Distance Based Fault Detection in Wireless Sensor Networks: A Survey

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***Abstract*—The wireless sensor network takes part in area monitoring, environmental monitoring, Medical application, structural monitoring, traffic monitoring and habitat monitoring. The wireless sensor network consists of large number of sensor nodes. They become failure due to hardware failure, communication error, energy depletion and malicious attack. Fault detection is one of the techniques in fault tolerance. Fault detection is to collect the information of possible faults. There are many mechanisms proposed to solve this issue, Distance based fault mechanisms is a method proposed to detect the faulty node. The aim of this paper is to survey the various Fault detection mechanisms.**

Keywords- Wireless Sensor Network (WSN); Sensor Fault Models; Fault Tolerance; Distance Based Fault Detection.

I. INTRODUCTION

A sensor node will have sensing unit, processing unit, power unit, Location finding unit and transceiver. Two components of sensor node, sensing unit and transceiver, directly connected with the environment. Sensing unit consists of sensor, analog to digital convertor. Sensor in the sensor node is capable of sensing data and some of them may be incorrect data. Three reasons for fault detection: (1) nodes with fault sensors and permanent communication fault are to be identified and removed from the network, (2) fault-free sensors are to be diagnosed and (3) sensor fault models have to be identified for faulty sensor. Distance based fault detection method for wireless sensor network using the average of confidence level and sensed data of sensor node used in for detecting faults.

A. Sensor Fault Models

In wireless sensor networks, sensor fault models like random noise fault (Noise generated by nodes varies, as it can be produced by several effects), gain fault (The measured data of a fault is noticed and compared between gain to the right value), offset fault (The amount of distance by which something is out of line), stuck at fault (A fault sensor that constantly report a fixed reading) have been found based on the distance. A sample Architecture of wireless sensor network model is shown in fig .1.

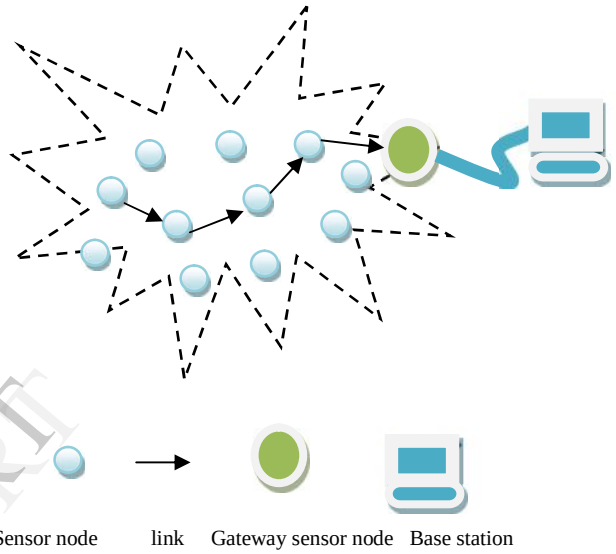

Fig .1 Architecture of WSN

B. Distance Based Fault Detection

The first step in the distance based fault detection algorithm is to find neighbor nodes with the help of network radius. The sensor nodes come into the radius of any node will be considered as neighbor of that node. At the beginning, confidence level (maximum) is the initial confidence level for all sensor .The second steps is to initialize the faulty node with the probability of sensor node being faulty and non-faulty node where distance of each node is calculated from the base station. For each fault free node the distance will be less than threshold value. The third step is to check the attribute faulty (struck at fault, gain fault, offset fault, random noise fault) and create a list which contains all faulted sensor information. To find faulty nodes for each time sensed data and neighbor list of sensor node is taken and weighted average calculation is done to find the faulty nodes with threshold value.

There are two metrics used to evaluate the performance, they are, CAR (Correct Detection Rate) and FAR (False Alarm Rate). The CAR is ratio of number of faulty sensor nodes detected to the total number of faulty nodes. FAR is for fault-free nodes specified as faulty to the total number of fault-free nodes.

C. *Sensor Networks Factor*

A sensor network design is influenced by many factors such as, Fault tolerance, accuracy, scalability, production cost, operating environment, sensor network topology, hardware constraint, transmission media and power consumption.

1) *Fault Tolerance*

A fault tolerance technique is used for fault diagnosis and recovery of faulty nodes in the sensor network.

2) *Accuracy*

Accuracy can be defined as how much the estimated position of sensor is deviated from the true position. Precision indicates how often we expect to get at least the given accuracy.

3) *Power Consumption*

Unlike cellular networks and adhoc networks, where energy has no limits in base station or batteries can be replaced as needed. Nodes in sensor network have very limited energy and their batteries can't be replaced due to hostile and bad environments.

4) *Production Cost*

The cost includes time spend for installation, money, computational effort or energy.

5) *Hardware Constraint*

Even if condition of the hardware is good, the communication between sensor nodes are affected by many factors, such as signal strength, antenna angle, obstacles, weather condition and interference.

II. RELATED WORKS

A. *Related Works on Fault Detection*

The researchers have done research on fault detection methods to detect the sensor fault. In [1], [3], [4] the authors have used different algorithm to identify the node that have highest probability to be good or faulty.

B. *Related Works on Fault Tolerance*

Fault tolerance mechanisms have been discussed by many authors by detecting the faults in the sensor nodes and used some techniques to correct such faults. In [2], [5], [6], [7], [8], [9] the authors have implemented algorithms for fault tolerance.

Ayasha Siddiqua et al., [1] discussed "Distance Based Fault Detection Algorithm". The main work of this algorithm is to find faulty node based on the distance. Different weights to neighbor measurement are used to detect faulty sensor node with high accuracy for wide range of fault probabilities while maintaining low false alarm rate.

Konshanfar F et al., [2] discussed "Fault Tolerance Techniques for Wireless Ad hoc Networks". The main idea is to use one type of sensor to back-up sensors of different types by exploiting flexibility during multimodal sensor data Fusion.

Konshanfar F et al., [3] have also said about "On-line fault detection on sensor measurement" .The important step is that On-line testing to identify the sensors that have the highest probability to be faulty using non-linear function minimization.

Chen J et al., [4] developed "Distributed Fault Detection of Wireless Sensor Network". Distributed Localized Faulty Sensor (DLFS) detection algorithm identifies the sensor's status as good or faulty. The probabilities of faulty sensors being diagnosed as good and good sensors not being diagnosed as good in the entire sensor network are very low.

Lilia et al., [5] explained "A Survey of Fault Management in Wireless Sensor Network". This paper reviewed current techniques which are dealing with faults in wireless sensor networks. Most fault management techniques in sensor networks have been integrated with application requirements differently from fault management in traditional networks.

Tsang-Yi Wang et al., [6] said that "Distributed fault-tolerant Classification in wireless sensor Network". The problem of fault-tolerant distributed classification in wireless sensor networks. They proposed DCFECC (Distributed Multiclass Classification Fusion Using Error Correcting Codes) approach is based on error-correcting codes and it is applicable to harsh environments.

T.Cloqueur et al., [7] explored **"**Fault Tolerance in collaborative sensor Networks for target detection". Two algorithms are used to solve the problem: value fusion and decision fusion. They were analyzed for their robustness to sensor nodes failure and compared for their Performance and communication overhead.

Cardei M et al., [8Discussed about **"**Fault-tolerant Topology Control for Heterogeneous Wireless Sensor Networks". The k-degree Anycast Topology Control (k-ATC) problem with the objective of selecting each sensor's transmission range such that each sensor is k-vertex supernode connected and the maximum sensor transmission power is minimized**.** Two solutions proposed for the k-ATC problem: A centralized algorithm that produces the optimal solution and a distributed and localized algorithm that incrementally adjusts sensors transmission range.

Krishnamachari B et al., [9] explained **"**Distributed Bayesian Algorithm for Fault Tolerant Event Region Detection in Wireless Sensor Network". The binary detection of environmental features (For example: Which regions in the environment have a chemical concentration greater than specific units.) for possibility of sensor measurement faults. A distributed Bayesian algorithm developed for detecting and correcting such faults.

III. SUMMARY

In wireless sensor network, fault detection have been done using average confidence level and sensed data of sensor node in distance based fault detection. Fault is unavoidable issue in sensor node due to erroneous nature, so it can be found and tolerated when it is occur. In this survey, various fault detection and fault tolerance mechanism have been studied. Fault detection is a challenging factor in WSN.

IV. REFERENCES

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