A SURVEY ON FLAW/FAILURE DETECTION IN WSNs

Jeethumol K Joy, Syamesh K G, Reshma Rajan

Abstract— In wireless sensor networks the number of sensor nodes present are really large. To send a data from the source node to the destination node, it is essential that the nodes in the network should be working properly for the normal functioning of the network. Hence we have to detect any flaw or hostile nodes in the network. This is important as the hostile users affect the QoS of the network. In case of networks with huge number of sensor nodes, the chance of failure is high.

***Index Terms*—flaw or hostile nodes, RTD, RTP**

I. INTRODUCTION

Wireless sensor network (WSN) consist of enormous number portable sensors (small, low-power and cost) placed in field measuring ground with the help of wireless communication module. The desire is to sense, collect and process the information from all sensor nodes and then sending it to for analyzing [1-3]. The sensor node failure may occur in WSN due to undisciplined environment, battery associated problem, failure in communication device [1,2]. Failure detection is crucial because failed or malfunctioning sensor node may produce incorrect inquiry or detection of parameter [2,4]. Failed sensor node may cutback the quality of service (QOS) of the entire WSN [1]. Manually analyzing of such failed sensor node in WSN is troublesome. To attain the good quality of WSN through certainty, soundness and performance, detection of sensor node failure or malfunctioning is crucial [1-3].

II. WIRELESS SENSOR NETWORKS

Wireless sensor networks consists of spatially diffused sensors to detect, monitor and record the physical and environmental parameters like temperature, pressure, intensity, sound, etc.. It is also used for transmitting data from one source node to the destination node. Unidirectional and bidirectional data transmission is possible. A WSN consists of hundreds or thousands of nodes depending upon the area to be monitored. Each sensor node consists of transceiver, internal antenna, microcontroller and battery unit.

WSNs finds application in a large number of areas. Some of the applications of WSNs are: process management, area monitoring, health care monitoring, environmental sensing, air pollution observing, forest fire recognition, landslide recognition, water quality surveilling, natural disaster prevention, machine health checking, data logging, water/waste water monitoring, structural health monitoring, etc..

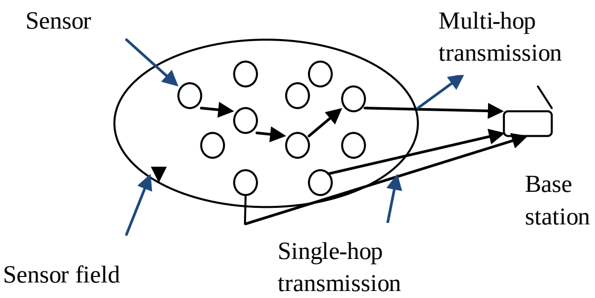

Fig.1.Wireless Sensor Networks with single-hop transmission and multi-hop transmission

There is chance for failure in WSNs. The Sensor nodes are working on limited power. Sensor nodes battery cannot be recouped. Sensor nodes consume more energy while sensing the local information, communication with other nodes, and Transmitting the local message to the base station. Energy utilization is the major problem of wireless sensor networks. The challenges in WSNs are 1) Wireless ad hoc nature: WSNs has no fixed communication framework. Due to constraints on common wireless media communication between nodes faces problem of undependable and asymmetric links. But, it provides the benefit of broadcasting: this means when a node convey the message to another node then message is accepted by all neighbors of transmitting nodes. 2) Mobility and topology changes: Mobility leads to the frequent path changes, which affect the delivery of the packet . New nodes can join the network and existing nodes may leave the network. Nodes may stop working. WSNs applications have to be active against nodes failures and dynamic topology. 3) Energy limitations: Initially the sensor nodes are supplied with limited amount of energy to perform different operations such as sensing, communicating, broadcasting data to base station. Energy Consumption is the major matter of the research in wireless sensor networks. 4) Physical distribution: Sensor nodes in WSNs are the self-governing device which contacts with other nodes via message and sensed data is broadcasted to the base station

Manuscript received Dec , 2015.
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ISSN: 2278 – 7798

with high communication costs. 5) Location discovery: Many applications require knowing the accurate or relative physical location of a sensor node in order to associate sensed data with the object under investigation. 6)Security: In Wireless Sensor Networks, sensor nodes can be substantially captured and negotiate their security. Security is the major issue which needs to be addressed. 7)Fault Tolerance: System should provide crave performance in the presence of faults or node failure. Sensor nodes are prone to deterioration or failing, fault tolerance should be seriously treated in many applications of wireless sensor networks.

III. FLAW DETECTION IN WSNs

The flaw or failure in WSNs can be due to many reasons. For proper functioning, the fault should be detected and corrected. This paper is based on different fault detection techniques.

A. Energy-efficient cluster-based scheme

In this method[6], the nodes in the cluster are classified as boundary, pre-boundary, internal nodes and cluster head. Failure of boundary nodes do not have much effect in the functioning and do not require any recovery. If the energy of a particular node falls below the threshold value, then it sends a fail-report-msg to other nodes. If the cluster head fails, then it causes it's children to exchange their residual energy information. Hence the node with maximum residual energy is selected as the new cluster head. The children are attached to this new cluster head. This method is more energy consuming as it exchanges their energy information and is time consuming.

B. Fault detection and recovery using clustering

In this paper, the drawback of [6] is overcome by employing a backup secondary cluster head[7]. The node with higher residual energy becomes the cluster head and the node with second maximum residual energy becomes the secondary cluster head. In this method, when the energy of the cluster head falls below the threshold value, the secondary cluster head becomes the main cluster head. Here there is no need of any messages regarding the residual energy to be send between the nodes. Hence this method is more time and energy efficient.

C. The distributed fault detection (DFD) scheme

In this paper, The distributed fault detection (DFD) scheme[8] checks out the hostile nodes by exchanging data and mutually testing among neighbour nodes. Fault detection accuracy decrease quickly when the number of neighbour nodes to be analysed is small and the node's failure ratio is high. For two neighbour nodes Si and Sj, a test result Cij is calculated by the data (such as temperature) sensed by each of them. The difference between this data should not go beyond a certain threshold $\theta 1$At another moment t+1, the difference of the data of the two neighbour nodes should not exceed a certain threshold $\theta 2$. If one of these two conditions is not satisfied, at least one of Si and Sj is determined as a hostile node, and the test result Cij = 1, otherwise Cij = 0.If there are more than half the number of neighbour nodes whose test conclusions are 1, then the initial detection status Ti of node Si is possibly faulty (LT), contrarily, it may be possibly normal (LG). If the number of its neighbour nodes with initial detection status of LG is less than half the number of neighbour nodes, then Snormal is misdiagnosed as faulty, reducing the fault detection accuracy. Improved DFD detection scheme is used to overcome the limitation of this method. This new method changes the detection criterion of DFD as, for any node Si and the nodes in Neighbour(Si) whose initial detection condition is LG, if the nodes whose test conclusion with Si is 0 are not less than the nodes whose test conclusion is 1, then the status of Si is normal (GD), contrarily, the status of Si is faulty (FT). With the reduction in the size of the network, the certainty of fault detection decreases for both the schemes.

D. Failure Detection Based on Round Trip Delay and Paths

In [9], the sensor node failure detection is based on the RTD(Round Trip Delay) time of different Round Trip Paths(RTP). RTD is the time required for a data to send from the source node and return to the same source node. RTP is formed by grouping three sensor nodes. Accuracy of this method can be increased by reducing the RTD time. When all the nodes are working properly, the RTD calculated gives the threshold RTD value. This value is used in comparison to detect the faulty node. The presence of faulty node changes the RTD values. The new RTD value can be either greater than the threshold value (node is malfunctioning) or infinity (node is dead).

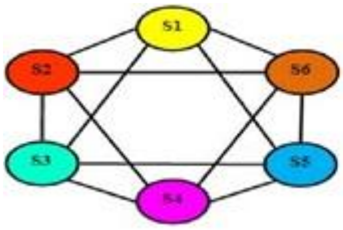

Fig. 1.Circular topology WSN with six sensor nodes.

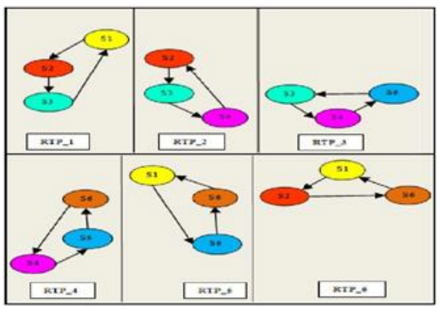

Fig.2.Illustration of six linear RTPs.

ISSN: 2278 – 7798

The faulty node can be detected by comparing the RTD values of different RTPs. Each node is a member of three RTPs. So comparison of such three RTPs is sufficient to find the failure.

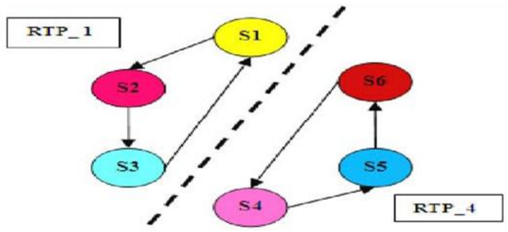

Fig. 3.Illustration of two discrete RTPs.

A network with six sensor nodes is shown in fig.2. There are six linear RTPs. In case of networks with large number of nodes, the number of linear RTPs will be high. Comparison of all such paths is time consuming. Hence, in-order to overcome this drawback, we select discrete RTPs. Discrete RTPs are selected from subsequent linear RTPs only. They are selected by discarding the two successive paths, after each selected linear path. The RTD value of first RTP is calculated and is compared with the threshold value. If it is not less than the threshold value, then one of the nodes is faulty. The RTDs of the RTPs in which the three nodes exist are calculated and compared. The node common to the RTPs with RTD value greater than the threshold value is faulty.

IV. CONCLUSION

In this paper, a survey on sensor node failure and detection is presented. The use and application of sensor nodes has increased a lot. Hence any fault in the network has to be detected and corrected. Many drawbacks of the previous detection methods is overcome by using RTD method. Necessity of received signal strength measurement in cluster head variation and accrediting separate wavelength for each link in other fault detection techniques are overcome here[10].

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ISSN: 2278 – 7798