RELATION BETWEEN CLUSTERING AND FAULT TOLERANCE IN WSN-A SURVEY

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ABSTRACT

WSN consists of sensor nodes which are using the battery for their power supply and so they have small amount of power supply. This reduces the lifespan of the WSN because the sensors continuously sensing and transmitting data are losing their energy. They transmit data to BS by sending it to the next neighbor node. Here if one of the node's energy reduces to vulnerable level, the transmission of data stops and for that fault tolerant mechanisms are made available. This paper analyze different fault tolerance techniques and shows how clustering is more effective than direct transmission of data in the term of reduction in data loss, expansion of network lifetime and recovery of faulty nodes.

KEYWORD: *WSN, Clustering, Energy efficiency, Base station, Fault tolerance.*

INTRODUCTION:

Wireless Sensor Network is a collection of hundreds of tiny sensor nodes. They senses the data, aggregates them and send it to the base stations (BS). In WSN, sensor node senses data and sends them to the sink node or base station where they are used for the betterment of humans. These sensor nodes are deployed in the mission critical areas like war zone and the area facing natural calamities. Recent advances in micro processing, wireless and battery technology, and smart sensors have enhanced data processing wireless communication, and detection capability. [1] These sensors use battery power for the computations and the data processes. So it has basically low power and so power consumption should be kept in mind while we are considering the wireless network. In WSN the sensor nodes senses the data and sends it to Base station (BS) directly or through the Sink nodes.
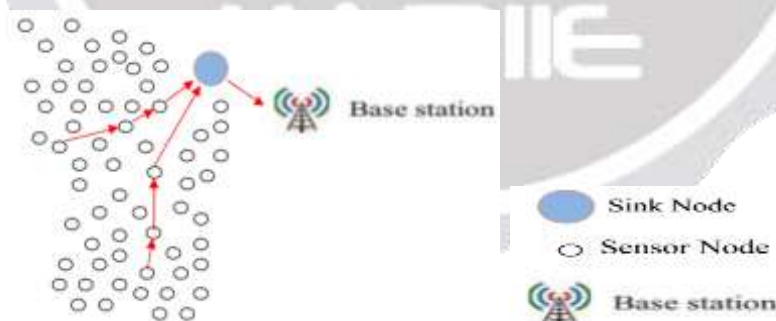

Fig 1.1 Working of WSN

Figure 1.1 shows the working of WSN, where sensor senses data and sends it to the Base station, where sensor sends data and first sends it to the neighbor node, that node send it to the next neighbor node and at last the node near to the Sink node send it to it or directly to the BS. Here from the data sensing to the receiving of the data by base station, in every task of the nodes battery is decreases. Here the power consumption of the takes place in the following manner. The sensor near the BS or MS decreases its battery faster than the nodes far from the SN or BS. In WSN the data transmission takes place in either single hopping or multi hopping where sensed data are transmitted direct to the Sink Node (single hopping) or by sending data to the next neighbor node and at last to the Bs. Nodes closer to the sink tend to deplete their energy faster than the others. And so if the nodes near the sink node

or BS deplete all their energy they cannot take part in the transmission and the network will be destroyed. So clustering approach is used in the WSN for increasing the energy efficiency of the sensor network.

CLUSTERING

Clustering is the technique in which the sensor nodes are grouped in small groups and assigned a cluster head to it. Where all the nodes communicates with the cluster head means sends their data to the cluster head and after that cluster head will send their data to the BS or SN. As shown in fig 1.2
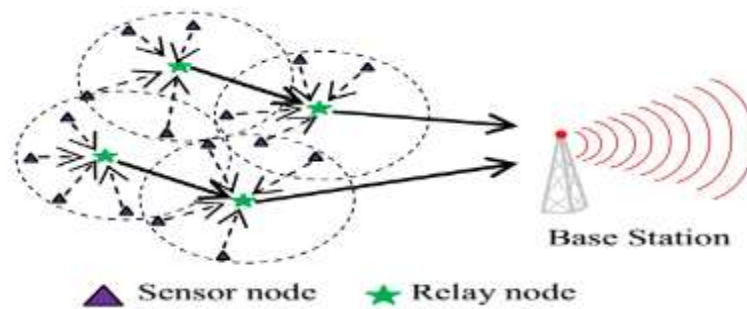

Fig 1.2 Cluster based WSN [3]

Clustering sensor nodes has been adopted as one of the most efficient and effective techniques in this concern. In a cluster based WSNs the sensor nodes are grouped into different clusters with a leader, known as cluster head (CH). Sensor nodes send the sensed data to their respective CHs. CHs then aggregate the data and forward it to a remote base station (BS) using single hop (direct) or multi-hop communication. In many WSNs, the CHs are usually selected amongst the normal sensor nodes and in doing so; they are liable to bear some extra load such as data aggregation, communication with member sensor nodes and so on. So their energy gets depleted soon which results their quick death.[3] But here we can say that they can apply more energy efficient network if fault tolerance is applied here. Here in this paper overview of decreasing nodes energy efficiency, how clustering can increase the lifetime of the network and improve network efficiency.

The rest of the paper is organized as follows. Related Work, Proposed work, conclusion, references.

RELATED WORK

[1] In this paper, A fault node recovery algorithm is proposed. This algorithm enhances the lifetime of a wireless sensor network on shutting down of some nodes. It uses combination of grade diffusion algorithm and genetic algorithms. As in WSN, sensor nodes use battery power supply and thus have limited energy resources. In addition to the routing, it is important to research the optimization of sensor node replacement, reducing the replacement cost, and reusing the most routing paths when some sensor nodes are nonfunctional. This algorithm replaces fewer sensor nodes and reuses the most routing paths, increasing the WSN lifetime and reducing the replacement cost. In the simulation, it increases the number of active nodes up to 8.7 times. The number of active snodes is enhanced 3.16 times on average after replacing an average of 32 sensor nodes for each calculation. The algorithm reduces the rate of data loss by approximately 98.8% and reduces the rate of energy consumption by approximately 31.1%. Therefore, the FNR algorithm not only replaces sensor nodes, but also reduces the replacement cost and reuses the most routing paths to increase the WSN lifetime.

[2] Due to WSN's steps in mobility based applications, an energy efficient routing algorithm named Cluster Based Mobile Wireless Sensor Network (MWSN), is introduced to deal with routing issues of mobile sensor nodes and to improve the life time of the network by making it energy efficient. In this protocol nodes are equipped with GPS for location tracking and delay in joining the mobile node that get out of the cluster in joining new cluster is high. But

here routing is not discussed and the fault tolerance and less packet loss is achieved while sending data either from cluster members to cluster head or low level cluster head to higher level cluster head. Delay also gets reduced as the cluster head sends the data to Base Station through level based architecture of nodes. Mobility of Cluster head during the round and heterogeneous sensor nodes in the network will be considered in the network as for future work

[3] In this paper two distributed algorithms are introduced one for the formation and other for fault tolerance. The cluster formation is based on residual energy and routing overhead with distance between sensor nodes and CH .And fault tolerance selects new CH using payoff or function. The MWSN does not provide routing facility, but the main function of WSN is to route sensed data to BS, and the main problem is irreplaceable power sources of sensor nodes due to which the network is facing the failure. A sensor node selects a cluster head (CH) having minimum routing overhead with higher ratio of residual energy of CH and corresponding distance. Routing overhead of CH is calculated only when the route from individual CH to base station (BS) is defined, so for defining the route amongst CH, GA based routing algorithm named as GAR was executed before selection of CH by sensor nodes. GAR algorithm used to take care of the sensor nodes which are not in communication range of the CH. And thus it solves fault tolerance issue of WSN. This algorithm does not provide design for energy balanced and fault tolerant distributed routing for mobile sensor network with partial and transient failure of the sensor nodes.

[4] In this paper, reduction in total transmission time and the energy consumption of wireless sensor networks using multi-hop data aggregation by forming coordination in hierarchical clustering. This algorithm addresses major requirements such as energy-efficient connectionless communication combined with speed, fault-tolerant, load balancing and scalability. Balanced energy consumption is achieved by transmission of data to the intermediate nodes at all the levels. It also provides scalability to network without any additional cost and still all nodes can send data with help of relay nodes and cluster coordinators. This improves network lifetime and also speed up the data communication. But in this protocol the control can't be placed into center as it is designed for the applications like border surveillance applications.

[5] It is a self organized cluster-based sensor network that has the cluster management mechanisms for new nodes joining and existing nodes leaving, is defined as DCWSN. It can be categorized into two types such as, one hop neighbor information while the other one considers partial one hop neighbor information for multi-node leaving for DCWSN. In this DCWSN, one of the proposed algorithms considers one hop and the other one considers the partial one hop. Here security, QoS and load balancing are not considered in this algorithm but it could be included.

[10] In this paper fault tolerance is achieved using the combination of FNR and the DFCA algorithms and the proposed algorithm provides energy efficiency and reduces the data loss as well. In this algorithm, first clustering is applied to the sensors and then the FNR algorithm is applied in that WSN's nodes. So that first DFCA will divide the network into different clusters and after that FNR makes it energy efficient and reduces data losses. And thus fault tolerance is achieved in this algorithm.

ANALYSIS

Wireless Sensor networks are very important in the context of data transmission and even they are like god gift in the data transmission when they are deployed in the emergency areas like disaster affected areas, war zone etc. Here in these areas, the data transmissions are very crucial as the loss of the data can make big loss in the form of either life loss or property loss. So we should reduce data loss so that we can improve the transmissions.

In WSN, data transmissions take place from the nodes which have sensed the data to the BS or to the sink nodes. In this process they loss their energy. This energy loss occurs in the ascending order.

    a)   Nodes sensing data: have minimum energy loss ,
    b)   Nodes transmitting data of other nodes as well ,
    c)   Nodes near the Sink node,

Here as shown above, in WSN the sensor nodes are performing different tasks as per their positions. The nodes which are far from the SN only senses the data, aggregates them and sends them to the next node near to them and the next node send it to the next one at last data reaches to SN. But he nodes near the SN have to receive data from the all the nodes next to them and send it to the SN. In this way, energy of the nodes near SN loses their energy first,

after that the nodes near them will reduce their energy. Here when any of the nodes lose their energy, they become faulty and thus the faulty node will break the transmission among the network. So we must apply a fault tolerant mechanism which will reduce breakdown in network. Clustering is also used as a fault tolerance mechanism, in which nodes of WSN are divided into small distributed groups of nodes. In each of these groups, a node is assigned as cluster head and all members of the cluster sends sensed data to it and these cluster head sends it to the SN or BS directly or using different CHs. Here in this Clustering system nodes are elected as a cluster head on the bases of the energy they have. The node having highest energy and shortest distance from SN are mostly elected as CH. All the nodes of the cluster send data to their respective cluster head and the CH receives that data aggregate them and transmits them to the BS , but in between that it is constantly losing its energy and so quickly it loses its energy and reaches to the faulty states. Means we can say that a node becomes when it is not able to send data. It occurs mostly due to the energy loss. So if any of the CH stops sending data, data transmissions stops and so in this paper fault tolerance is related to this. In the WSN when any of the node stops working the network fails so we have to fix the fault tolerance mechanism in which the node having good battery condition, can replace the faulty one. Here too many fault tolerant algorithms are proposed. FNR algorithm is one of them and it uses the combination of GA and GD algorithm. Using which it provides the reduction in the data loss and makes the network more energy efficient. But it don't use the clustering and if clustering is provided to it, it can make the network more energy efficient and reduce the amount of data loss as it also provides replacement in the CH and reduces the chance of network loss. In the paper [10], the clustering is applied to the FNR using the DFCA algorithm and it makes the network more faults tolerant. Here in this algorithm, the clustering is first applied to the sensor nodes and after the formation of the cluster, the FNR is applied to that clusters and by doing this network is made more energy efficient and reduces less data even it provides replacement of faulty nodes and thus network lifetime also increases. In this the steps included are as follows. As per given in the flowchart this method works as follows.
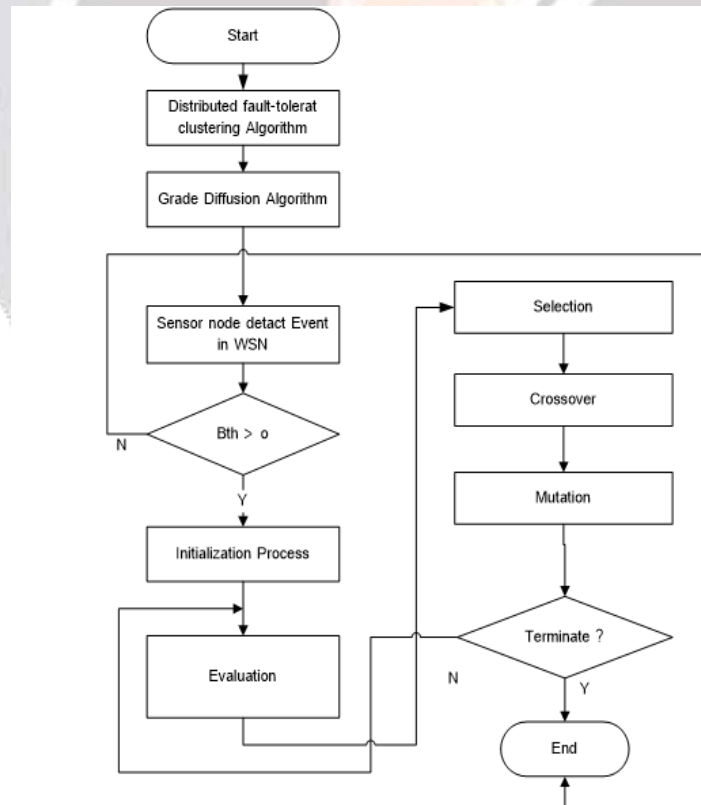

Fig 1.3 Combination of DFCA and FNR[10]

Step-1: Take Finite number of Nodes as input.

Step-2: Apply DFCA on these nodes and provide clustering to them.

Step-3: After that Grade diffusion is applied on that.

Step-4: Faulty sensor nodes detection occurs.

Step 5: Calculation of Bth takes place.

Step 6: Evaluation process starts.

Step 7: Selection takes place.

Step 8: Crossover takes place.

Step 9: Mutation takes place.

Step 10: Recovery and vulnerability checking. (if found than reapply the GA)

Step 11: Stop the process.

Thus whole process takes place and replaces the faulty nodes as well as the CHs and increases the lifespan of the WSN.

CONCLUSION

WSN consists of sensor nodes which are using the battery for their power supply and so they have small amount of power supply. This reduces the lifespan of the WSN because the sensors continuously sensing and transmitting data are losing their energy. They transmit data to BS by sending it to the next neighbor node. Here if one of the nodes energy reduces to vulnerable level, the transmission of data stops and for that fault tolerant mechanisms are made available. Different fault tolerant mechanisms are explained in this paper and are analyzed in this paper. And concluded that clustering makes WSN more long lasting than normal transmission. And other thing concluded is that if clustering is applied to the FNR it will become more energy efficient, reduces data loss and have more lifespan than normal one.

REFERENCES

[1] Hong-Chi Shih, Jiun-Huei Ho, Bin-Yih Liao, Jeng-Shyang Pan,"Fault Node Recovery Algorithm for Wireless Sensor Network" IEEE SENSORS JOURNAL, VOL. 13, NO. 7, ISSN 1530-437/X/13, pp: 2683-2689, JULY 2013.

[2] Jaideep Lakhotia, Rajeev Kumar, "Fault Tolerant and Mobility Aware Routing Protocol for Mobile Wireless Sensor Network,",International Conference on Control, Instrumentation, Communication and Computational Technologies(ICCICCT),ISSN978-1-4799-4190-2/14,pp:584-590,2014.

[3] Suneet K. Gupta, Pratyay Kuila, Prasanta K. Jana, "E3BFT: Energy Efficient and Energy Balanced Fault Tolerance Clustering in Wireless Sensor Networks,", IEEE, ISSN 978-1-4799-6629-5/14 pp: 714-719, 2014.

[4] Shalli Rani, Jyoteesh Malhotra, Rajneesh Talwar, "Energy efficient chain based cooperative routing protocol for WSN,",elsevier, Applied Soft Computing-7, ISSN 1568-4946/15, pp: 113–126, June, 2015

[5] Asim Zeb, A.K.M.Muzahidul Islam, Nafees Mansoor, Sabariah Baharun,Shozo Komaki, "Fault Tolerance in Dynamic Cluster-Based Wireless Sensor Networks,", IEEE, ISSN 978-1-4799-6369-0/15,pp:646-649, 2015.

[6] Md Azharuddin, Pratyay Kuila, Prasanta K. Jana, "A Distributed Fault-tolerant Clustering Algorithm for Wireless Sensor Networks,", ICACCI, ISSN978-1-4673-6217-7/13 pp:997-1002,2013.

[7] Alakesh Braman, Umapathi G. R.," A Comparative Study on Advances in LEACH Routing Protocol for Wireless Sensor Networks: A survey", International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 2, ISSN (Print) : 2319-5940/14, pp:5683-5690, February 2014.

[8] Jessica A. Carballido, Ignacio Ponzoni, Ne´lida B. Brignole, "CGD-GA: A graph-based genetic algorithm for sensor network design", Science Direct, ISSN0020-0255, pp: 5091-5102.

[9] Muhammad Farhan Khan, Dr. Emad A. Felemban, Dr. Saad Qaisar, Salman Ali, "Performance Analysis on Packet Delivery Ratio End-To-End Delay of Different Network Topologies in Wireless Sensor Networks", IEEE,ISSN 978-0-7695-5159-3/13, pp: 324-329.

[10]Mr. Nirav Chittaliya, Mr. Jignesh Vania," An Adaptive Routing Algorithm for Cluster Based WSN", International Journal of Advance Research and Innovative Ideas in Education (IJARIIE), ISSN: 2395-4396.

BIOGRAPHIES

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