ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 3, March 2015

Fault Node Recovery Algorithm for a Wireless Sensor Network

Mulla Imroj A[1], Shaikh Tareque A[2], Diware Ajinkya G[3], Prof.Kadam Vikas[4]

Computer Engineering, Sinhgad Institute of Technology, Lonavala[1,2,3,4]

Abstract: This project proposes a Distributed Dynamic Diffusion Based Algorithm [DDBA] to enhance the life time of a wireless sensor network [WSN] when some of the sensor nodes stop their working. This proposed algorithm is based on concurrent working of genetic algorithm [GA] and grade diffusion [GD] algorithm. This algorithm will increase the number of active nodes by reducing the rate of data loss and rate of energy consumption. The grade diffusion algorithm will generate the neighbor nodes, grade values, routing table and payload value for each sensor node. The genetic algorithm will search for the non-functioning sensor nodes and it will replace the non-functioning sensor nodes by selected functional nodes in the network. The algorithm is based on the battery levels, location and load on the node, and its goal is to divide the power consumption within the network so that the majority of the nodes consume their power supply at relatively the same rate regardless of their exact location. This leads to maximization in terms of system maintenance, such as replacement of the batteries all at once than doing it one by one, and maximizing the overall system performance by allowing the network to function at 100% capacity throughout most of its lifetime instead of having a steadily decreasing node population. The system distributes the lifetime and load on the network better than the previous approach.

Keywords: Genetic Algorithm, Grade Diffusion (GD) Algorithm, Wireless Sensor Networks (WSN).

I. INTRODUCTION

The architecture of the Wireless Sensor Network is shown in Fig.1. In Wireless Sensor Networks (WSN), Sensor nodes are severally constrained in terms of storage resources, computational capabilities, communication band width and power supply. Relying on resource-constrained embedded devices for communication, processing, and Congestion may occur due to a large number of nodes „simultaneous transitions from a power saving state to an active transmission state in response to an event – of- interest.

It often takes several hops to deliver data from a node to sink; therefore, failure of a single node or link may lead to missing reports from the entire region of the sensor network. Additionally, congestion that starts in one local area can propagate all the way to the sink and affect data delivery from other regions of the network.

II. PROBLEM DESCRIPTION

Faults may be due to a variety of factors, including hardware failure, software bugs, operator (user) error, and network problems. Data delivery in sensor networks is inherently faulty and unpredictable links may fail when permanently (or) temporarily blocked by an external object (or) environmental condition.

Packets may be corrupted due to the erroneous nature of communication In Fig: 2. Fault is occurred during the routing process in wireless sensor network because of some problem, the major problem that affect the design and performance of a WSN are as follows:

Hardware and Operating System for WSN

- Synchronization
- Localization
- Deployment
- Data Dissemination
- Data Aggregation

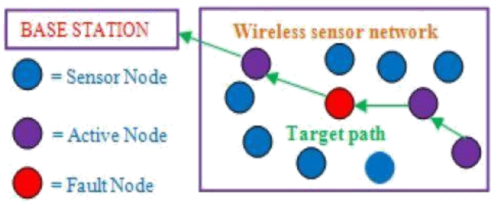

Fig 1 . Fault Occurred in WSN Network

In a wireless sensor network (WSN), sensor nodes are provided with batteries that can operate for only a short period of time, which results in short network lifespan. The short lifespan disables the application of WSNs for long term tasks such as road condition maintenance for bridges and tunnels, border surveillance, and so on.

III. RELATED WORK

In addition to everything that the basic diffusion algorithm performs, each node makes a list of suitable neighbors and ranks them in order of preference, likewise the previous approach. Every time that a node changes neighbors, the sender will require an acknowledgement for its first message which will ensure that the receiving node is still alive. If a time out occurs, the sending node will choose another neighbor to transmit to and the whole process continues again. Once communication is initiated, there

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 3, March 2015

will be no more acknowledgements for any messages. Except data messages, there are the introduce exception messages which serve as explicit synchronization messages. Only receivers can generate exception messages, and are primarily used to convey the sending node to stop sending and let the sender choose a different neighbor. An exception message is generated in only three instances: the receiving nodes queue is too much, the receiver's power is less than the Sender's power and the receiver has passed a certain threshold which means that it has very little power left. At any time throughout the systems lifetime, a receiver can tell a sender not to transmit anymore because the receiver's queues are not empty anymore. This should normally not happen, but in the event it does, an exception message would alleviate the problem. In the current schema, once the sending node receives an exception message and removes his respective neighbor off his neighbor list, the sending node will never consider that same neighbor again However, future considerations could be to place a receivingneighbor on probation in the event of an exception message, and only remove it as a valid neighbor after a certain number of exception messages. The second reason an exception message might be generated, is when the receiver's power is less than the senders power, in which if the receiver's power is less than the specified threshold, it would then analyze the receiving packets for the sender's battery levels. If the threshold level of battery was made too much less, then by the time the receiver managed to react and tell the sender to stop sending, too much of its power supply had been depleted and its life expectancy thereafter would be very limited while the sending nodes life expectance would be much longer due to its less energy consumption.

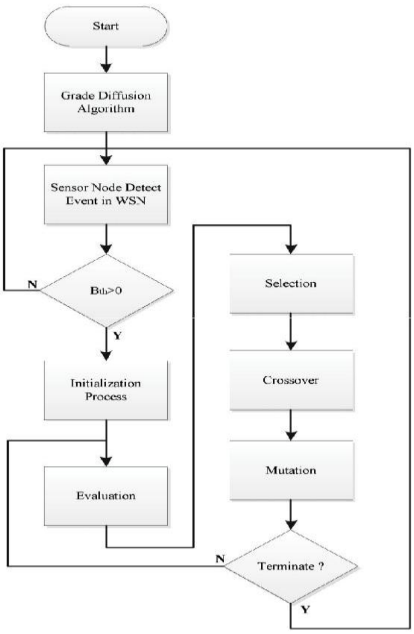

Fig 2.flow chart for FNR

In order to avoid having to acknowledge every message or even have heartbeat messages, we introduce Energy Efficient Distributed Dynamic Diffusion Based Algorithm using location, power, and load as metrics and an additional threshold that will tell the receiving node when its battery supply is almost gone. This threshold should be relatively less, in the 5-10% of total power, and is used for telling the senders that their neighbors are almost dead and that new more suitable neighbors should be elected. The synchronization cost of this diffusion is two messages for each pair of neighboring nodes. The rest of the decisions will depend on local look-ups in its memory for the next best suitable neighbors to which it should transmit to. Eventually, when all suitable neighbors are drained, the nodes opt to transmit directly to the base station. By observing at the empirical results obtained, it is only towards the end of the systems lifetime that the nodes decide to send directly to the base station. The main advantage of this algorithm is the near perfect system lifetime where most nodes in the network live relatively the similar duration. The system distributes the lifespan and load on the network better than the previous two approaches. The disadvantage, when compared to of this algorithm is its greater complexity, which needs some synchronization messages throughout the system lifespan. These synchronization message are less in number, and hence the price in the event that the application calls for such strict performance.

The diffusion algorithm is based on location, battery's power levels, and load on the node, and its goal is to divide the power consumption throughout the network so that the majority of the nodes consume their power supply at comparatively the same rate, no matter what the exact location is. This results in maximizing in the maintenance of the system, such as replacement of the batteries all at once than doing it one by one, and improving the overall system performance by allowing the network to function at maximum possible capacity throughout most of its lifespan instead of having a steadily decreasing node population.

i. Initialization

The genetic algorithm generates chromosomes in the initialization process. Each chromosome is an expected solution. The number of chromosomes is determined according to the population size. Each chromosome is a combination solution.

	7	25	29	35	43	59	66	68	72
1	1	0	1	0	0	1	0	0	1

Fig3. Initialization Process

Above Fig. represents a chromosome. The chromosome length is10 and the gene is 0 or 1, chosen randomly in the initialization process. In this case, there are 10 sensor nodes not functioning, and their node numbers are 7,9,27,31,37,45,62,68,70 and 74.

Chromosome length is the number of sensor nodes that non-functioning. The elements in the genes are either 0 or 1. 1 means the node should be replaced and a 0 means that the node will not be replaced.

DOI 10.17148/IJARCCE.2015.43145

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 3, March 2015

ii. Evaluation

The fitness value is calculated according to a fitness function, and the parameters of the fitness function are the chromosome's genes. However, we cannot put gene directly into the fitness function in the Energy Efficient Distributed Dynamic Diffusion Based Algorithm. In the FNR algorithm, the goal is also to reuse the most routing paths and to replace the fewest sensor nodes. Hence, the numbers of routing paths available if some non-functioning sensor nodes are replaced.

iii. Selection

	5	7	25	29	35	43	59	66	68	72
Active Nodes	1	1	0	1	0	0	1	0	0	1
	0	1	0	1	0	0	1	1	0	1
	1	0	0	0	1	1	1	0	1	0
	0	1	0	1	0	1	0	1	0	1
	1	0	1	1	0	1	1	0	1	0
Fitness function Threshold (fn)										
Fault nodes	1	0	0	0	1	1	1	0	1	0
	1	0	1	1	0	1	1	0	1	0
	0	1	0	0	1	0	0	1	0	1
	1	1	0	1	1	1	1	0	0	1
	0	1	0	1	0	1	1	1	0	1

Fig 4 .Selection Process

In above Fig. by use the selection process we can put the chromosomes with highest fitness function to the mating pool. This highest fitness chromosome is used for replacing function. Then the lowest fitness chromosomes will be eliminated. The selection process determines which chromosomes will mate (crossover) to produce a new chromosome.

iv. Crossover

0	7	25	29	35	43	59	66	68	72
1	1	0	1	0	0	1	0	0	1
0	0	0	1	0	1	0	1	0	1

⇩

0	7	25	29	35	43	59	66	68	72
1	1	0	1	0	0	1	0	0	1
0	0	0	1	0	1	0	1	0	1

Fig5.Cross Over Process

In above Fig by use the crossover operation where the crossover point is selected from the selection process and the gene values of participating parents are flipped to create a pair of child chromosomes. v. Mutation

	7	25	29	35	43	59	66	68	72
1	1	0	1	0	0	1	0	0	1
1	1	0	0	1	0	0	0	1	0

Fig 6.Mutation

In above Fig. the mutation adds variation in the next generation. In mutation, a node is randomly picked and its parent ID is reselected randomly. Similar to crossover, the mutation operation may produce a bad chromosome, which is also fixed using the repair function.

Node Replacement

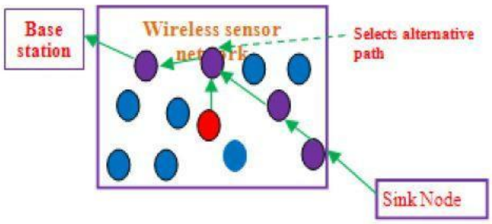

Fig 7.Fault Identification & Alternate Path Selection

In above Fig. the fault is occurred in WSN, so the sensor nodes select the alternative path for relay transmission. By use this alternative path, the network can transmit the data properly to the sink node.

V. SIMULATION

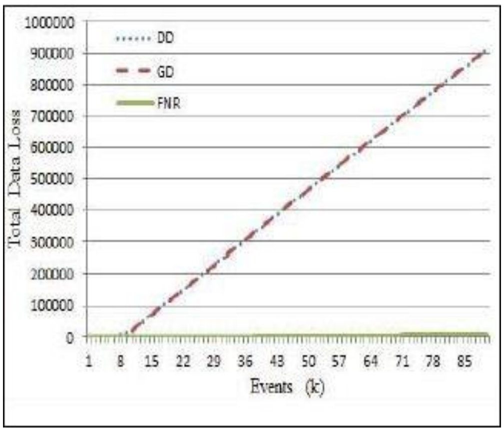

Fig8. Number of Active nodes

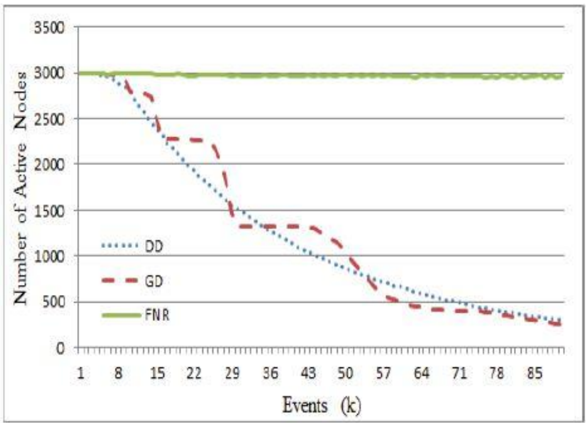

Fig9.Data Loss Comparison in Wireless Sensor Network

The active nodes mean that the sensor node has enough energy to transfer data to other nodes. The FNR, DD, and GD algorithms were implemented. The active sensor nodes and total data loss after some events are shown in Figs.8 and 9. The active nodes mean that the sensor node has enough energy to transfer data to other nodes, but

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 3, March 2015

some sensor nodes can be deleted from the active nodes list if their routing tables do not have a sensor node that can be used as a relay node, algorithms because the algorithm can replace the sensor nodes after the number of nonfunctioning nodes exceeds the threshold, by using the GA algorithm. In Fig. 9, the FNR algorithm exhibits smaller data losses because the algorithm can replace fewer sensor nodes and reuse more routing paths if the number of sensor nodes that are nonfunctioning exceeds the threshold. After the simulation, the FNR algorithm had only suffered less data losses, but the DD and GD algorithm had suffered more data losses. This new algorithm can reduce data loss compared to the traditional algorithms.

VI. SIMULATION RESULTS

By using this proposed energy based algorithm combined with genetic algorithm, the performance of sensor network analyses the calculation of packet data loss. It indicates the packets receives and transmit time of the total sensor nodes. The energy ratio and residual energy ratio calculations are shown.

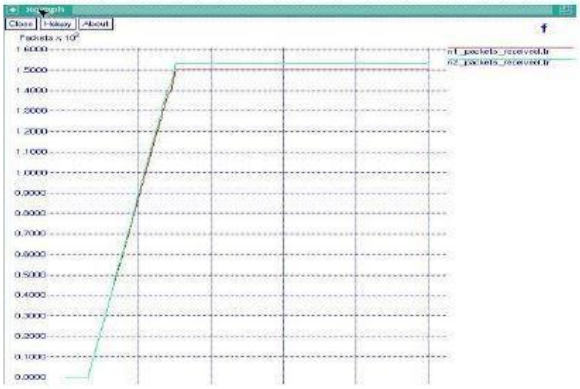

Fig.10 Packet Data Loss Calculation

VII. CONCLUSION

This paper proposes the fault node recovery algorithm that will enhance the life time of wireless sensor network when some of the sensor nodes get failed. This proposed algorithm is based on the energy dynamic distributed diffusion algorithm combined with the genetic algorithm. This algorithm will increases the number of active nodes by reducing the rate of data loss and rate of energy consumption. The diffusion algorithm will create the grade value, neighbor nodes, routing table, and payload value for each sensor node. The GA will identify the non - functioning sensor nodes and it will replace the non-functioning sensor nodes by selected functional nodes in the network.

REFERENCES

[1] Hong-Chi Shih, Jiun-HueiHo, Bin-Yih Liao and Jeng – Shyang Pan, "Fault Node Recovery Algorithm for a wireless sensor network."IEEE Sensors Journal, Vol-13, No. 7, July2013
[2] M Gen and R. Cheng, Genetic Algorithms and Engineering Design. New York, NY, USA: Wiley, 1997.
[3] S. Corson and J. Macker, Mobile Ad Hoc Networking (MANET):" Routing Protocol Performance Issues and Evaluation Considerations". RFC 2501, (1999).
[4] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci," Wireless sensor networks: a survey,Journal of Computer Networks", vol. 38, no. 4, pp. 393-422, 2002.
[5] D. Turgut, S. K. Das, R. Elmasri, and B. Turgut, "Optimizing clustering algorithm in mobile adhocnetworks using genetic algorithmic approach," in Proceedings of the Global Telecommunications conference (GLOBECOM), November 2002.
[6] Dr Alex Rogers , CM2408 – Symbolic Al Lecture 8 – Introduction to Genetic Algorithm,December 2002.
[7] C. Intanagonwiwat, R. Govindan, D. Estrin, J. Heidemann, and F. Silva,"Directed diffusion for wireless sensor networking," IEEE/ACM Trans.Netw., vol. 11, no. 1, pp. 2–16, Feb. 2003.
[8] HeinzelmanW.R.,A.P.Chandrakasan and H. Balakrishnan, "An Application specific Protocol Architecture for Wireless MicrosensorNetworks",IEEE Trans.on Wireless Communications vol. 1, no. 4, Oct. 2002, pp. 660-670.
[9] N. Ramanathan, E. Kohler, L. Girod, and D. Estrin, Sympathy:" A debugging system for sensornetworks", Proc. of. the 29th IEEE International Conference on Local Computer Networks, pp. 554-555, 2004.
[10] Al-Karaki J. N. and A. E. Kamal, "Routing Techniques in Wireless Sensor Networks",A Survey, IEEE Journal of Wireless Communications, vol. 11, no. 6, Dec. 2004, pp. 6–28.
[11] Calhoun B. H., D.C. Daly, N. Verma, D.F. Finchelstein, D.D. Wentzloff, A. Wang, S. Cho and A.P. Chandrakasan, "Design Considerations for Ultra- Low Energy Wireless Microsensor Nodes", IEEE Trans. on Computers, vol. 54, no. 6, Jun. 2005, pp. 727-740.
[12] W. L. Lee , A. Datta , and R. Cardell-oliver, WinMS: "Wireless sensor network-management, system,an adaptive policy- based management for wireless sensor networks", Proc. of CSSE Technical ReportUWA-CSSE-06-001, pp. 1-21, 2006.
[13] Amini N., M. Fazeli, S. G. Miremadi and M. T. Manzuri, "Distance-Based Segmentation: An Energy- Efficient Clustering Hierarchy for Wireless M,icrosensor Networks", Proc. of the 5thAnnual Conf. on Communication Networks and Services Research (CNSR 2007), Fredericton,Canada, May 2007, pp. 18-25.
[14] Z. He, B. S. Lee, and X. S. Wang, "Aggregation in sensor networks with a user-provided quality of service goal," Inf. Sci., vol. 178, no. 9,pp. 2128–2149, 2008.
[15] Z. Hea, B. S. Lee, and X. S. Wang," Aggregation in Sensor Networks with a User-Provided Quality of Service Goal". Information Sciences, Vol.178, No. 9, (2008), 2128-2149.
[16] T. P. Hong and C. H. Wu," An Improved Weighted Clustering Algorithm for Determination of Application Nodes in Heterogeneous Sensor Networks".Journal of Information Hiding and Multimedia Signal Processing, Vol. 2, No. 2, (2011), 173-184.
[17] R. V. Kulkarni, A. F¨orster, and G. K. Venayagamoorthy, "Computational Intelligence in Wireless Sensor Networks": A Survey, Journal of IEEE Communications Surveys &Tutorials, vol. 13, no. 1,pp. 68-96, 2011
[18] J. H. Ho, H. C. Shih, B. Y. Liao, and J. S. Pan, "Grade diffusion algorithm," in Proc. 2nd Int. Conf. Eng. Technol. Innov., 2012,pp. 2064–2068.
[19] M. Sivakumar, M. Balakumar and S. Omkumar "Node Failure Recovery Algorithm for a Wireless Sensor Network", in National Conference on Advances in Information and Communication Technology (AICT 2014), 27& 28 February, 2014
[20] K.Bichya"A Fault Node Recovery Algorithm to Improve the Life Span of WSNs", inInternationalJournal Of Computer Engineering In Research Trends. Volume 1, Issue 5, November 2014, PP 289-297.

BIOGRAPHIES

Mulla Imroj A.A. is student of BE in computer engineering from Sinhgad Institute of Technology, Lonavala, Pune affiliated to AICTE under Savitribai Phule Pune University and Completed Diploma in computer engineering in the year 2012 from B.Girwalkar Polytechnic, Ambajogai under MSBTE.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 3, March 2015

Shaikh Tareque Ajaz is student of BE in computer engineering from Sinhgad Institute of Technology, Lonavala, Pune affiliated to AICTE under Savitribai Phule Pune University and Completed Diploma in computer engineering in the year 2012 from T.B.Girwalkar Polytechnic, Ambajogai under MSBTE.

Diware Ajinkya G. is student of BE in computer engineering from Sinhgad Institute of Technology, Lonavala, Pune affiliated to AICTE under Savitribai Phule Pune University and Completed Diploma in computer engineering in the year 2012 from Dr.D.Y.Patil Polytechnic Talegaon, Pune under MSBTE. the year 2012 from Dr.D.Y.Patil Polytechnic, Ambi, Talegaon, Pune under MSBTE.

Prof.Vikas S. Kadam has received BE in Computer Science and Engineering from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharastra, India in the year 2001 and Mtech in Computer Engineering from Dr.Babasaheb Ambedkar Technological University. Lonere, Raigad, India and also he is working as a asst. Prof. in department of Computer Engineering Sinhgad Institutes of Technology, Lonavala, Pune affiliated to AICTE under Savitribai Phule Pune University.

DOI 10.17148/IJARCCE.2015.43145