of internal active attack in which the malicious node advertises itself to have shortest path to the destination, by sending fake route reply to source node in which it pretends to have highest destination sequence number. Instead of forwarding data packet to destination, malicious node drops it, resulting into denial of service attack. Next section includes related work and proposed BETC technique, which eradicates malicious node and secures AODV routing protocol against black hole attack.



**Fig. 1: Ad-Hoc Network With Black Hole Attack**

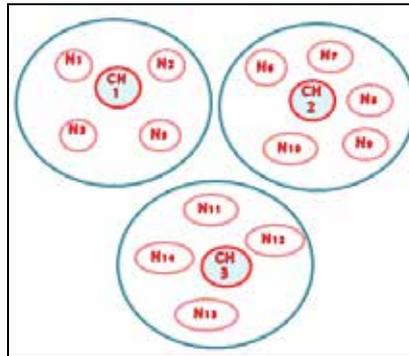
## II. RELATED WORK

So far many algorithms have been proposed to secure AODV against black hole attack. [3] has proposed a mobile agent based approach to detect selfish node by using a mobile agent that can freely move inside network and report for any misbehavior of node while forwarding data packet. Implementing Intrusion detection system in MANET is a tedious task. Hierarchical based IDS, provides multilayered architecture, whereas Distributed Intrusion Detection System uses multiple sensors etc.

M.Umaparvathi et.al in [4] has proposed two-tier architecture to secure AODV. They have proposed a tier – based algorithm which is capable of detecting single malicious node as well as group of nodes, collectively working to create black hole attack in a mobile ad-hoc network. Tier 1 detects single black hole node using verification message. Whereas tier 2 detect group of nodes, using  $R_c$  number of Control messages and  $R_m$  number of data packets. In [2] Murugan et.al has proposed cluster based technique to detect misbehaviour of nodes. Nodes are authenticated by implementing Proactive Secret sharing technique in a cluster based environment.

## III. PROPOSED WORK

In this paper we are combining AODV routing protocol with Cluster based intrusion detection system. As mentioned above hierarchical based IDS is a multilayered architecture which means that nodes are divided into clusters and a cluster head inside each cluster posses more responsibilities like granting permission to a particular node to send data packet on behalf of its trust value. Our algorithm raises an alarm after identifying malicious node so that other legitimate nodes can be informed.



**Fig.2: Division of nodes among Clusters**

We have discussed in [1] that suppose  $N_1$  be the source node,  $D$  is the destination node which can be either in same cluster or different cluster. Let us suppose  $IM_n$  be the intermediate nodes where  $n = 2, 3, 4, \dots$

During route discovery phase source node  $N_1$  request cluster head ( $CH_1$ ) to issue certificate.  $CH$  issues certificate to source node, after checking its trust value. Source node broadcast RREQ (route request) to all its neighbors. Format of RREQ is as follows:

RREQ < IPs, IPd, IDb, Seqs, Seqd, Cert, Hop\_count >

Here IPs, IPd, is the IP address of source and destination respectively. IDb denotes the broadcast Id, Cert represents Certificate issued by Cluster Head. Hop\_count depicts number of nodes message have passed. Since nodes are highly dynamic so it may be the case that destination may receive RREQ. We have categorized the entire scenario in three cases which are as follows:

**CASE1:  $IM_n$  has no route to destination.**

In this case  $IM_n$  would rebroadcast RREQ to its neighbors; a reverse path pointer is set to the node from which it received RREQ or source node. Hop\_count field is incremented by 1.  $IM_n$  would also add its own IP address to the rebroadcasted RREQ.

**CASE2:  $IM_n$  is Destination itself.**

Destination unicast Reply to next hop towards source node. Source node on receiving Reply from source node, transfers the data packet to destination and waits for acknowledgement.

**CASE3:  $IM_n$  has fresh route to destination.**

If  $IM_n$  has fresh route to destination, it generates RREP and forwards it towards source along with IP address of the nodes which comes in between the path from source to destination.

Source node chooses  $IM_n$  with higher sequence number and extracts the path details mentioned in RREP. Source stores the path details until it receives acknowledgement from destination. The format of RREP will be as such:

RREP < IPs, IPd, IDb, Seqs, Seqd, SeqIM, Cert, Hop\_count, detail ( $IP_i$ ) > where  $i = 1, 2, 3, 4, \dots$

$IP_i$  is the IP address of all the nodes which comes in between the path.  $i$  denotes the number of nodes.  $IP_i$  is stored temporarily and dumped when source receives acknowledgement from destination.

In proposed method all the nodes that receive data packet send acknowledgement to the node from which it received it. If source node receives acknowledgement from destination within threshold time, path is found to be

secure against black hole node and no further action is taken. Otherwise source starts verifying nodes. Source node unicast verification message to all the nodes whose details it had stored during RREP process. Through verification message source asks the corresponding nodes to reply either TRUE or FALSE. If IMn has received acknowledgement from its next node it replies TRUE otherwise FALSE. We assume that hijacked node would always intend to hide itself. Suppose in above figure N6 is the source node and N10 is the destination. N7, N8, N9 are the intermediate nodes whose details has been stored by N6. N6 unicast verification message to N7, N8, N9 and N10. Upon receiving verification message each IMn replies either TRUE or FALSE to source. N6 might receive TRUE, FALSE or no reply.

Suppose a scenario where N7 replies TRUE, N8 and N10 replies FALSE, and N9 does not reply at all. In that case N9 is found to be malicious which acts as black hole node and did not forward the data packet. Alarm is raised by source node and N9 is excluded from network.

Source node analyze black hole node by considering different combination of TRUE or FALSE messages. The pseudo code is as follows:

**Event: Source broadcast RREQ**

```
Send cert_request; // S sends Cert_request to cluster head.
If[ Cert_request = granted]
Send route_request ; // Start to search the Route for Destination ;
Initialize_timer T_Route_Request ; // denotes threshold time
```

**Event: Route Reply**

```
flag = true ;
while (flag = true)
```

**Case 1: Destination received RREQ**

```
if [ route_reply from destination ]
then
set destination_path = true // flag used to check that destination is connected or not ;
flag = false ;
end if
```

**Case 2: IM\_node received RREQ**

```
if [Route_reply from Intermediate _node]
then
add_IM_node(IM_node_id, Sequence_no. Path_node_list) ; // Adding intermediate node ids and their respective
sequence numbers to path node list.
end if
if [ T_Route_Request expire ]
then
flag = false ;
end if
if[IM_node consist no path towards destination]
set reverse_path_pointer;
hop_count=hop_count+1;
```

```

end if
end while
if [ destination_path = true ]
then
establish path ; // IM_node having greatest sequence number.
send data ;
end if
for i=1: 1:d // i denotes total number of nodes in path and d denotes last node
if [ ack received]
then
flag=false;
else
send Rverify;
end if

```

**Case 3: Duplicate RREQ received**

```

if [ route_request_id and destination_id is not in cache ] // Checking for duplicate request
if [ destination_id = node_id || destination_id= fresh route ]
then
send route_reply ;
else
set reverse path_pointer
end if

```

**Event: Verification**

```

While(flag=true)
For i=1:1:d
Send Rverify;
If[Reply Rverify=true|| Rverify=false]
then
Check next _Rverify;// check next node's Rverify.
If[next_Rverify=NULL]
Break;// node is found to be hijacked, alarm is raised.
end if
end if
end while

```

We have implemented this algorithm in Matlab, by taking a scenario in which there is a cluster of 12 nodes. Node 1 and 12 is the source and destination respectively. Inside a network we have introduced that node 11 is a malicious node causing black hole. Our proposed algorithm detects Node 11 and broadcast a message in order to inform other nodes regarding malicious node. Implementation result has been shown by snapshots.

When proposed algorithm was simulated in NS-2, we found that it has very closed packet delivery ratio with AODV. Simulation parameters are as follows:

Parameters	Value
Area	670mx670m
Total Number of nodes	50
Application Payload data size	512/Kb
Radio Model	IEEE 802.11
Wireless propagation Model	Two Way
Antenna type	Omni directional
Mobility pattern	Uniform
Packet type	UDP

```

l=2 A(l,1)=1 status=0 dist(i)=1
l=3 A(l,1)=1 status=0 dist(i)=1
l=4 A(l,1)=0 status=0 dist(i)=0
l=5 A(l,1)=1 status=0 dist(i)=1
l=6 A(l,1)=0 status=0 dist(i)=0
l=7 A(l,1)=1 status=0 dist(i)=1
l=8 A(l,1)=0 status=0 dist(i)=0
l=9 A(l,1)=0 status=0 dist(i)=0
l=10 A(l,1)=0 status=0 dist(i)=0
l=11 A(l,1)=0 status=0 dist(i)=0
l=12 A(l,1)=0 status=0 dist(i)=0
%efficiency granted to node 1 for sending data packet to node 13
node 1 sends RREQ to node 2
node 1 sends RREQ to node 3
node 1 sends RREQ to node 5
node 1 sends RREQ to node 7
node 1 sends RREQ to node 11
node 2 sends RREQ to node 1
node 3 sends RREQ to node 1
node 11 sends RREQ to node 1
data packet sent through node 11
node 11 found to be a black hole nodes
node 1 broadcasts RREQ message
node1 sends Data packet through other nodes
Node12 sends ACK to node 1
    
```

Fig.3: Snapshot of Implementation of Proposed Algorithm in Matlab

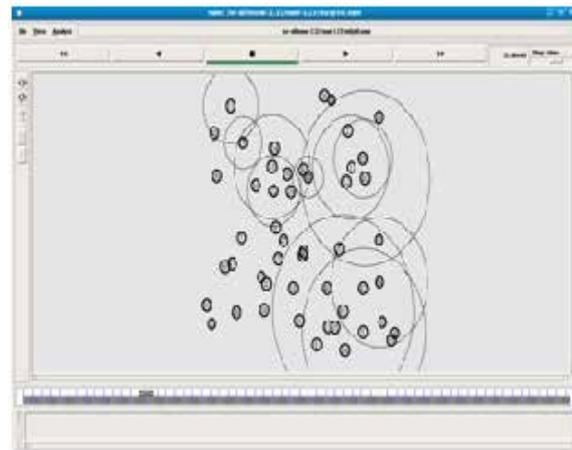


Fig.4: Simulation Of 50 Nodes In NS-2

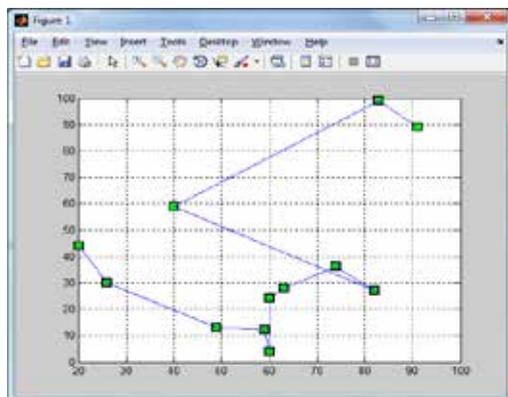


Fig.5: Graph Showing Path From Source To Destination

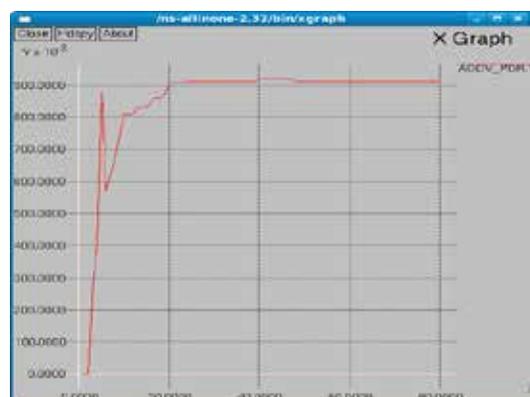


Fig.6: Packet Delivery Ratio Of AODV



Fig.7: Packet Delivery Ratio of Proposed Algorithm

Although, at earlier stage packet delivery ratio of BETC is lower than AODV. It is so because, in our proposed algorithm source node needs to seek permission from cluster head, whereas AODV establishes communication path faster. But once the route is build, BETC has Packet delivery ratio very close to AODV.

#### IV. CONCLUSION

In Proposed algorithm Black hole node is identified and an alert message is broadcasted against it. The security solution proposed in this paper combines hierarchal IDS with AODV. In order to find Packet delivery ratio, a network of 50 nodes has been simulated in NS-2 and it was found that packet delivery ratio of proposed algorithm is quite close to AODV routing protocol. This algorithm can further be developed to be more energy efficient with respect to throughput and high packet delivery ratio.

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# SCANNING METHODS FOR IMAGE COMPRESSION: A SURVEY

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## ABSTRACT

*All the multimedia services confront issue of bandwidth availability. Image compression can resolve this issue by cutting down storage space required to store the data. However before compression an important area of concern is scanning of images. This paper will focus on distinct sort of scanning techniques which are employed in image compression. Hence a survey has been created for different scanning techniques which describe the importance of the same. Comparison has been made within the finish of this paper.*

**Keywords:** *Scanning Techniques, Space Filled Curve (SFC), Zigzag scan, Raster Scan and Image Compression.*

## I. INTRODUCTION

Exponential growth of technology has made human life totally dependent on it. In today's world, web became a necessity instead of a requirement .Sharing of data could be a common example of its services. One can share any information from anywhere at any time from around this world. Modernization of web technologies increment in their users day by day. People share a huge amount of data among themselves across the world. Hence the main issue faced by these technologies is space required to store the large amount of data. Indeed there is demand of efficient data compression technique to provide uninterrupted service to the users. A major and vital field of data compression is image compression [1].A number of techniques have been formulated for the compression of images as titled in [2][3][4] .Image compression can be further divided up into two main categories i.e. lossy and lossless Image compression [5] [6]. Within the latter one information compression results into less compression ratio than the primary one has. The most important advantage of lossless data compression techniques isn't any information is lost throughout the total process whereas within the lossy algorithms one have to be compelled to compromise between high compression ratio and also the data as some information may be lost. Image compression comprises of two major steps i.e. encoding and decoding process. Further encoding process is sub divided into source coder and channel coder and reverses for the decoding. Before learning the techniques of image compression one must acquire knowledge of scanning methods for images. As before employing any transformation to image for compression the 2-Dimionesional signal of an

image is converted into a 1-D signal. This is accomplished by various scan methodologies. Multiple scan methods has been arose to convert 2-D signal into 1-D signal and studies shows

that these scan techniques can affect the rate of compression of an image irrespective of transform applied [2] . Thus one must aware about the different scanning techniques which can be utilized in image compression process. The scanning techniques a classified as Peano scan ,Hilbert scan, Raster scan, Fractional scan, Raster horizontal and vertical scan, Peano- Hilbert scan [7], Snake horizontal and vertical scan , Zigzag Scan. This paper is a comparative survey all the techniques employed for scanning purposes.

## II. IMPORTANCE OF SCANNING TECHNIQUES

Image processing is a vast field. One of its major applications is compression .Compression is composed of two sub method named as source and encoding method severally. These two sub method additionally depends upon among different parameters. One of the most important parameter is nature of scanning techniques to compress the data. It may be scanned horizontally or vertically. Fig.1 shows structure of Hilbert and Raster scan [8-10]. Subject of matter received from vertical scan may be completely different from that obtained by horizontal scan differs from. Since there are numerous directions to scan an image, therefore individual possibility of representations of its content. Fig.2. and Fig.3. shows structure of basic raster scan and snake (horizontal and vertical) respectively detecting the balance scan that brings more effective, much useful and applicable content of the image, could be useful for image processing. For compression, effective scan should exploit redundancy of the image.

## III. LITERATURE SURVEY

K.S. Thyagarajan and Shankar. Chatterjee in [2] proposed a novel scanning technique for images known as fractal scanning which is used to increase pixel correlation. The previously existing techniques for image compression generally reduce the correlation among the images or simply feat the correlation. The video images are acquired and kept by employing raster scan .However, according to them fractional scan can be achieved by using 1-D and 2-D adaptive Differential pulse code modulation (predictive techniques).

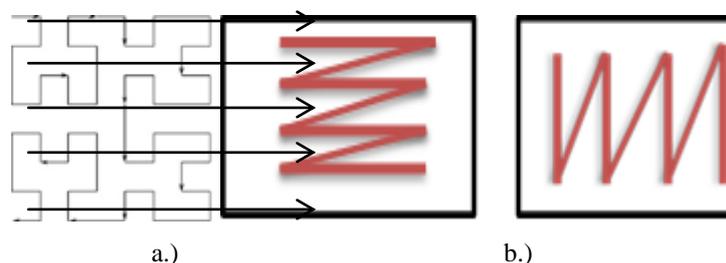
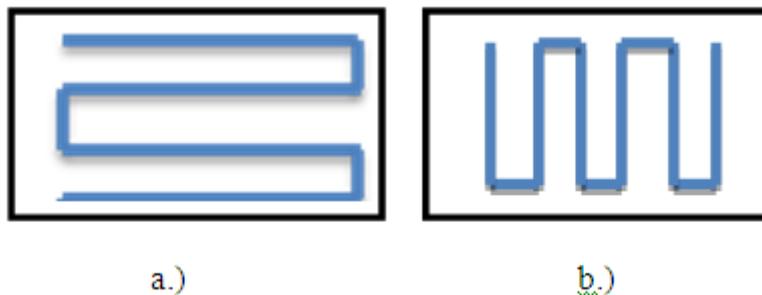


Fig.1a.) Hilbert Scan b.) Raster Scan. Fig.2 Raster scan, horizontal (left,) vertical (right)

After scanning for the image compression it have vector quantization has to be utilized. Vector quantization is generally used for compression of image as well as speech signals with very low bit rate. Further it is claimed to have better correlation for rescanned images with reduced bandwidth requirement. As a result rescanned

image achieved much better Pixel to noise ratio (PSNR) in comparison with the original images with a better image quality. It is suggested that result can be improved by using subband coding for image compression.

Revital Dafner *et.al* in [9] provides an alternative to classic scanning techniques by introducing a new context based scanning technique. Peano-Hilbert techniques are used to convert a 2-D image signal into 1-D signal. This technique employs space filling curve (SFC) to convert a 2-D spatial coherence into 1-D autocorrelation by continuously scanning every pixel of an image only once. Context based space filling curve scan an image on the bases of context. It exploits images or group of images. The presented technique diminishes the number of edge crossing during image scanning in comparison to the Peano-Hilbert scan. Also the entire algorithm aims and did provides a better spatial correlation. On conclude, claiming having such a scan technique which avoid edge crossing, achieves a better spatial correlation and same can be used in pattern recognition and texture analysis. This technique overcomes the issues of Peano-Hilbert Scan. Richard Pracko *et.al* in [10] proposed a novel scanning technique which is built on the bases of segmentation of an image. More specifically rather than utilizing traditional scanning methods, scanning of an image is done in an alternate manner such that scanning provides a greater extent of similarity in among neighboring pixels. Original image is segmented into sub segments and each segment is scanned individually. Two mode scan is applied i.e. firstly image is scanned by standard raster scan method and then a non-recursive 2-D continual scanning is employed which scan pixels as well as difference between them. Analysis has been made from entropy point of view. As a result it enhances adjacent pixel similarity without using SFC and Peano-Hilbert scan .Hence the asserted result having less correlation, reduced bit rate and less entropy of original image on the basis of histogram .



**Fig.3. Snake Scan (a.) Horizontal b.)Vertical**

result (as segmented image contain less gray levels ). Authors also proposed that in future more complex and sophisticated prediction error algorithms can be designed utilizing segment base scanning. Tang Haijiang *et.al* in [11] analyzed the effect of scanning techniques on gray scale image compression by introducing a multi scan strategy. Earlier all the literature studied above does provides a theoretical compression and briefly explains the different scanning techniques. Hilbert scan gives the better and promising results. In this paper multi scan strategy includes four scan named as raster scan, vertical scan and two diagonal scans respectively. The whole scenario is set to minimize the compression ratio for gray scale images. Further it is proposed a novel adaptive linear predictor. It is concluded and achieved compression ratio of 2-10 % by using JPEG-LS algorithm by first utilizing first two scans. However results are not satisfactory for the two diagonal scans. Xiaopeng Fan *et.al* in [13] presented a novel scheme

for image compression based on spatial prediction. More former techniques used discrete cosine transform based image coding which is based on zigzag scanning. This paper introduced a novel efficient scanning

technique of scanning which employ a tree structure. After scanning entropy coding is designed for the image compression. This algorithm improves the performance of AVC/H.264 intra frame coding and hence increases the coding efficiency. Particularly for the prediction based image compression. Though zigzag can be effective scan method than tree structure from a different point of view. Dawei and Shizhong Yang in [14] demonstrated a modern algorithm for compression of remote sensing images. Remote sensing images are compressed by using a novel zerotree[15] technique rather than orthodox Embedded Zerotree Wavelet (EZW) technique. EZW basically employ 2D wavelet. This technique is effective for compression but become more complex algorithm for large images. This algorithm employ RMEZW algorithm which utilize 2D wavelet transform with Differential phase code modulation. Moreover it employ zigzag scan which is better than Embedded Zerotree Wavelet (EZW) in the sense that it have multi tree root and it restore original image value more accurately. Zigzag scans the image in a one goes hence reduce the time cost. Further this algorithm receives higher compression ratio and better quality of reconstructed image. M. F. Fahmy and G. Fahmy in [17] presented a novel algorithm for signal processing and apply same for the image compression. Images are scanned in a similar in kind as in [14] that is in zigzag scan order. The only parameter it differs is that it utilized EZW algorithm after scanning. As we are concerned only about scanning method hence whole algorithm archives small signal reconstruction and hence reduced compression ratio. Torsten Palfner and Thomas Wedi in [18] suggested an alternative algorithm to [13] in terms of scanning. It is termed it as adaptive scanning which focus on the missing reference pixels and hence amend the intra prediction. Basic methodology employ transforms before quantization of an image. H.64/AVC utilized intra prediction before transformation. Hence instead of scanning images from left to right as done by zigzag image is scanned in a reverse order of 90, 180 and 270 degree respectively. Further after this reversible scanning process image filliping is enforced to improve spatial correlation of edges. This algorithm accomplishes lower PSNR value than [16] of 1dB just by changing the scan format. Shams MI mam et.al in [20] intended an algorithm for lossless image compression utilizing Generic Peano Pattern Mask Tree. This technique reduces unwanted data by employing Peano counter tree (P-tree), peano scan and Peano mask tree. P-tree results into compressed (lossless) data mining. One can who want detail of this tree can refer [21]. This novel algorithm uses mask rather than bits for compression. Hence performance of peano scans and hence of data mining can be mended by using Generic Peano Pattern Mask Tree. Tarek Ouni et.al in [22] proposed a potent approach for scanning of images by employing gradient based Space Filling Curves. This particular approach overcomes the issues of universal techniques which utilizes entropy coding (line by line scanning) for scanning process. One of the main advantages of this technique that it looks into correlation of pixel on the basis of context scanning curves. Context based SFC is computed by combining four different scans a) horizontal snake scan b) vertical snake scan c) first zigzag and d) second zigzag scan. The whole script leads to improved auto-correlation and better compression efficiency. Chien-Pen Chuang et.al in [23], intended a novel image compression (lossless). The algorithm is disunited into two sub parts. Firstly snake scan is used to convert a 2-d signal into 1-d signal and then arithmetic coding is applied. Snake results into residual data by vanishing the correlation between pixels. Since our main concern is on scan pattern we will not investigate coding method. However this algorithm achieves better results than conventional coding methods which does not use snake scan at first step. Ziya Arnavut et.al in [24], describes various scan method employed on pseudo color images. The fact why paper focus on pseudo color images because these images require less storage and increase the buffer space which ultimately leads to speeding of the data during transmission This

novel algorithm utilizes four scans namely horizontal and vertical scan and snake or combination of both . Further it exploits Burrows-Wheeler transformation for compression. On conclusion it is claimed having compression ratio of 1.55 by employing raster horizontal scan. Vascan O. Orest and Weingart Mircea in [25] just intended an approach which is inspired from the work of [2] . Basically improved the quality of reconstructed image by utilizing Hilbert scan and further improving vector quantization. Restricting on Hilbert scan those follow Hilbert curve order blocks rather than employing raster scan results. On further analysis and got results in the form of improved PSNR and diminished the processing time of Hilbert scan. . Nasir D. Memon et.al in [26] presented a prediction scheme for lossless image compression in which it is divided image into block and each block is scanned simultaneously hence it named there algorithm as lossless image compression with a codebook of block scan. Hence they developed a codebook from where a scan method can used freely while previously existing techniques work on the assumption that scan of image is done on regular pattern. This prediction scheme also reduced the prediction error rate. After removing the spatial redundancy (block by block) of an image by prediction tree hence performed residual image encoding which results into an effective error modeling scheme . The more focus this paper is on decoration process that is removal of spatial redundancy. Nasir Memon et.al in [27] planed a survey and analysis for the various scan techniques used in image compression. It is interpreted about effect of order of the pixel scan for predictive and context based lossless image compression . Authors analyzed the results among scans like raster scan progressive scan and Hilbert scan. Though it is well recognized that Hilbert scan commits better result than other methods yet they deduced their result in terms of predictive gain and discovered that random scan is lowest in the list . In the very next step authors computed optimal predictors which are used to test the average entropy of the prediction errors. Hence it is concluded and asserted having results in terms of entropy (prediction error) of 3.75, 3.78, 3.98 for progressive, raster and Hilbert scan respectively. Overall this paper provides a deep understanding of scanning methods. Seyun Kim and Seyun Kim in [28] proposed a hierarchical prediction scheme which scans the image than raster scan. It predicts upper, lower pixels and done by the same, left pixel.

#### **IV. CONCLUSION**

Scanning technique has an important role in image processing and it indeed affects the performance of the compression algorithm. A survey has been compiled on distinct scanning approaches. We conclude that various scanning techniques are used to convert 2-D signal into 1-D signal and it results a better efficient compression ratio. Also these techniques provide more complexity to the entire compression algorithms. An alternate technique can be employed which can substitute the conventional scan techniques with less complex algorithm.

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# SYNTHESIS AND ANALYSIS OF PURE AND Zn<sup>2+</sup> DOPED TETRAKIS THIOUREA BARIUM CHLORIDE: NON LINEAR OPTICAL SINGLE CRYSTALS

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## ABSTRACT

Single crystals of pure and Zinc chloride-doped tetrakis-thiourea barium chloride (TTBC), potential non linear optical materials, were grown successfully from aqueous solution at room temperature by the slow evaporation solution growth technique. The cell parameters of the crystals were measured by single crystal X-ray diffraction. The dopant concentration was measured using Atomic absorption study. The vibrational frequencies of various functional groups in the crystals have been derived from FT-IR analysis. The UV spectrum and band gap measurement by Tauc's method were used to ascertain the preferred optical transparency of the crystals. Kurtz method was employed for measuring the Second Harmonic Generation (SHG) of the crystals. The hardness measurements suggested a Reverse Indentation size effect (RISE) of the synthesized materials. Both the dielectric constant and the dielectric loss decreased with increasing frequency of applied field. These studies showed that the Zn<sup>2+</sup> doped crystals were found to exhibit improved properties than that of pure TTBC.

**Key Words:** AAS, FTIR Analysis, NLO, RISE , SHG , Slow Evaporation , Tauc's Plot

## I. INTRODUCTION

The field of Non linear optics (NLO) shows a constant and appreciable expansion, encompassing the knowledge from various fields: Chemistry, physics, crystal growth and crystal engineering. As a result, NLO materials have also arisen keen interest because of their applications in optical signal processing, switching and frequency generation, optical data storage, optical communication and image storage [1]. In this regard, some new classes of NLO crystals such as semi organic crystals have been developed which possess large nonlinearity, high resistance to laser induced damage, low angular sensitivity and good mechanical hardness compared to organic and inorganic materials [2,3]. Metal ion doped materials are currently receiving a great deal of attention due to the rapid development of laser diodes [4,5].

Among the various classes of semi organic NLO materials, metal complexes of thiourea have received potential interest as they can be effectively used as the better alternatives for KDP crystals in the frequency doubling process and laser fusion experiments [6,7]. Thiourea is a centrosymmetric molecule, but when it is coordinated with metal ions, it becomes noncentrosymmetric, which is an essential property for a crystal to exhibit NLO activity [6]. In this regard, bis-thiourea cadmium chloride [8] and tetrakis thiourea nickel chloride [9] crystals have been synthesized, grown and characterized, which were found to have remarkable NLO properties. Studies have been carried out on the influence of alkali, alkaline earth metal and transition metal doping on the growth and the SHG efficiency of thiourea complexes [10]. Addition of transition metals causes small changes in the host's lattice parameters as a result of lattice strain [11].

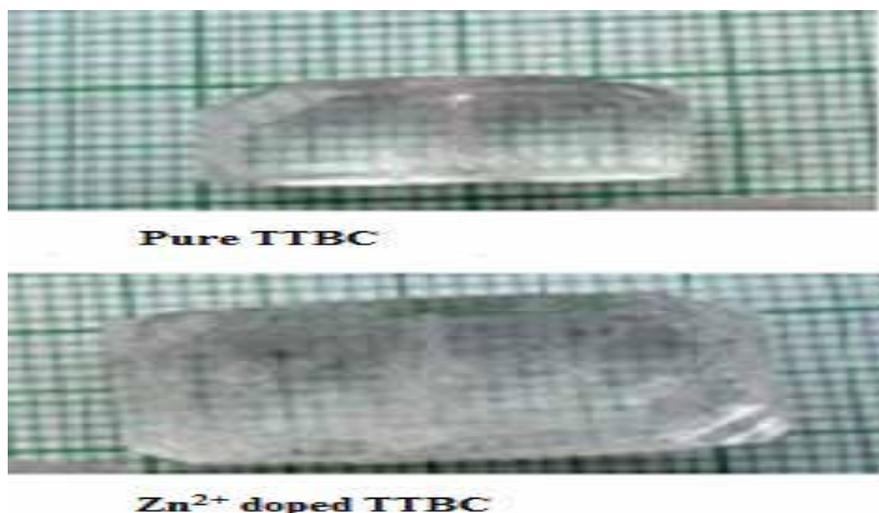
It has been reported that zinc doping in Bis (thiourea) cadmium chloride improved the SHG efficiency and optical property [12]. Though some preliminary studies were done on tetrakis-thiourea barium chloride (TTBC), only in the pure form, till now there is no report on zinc doped TTBC. Keeping those points in mind, in this present investigation, an attempt has been made to grow and characterize a semi organic complex of tetrakis-thiourea barium chloride (TTBC) single crystal and to study the impact of  $Zn^{2+}$  dopant on the same.

## II. MATERIALS AND METHODS

Tetrakis thiourea barium chloride (TTBC) was synthesized according to the reported method [13] using AR grade barium chloride and thiourea in a stoichiometric ratio 1:4



The mixtures of the reactants were stirred well for about 4 hours to avoid coprecipitation of multiple phases. The synthesized solution produced TTBC crystal and its purity was improved by repeated recrystallisation in aqueous solution. Crystals were grown by slow evaporation solution growth technique. During the crystallization process, doping of 10 mol% zinc in the form of zinc chloride was done. Pure and doped Crystals were harvested after 30 days (Fig. 1).



**Fig 1: Photograph of pure and  $Zn^{2+}$  doped TTBC crystals**

### III. CHARACTERISATION

Single-crystal X-ray diffraction analysis of pure and Zn<sup>2+</sup> doped Tertakis thiourea barium chloride crystals was carried out using Enraf Norius CAD4 diffractometer with Mo K $\alpha$  ( $\lambda = 0.7170 \text{ \AA}$ ) to determine the cell parameters of pure TTBC and doped TTBC. The presences of metals in the crystal lattice of grown crystals were determined by atomic absorption spectroscopy (AAS). The optical transmission spectra of the pure and Zn<sup>2+</sup> doped TTBC crystals have been recorded using Shimadzu UV-106 UV-vis spectrometer. The FTIR spectra were recorded in the region 400–4000 cm<sup>-1</sup> employing a JASCO FTIR 460 spectrometer by KBr pellet technique. The dielectric studies of pure and Zn<sup>2+</sup> doped TTBC single crystals were carried out in the frequency range 100Hz –5 MHz, using HIOCKI 3532-50 LCR HITESTER instrument at room and higher temperatures. The grown crystals were tested for their micro hardness property using Shimadzu HMV Vicker's tester fitted with a diamond indenter. The NLO property of the as grown crystals was confirmed by kurtz second harmonic generation (SHG) test.

### IV. RESULTS AND DISCUSSION

#### 4.1 Single crystal XRD analysis

The obtained unit cell dimensions by single crystal XRD studies are  $a = 6.996 \text{ \AA}$ ,  $b = 10.888 \text{ \AA}$ ,  $c = 7.295 \text{ \AA}$ ,  $v = 555.68 (\text{ \AA})^3$ ,  $\alpha = \gamma = 90^\circ$ ,  $\beta = 91.38^\circ$  for pure TTBC crystal and  $a = 7.132 \text{ \AA}$ ,  $b = 11.008 \text{ \AA}$ ,  $c = 7.451 \text{ \AA}$ ,  $v = 584.97 (\text{ \AA})^3$ ,  $\alpha = \gamma = 90^\circ$ ,  $\beta = 91.46^\circ$  for zinc chloride doped TTBC crystals which belong to monoclinic system. The obtained values for pure TTBC are in good agreement with the reported values of its similar homologous crystal, thiourea barium chloride [14]. The values of Zn<sup>2+</sup> doped TTBC show the possible incorporation of Zinc into the pure TTBC crystal lattice.

#### 4.2 Atomic absorption studies

Atomic absorption studies (AAS) have been made to ascertain the presence of zinc in the crystal lattice. AAS is one of the most widely used quantitative analytical methods. AAS is used for quantitative determination of metals, even in the case of their very low amounts, say 10<sup>-14</sup> g. From the experimental results, the concentration of Zn<sup>2+</sup> was found to be 6.15ppm. This indicates that quantity of zinc metal ion entering into the crystalline matrix is much less in comparison with the quantity introduced into the aqueous solution medium. It could be due to the limitations of the accommodating capability of the host material. Similar cases where even the minimum amounts of doping causing enhancement of NLO property in the doped crystals have been reported earlier [15].

#### 4.3 Fourier Transform infrared (FTIR) spectroscopy analysis

The FTIR spectra of pure and doped TTBC crystal are given in Fig.2. In the resultant complex, there are two possibilities are existing by which the metal may co-ordinate with thiourea. The co-ordination of Barium may occur either through nitrogen or through sulfur of thiourea [16]. Most of the metals form a complex through sulphur [17]. The presence of thiourea ligand and its coordination with the metal ion have been confirmed from

the FTIR spectrum of pure and doped TTBC. The values suggested that the stretching frequencies of Carbon – sulphur groups of thiourea were shifted to lower wavenumber region ( $740, 1415 \text{ cm}^{-1}$  to  $721, 1395 \text{ cm}^{-1}$ ). This trend indicated the reduced double bond character of CS bond on coordination. But, the CN stretching frequencies of thiourea showed increase ( $1090, 1471 \text{ cm}^{-1}$  to  $1123, 1491 \text{ cm}^{-1}$ ) in TTBC spectrum. These higher shifts of vibration indicated the presence of greater double bond of the carbon and nitrogen bond on complex formation. The broad envelope positioned in between  $2750$  and  $3500 \text{ cm}^{-1}$  corresponds to the symmetric and asymmetric stretching modes of  $-\text{NH}_2$  grouping, which remains almost unaltered. These observations suggested that the metal coordinates with thiourea through sulfur atom, and not through nitrogen. FT-IR spectrum of  $\text{Zn}^{2+}$  doped TTBC revealed that doping results in small shifts in some of the characteristic vibrational frequencies of host specimen and it could be due to lattice strain developed.

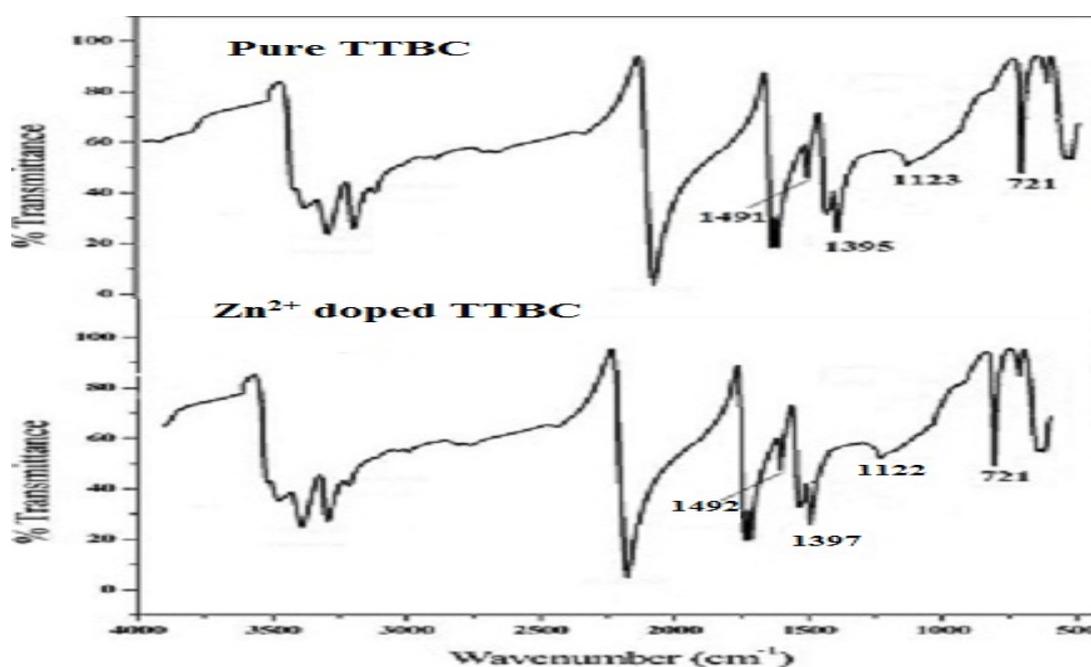
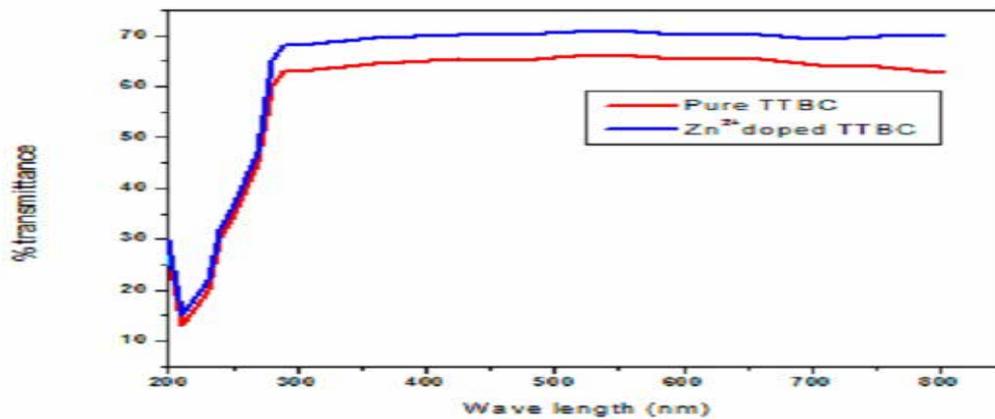


Fig 2: FT-IR spectrum of pure and  $\text{Zn}^{2+}$  doped TTBC crystals

#### 4.4 Optical Transmission studies

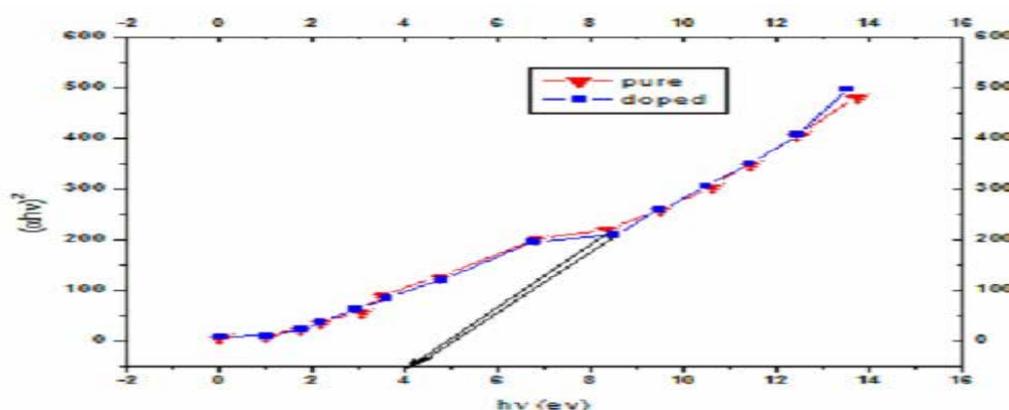
Absorption of UV and visible light involves promotion of the electron in  $\sigma$  and  $\pi$  orbital from the ground state to higher energy states and hence UV-Vis spectral study is a very useful technique to determine the structure of the molecule. Transmission spectra are very important for any NLO material because a non-linear optical material can be of practical use only if it has a wide transparency window. To find the transmission range of pure and doped TTBC, the optical transmission spectrum of them was recorded, in the range between 200 and 800 nm, ignoring the loss due to reflection. The UV-Vis spectrum (Fig 3) of pure and  $\text{Zn}^{2+}$  doped TTBC reveals that the cut off wavelength of both the samples is 285 nm. Absorption is minimum at 285–800 nm region. The absorption in the near UV region in these crystals represents the delocalized electron cloud available for charge transfer [18]. It is also inferred from the spectra that both pure and doped crystals have large transmission window in the entire visible region, and the Zn doped TTBC crystal has higher transmittance (70%) compared to pure TTBC crystal (63%). The increase in the percentage of transmission may be attributed

to a reduced scattering from crystal point and line effects [19].



**Fig. 3: Optical transmittance spectrum of pure and Zn<sup>2+</sup> doped TTBC crystals**

The dependence of optical absorption coefficient with the photon energy helps to study the band structure and the type of transition of electrons. The optical absorption coefficient ( $\alpha$ ) was determined from the transmittance using the relation:  $\alpha = [2.303 \log (1/T)] / d$ , where T is the transmittance and d is the thickness of the crystal. A material with wide band gap showing high transmittance in the entire visible regions has been reported [20]. The value of band gap energy was estimated from the Tauc's plot drawn between photon energy ( $h\nu$ ) and  $(\alpha h\nu)^2$  by extrapolating the linear portion of the curve to zero absorption. From the plot (Fig. 4), the band gap for pure and doped TTBC were found to be 4 and 4.2 eV respectively. This shows the metal doping in TTBC enhances its optical quality and optical band gap which makes it more suitable for optical applications.



**Fig.4 : Tauc's plot for pure and Zn<sup>2+</sup> doped TTBC crystals**

#### 4.5 Second Harmonic Generation – NLO studies

The second harmonic generation signal in the pure and zn doped TTBC crystals were examined by Kurtz powder technique [21]. The powders were packed densely between two transparent glass slides. Nd:YAG laser was used as a light source. A fundamental laser beam of 1064 nm wavelength, 8 ns pulse in depth with 10Hz pulse rate was made to fall on sample cell. The power of the incident beam was measured using a power meter and it was 5mJ / pulse, an energy level optimized not to cause any chemical decomposition of the sample. The transmitted fundamental wave was passed over a monochromator which separates 532 nm (SHG signal) from 1064 nm. The green light of 532 nm was detected by a photo multiplier tube and displayed on a storage

oscilloscope. The SHG output in each case was measured as the average of a few pulses to eliminate slight variations of input power. To make relevant comparisons with known SHG materials, KDP was also ground and sieved into the same particle size range. The SHG efficiency of TTBC (16.5 mV) was found to be 1.1 times that of KDP (15mV) and for doped TTBC, it was 1.25 times approximately (18.8 mV). These results are in accordance with the earlier findings that SHG can be enhanced by altering the molecular alignment through inclusion complexation [22].

#### 4.6 Dielectric Studies

The dielectric constant of the pure and doped TTBC samples were studied using HIOKI 3532-50 LCR HITESTER in the frequency region 50 Hz to 5 MHz at 308K, 318K, 328K, 338K and 348K. The variation of dielectric constant of pure and doped TTBC as a function of frequency at various temperatures is shown in Fig. 5. It is observed from the figure that initially the dielectric constants of both pure and doped TTBC have high values at low frequency and then decrease with increase in frequency and attains a constant value. The contributions of all the four polarizations such as electronic, dipolar and space charge are predominant in the low-frequency region [23]. It is also observed that as the temperature increases, the value of dielectric constant also increases to a considerable value. Such variations at high temperature may be attributed to the blocking of charge carriers at the electrodes. Because of the impedance to their motion at the electrodes, space charge and macroscopic distortion results, which might cause the observed larger values of dielectric constant at lower frequencies. With increasing temperature, a high degree of dispersion in the permittivity begins to occur at lower frequency. This could be again due to the thermally generated charge carriers from the onset of space charge limited to dc conduction. It is in fact the space charge effect that leads the dispersion of dielectric constant at low frequencies [24]. The characteristic of low dielectric constant with high frequency for a given sample suggests that the sample possesses enhanced optical quality with lesser defects and this parameter is of vital importance for various nonlinear optical materials and their applications [25]. From the plot, it is also inferred that  $Zn^{2+}$  doped TTBC has high dielectric constant compared to pure TTBC at lower-frequency, which may be attributed to the higher polarizability of doped crystals [23].

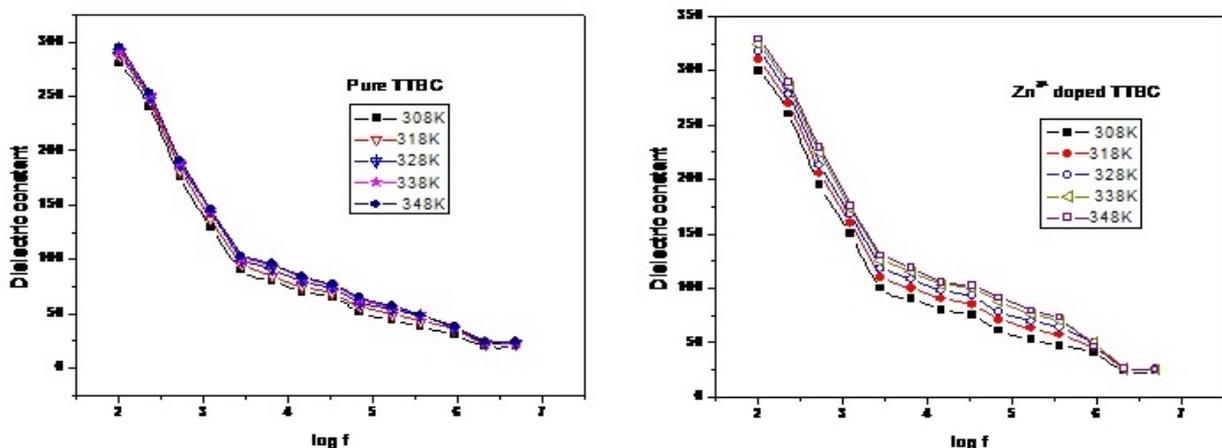


Fig 5: Plot of dielectric constant Vs log f for pure and  $Zn^{2+}$  doped TTBC crystals

#### 4.7 Vickers Micro Hardness Studies

The mechanical strength of the materials plays a key role in device fabrication. To evaluate the mechanical properties and to check the suitability of the material for devices, the hardness studies of pure and doped TTBC single crystals were made by Vickers microhardness tests at room temperature. The crystal with the smooth surface was mounted properly on the base of the microscope. Now, the selected faces were indented gently by loads varying from 15 to 60 g by keeping the constant indentation time of 8 s using Vickers diamond pyramid indenter. The Vickers indented impressions were approximately square in shape. The length of the two diagonals was measured by a calibrated micrometer attached to the eyepiece of the microscope after unloading and the average was found out. For a particular load at least five well defined indentations were considered and the average of all the diagonals (d) was considered. The  $H_v$  was calculated using the standard formula:  $H_v = 1.8544P/d^2$ , where P is the applied load in g and d is the average diagonal length in micrometer.

A graph has been plotted between the hardness values and the corresponding loads for pure TTBC and  $Zn^{2+}$  doped crystals as shown in Fig 6. From the results, it was observed that hardness number increases as the load increases. This phenomenon is in accordance with Reverse Indentation Size effect (RISE). This is because the introduction of barium (in the case of pure TTBC) and zinc (in the case of doped TTBC) in the crystal lattice of thiourea creates ionic vacancy, which acts as an obstacle to dislocation motion thus increasing the hardness of the crystal. At higher concentration of impurity, the impurity vacancy associates into larger aggregate. So, hardness saturates at higher concentration of impurity which may be due to the release of internal stresses generated locally by indentation [26]. However, the hardness value of  $Zn^{2+}$  doped TTBC crystal is found to be greater than that of the pure TTBC crystal for the same range of applied loads. Vicker's microhardness measurement clearly shows that the inclusion of  $Zn^{2+}$  has improved the mechanical stability of TTBC and hence it can be fruitfully utilized for devices.

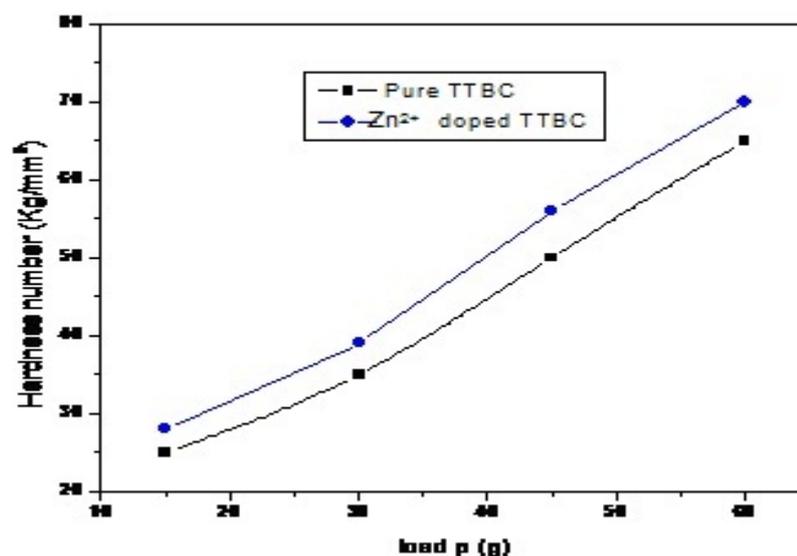


Fig. 6: Plot of hardness Vs load for pure and  $Zn^{2+}$  doped TTBC crystals

## V. CONCLUSIONS

Single crystals of pure and Zn<sup>2+</sup> doped Tetrakis thiourea barium chloride (TTBC) were grown using the slow solvent evaporation technique. The single crystal X-ray diffraction studies confirmed the unit cell parameter. From the XRD studies, it is obvious that the crystals belong to orthorhombic crystal structure. UV spectrum and Tauc's plot revealed the required optical transparency of the grown crystals. The functional groups and metal coordination pattern were confirmed by FTIR analysis. The SHG efficiency of the pure and Zn<sup>2+</sup> doped TTBC samples was found to be about 1.1 and 1.25 times greater than that of KDP. The micro hardness studies revealed the existence of RISE pattern for both the crystals. Dielectric studies showed that the dielectric constant decreased with increase in frequency. Thus, the investigated results indicate the suitability of the grown crystals for photonic device fabrication.

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### **BIOGRAPHICAL NOTES**

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# RELATIONAL DATABASE WITH SQL AND GRAPH DATABASE

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## ABSTRACT

*This paper represents the study of various theory based on database model. In this paper a study of various papers is done, and in the reviewed paper graph database and SQL is done. This huge repository of unstructured data has resulted in making the data search and knowledge extraction, a very cumbersome task if one continues using the legacy relational database.*

**Keywords:** DBMS, flexibility, Relational DBMS, SQL, security

## I. INTRODUCTION

A database management system (DBMS) is the software that allows a computer to perform database functions of storing, retrieving, adding, deleting and modifying data. It provides facilities for controlling data access, enforcing data integrity, managing concurrency control, recovering the database after failures and restoring it from backup files, as well as maintaining database security.

### 1.1 Relational DBMS

The relational database model was modelled by E. F. Codd in 1969, a researcher at IBM. The model is based on set theory and predicate logic. The basic idea behind the relational model is that a database consists of a series of unordered tables (or relations) that can be manipulated using non-procedural operations that return tables. This model was in contrast to the more traditional database theories of the time that were much more complicated, less flexible and dependent on the physical storage methods of the data.

The word relational has its roots in the terminology that Codd used to define the relational model. The table in Codd's model was actually referred to as a relation (a related set of information). In fact, Codd (and other relational database theorists) used. Relational database has been providing support with implementation of many decades like oracle, MySql etc [1].The pages of WWW which are connecting to network of hyperlink is highly complex and not efficient in relational database [2].similarly these issues involved in the modeling of social network like facebook, orkut etc. To implement such issues is very expensive to calculate it[3].

## II .LITERATURE REVIEW

Ø Information Storage has been a challenge throughout human history and existed long before modern computer systems. With examples like Dewey Decimal Classification (also called the Dewey Decimal System) , a proprietary system of library classification developed by Melvil Dewey in 1876 made information retrieval and indexing more efficient. However it still required vast amounts of physical volume to store data and relied on the human intellect to process trivial relations in that data.

Ø In 1964, Charles Bachmann developed the first commercial database management system (DBMS), IDS - Integrated Data Store based upon an early network data model while working at Honeywell. IDS maintained

a single set of shared files on disk. Programs responsible for particular tasks, such as billing or inventory updates, retrieved and updated these files by sending requests to IDS. IDS provided application programmers with a set of powerful commands to manipulate data.

- Ø In the late 1960s, IBM and North American Aviation (later Rockwell International) developed the first commercial hierarchical DBMS, IMS - Information Management System, and its DL/I-language. These models lack a good abstraction level which implies that it is difficult to separate the db-model from the actual implementation. The data structures provided are not apt for modelling non traditional applications. They permit database navigation at the record level by providing low-level operations that can be used to derive more abstract structures. The solution to these problems was given by Codd. In 1970, Codd released —A Relational Model of Data for Large Shared Data Banks. which provided the first definition of Relational Model.
- Ø Codd's relational model suggested that all data in a database could be represented as a tabular structure (tables with columns and rows, which he called relations) and that these relations could be accessed using a high-level non-procedural (or declarative) language [reference]. Edgar F. Codd published a series of papers about relational databases from 1970 to 1972, in which he focused on the concept of abstraction levels by introducing a separation between the physical and logical levels. It was a major development because it gave the data modelling discipline a mathematical foundation. It is based on the simple notion of relation, which together with its logic and algebra, made it the most widely used model and its standard query language SQL, became a paradigmatic language for querying. But with time, database community realized that the relational model was inadequate for data intensive domains (knowledge bases, engineering applications) involving complex data objects and object interactions such as CAD/CAM software, computer graphics, and information retrieval.
- Ø In order to provide additional semantics necessary to model these new applications Object-oriented (O-O) db-models appeared in the eighties. According to Rao in 1994, "The object-oriented database (OODB) paradigm is the combination of object-oriented programming language (OOPL) systems and persistent systems. O-O db-models view the world as a set of complex objects having certain states (data), where interaction is via method passing. Although O-O db-models permit much richer structures than the relational db-model, they still require that all data conform to a predefined schema. One of the promising solutions to this problem was given by document databases such as Lucene, which is able to fully index large document collections and support queries that rank the documents according to information retrieval measures.
- Ø But what makes document databases really different, is the fact that documents are usually retrieved through dynamic and unpredictable queries. Thus document databases can usually associate any number of fields of any length to a document. Document databases are usually schema-less, i.e. there is no predefined data model. But with the vast increase in the usage of internet, these document models were not proving to be efficient in performing many operations for example the World Wide Web exhibits far more complicated networks of relationships than were expected. The network of hyperlinks connecting all the pages on the World Wide Web is highly complex and almost impossible to model efficiently in a document database. Similar issues are involved in modeling the social network like Twitter, Facebook, etc. Implementing such a large network of relationships in the form of these conventional databases was an

impossible task. So there was a need of the kind of model where both data manipulation and representation are graph-based.

- Ø The database community became aware of this need and proposed graph databases. A survey of the literature on community structure, link prediction and social influence shows that graphs are the predominant model for social networks. Adrian Silvescu in his paper on graph databases showed how graph databases easily handle changes in the schema. A survey on the literature of graph databases shows that although activities around graph databases flourished in the first half of the nineties, the topic almost disappeared in later years. The reason behind it was the emergence of XML that captured all the attention of those working on hypertext which forced people working on graph databases to move to particular applications like spatial data, Web, and documents; the tree-like structure was enough for most applications at that time.
- Ø A number of papers have been published on graph databases during the 70's and 80's in early approach, Roussopoulos and Mylopoulos proposed a semantic network to store data about the database in 1975. Shipman in 1981 presented an implicit structure of graphs for the data itself in the Functional Data Model, whose goal was to provide a —conceptually natural database interface. Logical Data Model (LDM) developed by Kuper and Vardi in 1984, was proposed on a different approach according to which an explicit graph db-model intended to generalize the relational, hierarchical and network models. Later Kunii in 1987 proposed a graph db-model for representing complex structures of knowledge called G-Base.
- Ø In the late eighties, Lecluse in 1988 introduced O2, an object-oriented db-model based on a graph structure. Along the same lines, GOOD developed by Gyssens in 1990 was a system in which manipulations as well as representation are transparently graph based. Among the subsequent developments based on GOOD are: GMOD by Andries in 1992, which proposes a number of concepts for graph-oriented database user interfaces; Gram by Amann and Scholl in 1992, which is an explicit graph db-model for hypertext data; PaMaL by Gemis and Paredaens in 1993, which extends GOOD with explicit representation of tuples and sets; GOAL developed by Hidders and Paredaens in 1993, which introduces the notion of association nodes; G-Log in 1995, proposed a declarative query language for graphs; and GDM developed by Hidders in 2005 which incorporates representation of n-ary symmetric relationships.
- Ø There were proposals that used generalization of graphs with data modeling purposes. Levene and Poulouvasilis in 1990 introduced a db-model based on nested graphs, called the Hypernode Model, on which subsequent work was developed by Poulouvasilis and Levene in 1994 and Levene and Loizou in 1995. The same idea was used for modelling multi-scaled networks and genome data [Graves et al. 1995a]. GROOVY is an object-oriented db-model which is formalized using hypergraphs. There are several other proposals that deal with graph data models. Guting in 1994 proposed GraphDB, intended for modeling and querying graphs in object-oriented databases and motivated by managing information in transport networks. Database Graph Views [Gutiérrez et al. 1994] proposed an abstraction mechanism to define and manipulate graphs stored in either relational object-oriented or file systems. The project GRAS [Kiesel et al. 1996] uses attributed graphs for modeling complex information from software engineering projects. The well known OEM [Papakonstantinou et al. 1995] model aims at providing integrated access to heterogeneous information sources, focusing on information exchange.
- Ø One more problem that arose with the evolution of Internet was the need of searching and accessing information from the WWW. A search engine is a document retrieval system designed to help find

information stored in a computer system, such as on the World Wide Web, inside a corporate or proprietary network, or in a personal computer. But the presence of huge amount of resources on the Web poses a serious problem of accurate search. This is mainly because today's Web is a human-readable Web where information cannot be easily processed by machine. Highly sophisticated, efficient keyword based search engines that have evolved today have not been able to bridge this gap. This huge repository of unstructured data has resulted in making the data search and knowledge extraction, a very cumbersome task if one continues using the legacy relational databases. One of the proposed solutions is to shift to the graph databases as they not only makes it easier to store and retrieve data for the world wide web but also provide relevant and streamlined search results from the abundant information present on the internet.

### **III. GRAPH DATABASE**

Graph database models can be defined as those in which data structures for the schema and instances are modelled as graphs or generalizations of them, and data manipulation is expressed by graph-oriented operations and type constructors. These models took off in the eighties and early nineties alongside object oriented models. Recently, the need to manage information with graph-like nature has re-established the relevance of this area.

In graph database entity ,object have equal importance with object themselves[5]. With the exponential rapid development of Internet and its advent as an indispensable medium for electronic sharing of data, it has emerged as a huge repository of unstructured data. This has resulted in making the data search and knowledge extraction, a very cumbersome task if one continues using the legacy relational databases. The retrieval of relevant information from internet in minimum possible time and with maximum efficiency has been possible with the help of graph databases. Easily retrieving the relevant search results from the vast ocean of information requires the search to be semantic and not syntactic.

Some examples of are Infogrid, HypergraphDB, Jena, DEx, FlockdB,sQl and Neo4j[6]-[8].

Out of these sql is explained below

### **IV MYSQL**

To implement relational databases, MySQL version 5.1.41 was used. The database was queried using PHP scripting language. Queries designed to analyze the performance difference between a relational database and a graph database are:

S0: Find all friends of Esha.

S1: Find the favorite movies of Esha's friends.

S2: Find the lead actors of favorite movies Esha's friends.

The first step is to connect to the MySQL server. Once the connection has been established to MySQL server, a new database is created.

Next step is to create tables within the database. Schema for relational database includes the following tables

- 1) User: user\_id, user\_name
- 2) Friends: user\_id, friend\_id
- 3) Fav\_movies: user\_id , movie\_name
- 4) Actors: movie\_name, actor\_name

To retrieve the query results and note down the retrieval times of each query for hundred and five hundred nodes respectively. Unlike Neo4j, MySQL gives the retrieval time in seconds and not milliseconds. To get the retrieval time in milliseconds, we need to explicitly do the coding.

## **V. SECURITY**

The database is queried using PHP scripting language. Retrieval times for the above query as calculated by MySQL for hundred and five hundred MySQL has extensive multi user support. However Neo4j does not have any built in mechanisms for managing security restrictions and multiple users. It presumes a trusted environment. Although there is Access Control List security mechanisms but even Access Control List management is handled at application layer. On the other hand, there is extensive support for ACL based security in MySQL users.

## **VI.FLEXIBILITY**

Although relational databases are more mature and secure as compared to graph databases, but its schema is fixed, which makes it difficult to extend these databases and less suitable to manage ad-hoc schemas that evolve over time.

## **VII. CONCLUSION**

This paper represents the graph database as well as MYSQL. In general, graph databases retrieve the results of the set of predefined query faster than relational databases. Not only this, graph databases are more flexible than relational databases as new relationships can be added to graph databases without the need to restructure the schema again. Graph databases are more scalable as well as increasing number of nodes from one hundred to five hundred does not increase the retrieval time by much as can be visualized.

## **VIII. FUTURE SCOPE**

My SQL has extensive multiuser support. Although there is Access Control List security mechanisms but even Access Control List management is handled at application layer. On the other hand, there is extensive support for ACL based security in MySQL.

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# SCOPE OF UTILISATION OF E-WASTE IN CONCRETE

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## ABSTRACT

*Recently the electronics industry had made advancement with leaps and bounds in the production of products. The amazing developments have certainly enriched the quality of our lives. Rapid growth of technology, up gradation of technical innovations and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world, simply called as E-waste. Improper disposal of E-waste can cause serious threats to human health and environment.*

*Published literature shown that there is a strongly possibility of E-waste being used as substitute/ replacement of aggregate. Its use in concrete becomes more significant and important in view of the fact that sources of natural aggregates are getting depleted gradually, and it is of prime importance that substitute of aggregates be explored.*

*This paper presents an overview of the published literature on the use of E-waste in concrete. Effect of E-waste on the properties of concrete such as compressive strength, split tensile strength and durability are presented.*

**Keywords: Compressive strength, Concrete, Durability, E-waste, split tensile strength,**

## I. INTRODUCTION

Waste materials from other industries are being utilised in concrete productions such as fly ash, silica fume etc. The waste materials from electronics and electrical industries are divided in two categories hazardous and inert waste materials. The inert waste is also known as E-waste describes obsolete, discarded and malfunctioned electrical or electronics devices. The European Union countries have developed policies and scientific measures for recycling, reuse and disposal of such waste.

Although no definite official data exist on how much waste is generated in India or how much is disposed of, there are estimations based on independent studies conducted by the NGOs or government agencies. According to the Comptroller and Auditor- General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually [9]. A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo – "ComponexNepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tonnes by end 2009 [7]. The CPCB has estimated that it will exceed

the 8 lakh tonnes or 0.8 MT mark by 2012 [8]. Two small E-waste dismantling and recycling facilities are operational in Chennai and Bangalore. There is no large scale organized E-waste recycling facility in India and the entire recycling exists in unorganized sector.

### 1.1 Methods of disposal of E-waste

The E-waste that generated is usually disposed of in the following ways.

- *Land Fill*

A land fill is a disposal area where garbage is piled up and eventually covered with dirt and dust. Fractions of E-waste is most often dumped into landfills. Over time, the e-waste leads to certain amount of chemical and metal leaching. This can very often lead to ground water contamination.

- *Incineration*

E-waste is burnt in incineration process. Individuals in unorganized sectors carry out such operations in which release of harmful toxic gases like dioxins, which escape to the atmosphere and contaminate it.

- *Reuse*

About 3%-5% of the computers that have been discarded by their users are reused. Reuse made possible either direct second hand use or use after slight modification. Non-working old computers are repaired and resold for profit in developing countries. These older units obviously have a limited lifespan and end up as waste sooner or later in these developing countries.

- *Recycling*

In order to combat the environmental impact of improper electronic waste disposal many organizations have opted to recycle their old technology. After the possibilities of reuse have been exhausted, then the next preference lies on recycling process. Recycling means that the old raw materials are reclaimed to be made of in making new products. However, the costs of recycling are high. It is necessary to arrive at a cost effective and environmental friendly recycling process, which may be considered as the real need hour.

### 1.2 Scope of investigation

Increasing the need for landfills is a burden to our environment. Also with the storage of landfills capacity and an increased concern about environmental quality, diverted waste treatment methods are desired. New waste management options are needed to divert End-Of-Life (EOL) electronics from landfills and incineration. However, there are several factors to consider in the development of a successful diversion strategy. This strategy must be based on its economic, sustainability, technical feasibility and a realistic level of social support for the program.

One aspect of the strategy should include recycling and reuse of EOL electronic products in construction field.

1. Efforts have been made in construction industry to use E-waste as a partial replacement of the coarse or fine aggregate (Chen and Hwang, 2006).

2. The successful use of other industrial by products of wastes such as fly ash and silica fume in concrete set as good example for waste to be used in a different way.

3. Trials are also suggesting utilizing shredded waste plastics usage in concrete as a partial replacement of the coarse aggregate.

4. Recent studies have shown that glass and plastic fractions generated from e-waste can be used as aggregate in road constructions and building materials such as tiles and bricks (Shayan and Xu, 2006).

The current study is aimed to review the published literature on concrete with E-waste in which different proportions of E-plastic particles are used as replacement to aggregates.

## II. PROPERTIES OF HARDENED CONCRETE

### 2.1 Compressive strength

*Chen et al (2006)*[6] demonstrated that use of E-glass waste in concrete as fine aggregate replacement. The compressive strength of specimen with 40% E-waste glass is 17%, 27% and 43% higher than control concrete at the ages of 28, 91 and 365 days. The E-waste particles act as crack resistors in concrete. *Lakshmi and Nagan (2011)*[2] utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. The decrease in strength was observed at all substitution levels. At 20% replacement the highest strength reduction was observed. They also utilised 10% fly ash as mineral admixture which resulted in better compressive strength. Till 12% replacement of natural aggregates the compressive strength was better than reference concrete. *Prasanna and Rao (2014)*[5] investigated the use of E-waste in concrete as partial replacement of concrete. The strength loss was 33.7% when 20% of E-waste is used to replace coarse aggregate, it is reduced by 16.86% when coarse aggregate is replaced by 20% of E-waste plus 10% Fly ash. *Arora and Dave (2013)* [4] studied the low amount replacement of E-waste as fine aggregates in mortars. They concluded that 4% replacement of E-waste as fine aggregates resulted in acceptable strength gain. *Nagajothi and Felixkala (2014)*[3] reported that utilising E-fiber waste as additive in concrete till 2.5% resulted in almost twice compressive strength as compared to control mix. The compressive strength increased constantly with addition of E-fiber waste.

### 2.2 Split tensile strength

*Lakshmi and Nagan (2011)*[2] utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. The decrease in strength was observed at all substitution levels. At 20% replacement the highest strength reduction was observed. They also utilised 10% fly ash as mineral admixture which resulted in better split tensile strength. Till 12% replacement of natural aggregates the split tensile strength was better than reference concrete. The utilisation of fly ash improved the split tensile strength by 50%.

## III. DURABILITY PROPERTIES OF CONCRETE

### 3.1 Sulfate resistance

*Chen et al (2006)* [6] demonstrated that use of E-glass waste in concrete as fine aggregate replacement. The increase in E-glass content significantly decreases weight and strength loss, mostly for the specimens with lower water/cement ratio. The surface defects of tested specimens also show a qualitative evidence of sulfate attack.

The positive effect of E-glass on sulfate resistance of concrete is very prominent. *Lakshmi and Nagan (2011)*[2] utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. The average loss of weight and loss of compressive strength of E-plastic concrete is considerably lesser than the corresponding loss of weight and loss of compressive strength of conventional concrete. It shows that E-plastic particles in the concrete is not influenced by Sulphate.

### 3.2 Resistance to chloride attack

*Chen et al (2006)* [6] demonstrated that use of E-glass waste in concrete as fine aggregate replacement. It is evident that the total charge passed decrease with an increasing E-glass content. The total charge passed as reported is less than 2000 which indicates very low chloride permeability.

### 3.3 Permeability

*Lakshmi and Nagan (2011)*[2] utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. E-waste concrete exhibits slightly higher values than conventional concrete. This can be explained by the E-waste aggregates dispersed in concrete may comprised of inter particle voids which may be assumed to be contributed the increase in Saturated water absorption, Porosity and sorptivity as all these factors linked directly to voids in structure. However, with proper vibration mechanism the possibility of voids can be minimized.

## IV. OBSERVATIONS AND CONCLUSIONS

The review of different published literature results that E-waste has potential to be utilised as lower aggregate replacement in concrete. The strength development pattern of E-waste concrete is similar to that of conventional concrete but there is decrease in strength at all the curing ages. The utilisation of mineral admixtures can be used to increase compressive strength. From the published research work it is concluded that:-

1. E-waste is the potential viable material to be used as fine aggregate to produce durable concrete.
2. Its use as fine aggregate in concrete will help in alleviating the potential problem of dwindling natural resources.
3. Its use will also help in protecting the environment surroundings.

Till date a very limited research work on E-waste as aggregate in concrete has been carried out. Therefore further investigations to study the ways in which E-waste as aggregate replacement in concrete affects the rheological properties of fresh concrete, mechanical and durability properties of hardened mass are needed.

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# INTELLIGENT ROUTING TECHNIQUES FOR WIRELESS SENSOR NETWORKS USING SWARM INTELLIGENCE: A SURVEY

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## ABSTRACT

A Mobile Ad-Hoc Network (MANET) is a collection of autonomous self-organizing wireless mobile nodes forming a temporary network without using centralized access points. They use wireless medium for communication, hence two nodes can communicate directly if and only if they are within each other's transmission radius in a multi-hop fashion. In MANET, each node can act as a node as well as a router. But due to non-availability of centralized administration, there is a difficulty of routing optimization. Many conventional routing algorithms have been proposed for MANETs. There are various protocols like AODV, DSDV, DSR, ZRP etc. available for routing in MANET. Routing strategies are an important feature of network administration, as they have a significant influence on the overall network performance. An emerging area that has recently captured much attention in network routing researches is Swarm Intelligence (SI). Besides conventional approaches, a lot of new researches have proposed the adoption of Swarm Intelligence for MANET routing. Swarm Intelligence refers to complex behaviors that arise from very simple individual behaviors and interactions, which is regularly observed in nature, particularly among social insects such as ants, bees, fishes etc. While each individual has little intelligence and simply follows basic rules using local information obtained from the environment. Basically, Swarm Intelligence is an artificial intelligence technique based around on the study of collective behaviour in decentralized, self-organized systems. Ants routing resembles basic mechanisms from distributed Swarm Intelligence in biological systems and turns out to become an interesting solution where routing is a crisis. Ants based routing is becoming more popular because of its adaptive and dynamic nature. Also, they are more robust and reliable than other conventional routing techniques. Ant Colony Optimization is well-liked among other Swarm Intelligent Techniques. In this paper, we study bio-inspired routing protocols for MANETs. This paper also introduces the preliminary studies for Mobile Ad Hoc Networks.

**Keywords:** Ant Based Routing Protocol, ABC, MANET, SI

## I. INTRODUCTION

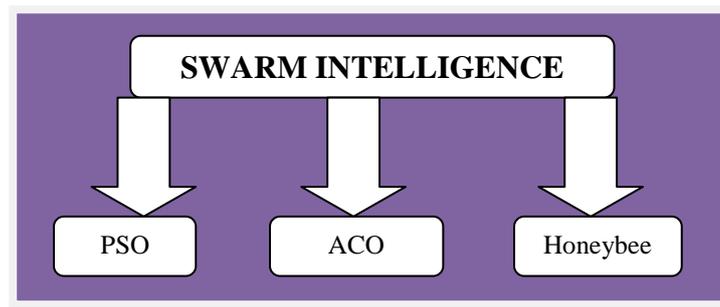
Wireless sensor networks (WSNs) [1] consist of a large number of autonomous nodes equipped with sensing abilities, wireless interfaces, limited processing and energy resources. WSNs are used for distributed and cooperative sensing of physical phenomena and events of interests. Yet, they can also be mobile and capable of

interacting with the environment. In these cases, the network is more appropriately referred to as a robotic network and/or as a sensor-actor network. Wireless networks have become increasingly popular in the computing industry. This is particularly true within the past decade, which has seen wireless networks being adapted to enable mobility. There are currently two types of mobile wireless networks. The first is known as the infrastructure network (i.e., a network with fixed and wired gateways). The bridges for infrastructure networks are known as base stations. A mobile unit inside these networks connects to, and communicates with nearest base station that is within its communication radius. The second type of mobile wireless network is the infrastructure less mobile network, commonly known as an ad hoc network. These networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks function as node as well as routers which discover and maintain routes to other nodes in the network. WSNs can be employed in a wide spectrum of applications in both civilian and military scenarios, environmental monitoring, surveillance for safety and security, automated health care, intelligent building control, traffic control, object tracking, etc. [2,3]. From the point of view of information processing, in WSNs, aggregation of the sensed data and its use for statistical inference can be realized in a number of ways, resulting in different network architectures. The requirements of routing protocols for WSNs are similar to those of routing protocols for mobile ad hoc networks (MANETs) [5]. However, compared to MANETs, in the case of WSNs, the restrictions on energy efficiency are more compelling, nodes are usually static, and the networks are in general assumed to be much larger. Moreover, while in the case of MANETs traffic patterns strictly depend on the application and are address centric, in WSNs they are usually data-centric. So far, a large number of different routing protocols have been proposed for WSNs based on a variety of different mechanisms and optimization criteria. In recent years, several wireless routing protocols are designed to provide communication in wireless environment, such as AODV, DSR, DSDV, ZRP, LEACH, OLSR etc. The paper is introduced with a review of all necessary background and previous work in the general fields of swarm intelligence and network routing.

## **II. SWARM INTELLIGENCE**

In nature several animals tend to live in large swarms like insect colonies, bird flocks or fish schools. The reason is that in the swarm each animal is more effective for evolution than single animals. Many social insects like ants, bees, termites, or wasps live in colonies or hives. They exhibit an astonishingly well developed social behavior and are able to self-organize, even in the absence of a central leader like a queen. Honey bees communicate locations of food sources by the language of dance that is understood by all nearby honey bees. On the other hand, many insects use a form of indirect communication called stigmergy. Stigmergy works by leaving traces in the environment that can be understood by other insects. Swarm Intelligence (SI) [6] is an Artificial Intelligence technique based on the study of collective behavior in decentralized, self-organized systems. The term “swarm intelligence” was introduced by Beni & Wang in 1989, in the framework of cellular robotic systems. Swarm intelligence is “The emergent collective intelligence of groups of simple agents” [6]. It gives increase to complex and intelligent behavior through simple, unsupervised interactions between a total numbers of autonomous swarm members. Usually there is no centralized control structure dictating how the individual agents should behave, but interactions between such agents lead to the appearance of a global behavior. Swarm is considered as biological insects like ants, bees, wasps, fish etc. The quick coordinated flight of a group of birds with very little visual communication and the concerted effort of an ant colony in gathering food, building nests, etc are some of the

vivid examples of emergence in natural world. SI has found immense applicability in fields like Robotics, Artificial Intelligence, process optimization, telecommunications, routing, software testing, networking etc. Swarm Intelligence is subfield of Computational Intelligence which provides solution for complex optimization problems which are not easily tackled by other techniques. Swarm Intelligence based approaches are bio inspired. Swarm is defined as a set of mobile agents that collectively solve troubles. Each individual of the swarm has easy rule of action and access to a limited amount of information via its immediate neighbor. On the other hand, even with of limited information and simple actions of members, the swarm, as a whole, is capable to accomplish very hard problems of the computation and optimization. Swarm Intelligence consists of Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) and Honeybees paradigms. These paradigms copy the behavior of real insects for food searching, organized living and self-protective styles for computational problems.



**Figure 1. Sub-Domains of Swarm Intelligence**

The SI based techniques are more capable from other conventional techniques for optimization problems. These approaches are more suitable for the routing and energy resources optimization, due to the nature, architecture, topology and functionality of ad hoc and wireless sensor networks. Bio inspired approaches are more promising due to the following prominent aspects i.e. [7] a) Locality of interactions, b) Availability of multiple paths, c) Self-organized behaviors, d) Failure backup, e) Ability to adapt in a quick and robust way to topological and traffic changes and component failures, f) Scalable performance robustness to failures, g) Losses internal to the protocol, h) Easiness of design and tuning.

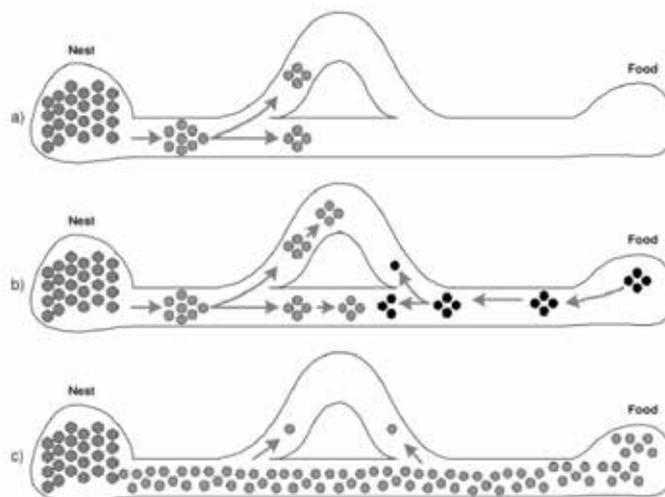
## 2.1 Particle Swarm Optimization

Particle Swarm Optimization is subfield of Swarm Intelligence which exploits the behavior of swarms for the solution of complex problems. The particle swarm optimization natured algorithm maintains a swarm of particles. Particle Swarm Optimization exploits the mutual intelligence and information sharing capacity of swarms. PSO applies the idea of social interaction for the solutions of hard and optimization problems. It was developed [8] in 1995 by James Kennedy and Russell Eberhart. In PSO each particle individually emerges a potential solution for the hard problem to be solved. In PSO, particles are flown through the multi-dimensional search space and the next location of each particle is determined as a factor of its own experience and that of other particles. The working of PSO based on fundamentally on the position of particle and velocity of the particle at given time. The searching depends on the previous location and velocity of the particle. The particles will mostly search the space between the global best and their personal bests for the improved solutions. At the start of PSO algorithm, particle position, personal best position and velocities of particles are initialized randomly within the constraints of the search space and after that the parameters updated accordingly given strategies. As bio inspired approaches are iterative, some termination mechanism is applied. For PSO algorithmic, stopping state can be implied are

maximum number of iterations, acceptable solution achievement or no improvement observed over a number iterations. There are various types of PSO algorithms proposed for the solution of problems, like Network security, Optimization, Association rule mining, Classification purposed and mostly in Wireless Sensor Network.

## 2.2 Ant Colony Optimization

The phenomenon of emergence found in natural systems show how simple behavioral patterns from participants give rise to complex self-regulatory behavior of the complete system [9]. Ant Colony Optimization (ACO) [10] is a branch of a newly developed form of Swarm Intelligence. Ant Colony Optimization is paradigm of Swarm Intelligence that is inspired by the collective behavior of ants. The Ant Colony Optimization algorithmic approach models the concept of food foraging, net building, and division of labor, cooperative support, self assembly and cemetery organization of real ants for the meta-heuristic approaches, for the optimization problems. ACO meta-heuristic approach was proposed by Marco Dorigo in 1996. The basic principle of ACO is ability of ants to find the shortest path between their nest and a food source. Ants are able to find the shortest path between their nest and food source, without any central and active coordination. The real ants drop a pheromone, chemical from their bodies naturally, on the path which leads them for the various decisions. The path optimization between nest and food is achieved by ant colonies by exploiting the pheromone amount dropped by the ants. The path selection of the ants is done on the bases of the pheromone concentration deposited on the set of paths. With high concentration of pheromone value path selection probability is greater than others. The indirect pheromone based communication is known as stigmergy. There is a natural evaporation of the pheromone, which favors the shorter path than the larger one. An artificial ant can be considered as a simple computational agent. In basic ACO algorithm pheromone value update and pheromone value evaporation is done by using the mathematical expression. Normally, the rate of pheromone evaporation is directly proportional to the length of path. Similarly to the PSO, ACO works in iterative manor and various termination criteria are anticipated. The stopping criteria for ACO algorithm suggested are, a) fixed number of iterations, b) adequate solution and c) the number of ants that following the same path repetitively.



**Figure 2 : All ants take the shortest path after an initial searching time**

In groups of insects, which live in colonies, like ants and bees, an individual can only do simple tasks on its own, which the colony's cooperative work is main reason determining the intelligence behavior it shows. Figure 2 shows a scenario in which the best route between two choices is chosen by the ants. Ant colony optimization

(ACO) [11] is an optimization technique inspired by the exploratory behavior of ants while finding food. The ants in the colony form a collective behavior. A colony of ants has a wide range of duties like collecting food, building/guarding the nest, removing the dead ants, etc and has simple one-to-one communication. The individual messages passed between ants are very insignificant, but the collective messages help in coordinated work control of ants without the presence of a centralized control system. Ants use scent called pheromone for communication among them. Ants have ability to smell this pheromone. They can produce few different types of pheromones – usually one each to signify different work categories like collecting food trails, signifying emergency, moving dead ants, etc. The source of ACO is the pheromone trail laying and following behavior of ants which use pheromone as a communication medium. While searching the environment for food, the ants deposit pheromones on the ground. Other ants are attracted by pheromones and tend to follow trails of previous one. This process enables the ants to find shortest paths between the nest and a food source. When ants fan out to find food, it may happen that a lucky ant finds a short path to a new food source. It then takes some food with it and makes its way back to the nest. Since it is attracted by its own pheromone trail, it is likely that the ant follows its own path back to the nest, thereby leaving a second pheromone trail. If other ants happened to take a longer path to the food source, they arrive after the first ant and, when trying to make their way back to the nest, there is a good chance for them to be attracted by the short path, where already two pheromone trails have been laid. This reinforces the short path even more and makes it more attractive. Concerning the longer path, pheromones tend to evaporate after some time, so in the long run the long paths will be forgotten and almost all ants will take the short path. The characteristics of ants are similar to the characteristics of MANETs. This helps us to apply the food searching characteristics of ants for routing packets in MANETs.

### **2.3 Bee Colony System**

Honey bee colonies have attracted a strong interest as a potential source of inspiration for the design of optimization strategies for dynamic, time-varying, and multi-objective problems. Bee colonies show structural characteristics similar to those of ant colonies. Bees utilize a sophisticated communication protocol that enables them to communicate directly through bee-to-bee signals and when required, similar to ants, use stigmergic feedback cues for bee-to-group or group-to-bee communication. In these two classes of insects, communication and cooperation is realized according to radically different modalities due to the different nature of these insects (ants mainly walk, while bees mainly fly). In the case of ants communication is achieved via a pheromone trail that is laid on the ground while walking, in the case of bees it is a form of visual communication that plays an equivalent role.

Bee Colony Optimization (BCO) [12] is the SI system where the low level agent is the bee. BCO is the name given to the collective food foraging behavior of honey bee. This system is a standard example of organized team work, well coordinated interaction, coordination, work division, simultaneous task performance, specialized individuals, and well-knit communication. In a bee colony there are different types of bees like a queen bee, many male drone bees and thousands of worker bees. The Queen's responsibility is of laying eggs so that new colonies can be formed. The Drones are males of the hive and are responsible to mate with the Queen. This is their sole role in the hive. The worker bees are the females of the hive. They are the major building blocks of the hive. They build the honey bee comb, clean it, maintain it, guard it and feed the queen and drones. In addition to these, the main job of a worker bee is to search and collect rich food. There are two types of worker bees namely scout bees

and forager bees. Scout bees fly around and search for food sources available randomly. They return back to the hive after they exhaust their energy and distance limits. Upon returning to the hive they share their exploration experience and a lot of important information with the forager bees. The scouts tell the foragers about the location of rich food sources which comprises of the direction of the food source from the hive with respect to sun and distance from hive. This is completed using a dance called “waggle dance” which is in the figure of digit “8”. It also indicates the quality of food. The forager bee closely observes the scout bee to learn the directions and information given by scout and then goes to collect food.

### **III. SWARM INTELLIGENCE BASED ROUTING**

Swarm intelligent (SI) based routing discussed in this section. SI routing does away with firm rules and instead allows the system to self-organize on its own accord. Swarm intelligent based routing for wired and wireless networks are discussed with ad-hoc protocols.

#### **3.1 Wired Networks**

A number of proposals exist which apply the principles of swarm intelligence to routing in wired networks. These include Ant-Based Control (ABC), AntNet, Cooperative Asymmetric Forwarding (CAF), Virtual-Wavelength Path Routing (VWPR), Multiple Ant Colony Optimization (MACO) [13], Mobile Ants-Based Routing (MABR) [14], among others. ABC is the oldest with its introduction in 1996. AntNet is to be credited as the most well known due to its solid performance and design by the inventors of the related and extremely successful Ant Colony Optimization (ACO) algorithm. CAF optimizes some approaches used by AntNet and also extends a distance vector methodology. VWPR is included for its introduction of the pheromone repel feature in routing, a vastly underappreciated technique in this field borrowed from ACO. The Multiple Ant Colony Optimization algorithm is a more straightforward adaptation of ACO to routing. It uses the idea of having multiple ant colonies discover paths, each being repelled by the pheromone of the other. This ensures that a larger search space will be covered and thus better routes should be found faster. MABR is based on AntNet and describe a hierarchical location-based routing scheme. The network topology is broken into a regular grid by an abstraction layer, and pheromone based routing is executed on the grid.

#### **3.2 Wireless Routing**

The routing problem in mobile wireless ad-hoc networks has received some attention from the swarm intelligence community. The properties of SI algorithms are very well suited to the problem, which requires optimization in a dynamic environment. The Probabilistic Emergent Routing Algorithm (PERA) is the first routing algorithm to be proposed in 2002. This was quickly followed by the Ant-like Routing Algorithm (ARA) and Termite in 2003, with Ad-Hoc Networking with Swarm Intelligence (ANSI) in 2004. Many of these algorithms extend AntNet or ABC to the ad-hoc problem; the forward/backward ant architecture is used for route discovery and then various route repair and error schemes are proposed.

#### **3.3 Ad-Hoc Networking with Swarm Intelligence**

The Ad-Hoc Networking with Swarm Intelligence algorithm (ANSI) by Rajagopalan and Shen is the most recent addition to the SI MANET routing family in 2004 [15]. This algorithm is introduced with the intention of creating an algorithm with complementary proactive and reactive components, able to adapt to more flexible metrics, such

as a node capability. In contrast to many other SI routing algorithms, ANSI allows a proactive routing feature in addition to the standard reactive approach. This follows in the footsteps of other dual mode MANET routing algorithms such as the Zone Routing Protocol (ZRP) [16] and the Sharp Hybrid Ad-hoc Routing Protocol (SHARP) [17]. Such systems are generally defined such that a node proactively keeps track of routes to all destinations within a certain zone, and routes to the rest are maintained reactively. A separate proactive routing protocol and reactive routing protocol are defined to handle each case. The hybrid protocol is often designed such that any previously defined proactive and reactive algorithms can simply be plugged in. The hybrid protocol then defines how zones are managed. The zone of a node is an area defined by a given hop diameter. The zone may be predefined or calculated online according to the needs of the network. In ANSI, proactive ants are sent periodically by each node in order to establish routes to their source. This is similar to the route discovery approach used by PERA. The impact of the flood is minimized by using packet identifiers, a limited time-to-live in each packet, and a probabilistic flooding (gossiping) scheme. As each proactive ant moves through the network, it updates the current node with information from its stack. ANSI follows the PERA method for reactive routing to non-local destinations. Forward ants are flooded while keeping their path and metric information on a stack. When a forward ant arrives at the destination, a backward ant is unicast along the forward ant's reversed path to the source. However, the forward ant flood radius is increased iteratively, equivalent to AODV's optional expanding ring search.

#### **IV. SWARM INTELLIGENCE BASED ROUTING PROTOCOLS AND ALGORITHMS**

Akkaya and Younis [2] group routing protocols for WSNs into four categories: (1) data-centric, (2) hierarchical, (3) location based, and (4) QoS-aware. Data-centric protocols do not require a globally unique ID for each sensor node, and perform multihop routing by using attribute-based naming approaches. Hierarchical protocols separate the network into small clusters with a representative node acting as a cluster head. Location-aware algorithms make use of the information related with geographical position of a node to perform energy efficient routing. QoS-aware protocols can explicitly deal with multi-constrained requests for data transmissions. More recently, Boukerche et al. [18] have proposed a taxonomy that enlarges Akkaya and Younis's by considering six architectural categories: attribute-based, flat, geographical, hierarchical, multipath, and QoS-based.

The new category flat refers to the case in which a large number of nodes collaborate together to sense the environment. The nodes are all similar and global IDs cannot be assigned to them. This category includes the algorithms that compute multiple paths from sources to destinations in order to cope effectively with failing nodes. In this section, we review selected SI routing protocols for WSNs and highlight their properties with respect to the taxonomy of routing protocols. In the following subsections, we discuss ACO-based protocols, bee-inspired protocols and others.

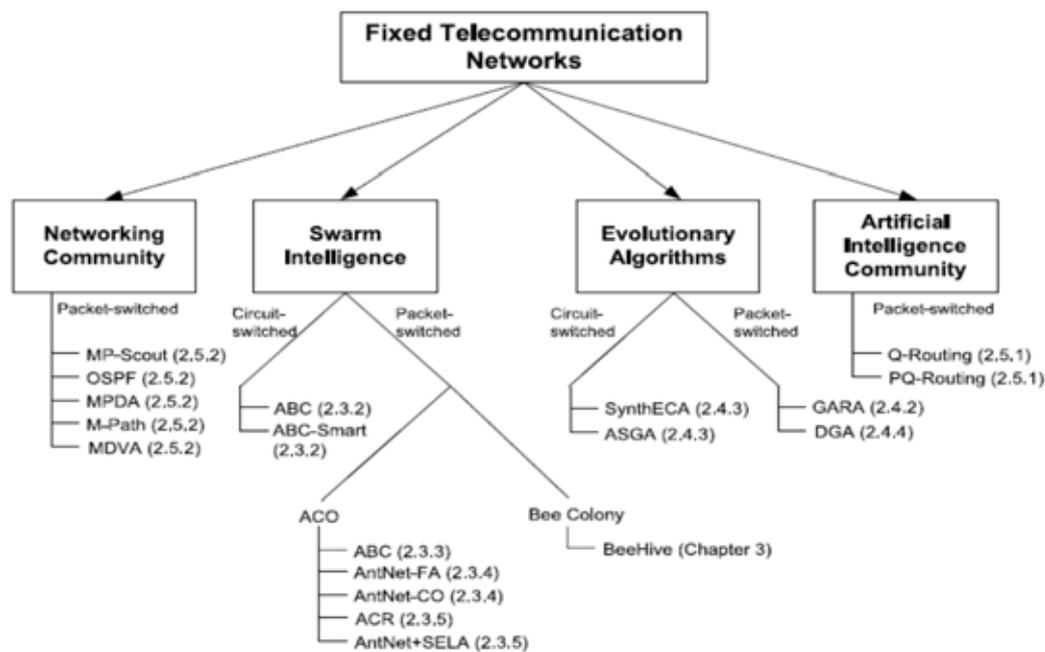


Figure 3. A taxonomy of routing protocols for fixed telecommunication Networks [19]

#### 4.1 Ant Based Routing Protocol

ANT Based Routing Protocol has taken the inspiration from real ants which are wandering around their nests to forage for search of food. Upon finding food they will return back to their nests and simultaneously deposit pheromone trails along the paths. The ant selects its next hop based on the amount of pheromone deposited on the path to the next node. The problem of finding shortest paths maps quite well to the problem of routing in networks. The ants are nothing but small control packets, which have the task to find a path towards their destination and gather information about it. Ant-like mobile software agents, who are analogous to the ones used real ant colony's biological behaviour, are employed for discovering network topologies and thus efficient routing in the networks. Ant-like mobile agents are an effective means to discover the network topology in particular in circumstances such as MANET in which the network topology frequently changes. Routing based on ant-like agents does not require frequent exchanges of update messages for routing tables. As the network population becomes dense, an ant-like agent becomes more effective for load balancing in the network. Ant-like agents are a known means to mitigate congestion. The pheromones may be used as a measure for any metric under consideration such as average delay, bandwidth and jitter. The basic principle of all these algorithms is that current traffic conditions and link costs are measured by transmitting "artificial ants" into the network. These ant packets mark the travelled path with an "artificial pheromone," that is, update the routing table depending on the collected information. Therefore, they increase the probability of choosing a certain link for a given destination. Results from ant based routing applications in fixed and wired network are very promising.

##### 4.1.1 Ant Based Control

Ant based control (ABC) is another stigmergy based ant algorithm designed for telephone networks. It shares many similarities with AntNet, but also incorporates certain differences. Ant-Based Control was introduced by Schoonderwood, Holland, Bruten, and Rothkrantz in 1996 and is considered to be the first biologically inspired

routing algorithm [22]. It is a routing algorithm for circuit-switched (eg. telephone) networks which routes calls based on the local interaction of mobile agents. Mobile agents (ant packets) traverse the network, updating routing tables at each node depending on the observed path quality. Routing tables consist of next hop probabilities for each destination. Ants traveling in one direction influence the placement of calls in the opposite direction. Symmetric bidirectional links are assumed. ABC follows the ant food foraging analogy very closely. The basic principle relies on mobile routing agents, which arbitrarily explore the network and bring up to date the routing tables according to the current network state. The routing table, storing probabilities instead of pheromone concentrations, is exactly similar as in AntNet. Also, probability balanced randomness of the ants path selection is employed to favour the detection of new paths. One significant difference applies to the use of the routing agents is; ABC only uses a single class of ants (i.e. FANTs), which are initiated at regular time intervals from every source to a randomly chosen destination. After arriving at a node they immediately update the routing table entries for their source node, meaning that the pheromone pointing to the previous node is increased. It is important to see that only the backward route is influenced, and packets travelling towards the ant's source profit from that route update. Ant packets are launched on regular intervals by each node in the network to a random destination. They are routed randomly according to the probabilities present in the pheromone table for their particular destination. In order to encourage ants to try new paths, a noise factor is added to the routing decision. This is necessary in case the network conditions should change or better routes become available. If a high probability route exists, there is little incentive to stop using it, even if its quality drops. The probability update equation only allows routing probabilities to be positively reinforced when a link is used.

#### **4.1.2 Ant Net**

AntNet is an approach from 1997 by Dorigo and Di Caro to using the social insect analogy to solve the routing problem in wired packet switched networks [23]. Unlike ABC, AntNet assumes asymmetric bidirectional links. Routes from destination to source, also known as reverse routes, cannot be influenced by an ant moving from source to destination as was the case in ABC. An ant moving in the forward direction will experience different costs than an ant moving in the reverse direction. AntNet is an algorithm conceived for fixed and wired networks, which derives features to use two different network exploration agents, i.e. forward and backward ants (BANTs), which collect information about delay, congestion status and the followed path in the network. At regular intervals, each node in the network sends a forward ant packet to a randomly chosen destination. Forward ants are routed probabilistically as in ABC. Each node contains a routing (pheromone) table indicating the utility of a particular link to arrive at a destination. This utility is described by a probability. In order to ensure that the entire network is explored consistently, a forward ant chooses a next hop uniformly according to an exploration probability. This feature serves the same purpose as that of noise in ABC. Forward ants (FANTs) are emitted at regular time intervals from each node to a randomly selected destination. This transmission occurs asynchronously and concurrently with the data traffic. As soon as a FANT arrives at the destination, a BANT moves back to the source node reverse the path taken by the FANT. The subdivision in forward and BANTs has the following reasons. The FANTs are just employed for data aggregation of trip times and node numbers of the path taken without performing any routing table updates at the nodes. The BANTs get their information from the FANTs and use it to achieve routing updates at the nodes. Each node in the network maintains two structures, which the agents co-operate with and concurrently read and write to routing table.

#### 4.1.3 Probabilistic Emergent Routing Algorithm (PERA)

The Probabilistic Emergent Routing Algorithm (PERA) designed by Baras and Mehta in 2002 is the first swarm intelligent MANET routing algorithm [24]. It operates very much in the way of AntNet, using forward and backward ants to collect and distribute information about the network. It also borrows elements from more traditional contemporary routing algorithms such as AODV and DSR. This algorithm works in an on-demand way, with ants being broadcast towards the destination at the start of a data session. Multiple paths are set up, but only the one with the highest pheromone value is used by data and the other paths are available for backup. The route discovery and maintenance is done by flooding the network with ants. Both forward and backward ants are used to fill the routing tables with probabilities. These probabilities reflect the likelihood that a neighbour will forward a packet to the given destination. Multiple paths between source and destination are created. First of all, neighbours are discovered using HELLO messages, but entries are only inserted in the routing table after receiving a backward ant from the destination node. Each neighbour receives an equi- probable value for destination. This value is increased as a backward ant comes from that node, establishing a path towards destination. As ants are flooded, the algorithm uses sequence numbers to avoid duplicate packets. Only the greater sequence number from the same previous hop is taken into account. Forward ants with a lower sequence number are dropped. This approach is similar to AODV Route Request packets, but discovers a set of routes instead of one. Data packets can be routed according to the highest probability in the routing table for the next hop.

#### 4.1.4 Ant Agents for Hybrid Multipath Routing [AntHocNet]

Frederick et al proposed a routing algorithm for mobile ad hoc networks, inspired by bio ant colonies behavior, named as AntHocNet [25]. Ant Agents for Hybrid Multipath Routing in Mobile Ad hoc networks (AntHocNet) technique is used for the typical path sampling. AntHocNet is a multipath routing algorithm for mobile ad-hoc networks that combines both proactive and reactive components. It maintains routes only for the open data sessions. This is done in a Reactive Route Setup phase, where reactive forward ants are sent by the source node to find multiple paths towards the destination node. Backward ants are used to actually setup the route. While the data session is open, paths are monitored, maintained and improved proactively using different agents, called proactive forward ants.

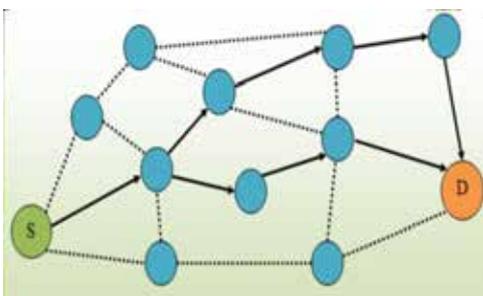


Figure 4. Kite-shaped, multiple paths

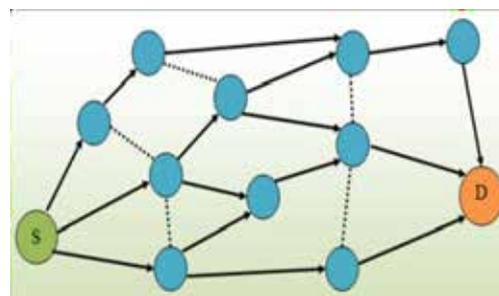


Figure 5. A mesh of multiple paths

The proposed algorithm works reactive as well as proactive components. Multiple paths are built up between the source and destination in reactive behavior. In AntHocNet data is stochastically spread over the paths depending on the estimated quality. Proactively all the paths are monitored during the course of session. The simulation of this algorithm is done in the Qualnet. The simulation results are better than the AODV algorithm. The ACO

behavior is incorporated in the pheromone bootstrapping mechanism is exploited for the efficient learning of pheromone table. Figure 4 shows the reactive path setup process which depicts the Kite-shaped scenario.

Figure 5 shows the multiple path setup process in the AntHocNet algorithm which mesh of multiple paths. AntHocNet algorithm is better in performance than AODV protocol.

#### **4.1.5 ABDRA**

Rajeshwar Singh et al proposed routing algorithm for MANETs based on Swarm Intelligence paradigm named as Ant Based on Demand Routing Algorithm (ABDRA) in [27]. This is multi-path routing algorithm, resulted in upgrading in packet delivery ratio. The ABDRA exploits various features of both AODV and DSR algorithms. This algorithm is able to reducing the route discovery time that results in effectively network topology change management. In ABDRA, two ants FANT (forward ant) and BANT (backward ant) are used. FANT is formed at source and moves to destination while BANT is formed at destination and follows the part of FANT. The route finding is done by searching the destination path from the routing table. On the non availability in the routing table, forward ant is formed and broadcasted to all adjoining nodes. The congestion is controlled by the route maintenance phase by changing the pheromone value. This algorithm is simulated in NS2.29 and compared with AODV protocol. The performance metrics was average end to end delay and packet delivery fraction for evaluation of AODV and ABDRA. The simulation results provide the performance of ABDRA is better than AODV.

#### **4.1.6 ARAMA**

Ant Routing Algorithm for Mobile Ad-hoc networks (ARMA) algorithms was proposed by O. Hussein and T. Saadawi in 2003 [28]. Every node in the network can work as a source node, destination node, and intermediate node. The functionality of source, intermediate and destination nodes is sending forward ants for path request, updating of the probability routing table and gradation of forward and backward ants correspondingly. The search or path maintenance to a destination is done by sending forward ants. ARAMA is implemented using OPNET simulation model for MANET node to study the performance of ARAMA. In addition, ARAMA is self-built and self configured routing protocol for MANETs that combines both on-demand and table based routing features.

#### **4.1.7 EEABR**

Tiago Camilo et al proposed a new energy constrained routing protocol based on subfield of Swarm Intelligence paradigm, Ant Colony Optimization for Wireless Sensor Networks, known as Energy-Efficient Ant-based Routing algorithm (EEABR) in [29]. The EEABR algorithm exploits bio inspired, ant behavior, meta-heuristic approach, Ant Colony Optimization (ACO) for optimization in selection of paths between the sensor nodes and destination node with under consideration of short in length, energy efficiency and lifetime maximization of the Wireless Sensor Network. In this algorithm, the selection of next network node probability is a function of the node energy and pheromone value deposited on the connections between the nodes. The proposed approach promises for the reduction of communication load related to the ants and the energy consumption during communications. The energy saving is directly proportional for the lifetime of the network. In EEABR algorithm, ant information is stored on every node while timeout value, previous and forward node information and the ant identification is stored in the routing table. On the arrival of forward ant, node searches the routing table for the

corresponding ant identification, if found then ant is eliminated otherwise node saves necessary information relevant to the ant. On receiving of backward ant, node searches its routing table for the next node. Backward ant record is updated according to a defined time period. The authors have given simulation results in NS2, comparison of proposed approach (EEABR) against basic ant-based routing algorithm (BABR) and improved ant-based routing algorithm (IABR). For the performance comparison, four metrics were used, that are average energy, minimum energy, standard deviation and energy efficiency. With respect of performance metrics, the proposed approach is promising.

#### **4.1.8 LEACH-P**

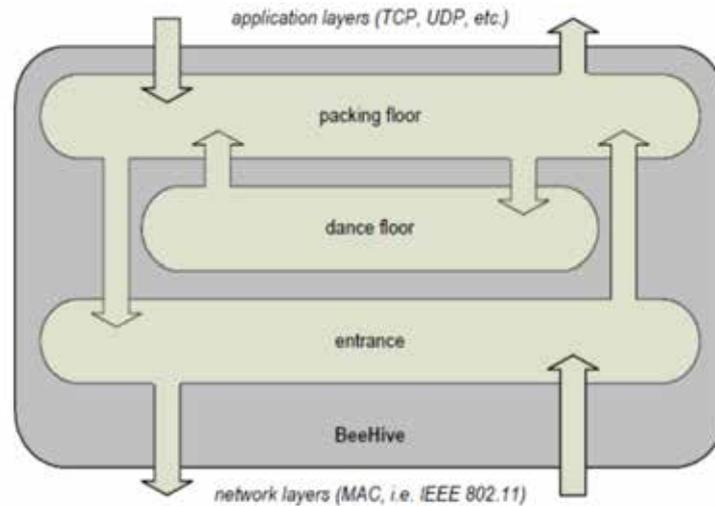
Liao Ming-hua et al proposed a energy aware routing algorithm based on ant colony principle and Low Energy Adaptive Clustering Hierarchy (LEACH) protocol named LEACH-P, for wireless sensor networks in [30]. This routing method concentrates on the minimization of energy consumption during the data transmission to the sink by multiple hops. In the new protocol, the node energy consumption is predicted during the next-hop probability calculation. The proposed algorithm works in four steps. The cluster-head nodes are elected according to LEACH protocol and a cluster-head is selected from the cluster-head set. The LEACH-P algorithm is simulated in MATLAB 7.0. This approach is compared with LEACH, with respect to the network lifetime and cluster-head energy consumption. The simulation results gives the performance of LEACH-P algorithm is promising. As a future work, the relationship between the node hop and the optimal path can be researched.

### **4.2 Bee Inspired Routing Protocols**

Bee Colony Optimization (BCO) can be applied to software testing, puzzle solving, numerical complexity problems, routing problems, networking problems, assignment problems, optimization problems, accident diagnosis etc. BCO has immense capabilities to solve problems with minimum scope to solution. In the area of routing protocols for ad hoc networks, researches have proposed few protocols based on BCO, which include Artificial Bee Colony (ABC), BeeAdHoc protocol etc.

#### **4.2.1 BeeAdHoc**

BeeAdHoc is a nature inspired routing protocol for MANETs based on the foraging principles of honey bees [32]. It mainly utilizes two types of agents – scouts to discover routes and foragers to transport data. Figure 6 will give an overview of the BeeAdHoc architecture. In this, every node maintains a hive with an Entrance, Packing Floor and a Dance Floor. Entrance provides an interface to the Media Access Control (MAC) layer of the network stack and handles all incoming/outgoing packets. A scout received at the entrance is broadcasted further if its time to live (TTL) timer has not expired or if it has not arrived at the destination. The information about the id of the scout and its source node is stored in a table. If another replica of an already received scout arrives at an entrance of a hive then the new replica is killed. If a forager with a same destination as that of the scout already exists in the dance floor then the route to the destination is given to the scout by appending the route in the forager to its current route. If the current node is the destination of a forager then it is forwarded to the packing floor else it is directly forwarded to the MAC interface of the next hop node.



**Figure 6: Overview of the BeeAdHoc architecture**

Packing floor is an interface to the transport layer and receives data from it. Once a data packet arrives from the transport layer, a packer is created in this floor which stores the data. After this, packer tries to locate a suitable forager for the data packet from dance floor. If it finds then it handovers the data to forager and dies. The dance floor is the heart of the hive because it takes important routing decisions. Once a forager returns after its journey it recruits new foragers by dancing according to the quality of path that it traversed. A lifetime forager evaluates the quality of its route based on the average remaining battery capacity of the nodes on its route. A lifetime forager might allow itself to be cloned many times in two scenarios: one, the nodes on the route have enough remaining battery capacity (good route), two, if large number of packers are waiting for it even though its route might be having nodes with little battery capacity. On the other hand, if none of the packers are waiting then a forager with a very good route might not dance because its colleagues are doing a nice job in transporting the data packets. This concept is directly borrowed from the behavior of scout/forager bees in Nature, and it helps in regulating the number of foragers for each route.

### 4.3 PSO-ODMRP

E.Baburaj and V.Vasudevan proposed a new, bio-inspired, based on PSO, On Demand Multicast Routing Protocol (PSO-ODMRP) to reduce the vulnerability in multicast routing protocols, due to component breakdown in ad-hoc networks [33]. The working procedure of On Demand Multicast Routing Protocol is a mesh-based. The ODMRP is a demand driven multicast protocol, forming a mesh of nodes used for forwarding data packets between source and receiver. A multicast tree is built by the source periodically for groups by flooding a control packet throughout the network and nodes responding to the flood join the tree. PSO based algorithms is designed on the natural principle of a fitness function. Due to the control of physical and social behavior such as movement of hosts, interference, terrain, battery power or weather, links can go up and down in a MANET. The simulation is done in NS-2 for ODMRP and PSO-ODMRP protocols for the performance evaluation. The performance metric for this comparison was consists on “packet delivery ratio” and “control overhead”. The simulation results are promising for PSO-ODMRP than ODMRP. The author find out that the performance of proposed protocols is good in low mobility while it decreases with the increase in mobility. This proposed protocol is more appropriate for the MANETs where topology changes are frequent and power constrained.

#### **4.4 M-DiPSO**

Ping Yuan et al proposed optimal multicast routing protocol in Wireless Ad hoc Sensor Networks named as Multiphase Discrete Particle Swarm Optimization (M-DiPSO) [34]. M-DiPSO gives flavor to of discrete version of particle swarm optimization algorithms. This approach incorporates hill climbing using random-sized steps in the search space. So the hill climbing speeds up the convergence. The particles in the swarm deployed in M-DiPSO, are divided into groups that follow various search strategies. This approach focused on connectivity and broadcast constraints as well as energy-aware multicast routing. This method is appropriate for static and low speed wireless ad hoc networks.

#### **4.5 TPSO**

Shahin Gheitanchi et al proposed a model for communication networks based on Swarm Intelligence approach, particle swarm optimization, named trained PSO (TPSO) in [35]. The proposed approach is promising to reduce traffic and computational overhead of the optimization process. The TPSO approach is employed for the finding of node, possessing highest processing load, in an ad-hoc network. The working of the TPSO is similar that of basic PSO with some modifications. Here each particle exploits fitness function specific for the measure of solution quality. The local best (LB) and global best (GB) solutions are saved simultaneously and comparison is done between LB and GB to choose direction. Due to the distributed nature of particles, the proposed model for ad hoc networks is promising for efficient distributed processing with multi-objectives. The authors simulated the TPSO against PSO, in ad-hoc collaborative computing network with 50 nodes and 30 particles. The simulations results show the very low traffic overhead for the TPSO against PSO. The particles convergence is near constant in comparison to PSO.

### **V. CONCLUSION**

Wireless sensor networks consist of large sets of resource-constrained nodes. The design of effective, robust, and scalable routing protocols in these networks is a challenging task. On the other hand, the relatively novel domain of swarm intelligence offers algorithmic design principles, inspired by complex adaptive biological systems that well match the constraints and the challenges of WSNs. Therefore, a number of routing protocols for WSNs have been developed in the last years based on SI principles and taking inspiration from foraging behaviors of ant and bee colonies. In this paper, we have presented a rather extensive survey of these SI-based algorithms for routing in WSNs. We have also pointed out a number of methodological flaws in the way these algorithms are commonly presented and empirically evaluated. Finally, we have outlined a general recipe for the definition of scientifically sound experiments and performance evaluation. In this survey paper, Swarm Intelligence based classification, PSO, ACO and Honeybees, nature inspired routing algorithms in WSNs are critically analyzed and their suitability is observed. SI based routing techniques are more promising for specific nature of Ad hoc & Sensor Networks due to the freely mobility and frequent topology changes. The researches done have made known that ant based routing protocols can eliminate at least one or several problems such as battery life, scalability, maintainability, survivability and adaptability. Therefore, ant based approaches are attracted by much researchers than other approaches. This paper concludes that ACO approaches are very promising for route optimization in MANETs while PSO is very effective for load balancing and energy optimization in WSNs.

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# THEORETICAL MODELING OF GASB/INASSB MWIR-APD FOR FREE-SPACE OPTICAL COMMUNICATION APPLICATIONS

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## ABSTRACT

*A generic numerical model of a MWIR avalanche photodiode (APD) based on narrow bandgap semiconductor InAsSb is reported in the present paper. The model has been applied for theoretical characterization of a proposed  $N^+$  GaSb/P- InAsSb avalanche photodiode structure for possible application in 2-5 $\mu\text{m}$  wavelength region. The multiplication gain of the APD has been computed on the basis of local field theory. The MWIR APD is expected to find application in free-space optical communication system.*

**Keywords:** *Gasb, FOC, Avalanche Photodiode, Multiplication Gain, Excess Noise Factor*

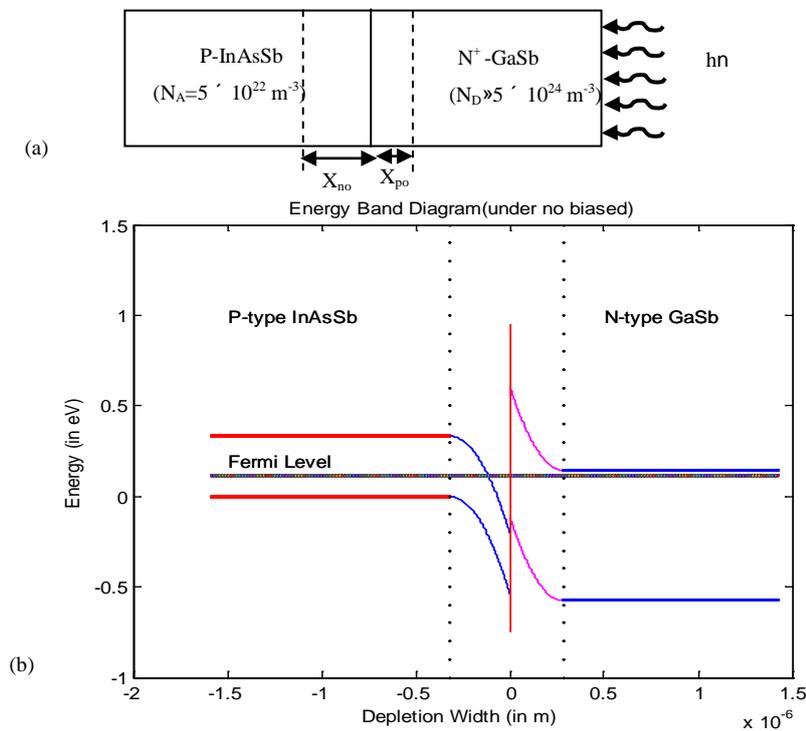
## I. INTRODUCTION

Free-space Optical Communication (FOC) represents one of the most promising approaches for addressing the emerging broadband access market. In the recent years, free-space optical communication has drawn considerable interest in commercial and military applications due to high available bandwidths, portability and high security of systems. The other advantages of free-space optical communication over optical fiber communication include quick link set up, rapid deployment time, license- and tariff-free bandwidth allocation, low power consumption etc. FOC system can offer up to 100 Gb/s data rates between two points [1]. These systems are also compatible to a wide range of other communication system and are sufficiently flexible so as to be easily implemented using a variety of different architectures. Several researchers have already established that infrared region is best suited for free-space optical communication [2],[3]. InAsSb based mid-wavelength infrared (MWIR) photodetectors operating in the 2-5  $\mu\text{m}$  spectral range find application in free-space optical communication. In free-space optical communication system, photodetector is the key component in the receiver unit. Successful implementation of free-space optical communication receiver at these wavelengths requires development of suitable photodetectors operating at these wavelengths. Long-wavelength infrared semiconductor photodetectors also find a variety of non-telecommunication applications. As the long-wavelength region contains the fundamental fingerprint absorption bands of a pollutant and toxic gases, the LWIR photodetectors are very attractive use in optical gas sensors [4]-[6]. The gas sensing instrumentation can be greatly simplified by making use of multiplication photodetector such as an avalanche photodiode (APD). The energy bandgap of  $\text{InAs}_{1-x}\text{Sb}_x$  vary with composition from 0.4 eV (77 K) to 0.1 eV (300 K) making it attractive for use in the 3-5  $\mu\text{m}$  and 8-13  $\mu\text{m}$  spectral range, respectively [7]. The advantage of InAsSb over the other material include higher electron and hole mobilities, high-quality and low cost substrate. The performance

of such devices is strongly influenced by several factors which are special to narrow band gap semiconductors. The operation of such devices is highly restricted by the requirement of low temperature operation.

## II. THEORETICAL MODEL

The structure under consideration is avalanche photodiode (APD) in which InAsSb is intended to be used as the light absorption region. The proposed APD structure is supposed to be grown on a GaSb substrate. The structure and energy band diagram of proposed structure shown in Fig.1(a).



**Fig. 1- (a) Schematic diagram of the Avalanche photodetector structure (b) energy band diagram**

The N<sup>+</sup>-P junction is used to create a narrow multiplying region. The photogenerated carriers in the narrow bandgap InAsSb material undergo avalanche multiplication before being collected at the output terminals. The theoretical characterization of the detector has been carried out in respect of multiplication gain (M) and excess noise factor F(M) of the APD at room temperature using the local field theory of impact ionization.

The equation governing the electron and hole current distributions at any point x in the avalanche multiplication region can be written as

$$\frac{di_p(x)}{dx} = -\frac{di_n}{dx} = a(x)i_n(x) + b(x)i_p(x) + g_0(x) \quad (1)$$

where  $g_0(x)$  is the sum of the thermal and optical current generation rate,  $a$  and  $b$  are electron and hole ionization coefficients which are functions of electric field at the point  $x$ . For steady state these equations are easily solved to find the multiplication gain at any point  $x$  as

$$M(x) = \frac{\exp\left(\int_{x_0}^x (a-b) dx\right)}{1 - \int_0^W a \exp\left(\int_{x_0}^x (a-b) dx\right) dx} \quad (2)$$

Here the limits of integration in equation (2) e.g., 0 and W are the two boundary surfaces of the photodiode where avalanche multiplication takes place.

$$\text{Here } M_n = M(0) \text{ at } x = 0;$$

$$\text{and } M_p = M(W) \text{ at } x = W;$$

where W is avalanche multiplication thickness.

If the only carriers injected into depletion layer are holes then the excess noise factor for holes is given by

$$F_p = M_p \left[ 1 + \frac{a - k}{k} \frac{M_p - 1}{M_p} \right] \quad (5)$$

$$\text{and } F_n = M_n \left[ 1 - (1 - k) \frac{M_n - 1}{M_n} \right] \quad (6)$$

if the only injected carriers are electrons.

where  $k = b/a$  is constant,  $a$  and  $b$  are the ionization coefficients of electrons and holes, respectively and  $M_n$  and  $M_p$  are the electron and hole multiplication factors respectively.

Also, for a general avalanche photo diode with non-uniform electric field examined the validity of the constant  $k$  approximation by defining the quantities,

$$k_1 = \frac{\int_0^w b M(x) dx}{\int_0^w a M(x) dx} \quad (7)$$

and

$$k_2 = \frac{\int_0^w b M^2(x) dx}{\int_0^w a M^2(x) dx} \quad (8)$$

Where,  $M(x)$  is the position-dependent multiplication of electron-hole pair injected at position  $x_0$ . Using these quantities the expressions for the excess noise factor can be written as

$$F_n = k_{eff} M_n + \frac{1}{M_n} (1 - k_{eff}) \quad (9)$$

and

$$F_p = k'_{eff} M_p + \frac{1}{M_p} (1 - k'_{eff}) \quad (10)$$

where,  $k_{eff} = (k_2 - k_1^2)/(1 - k_2)$  and  $k'_{eff} = k_{eff}/k_1^2$

The Eq. (9) and (10) is used to analyze the noise performance of avalanche photodiodes.

### III. RESULT AND DISCUSSION

The numerical calculations have been performed on an  $N^+$ -GaSb/P-InAs<sub>1-x</sub>Sb<sub>x</sub> for wavelength in mid infrared region operated at 300K. The incident photons with energy lower than bandgap of GaSb cross the  $N^+$  region with negligible absorption and get absorbed mostly in the narrow bandgap InAs<sub>0.88</sub>Sb<sub>0.12</sub> region creating electron-hole pairs. Fig. 2 shows the variation of electric field with distance  $x$  in the depletion region. The maximum value of electric field is attained at the junction (at  $x=0$ ). It decreases linearly as we move either side of the junction. The maximum value of electric field is  $1.5 \times 10^7$  V/m at  $x=0$  which is attained at reverse bias voltage 7.63 V.

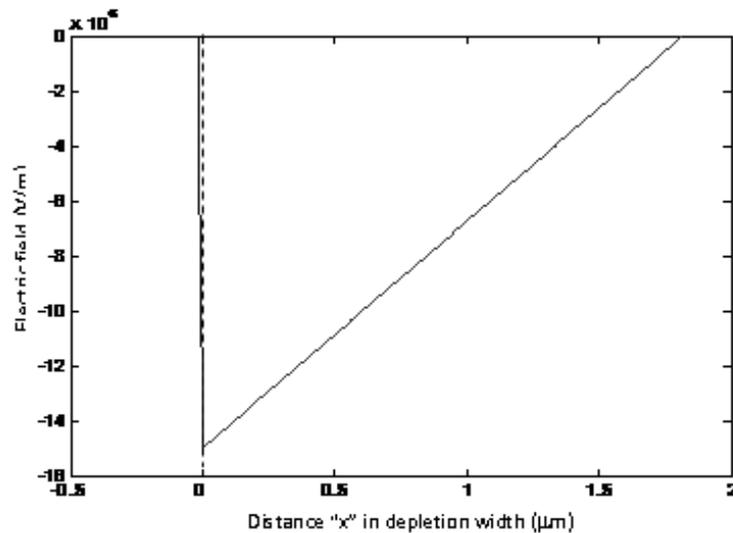


Fig. 2- Variation of electric field within depletion region

The dependence of multiplication gain where an electron hole pair is generated or injected in the depletion region is shown in Fig.3. It is seen that the multiplication gain of the APD remains low upto a reverse voltage very close to breakdown and increases sharply at breakdown. The actual multiplication gain depends on where the electron hole pair is injected as well on the variation on  $a$  and  $b$  with position throughout the depletion region.

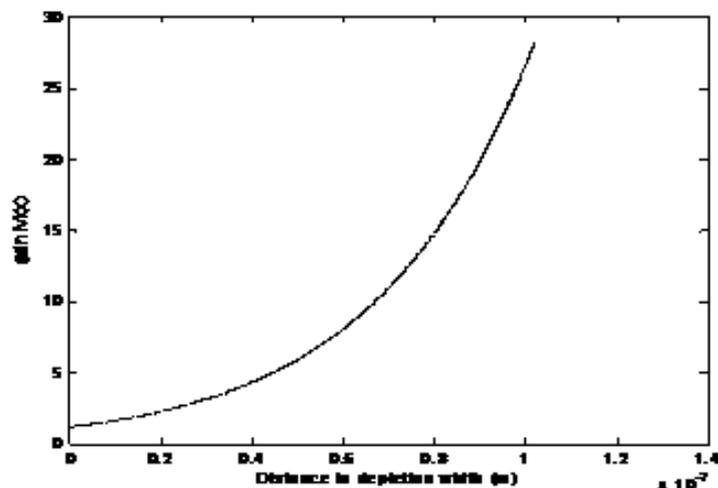


Fig. 3- Plot of net multiplication gain within avalanche multiplication layer thickness

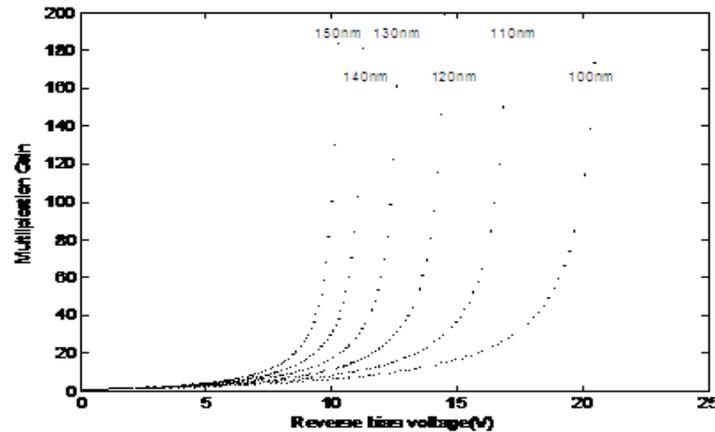


Fig. 4- Multiplication gain curves at different avalanche multiplication layer thickness.

Figure 4 shows the variation of multiplication gain with applied reverse bias voltage. At low voltage, the photo current response is relatively flat independent of bias which facilitates the identification of unity gain. This plot shows the calculated values for different thickness of avalanche zone. In this figure, it can be seen that the reverse bias voltage has to be increased for short avalanche width to achieve same values of gain at higher value of avalanche width.

#### IV. CONCLUSION

Free-space optical communication is the up-to-date technology for security and high available bandwidth of systems. A MWIR APD has been simulated to determine the electrical and optical characteristic of the device. The simulation is based on gain theory of history dependent ionization coefficient. The device can be operated at a suitable breakdown voltage to provide a high multiplication gain. FOC technology can be utilized for terrestrial communications, mobile communications and satellite communications.

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# SIGNALLING SYSTEM FOR UNMANNED LEVEL CROSSINGS

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## ABSTRACT

The objective of this paper is to provide a solution to the accidents that takes place at un-manned railway crossings of Indian Railway, with the application of laser sensor and comparators. Most of the accidents are due to negligence of rules. We are here describing a way to tackle this problem with LASER and PHOTO-SENSOR to make a signalling system which indicates an approaching train. This will reduce the loss of precious life and costs very low to be installed in any un-manned crossing.

**Keywords:** Comparator, Laser, Photo-resistor, Solar Energy, Un-manned Crossings.

## I. INTRODUCTION

Railway is the cheapest and time saving means of travelling. Indian railway is one of the world's largest rail networks covering approx 15,000kms on track and 65,436 kms on route with 7,172 intermediate stations.<sup>[1]</sup> The place where railroad crosses the roadways at same level is called 'level crossings'. Normally such crossings have a manned controlled gate to cut off road traffic for the approaching train.

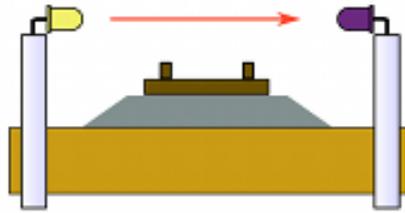
But in some rural and outskirts areas there is an unmanned crossing. The rule is "STOP; WATCH; LISTEN" i.e. Stop at the crossing; look both sides for approaching train; listen for the whistle. But in this world of hurry, no one has a time for stopping and looking, they just simply have a casual look and crosses. But the train approaches at a speed of 110 km/hr. This means 31 meter in just a second. It is a speed worth noticeable by naked eyes. And thus leading a crash accident with a lot of casualties. It has been noticed that mostly such accidents occurs in broad daylight.<sup>[2]</sup>



**Fig: 1 AN UNMANNED LEVEL CROSSING.**

Here we are proposing a signalling system which uses a laser and a photo-resistor sensor on the either side of the track.

## The Setup



**Fig:2 Laser And Sensor Placed on Track.**

The Photo-resistors are placed on one side of track and on other side the other side a laser beam is directed to it. When a train approaches it cut the light beam, which falls on the photo-resistor. This will lead to the “RED COLOURED LED LIGHTS” on the level crossing to glow. And when the train passes it will again set the laser light to fall on the photo-resistor and the LED LIGHTS will turn off.



**Fig:3 Common Chassis For All Types of Wagons.**

As railway uses a various types of wagons, so we have to place our setup at the level just above the wheels which is same for all types of wagons. For the power source, a solar panel and a battery is to be used. The circuit for this proposal needs very less power as we are using LED indicator which requires very less energy.

## II. THE CIRCUIT

The Circuit consist of a led which act as indicator , a photo- resistor which act as sensor, a laser which act as light source and the main component. A solar panel and battery to provide electricity. A comparator to read the sensor.

### 1.1. The LED indicator

LED stands for “Light Emitting Diode” it is a p-n junction diode which emits light when activated. When activated Electrons recombine with the holes and produces Light in form of ‘Photon’. It requires very less power, and these days widely used, so is ideal for Indicators. We need Red light to indicate approaching Train as Red is noticeable from a long distance.

### 1.2. Photo-Resistor

Photo resistor is also known as Light Dependent Resistor (LDR) or Photocell. It is a variable Resistor which is controlled by the amount of light falling on it. When the light beam falls on the receiver section of photo-resistor, then it offers a very low resistance. But in dark it offers a very high resistance. The variance of resistance on the effect of light makes it suitable for the light sensing. The resistance also varies on the intensity of light.

### 1.3. Laser

LASER simply stands for Light Amplification by Stimulated Emission of Radiation. We are using Laser as it is small but a rather powerful light source. We have placed the laser so that it falls on the photo-resistor to activate

it. We have chosen LASER LIGHTS over other source as it is compact and uses very less power. The power input and the strength of laser would depend on the “Width of the track at the crossing”. The resistance of Photo Resistor depends upon the frequency of the laser light also.

### 1.4. Comparator

Comparator is an electronic device which compares the input Voltages. It has two inputs ( $V_1$  &  $V_2$ ) and one output ( $V_{out}$ ). The output varies accordingly to the input. Output ( $V_{out}$ ) is 1 when the input voltage  $V_1$  is greater than input voltage  $V_2$ . And output ( $V_{out}$ ) is 0 when  $V_1$  is less than  $V_2$  [4]. The block diagram of Comparator is given as:

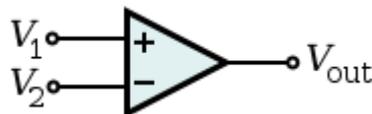


Fig:4 Block Diagram of comparator

Comparator is used to read the sensor (photo-Resistor) according to which the decision of signalling is taken. The circuit is designed so that the output will lead to the LED and signalling the approaching train.

### 1.5. Solar panel and other power components

For the circuit to work it need power source. A solar panel and a battery would be ideal for this as sun is the prominent source of energy. One  $m^2$  area of solar panel produces 1000Watt [3] which is sufficient for our circuit.

### 1.6. Circuit Diagram

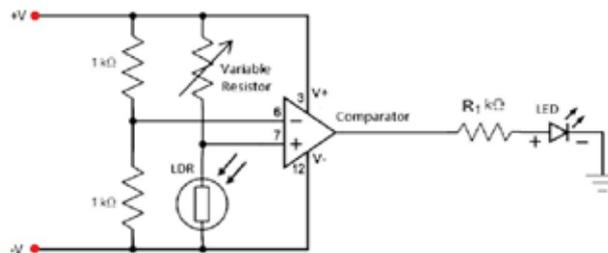


Fig:5 Circuit Diagram for Reading Sensor(LDR).

The voltage  $V$  is to be selected as per the Comparator. The Variable resistor is provided so that in case of change in frequency or intensity of the light it could be changed for the circuit to work. The resistor  $R_1$  is provided to control the current to the LED indicator. The final setup may look like

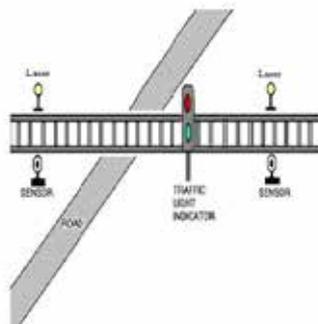


Fig:6 The Final Setup of Sensors

## **II. CONCLUSION**

This paper is intended to reduce the accidents at level crossing with a very less input cost. As everything in the world has its limitations, so do this system. If a person ignores the signal then this system fails. This system also fails if any animal or other obstruction is there in between laser n sensor. Foggy weather also affects the efficiency of this system. But still this system has much more benefit rather than limitations.

## **III. ACKNOWLEDGMENT**

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# AN EFFICIENT ENERGY ROUTING METHOD FOR WIRELESS SENSOR NETWORKS USING FAF

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## ABSTRACT

*Wireless sensor networks are made of sensor nodes with restricted battery life and transmission capability. Existing algorithms such as LEACH and FAF-EBRM do not have effective node selection mechanisms. To overcome this issue a Fuzzy logic rule based approach (FAF-EBRM) is proposed in this work and has been found to be more suitable of using fuzzy is to manage tolerance fuzzy logic implementation. Here Fuzzy logic rule is used to select the next hop node to transmit the data. The advantage of using fuzzy logic is to manage tolerance for imprecision and low cost of computation.*

**Index terms:** *Energy Balance Forward Aware Factor (EB-FAF), FuzzyLogic (FL)*

## I INTRODUCTION

WSN is an emerging technology that can modernize communication technology. Absolutely it has the potential to significantly change the way we live. The power of WSN lies in creating a persistent environment capable of remote sensing, monitoring and control. In the present scenario of global warming, WSN can enable fine grain remote monitoring of components. A radio, a processor sensors and battery. A WSN is formed by closely deployed sensor nodes in an applications. In most of the deployments, the sensor nodes have self-organizing capabilities, to create an appropriate structure in order to collaboratively perform a particular task. Wireless Sensor Networks are found more suitable for applications such as vigilance, precision cultivation, smart homes, automation, vehicular traffic management, environment monitoring, and disaster detection. In the wireless sensor networks, each sensor node collects signal from a limited region. This signal is getting processed in that sensor node. Information is generally transmitted to the observers.

Sensor nodes consume energy while receiving, processing and transmitting the information. In most of the cases, the sensor nodes are equipped with batteries which are not rechargeable. Therefore, energy competency is one of the important design goal in wireless sensor network. Nodes can be distributed into a number of small groups, called clusters, for collecting the data through efficient network organization. In general, each cluster has a cluster-head which coordinates the data gathering and aggregating process in a particular cluster. Each cluster member forward its data packets to the cluster-head. Clustering in wireless sensor networks guarantee the basic performance

achievement with a large number of sensor nodes. In other words, clustering improves the scalability of wireless sensor networks. This is because clustering minimizes the need for central organization and promotes local decisions.

The major benefits of clustering are:

1) Clustering provides the spatial reuse of resources to increase system capacity. For example, if the clusters are not neighbor, they can use the same frequency for wireless communication.

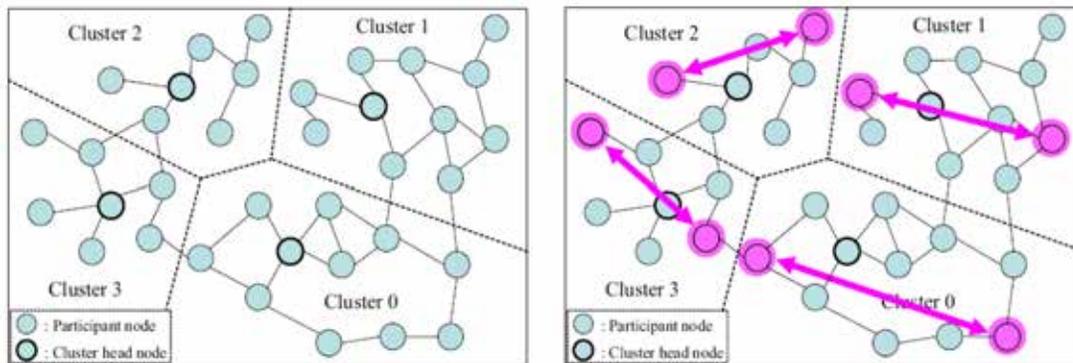
2) Routing informations of a cluster is shared with only other cluster-heads or cluster gateways. This restriction reduces number of transmissions performed for distributing routing information, By using the advantage of clustering, more energy efficient routing protocol have been implemented. When cluster structure is used in WSN, the local changes need not be reflected to entire network. This reduces information processed by the sensor nodes and stored in sensor nodes.

3) However, generally sensor nodes are deployed randomly by throwing them to the target region. Hence, this approach is not a practical one for real environments in most of the case. Some of the clustering algorithms employ uncertainties in the Wireless Sensor Networks. So, fuzzy logic rule can be used to avoid uncertainty. Basically, a fuzzy logic for blending a different clustering parameters to elect cluster heads according to the defuzzified output of fuzzy if-then rules. In the next section, we briefly discuss about the existing protocols available.

## II RELATED WORK

Energy dissipation over the network. LEACH also performs local data compression in cluster heads to decrease the amount of data that is forwarded to the base station. (2), Geographic routing is an attractive localized routing scheme for wireless sensor networks (WSNs) due to desirable scalability and efficiency. Maintaining neighborhood information for packet forwarding can achieve a high efficiency in geographic routing changes frequently due nodes mobility and availability.

Here, a novel on line routing scheme is proposed, called Energy-efficient Beaconless geographic Routing(EBGR),which can provide loop free, fullystateless, energy efficient sensor-to-sink routing at a low communication overhead without the help of prior neighborhood knowledge. In EBGR, each node first calculates its ideal next-hop relay position on the straight line toward the sink based on the energy-optimal forwarding distance, and each forwarder selects the neighbor closest to its ideal next-hop relay position as the next-hop relay using the Request-To-Send/Clear-To-Send (RTS/CTS).



**Fig 1 Cluster in WSN**

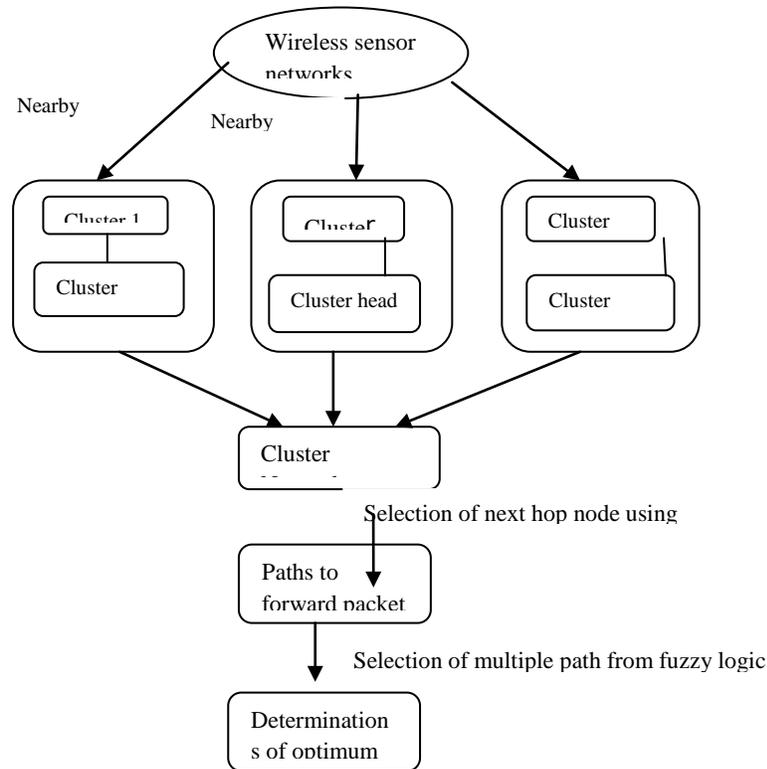
The application of sensor networks are endless, limited only by human imaginations. It also has some issues. Each sensor node has limited life time. So the network to be formed to avoid the data lost. For that the nearby nodes are formed as clusters. Among the nodes, one node is selected as the cluster head. Distance between the nodes and the cluster head also to be minimized for effective transmission of data.

Life time of sensor node is very less. To avoid the data lost in destroy of one sensor node, the additional node is needed to transmit data of the corresponding sensor node. For managing all the nodes, one head is needed. So all the sensor nodes are grouped in to clusters and cluster head is selected to forward the message to the nodes. The major challenges is how to forward the message with minimum energy.

### III EXISTING SYSTEM

BBV model is widely used to analyze the real complex networks such as scientist collaboration network and worldwide airport network. Similar to SCN and WWAN, there are numerous nodes and community structures (Clusters) In WSN, important nodes (cluster heads) have more connections than common nodes. Many researches on “energyhole” show that the data flow on each connection varies considerably in WSN because of these different distances to the sink node. Thus it is not suitable represent a connection as connected (“1”) or connection less (“0”).

Global information is limited in WSN of IA sensors exchange information in their “localworld”. The overall network and local-world theory is appropriate to model WSN of IA.



**Fig 2 Block Diagram Of a fuzzy logic based path determinations.**

## IV PROPOSED SYSTEM

A fuzzy clustering approach to the WSNs is analyzed to maximize its lifetime. This approach is a distributed competitive algorithm. It selects the cluster-head via energy based competition among the tentative cluster heads which are selected using a probabilistic model. This approach mostly focuses on wisely assigning competition ranges to the tentative cluster heads. In order to make wise decisions, it utilizes the residual energy and distance to the base station parameters of the sensor nodes, In performance Analysis of Clustering protocol handle uncertainties in competition ranges to the tentative cluster-heads which have higher residual energy levels, because they can serve as larger region. The system is implemented using the following.

### 4.1 Cluster Network Formation

Minimum number of cluster heads is identified to optimize energy in cluster formation for handshaking mechanism stateless, energy-efficient sensor-To-sink routing at a low communication overhead without the help of prior neighborhood knowledge. In(4) T-LEACH stands for threshold based LEACH because it replaces cluster heads based on the threshold value of residual energy on the sensor nodes. In traditional protocols relating to the cluster optimization, the authors proposed that the number of cluster heads be reduced to decrease energy consumption or that energy efficiency base optimal cluster sizes be constructed to extend the survival time of the network.

A set or randomly scattered wireless sensors. Sensors within a cluster are expected to be communicating with a cluster head only. The cluster heads summarize and process sensor data from the clusters and maintain the link with the base station. The clustering is driven by the minimization of energy for all the sensors.

Most clustering algorithms utilize two techniques which are selecting cluster heads with more residual energy and rotating cluster heads periodically to balance the energy consumption of the sensor nodes over network. These clustering algorithm do not take the location of the base station into consideration causes hot spot problems in multi-hop WSNs. The cluster heads near the base station die earlier, because they will be in heavier relay traffic than the cluster-heads which are relatively far from the base station. In order to solve this problem and to balance energy consumption of clustered-heads, next module is raised.

#### 4.2 Optimization of energy

After cluster network formation, Optimization of energy is done based on fuzzy logic rule. It is applied to select the next hop node for routing the data from one node to another node. It is achieved by considering the following parameters in selecting the next hop node. They are

- Time factor
- Node factor
- Threshold value

##### Time factor

The base station broadcasts the information to the node at time (t1), the acknowledgement received from the node at time (t2), then the Time Factor is calculated using

$$\text{Time Factor} = t_2 - t_1$$

##### Threshold value

Let p be path from the source to any destination and let r be the energy level of the ith node in the path p. The cluster-heads are stochastically selected. In order to select the cluster heads, each node generates a random number between 0 and 1. If the number is smaller than the threshold, T, the node becomes a cluster round. The threshold is calculated as follows.

$$T = \frac{P}{1 - P \times (r \bmod^{1/P})}$$

P is the number of the nodes becoming the cluster-heads and r is the number of current round. If a node once has been a cluster-head in the last 1/P rounds, it cannot be a cluster-head again.

##### Node Factor

Node factor for each node is determined. Node factor for each node is determined. Node Factor for nodes taking less time to communicate with base station.

## V PROPOSED ALGORITHM

Wireless Sensor Networks uses Forward Aware Factor routing algorithm for static data collection and event detection. The algorithm is implemented as follows.

- Determine the path from the source to the sink and also the next hop node for all the nodes in the corresponding path.
- It determine the set of all of the nodes that has destination as the node i
- Select the nodes that closer to Sink which constitutes the set of all of the possible next-hop nodes and the furthest node determine the path.
- Energy density is determined for the next hop node
- To calculate the weight of edges between i and each nodes.

## VI CONCLUSION

The proposed method uses the fuzzy logic for selection of next hop is based for the transmission because the crisp logic is not possible in imprecision situation. The results show that the node with higher remaining energy, lower distance has more probability. Being selected as the next node in forwarding the data to base station. In the experimental results show that FAFEBRM outperforms both. The proposed one balances the energy consumption, prolongs the function lifetime, and guarantees high QoS for Wireless Sensor Networks.

## VII ACKNOWLEDGEMENT

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# PLUMBOAT

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## ABSTRACT

*In the world of science and technology we can see that robots are revolutioning our world, thus performing critical jobs in extreme environment through engineering techniques. Recently, there has been increasing interest in the emerging field of robotics thus leading emerging era of robots calls for different types of skills. In this paper we are going to present an idea on robotics and its application in various fields we come across. Our main idea is to develop a system which will sense the parameter such as water leakage, gas leakage or the noise generated in the underground pipes. As we heard Leaky water pipes pose serious problems for cities, as it leads to the loss of roughly a billion Litres of clean drinking water every day, causing inconvenience to the people. Whenever there is a leakage problem in the underground pipes the entire roadways are dug to detect the cracks in the pipes and also the water supply is stopped for the same amount of span causing inconvenience to the people. Also, due to the destruction of entire roadways it becomes very difficult for the people to drive vehicles on the roads leading to traffic jam and inconvenience. The main purpose of our project is water-management. To avoid such problems. We have designed a robot which will sense the parameter such as water leakage, gas leakage or the noise generated in the pipe. which helps us to find the exact location of the leakage thus avoiding the dig up of entire length of the pipe. Which will not only save money, time and manpower but also will prove to be beneficial and thus giving a effective working environment.*

**Keywords:** *Dug, Leakages, Robot, Roadways, Water management.*

## I. INTRODUCTION

The important objectives that are associated in installing of robotic systems in industries are: 1) Saving of manpower. 2) Improved quality & efficiency. 3) Ability to work in any hostile environment. Our project is aimed at developing an intelligence robot named as "PLUMBOAT" to detect dangerous water, gas leakages and noise in the underground pipes. The robot is designed to move as per the command given by the controller. To move in all the direction like forward, reverse, right and left. If any gas or water leakage detected, robot will inform to control unit with the help modules at transmitting and receiving end . It can move from one location to another location. It is also a Mobile Robot which has got certain artificial intelligence features. Robotic workers never get tired. Do not need to be paid. It can be made to perform even the most dangerous tasks without concern.

## II. LITERATURE SURVEY

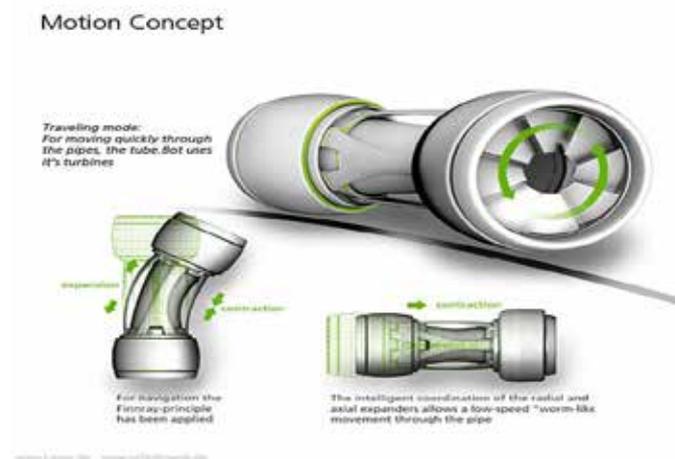
After the survey of various methods used for water leakage detection we came through a few of these like water leakage detection using acoustics and ultrasonic scanning.

### 2.1. Tube Bot

Leaky water pipes pose serious problems for cities, as it leads to the loss of roughly a billion liters of clean drinking water every day. A self-powering robot, called TubeBot, a maintenance robot designed for use in the piping of urban drinking water systems. TubeBot is an autonomous robot that generates electricity from the pressure of water to power itself and keep it moving. The system ultrasonically scans the whole length of the piping system and sends the data to a remote location. In this way the cracks are detected using this robot.

It's quick at detecting and can fix almost all kinds of leaks. The tubebot works without an additional energy supply, this is because it incorporates intelligent functionality of using the existing pressure in the pipes to move. By employing this robot, urban drinking water agencies can expect to save and conserve this precious resource.

As observed the design in the above project is such that it requires ultrasonic scanning thus making it expensive. It also requires considerable amount of research to enable it to fit into the pipes of smaller diameter.



**Fig. 1 TUBE BOT**

### 2.2 Understanding Acoustic Leak Detection

What are the Sounds of Water Leaks?

Water leaks in underground, pressurized pipes may make many different sounds:

- “Hiss” or “Whoosh” from pipe vibration and orifice pressure reduction
- “Splashing” or “Babbling Brook” sounds from water flowing around the pipe
- Rapid “beating/thumping” sounds from water spray striking the wall of the soil cavity

- Small “clinking” sounds of stones and pebbles bouncing off the pipe

What Factors Affect These Sounds?

There are several factors that affect the loudness and the frequency range of the sounds made by water leaks transmitted on the pipes and transmitted to the surface of the ground:

1. Water pressure in the pipe
2. Pipe material and pipe diameter
3. Soil type and soil compaction
4. Depth of soil over the pipe
5. Surface cover: grass, loose soil, asphalt, concrete slab, etc.
6. The loudness or intensity of the leak sound is directly proportional to the water pressure inside the pipe (up to a limit).

How Do Leak Sounds Travel on Pipes?

1. Metal pipes, particularly iron mains between 6 inches and 12 inches, copper services, and steel pipes transmit the sounds of water leaks for hundreds of feet in every direction. Asbestos-cement pipe and PVC pipe do not transmit the sounds nearly as far.
2. Thus knowledge of the pipe material and diameter is important to knowing how far the leak sound may be transmitted along the pipe walls.

## **2.3 Problem Statement**

### **2.3.1 Tubebot**

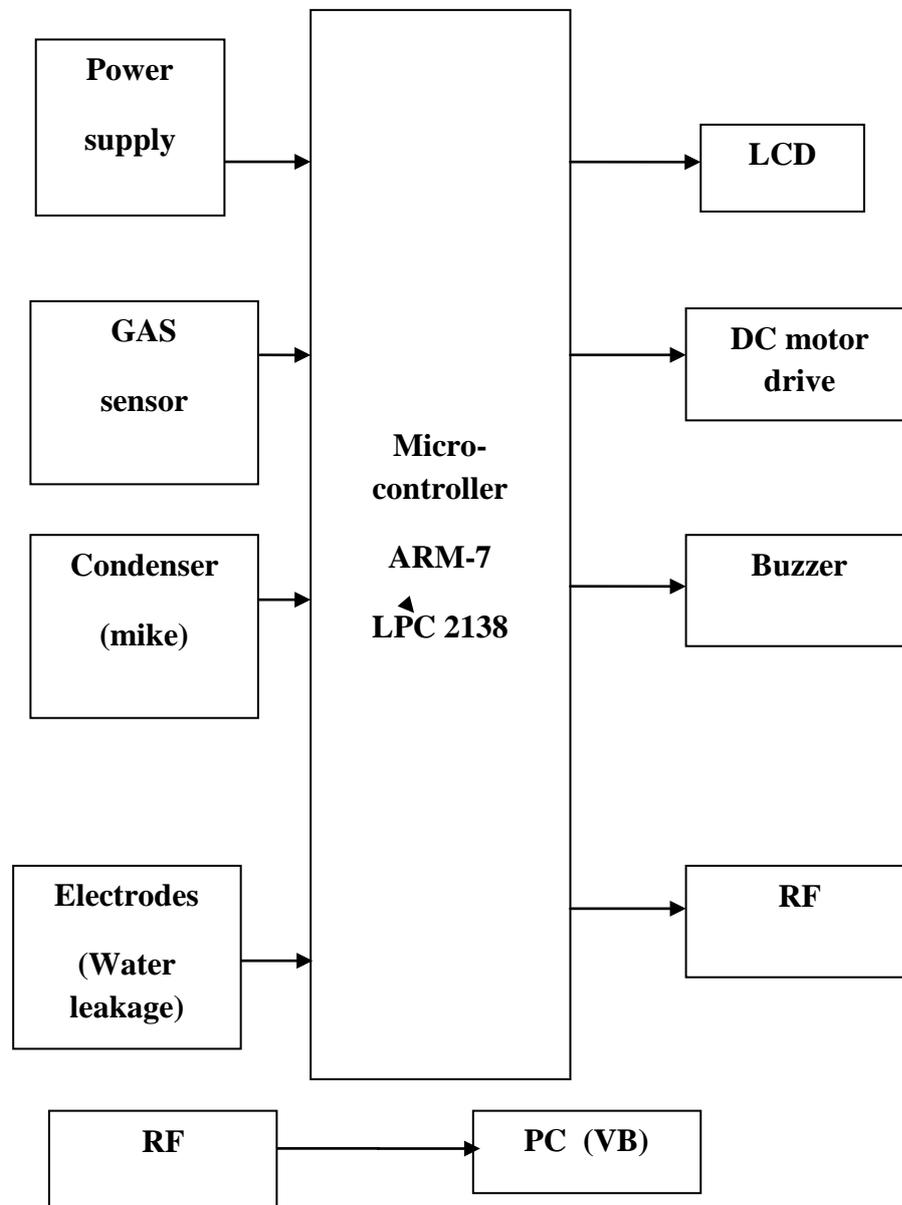
As observed the design in the above project is such that it requires ultrasonic scanning thus making it expensive. It also requires considerable amount of research to enable it to fit into the pipes of smaller diameter.

### **2.3.2 Detection using acoustics**

The above method is adopted in foreign countries for the detection of leakage in the underground pipes. It is also very costly since it requires the core knowledge and application of acoustics. It consists of methods wherein a human being has to hear the sounds and also study the intensity of the sounds underground. Also, the pressure and sound intensity need to be compared. The material of pipes used need to be examined. Size of the pipe also needs to be considered. This method is not always accurate. Its implementation also requires a large amount of concentration. It is also very expensive.

Assuming the issues of concern from the above projects created in the past we have come to a conclusion to design a robot that will detect the underground leakages in the pipes. This robot is simple to design and very cost efficient.

### III. BLOCK DIAGRAM



### IV. BLOCK DIAGRAM DESCRIPTION

#### 4.1 ARM 7

This generation introduced the Thumb 16-bit instruction set providing improved code density compared to previous designs. The most widely used ARM7 designs implement the ARMv4T architecture, but some implement ARMv3 or ARMv5TEJ. All these designs use Von Neumann architecture, thus the few versions comprising a cache do not separate data and instruction caches. Some ARM7 cores are obsolete. One historically significant model, the ARM7DI is notable for having introduced JTAG based on-chip debugging; the preceding ARM6 cores did not support it. The "D" represented a JTAG TAP for debugging; the "I" denoted an Icebreaker

debug module supporting hardware breakpoints and watch points, and letting the system be stalled for debugging. Subsequent cores included and enhanced this support. It is a versatile processor designed for mobile devices and other low power electronics. This processor architecture is capable of up to 130 MIPS on a typical 0.13  $\mu\text{m}$  process. The ARM7TDMI processor core implements ARM architecture v4T. The processor supports both 32-bit and 16-bit instructions via the ARM and Thumb instruction sets. The ARM7TDMI (ARM7+Thumb tag Debug fast Multiplier enhanced ICE) processor is a 32-bit RISC CPU designed by ARM, and licensed for manufacture by an array of semiconductor companies. The ARM7TDMI-S variant is the synthesizable core.

#### **4.2. Dc Motor Driver (L293d)**

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz. The L293D is assembled in a 16 lead plastic package which has 4 center pins connected together and used for heat sinking The L293DD is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heat sinking.

#### **4.3. Dc Motor**

DC motors are used to physically drive the application as per the requirement provided in software. The dc motor works on 12v. To drive a dc motor, we need a dc motor driver called L293D. This dc motor driver is capable of driving 2 dc motors at a time. In order to protect the dc motor from a back EMF generated by the dc motor while changing the direction of rotation, the dc motor driver have an internal protection suit. We can also provide the back EMF protection suit by connecting 4 diode configurations across each dc motor.

#### **4.4. Rs232**

RS232 is compatible with today's microcontrollers. It uses a 5V power supply which is same as source voltage of ARM-7. There is no need of dual power supply.

#### **4.5. Liquid Crystal Display**

LCD is used in a project to visualize the output of the application. We have used 16x2 LCD which indicates 16 columns and 2 rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2LCD.LCD can also used in a project to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

#### **4.6. Gas Sensor**

Gas sensor we are using is **MQ-6**. Sensitive material of MQ-6 gas sensor is SnO<sub>2</sub>, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. Please use simple electro circuit, Convert change of conductivity to correspond output signal of gas concentration. MQ-6 gas sensor has high sensitivity to Propane, Butane and LPG, also response to Natural gas. The sensor could be used to detect different combustible gas, especially Methane; it is with low cost and suitable for different application.

#### **4.7. Electrodes (Water Leakage) Condenser Mike**

Condenser means capacitor, an electronic component which stores energy in the form of an electrostatic field. The term condenser is actually obsolete but has stuck as the name for this type of microphone, which uses a capacitor to convert acoustical energy into electrical energy. Condenser microphones require power from a \