OPEN ACCESS
International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-3 Issue-1, October 2013

Proficient Multipath Routing and Hole Handling using Cascading Movement algorithm in WSN

J.Naskath, R.Abinaya Gomathi

Abstract - Sensing technology is a cornerstone for many industrial applications. Manufacturing plants and engineering facilities, such as shipboard engine rooms, require sensors to ensure product quality and efficient and safe operation. Due to its scalability and efficiency, multipath routing has gained much research attention in routing primitive in wireless sensor networks (WSN). However, in multipath routing, due to ad hoc or random deployments and network dynamics of WSN, communication holes may exist in a network area. For long life efficient network need some recovery strategies for avoiding holes and smooth transmission of data. This paper explores the recovery strategy for an urgent transmission, forwarded packets through alternative path does exist in the multipath routing. For enduring shortest transmission, this paper proposed to reuse the same primary path, by replacing the holes using the redundant sensors.

Keywords: Sensor networks, Multipath routing, voidhandling, hole.

I. INTRODUCTION

A Wireless Sensor Network (WSN) contains hundreds or thousands of sensor nodes which have the ability to communicate either among each other or directly to an external base-station (BS). The base station aggregates and analyzes the report messages received and decides whether there is an unusual or concerned event occurrence in the area of interest. Routing discovery and maintenance is crucial issues in WSN. The main challenge of routing protocols is to achieve maximal robustness against path failure with low energy consumption. There are two different approaches to constructing multipath between two nodes. One is the disjoint multipath (DM), where the alternate paths do not interfere with the primary path. Braided multipath (BM) builds multiple paths for a data delivery, but only one of them is used, while others are maintained as backup paths. Multipath routing is the routing technique which can yield a variety of benefits such as fault tolerance, increased bandwidth, or improved security. Concurrent Multipath Routing (CMR) [2] [3] [4] is the management or utilization of multiple available paths for the transmission of streams of data emanating from an application or multiple applications. If a particular path is failed to transmit, only the traffic assigned to that path is affected, the other paths continuing to serve their stream.

Manuscript published on 30 October 2013.
***** Correspondence Author (s)
Ms. J.Naskath Assistant Professor. She received her B.E Degree in Computer Science Engineering from Anna University, Chennai, Tamilnadu, India
Ms.R.Abinaya Gomathi Computer Science Engineering from Anna University, Chennai, Tamilnadu, India.

In Multipath routing each source node can use only one path for data transmission and switch to another path upon node or link failures [2]. This one is mainly used for fault-tolerance purposes, and this is known as alternative path routing. Multipath routing protocols can provide load balancing over network, when a link becomes over used and causes congestion, multipath routing protocols can choose to divert traffic through alternate paths [6] to ease the burden of the congested link. During routing period primary path or shortest path is used often the remaining paths are under control in XGAF algorithm [7]. When the primary or usage path gets repaired by voids, use the alternative path for instant revival. For enduring and efficient transmission, multipath routing concept provides the best path as primary path. So renovate the primary path is better solution than alternative path based void handling concept [10]. In random deployment, the sensor may place in random fashion. So automatically some area covered by bunch of sensors. To replace the redundant sensors [9] from high density area to void area using cascaded movement. The remainder of this paper is organized as follows: Section 2 system Design section 3 introduces multipath routing and its techniques. In section 4 simulation results and Section 5 presents conclusion.

II. SYSTEM DESIGN

The system design deals with the development of state machine and flowchart diagram and focus on routing and void handling as shown in fig 1 and 2. After the construction of network, route construction is initiated. During route construction multiple paths are identified and constructed to forward the packets to the destination. Further onwards the most important state in this routing mechanism is neighbor management. New or a better neighbor will be managed through this state. Common function in neighbor management state is neighbor table maintenance, neighbor discovery; insert new neighbor, neighbor replacement, etc. The optimal route discovery is tackled by Dijkstra's algorithm. The mechanism used is braided multipath and it works as each node on primary path sends alternate path reinforcement to find alternate paths. These alternate paths do not completely disjoint from the primary path.

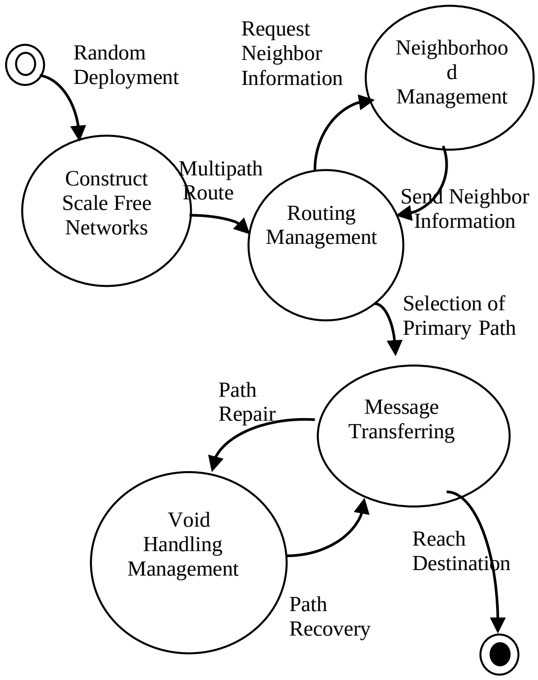

Fig 1: System Diagram

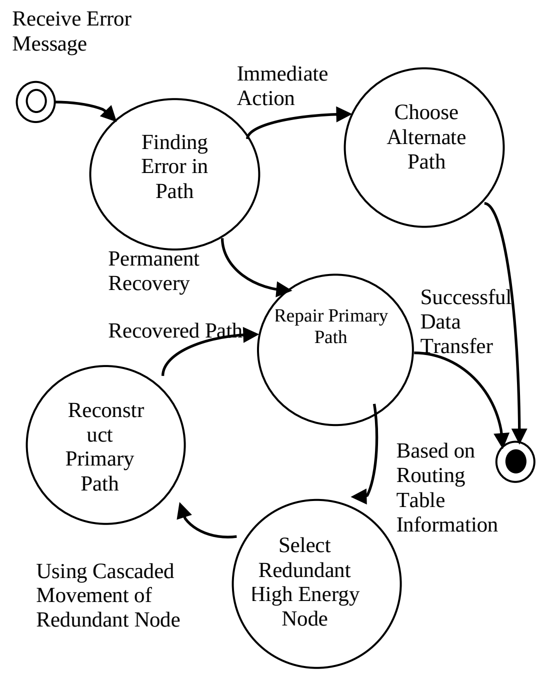

Fig 2: Void Handling Management

After the construction of multipath, the message is transferred through primary path. If any node failure occurs in that path, void handling management as shown fig 2 is performed. One intuitive approach for achieving a high delivery ratio with low energy consumption is to forward data along a single path and to repair the path whenever a break is detected. The cascaded movement is used to address the problem of void. It finds some intermediate nodes i.e.) cascading nodes, and use them for relocation to reduce delay and balance the power.

During void handling process when a path break is detected, then immediately the backup route from the pivot node is chosen, which is located at the immediate upstream of a path break, is responsible for seeking alternative paths through a local survey. If alternative paths exist, data forwarding will proceed along the best of them without restarting from the source node. Although the selected alternative path may not be optimal from the view of the source node, the energy is conserved by preventing the previous transmission effort from being wasted, avoiding long-distance failure notification, and restricting the range of alternative path seeking into a small local area.

Also, the void occurred in that path is recovered using path recovery algorithm. Based on routing table information the redundant sensors are identified and chosen to move to the void area using cascaded movement. So that the path is reconstructed and it can be used for further transmission to achieve highest delivery ratio.

III. MULTIPATH ROUTING

Multipath routing is the routing technique of using multiple alternative paths through a network, which can yield a variety of benefits such as fault tolerance, increased bandwidth or improved security. In this section, we describe how our scheme exploits the multitude of paths, in order to offer increased protection against path failures. The three major components of multipath routing is multipath calculation to compute multiple paths, multipath forwarding to ensure that packets travel on their specified paths and an end-host protocol that effectively uses the determined multiple paths. Note that the multipath routing consists of two major things that are route discovery and route maintenance. During route discovery process, optimal path and backup routes are identified; data is forwarded along the optimal path and detect the broken link in transmission. During route maintenance process, forward the packets through backup route and repair the optimal path by moving the redundant sensor node to that location.

A. Route Discovery

In the proposed scheme, before transmitting the data an optimal and backup paths are find from each sensor node to sink node needs to be established which should be lowest cost path.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

To find those routes, the optimized route finding algorithm using Dijkstra's [4] is used. Consider a node structure in which S denotes the source node that is going to send the data and D denotes the destination that is going to receive the data.

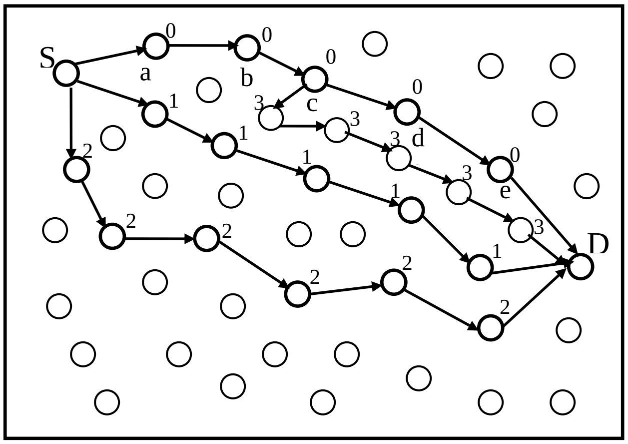

Fig 3: Possible Routes from S to D

There are multiple paths that exist in the network that is shown in fig 3. For data forwarding, using the route finding algorithm the optimal path which is denoted as 0 where as the backup routes which are denoted as 1, 2 and 3. Also the nodes present in optimal path 0 are represented as a, b, c, d and e. Path selection involves applying a possible routing metric to multiple routes, to select the best optimal route. The metric is computed by a routing algorithm and can cover such information as bandwidth, network delay, hop count, path cost, load, reliability and communication cost. The routing table stores only the best possible routes, while linking state databases may store all other information because routing metric is specific to a routing protocol.

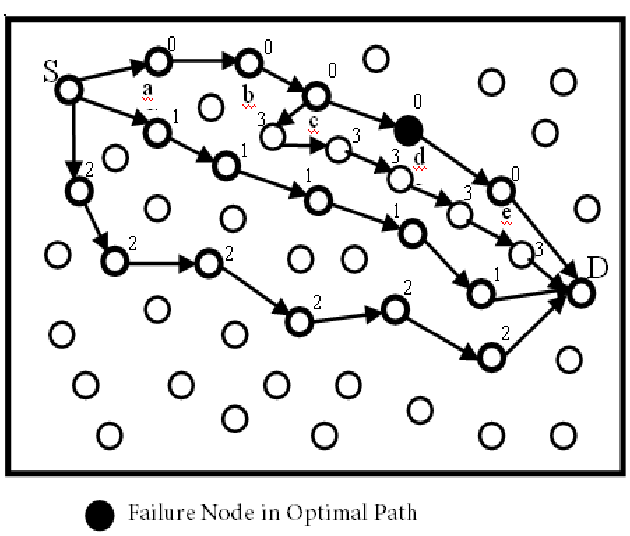

Fig 4: Sending Data through Alternate Path

After selecting the optimal path, the data are transferred through that path. If any node failed in the optimal path as shown in fig 4, then the data are forwarded through the backup or alternate path as available. So that transmission delay is reduced and the data can be forwarded to the destination without any loss. During this period the void area is also filled by moving the redundant nodes using void handling algorithm as discussed in next section.

B. Void Handling

This proposed method void handling management comes under the Route maintenance strategy. Void represents the null or empty space in the network area. An unexpected occurrence of gap in the routing path is main reason for path failure. The routing techniques can be generally classified into two categories: beacon based or Beacon free. In the beacon-based protocols [10], the next hop is deterministically selected by the packet holder from a set of its neighbors collected by the periodically exchanged beacons. The nearest redundant nodes and its properties are easily identify, then select appropriate node, move and fill the gap using this Beacon messages. In existing methodology [10] the void is handled by three steps are select the nearest destination node, construct the path and move the packets. But this paper proposed to select the nearest node from the already constructed path or alternate path of multipath routing in order to reduce the communication delay. Consequent time period, reconstruct the damaged primary path using redundant sensors. This proposed work address the problem of sensor relocation, i.e., moving previously deployed sensors to overcome the failure of other nodes, or to respond to an occurring event that requires that a sensor be moved to its location.

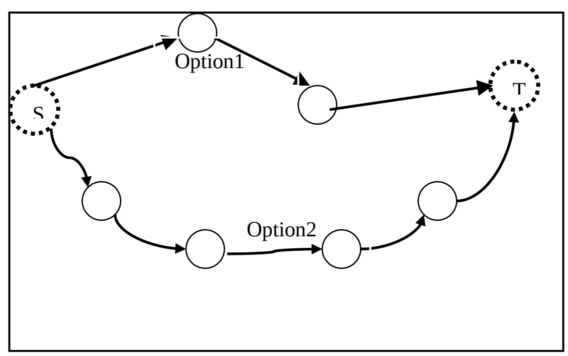

Fig 5: Various options for cascading schedule

Node selection:

1 Receive the beacon messages from neighbor nodes
2 While (TRUE)!
3 If (node==Rn && Ern>=threshold value)
4 Select node
5 Else
6 Select next.

Fig. 6.Node selection Algorithm

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Movements of Sensors categorized in to two ways are Direct or Cascaded movement. In direct movement moves the redundant sensor directly to the destination. It is a possible solution, but it may take a longer time. For example, a sensor monitoring a strategic area dies and the application specifies that the maximum tolerable time for such a sensing hole is thirty seconds. If the redundant sensor is 100 meters away and it takes at least one minute for the sensor to reach its destination, the application requirement cannot be met. Moreover, moving a sensor for a long distance consumes too much energy. If the sensor dies shortly after it reaches the destination, this movement is wasted and another sensor has to be found and relocated. Hence, apply the cascaded movement to address the problem. The idea is to find some redundant and energetic intermediate nodes, and use them for relocation to reduce the delay and balance the power E_{DM} and E_{CM} are total energy consumes of direct and cascaded movement respectively.

$$E_{DM} > E_{CM}$$

$$E_{CM} = \sum_{i=0}^{n} E_{Ci} \text{ -------------------------- } 1$$

$$\sum_{i=0.}^{n} E_{Ci} = E_{ci}+E_{ci+1}+E_{ci+2}\ldots\ldots E_{cn}$$

Cascading schedule Fig 5 could provide minimize the total energy, maximize the remaining energy and minimal recovery time. But in most cases these goals cannot be reached at the same time. For example option1 consumes less total energy, high recovery time and each sensor will have lower remaining energy and option2 have higher remaining energy and lower recovery time, but the total energy consumption is higher than option1. So selection of option from cascading schedule is depends on the total energy consumption, remaining energy of individual sensors and the recovery time. The following equation describes the best options selected for cascaded movement. E_{T1} and E_{T2} are total energy consumption of option 1 and 2.E_{min1} and E_{min2} are minimum remaining energy R_{T1} and R_{T2} are recovery time.

$$E_{T1} - E_{min1} \leq E_{T2} - E_{min2}$$

$$E_{T1} - E_{T2} \leq E_{min1} - E_{min2} \text{ --------- } 2$$

The recovery time of the each option is depends on the number of intermediate hops. So,

$$R_{T1} > R_{T2} \text{ -------------------}3$$

From equation 2 and 3 option2 is suitable for cascaded movement

Movement Algorithm:

1. Receive message from neighbor node
2. While (TRUE)
3. If (Ern > Threshold value)
4. Find average traveling distance d;
5. Move d distance
6. Stop and replace the node
7. Else
8. Select next redundant node
9. Until replace failure node.

Fig 7: Movement Algorithm

Using node selection and movement algorithm the redundant node is selected based on the energy Ern value then activate the mobile sensor to reach next target place using average traveling distance d. The traveling distance is calculated using $d=\sqrt{(xt-xs)^2+(yt-ys)^2}$ here (xt,yt) and (xs,ys) are locations of target and source node.

IV. SIMULATION RESULTS

The simulation parameters are described as follows. Our simulation modeled a network of N nodes placed randomly within a 200m * 200m area uniformly. The value of N varies in different experiments. Radio propagation range for each node was 50meters and transmission rate was 256 kbit/sec. Initial energy of each node has been assumed to be equal to 1 joule. The simulation results compared the multipath routing concept and cascading scheduling concept based on the recovery time, total consumable energy and maximum remaining energy of nodes. Fig 8 describes the results obtained using NS2 simulation software. Fig 9 describes the cascading scheduling mechanism depends on the recovery time of the damaged path.

The end to end delay performance of routing protocol is analyzed in fig 10. Delay is the term refers to the time taken for a packet to be transmitted across a network from source to destination. It shows the comparison of delay occurred between repairing the void in the failure path to transmit the data and without repair the void in the path. The delay is minimized by repairing the void in the path and the path can be used for further transmission. So that data loss during transmission is minimized and can achieve higher delivery ratio.

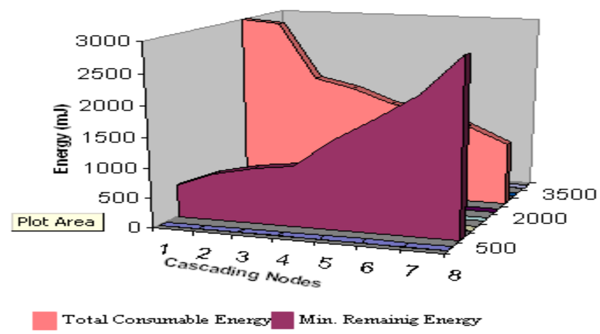

Fig 8. Comparison of Energy levels with cascading Nodes

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-3 Issue-1, October 2013

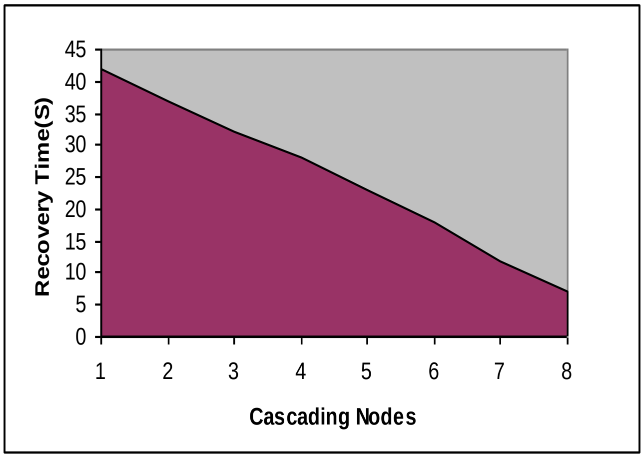

Fig 9. Recovery Time Vs cascading Nodes

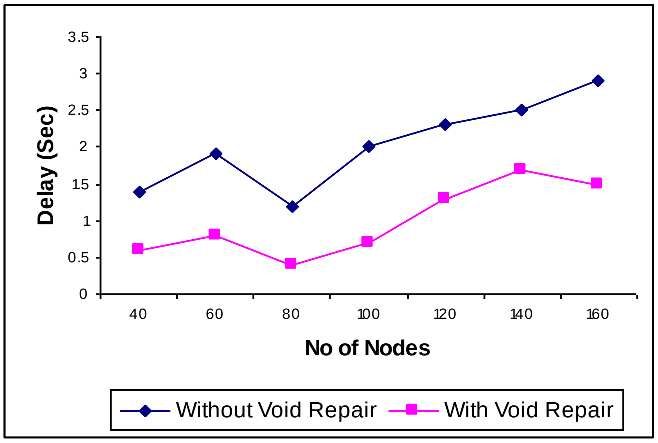

Fig 10: No of nodes Vs Delay

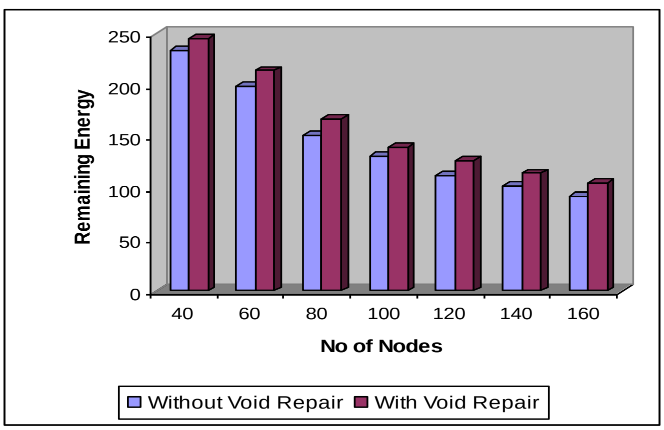

Fig 11: No of nodes Vs Energy

Fig 11 shows the comparison of remaining energy level of nodes in the network when the void occurred in the path is repaired and not repaired. When repairing the void in the path, the network achieves higher remaining energy level. Also it improves the lifetime of the network. When the void is repaired, the temporary path is used to send the data. For that purpose the temporary path is selected for cascading node replacement based on the average distance, average time and average energy range values. Consider the given below tables for choosing the temporary paths.

Table1: Selection of paths with respect to energy ranges

S. No	**Temporary Path for cascading node replacement**	**No. of participating nodes**	**Node energy ranges (Jou)**	**Avg. energy range to reach the goal(Jou)**
1	TP1	4	0.75J:0.6J:0.72J:0.5J	0.6425
2	TP2	2	0.8J:0.5J	0.65
3	TP3	3	0.65J:0.43J:0.5J	0.526
4	TP4	1	0.32J	0.32
5	TP5	6	0.65J:0.72J:0.4J:0.35J:0.25J:0.4J	0.46

Table2: Selection of paths with respect to distance ranges

S. No	**Temporary Path (TP)for cascading node replacement**	**No.of participating nodes**	**Distance ranges**	**Avg. distance to reach the goal(m)**
1	TP1	4	22m:27m:15m:5m	17.25
2	TP2	2	37m:5m	21
3	TP3	3	17m:28m:5ms	16.6
4	TP4	1	5m	5
5	TP5	6	20m:38m:15m:25m:27m:5m	21.6

Table3: Selection of paths with respect to time ranges

S.No	**Temporary Path for cascading node replacement**	**No.of participating nodes**	**Average Time ranges to reach the goal (Sec)**
1	TP1	4	25
2	TP2	2	37
3	TP3	3	32
4	TP4	1	42
5	TP5	6	18

In these above given tables the temporary path to be selected was discussed with respect to energy, distance and time ranges.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

The path to be selected will have satisfying values of average energy, average time and average distance to reach the goal. For selecting such a path all possible temporary paths for cascading node replacement was compared and analyzed with one another. At last, the single path which promised better results was taken into consideration. First we considered the temporary path TP5; the average moving distance was high with a value of 21.6 m. So chances for considering TP5 as a temporary path for cascading node replacement was low. Secondly we considered the temporary path TP4, the average time taken for replacement was high with 42 seconds. Moreover, it lost high energy due to continuous movement and it remained with the total energy value of 0.32J.

So considering the temporary path of TP4 was also low. Now we compared the remaining temporary paths TP1, TP2, TP3 for average time, average distance and average energy ranges values. The temporary path TP3 had just 0.525 J as its total average energy and the temporary path TP2 took 37 second as average time to reach the goal. It was observed that TP1 showed better results in respect to average moving distance of 17.25 m, average total energy of 0.6425 J, and average time of 25 seconds. Therefore the temporary path for cascading node replacement was assigned as TP1. It showed promising results and found worth for hole replacement concepts.

V. CONCLUSION

WSN are designed to monitor a phenomenon throughout a field of interest. In sensor networks, Void is an uncovered area in the network occurred by lifeless nodes or no node in that area. Void is a key issue in coverage and connectivity of network. This paper defined two step solutions for void handling process to achieve the highly covered network. In existing work [10] void is a recovered using virtual destination scheme. But it is a temporary solution. When the hole has occurred during routing, first take diversion to forward the packets from damaged path to alternative path for avoiding delay, and then repair the primary path or damaged path in parallel using relocating the redundant sensor to void area. The results show that significant energy savings is possible compared with existing scheme. Also it shows that during transmission energy is considered and multihop routing saves energy and choosing alternate path immediately minimizes the delay.

The future work in this regard will be the optimization of the data delivery. When a particular sensor in the optimal path receives the data but lost its energy thereafter it loses the ability to transfer data. This may lead to loss of data. To prevent the system will be developed in such a way that the sensors on reaching the threshold value will alert its neighbor. Therefore the nearest sensor in that optimal path starts searching for nearby sensor to transfer as soon as possible. This will save time and energy.

REFERENCES

[1] Neha Jain and Dharma P. Agrawal "Current Trends in Wireless Sensor Network Design", *International Journal of Distributed Sensor Networks*, 1: 101–122, 2005.

[2] Marjan Radi, Behnam Dezfouli, Kamalrulnizam Abu Bakar and Malrey Lee, "Multipath Routing in Wireless Sensor Networks: Survey and Research Challenges "*Sensors* 2012

[3] G. Murali, D. Pavan, V.V. Rajesh Reddy, P. Bharath kumar, "Dynamic Routing With Security Considerations", International Journal of Computer Technology and Applications (IJCTA)., Vol 2 (6), NOV-DEC 2011.

[4] Maheswari. K, Punithavalli.M, "Design and implementation of multipath routing approach for secured and reliable data delivery in VoIP", International Journal of Applied Engineering Research, Volume 2, No 2, 2011.

[5] Yunfeng Chen and Nidal Nasser, "Enabling QoS Multipath Routing Protocol for Wireless Sensor Networks", IEEE, 2008.

[6] Shiva Prakash, JP.Saini, "A Survey of Multipath Routing in Mobile Adhoc Networks", *GJCAT, Vol 1 (1), 2011.*

[7] Jacob Salzmann "Energy and Coverage Aware Routing Algorithm in Self Organized Sensor Networks", *GJCAT, Vol 1 (1), April 2007.*

[8] Yongguo Mei, Xian, Saumitra, and Yung-Hsiang Lu, "Sensor Replacement using Mobile Robots", Elsevier 2007.

[9] Heping Wang, Xiaobo Zhang and Ashaf, "Efficient Void handling in contention-based geographic routing for wireless Sensor networks", IEEE GLOBECOM, 2007.

Ms. J.Naskath is working as a Assistant Professor. She received her B.E Degree in Computer Science Engineering from Anna University, Chennai, Tamilnadu, India in 2005 and M.E degree in Computer Science Engineering from Anna University of Technology, Tirunelveli, Tamilnadu, India in 2011. Her present areas of interest are Wireless Sensor Networks and AdHoc Networks.my mail id is nash_naskath@yahoo.com

Ms.R.AbinayaGomathi is doing her under graduate in Computer Science Engineering from Anna University, Chennai, Tamilnadu, India.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)