International Journal of Engineering Research and General Science Volume 3, Issue 2, Part 2, March-April, 2015
ISSN 2091-2730

A Survey on Fault Detection and Recovery techniques in Wireless Sensor networks

Er. Jaspreet Kaur, Er. Parminder Kaur

Student of M.E (IT), jaspreetsandhu1990@gmail.com

Abstract— From last few years Wireless Sensor Networks have gained attention of lots of researchers in various applications like environmental monitoring, battle field and health care monitoring etc. Sensor nodes in WSN are prone to failure due to hardware failure, depletion of energy, malicious attacks etc. This paper presents the survey on various fault detection and recovery technique.

Keywords— Wireless Sensor Networks, Fault Recovery algorithm, RIM, LeDir.

Introduction

Wireless Sensor Networks (WSNs) have gained the attention of lots of researchers, particularly with amplification in Micro-Electro-Mechanical Systems (MEMS) which has facilitated the development of sensors [1]. Wireless sensor networks consist of a large number of tiny sensor nodes and a special node known as base station. Sensor nodes are deployed in a target area to perform a particular task such as monitoring the environmental conditions (pollution detection, pressure, sound etc), energy detection in military areas. Sensor nodes send the sensed data to base station through single-hop or multi-hop transmission and then base station make further decisions. The positions of sensor nodes need not to be pre-determined because sensor network protocol has self-organized capabilities. [2].

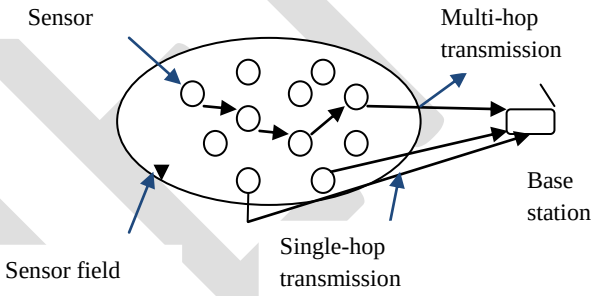

Figure: 1 Wireless Sensor Networks with single-hop transmission and multi-hop transmission

A. Components of Wireless Sensor Network

1) Sensor Field: Sensor Field is the target area in which sensor nodes are placed to perform a particular task.
2) Sensor nodes: Sensor nodes collect data and route the information back to Base Station. Sensor nodes are made up of four components (a sensor, a processor, a radio transceiver and a power supply/ Battery).
3) Base Station: Base station extracts the information from the network. It may be gateway to other networks, a storage centre. Base Station may be a laptop or a workstation.

Sensor nodes communicate with other sensor nodes or with base station through wireless communication media such as radio signals, infrared, Bluetooth. Sensor nodes use either Single hop transmission or Multi-hop transmission. In a single hop transmission all the sensor nodes send their sensed data directly to the base station. Single hop transmission is easy to implement. In Multi-hop transmission sensor nodes transmit their sensed information to base station through intermediate nodes. Fig 1.1 shows the Single hop Transmission and Multi-hop Transmission in wireless sensor networks.

Sensor nodes are operated on limited power. Sensor nodes battery cannot be replaced. Sensor nodes consume more energy while performing various operations such as

a) sensing the local information,
b) communication with other nodes, and
c) Transmitting the local information to the base station.

Energy Consumption is the major issue of wireless sensor networks.

B. Challenges in Wireless Sensor Networks:

- *Wireless ad hoc nature:* WSNs has no fixed communication infrastructure. Due to restrictions on shared wireless media communication between nodes faces problem of unreliable and asymmetric links [4].But, it provides the advantage of broadcasting: this means when a node transmit the message to another node then message is received by all neighbors of transmitting nodes.

- *Mobility and topology changes:* Mobility leads to the frequent route changes, which affect the delivery of the packet [5]. New nodes can join the network and existing nodes may move out of the network. Nodes may stop functioning. WSNs applications have to be vigorous against nodes failures and dynamic topology.

- *Energy limitations:* Initially the sensor nodes are provided with limited amount of energy to perform various operations such as sensing, communicating, transmitting data to base station. Energy Consumption is the major issue of the research in wireless sensor networks.

- *Physical distribution:* Sensor nodes in WSNs are the autonomous device which communicates with other nodes via message and sensed data is transmitted to the base station with high communication costs.

- *Location discovery:* Many applications require knowing the exact or approximate physical location of a sensor node in order to link sensed data with the object under investigation.

- *Security*: In Wireless Sensor Networks, sensor nodes can be physically captured and compromised their security. Security is the major issue which needs to be addressed.

- *Fault Tolerance*: System should provide desired functionality in the presence of faults. Sensor nodes are prone to failure, fault tolerance should be seriously considered in many applications of wireless sensor networks.

REASONS OF FAILURE OF SENSOR NODE IN WSN:

In Wireless Sensor Networks, Sensor nodes get fail due to their deployment in harsh environment. Sensor nodes get fail due to hardware failure, energy utilization, and malicious attacks.

- In Wireless sensor networks, sensing unit and transceiver directly interact with the environment which is subject to variety of physical, chemical and biological factors which further affect the reliability of sensor nodes.

- In WSN, Whether the hardware condition is good, but the communication between sensor nodes get affected by signal strength, interferences, obstacles.[6]

- Sensor nodes have limited battery power that cannot be replenished. When sensor node deplete their energy then that node become the fault node and cannot relay the data to the base station and network functionality get affected.

- Example of fault node:

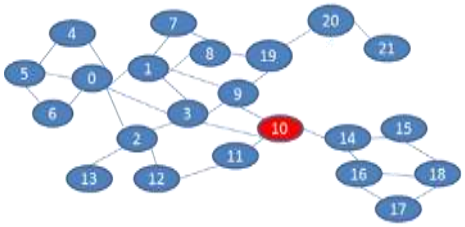

Figure: 2 Network examples with fault node [18]

FAULT DETECTION:

To deals with faults in WSN there are two steps: Fault detection and Fault recovery. First step is fault detection. There are two types of failure detection approaches: centralized and distributed approach. [7]

A. Centralized Approach

Centralized approach is used to identify and localize failure nodes in WSNs. Usually base station, central controller or manager, sink are used to monitoring and tracing the failed node in the network. [8][21] The Central node adopts an active detection model to take back the states of network performance and individual sensor nodes by periodically injecting queries to the network. Central approach analyzes this information to identify the failed nodes. The problem of this approach is that central node easily become data traffic concentration in the network, which further causes a high message traffic and quick energy utilization in certain regions of network specially node closer to base station.

B. Distributed Approach

The aim of this is to allow a sensor node to make various decisions before communicating with the central node. [9] Central node should not be informed unless there is really a fault occurred in the network. Example: node fault self detection on its hardware physical malfunction.

- Node Self Detection: Faults occurred by depletion of energy is detected by sensor node itself. [6]
- Neighbor Coordination: Nodes communicates with neighbor nodes to identify the failed nodes.[9]
- Clustering approach: In [10] authors presented a efficient failure detection solution using a cluster-based technique. The cluster head identifies the failure node by sending the heartbeat messages. If a failure is detected then the information is disseminated to the all clusters.

FAULT RECOVERY ALGORITHM:

After the detection of fault the next step is fault recovery. In [11] authors have presented a MDRN (Minimum distance redundant nodes). By employing redundant nodes, the recovery algorithm is deployed on the sink node which has the knowledge about the location of sensor nodes and redundant nodes in WSNs. Result shows that, by choosing the suitable number of redundant nodes the algorithm will provide accurate recovery. In [12] authors proposed Directed Diffusion protocol to reduce the data relay to manage power consumption. It is a query transmission protocol. The collected data is sent only if they matches the query from the sink node thereby reducing the power consumption. In Directed Diffusion Protocol, there are several circle routes which are built when queries are broadcasted, result in wastage of power consumption and storage. In [13] authors proposed a fault management architecture, in which network is divided into virtual grid of cells, in each cells there are cell manager and gateway nodes to support management tasks. Nodes have equal no. of resources and back up each other in the case of recovery. In [14] authors extend the cellular architecture and proposed a new technique in which network is divided into virtual grid to perform fault detection and recovery with minimum energy consumption. The proposed failure detection and recovery algorithm is compared with existing work and proven be energy efficient. In [15] authors provide a cluster based and cellular approach for wireless sensor networks. This proposed algorithm is based on clustering to address many issues like, energy efficiency, routing and management. This algorithm is similar to previous as in

that, nodes are converted to virtual grid. But in this algorithm, if the connection with cluster head is break then choosing a new cluster head is energy consuming task, so at this place a backup node is placed which does not interrupt the previous functioning. These nodes are less energy consuming nodes and take no energy of network in order to recover cell manager failure.

In [16] authors proposed an algorithm on ladder diffusion and ACO to solve power consumption and transmission routing problems in wireless sensor networks. The algorithm balances the transmission load in order to increase the network lifetime of sensor node and transmission efficiency. Ladder diffusion algorithm avoid the generation of circle routes. To ensure the safety and data reliability ladder diffusion algorithm provide back-up routes to avoid wasted power consumption and processing time when rebuilding the routing table. The algorithm compared with DD and AODV and reduces power consumption by 52.36% and increase data forwarding efficiency by 61.11 as compared to Directed Diffusion. In [17] authors proposed a fault node recovery algorithm in order to increase the lifetime of wireless sensor networks when some nodes shut down due to their energy depletion. The algorithm is based on grade diffusion algorithm combined with genetic algorithm. The algorithm replace fewer sensor nodes and more reused routing path. The simulation result shows the increase the number of active nodes upto 8.7 times reduces the rate of data loss by approximately 98.8% and reduce the rate of energy consumption by approximately 31.1%. In [18] DARA (Distributed actor recovery algorithm) algorithm has been presented by authors. When a node fails, the node which has minimum distance from the failure node is selected to replace the fault node. In this algorithm shortest path between nodes is extended. In [19] authors proposed a RIM (Recovery through inward motion). RIM method moves the healthy node towards the failure and replaces the failure node. In this approach every node has a 1-hop neighbor list and nodes are aware about their neighbor's locality and proximity. In [20] authors presented LeDiR (Least disruptive repair topology). LeDiR approach has a local view of sensor node. In this approach a small block is identified which is move towards the failure node and maintain the connectivity of the network.

CONCLUSION:

From the last few years, Wireless Sensor Networks have got the attention of lots of researchers due to their real time applications. Fault tolerance is the major issue of Wireless Sensor networks. If a node get fails it divide the network and affect the network performance. In this paper a survey is presented on the fault detection and recovery techniques in Wireless Sensor Networks.

REFERENCES:

1. Yick, J., Mukherjee,B., Ghosal,D., "Wireless sensor network survey" Computer Networks 52,Accepted in April,2008, , pp. 2292-2330.
2. I.F.Akyildiz, W.Su., Y.Sankarasubramaniam, E. Cayirci, "A survey on sensor networks", IEEE communications Magazine 40 (8), Published in 2002, pp. 104-112.
3. Abassi, A.,Younis, M.,"A survey on clustering algorithm for wireless sensor network" Computer Communications 30,Published in June,2007, pp. 2826-2841.
4. Kulkarni, R.V.; Forster, A.; Venayagamoorthy, G.K. Computational intelligence in wireless sensor networks: A survey. IEEE COMMUNICATIONS SURVEYS & TUTORIALS, Vol. 13 ,2011, pp.68–96.
5. Bharti,D., Behniwal,M., Sharma, A.,K.," Performance Analysis and Mobility Management in Wireless Sensor Network", International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 3, issue 7, Published in July, 2013.
6. Liu. H.,Nayak. A., Stojmenovic. I., "Fault Tolerant Algorithms/Protocols in Wireless Sensor Networks." Guide to Wireless Sensor Networks. Springer London.,2009, pp.261-291,.
7. M. Yu., H. Mokhtar., "A Survey on Fault Management in Wireless Sensor Networks", ISBN, 2007.
8. A.Perrig, R.Szewczyk, V.Wen, D.Culler, J.D.Tygar. "SPINS: Security protocols for sensor networks." in ACM MobiCom'01. Rome, Italy:ACM Press,2001
9. K. Farinaz., P. Miodrag., S. Alberto., "Fault Tolerance Techniques for Wireless Ad Hoc Sensor Networks." 2000.
10. Ann T. Tai, Kam S. Tso, William H. Sanders. "Cluster-Based Failure Detection Service for Large-Scale Ad Hoc Wireless Network Applications in Dependable Systems and Networks" DSN ' 04. 2004.
11. J. Sony., W. Bailing, P. Xiyar, Li Jianfeng and Zhong cheng, "A Recovery Based on Minimum Distance redundant Nodes Fault Management in WSNs," International Journal of control and automation, vol 6,No.2 April 2013.
12. Intanagonwiwat, C., et al. "Directed diffusion for wireless sensor networking." Networking, IEEE/ACM Transactions on 11.1 (2003), pp. 2-16.

13. Asim, M., H. Mokhtar, and M. Merabti. "A Fault management architecture for wireless sensor network." Wireless Communications and Mobile Computing Conference, 2008. IWCMC'08. International. IEEE, 2008.
14. Asim,M., H.Mokhtar, and M.Merabti, "A cellular approach to fault detection and recovery in wireless sensor networks", IEEE 2009 Third International Conference on Sensor Technologies and Applications.
15. Akbari, A., and Neda B., "Cluster-based and cellular approach to fault detection and recovery in wireless sensor networks." Advanced Computer Theory and Engineering (ICACTE), 2010 3rd International Conference on. Vol. 5. IEEE, 2010.
16. Ho, J-H., et al. "A ladder diffusion algorithm using ant colony optimization for wireless sensor networks." Information Sciences 192 (2012) pp.204-212.
17. Shih, H-C., et al. "Fault node recovery algorithm for a wireless sensor network."Sensors Journal, IEEE 13.7 (2013), pp. 2683-2689.
18. A. Abbasi, M. Younis, and K. Akkaya, "Movement-assisted connectivity restoration in wireless sensor and actor networks," IEEE Trans. Parallel Distrib. Syst., vol. 20, no. 9, Sep. 2009, pp. 1366–1379,.
19. M. Younis, S. Lee, S. Gupta, and K. Fisher, "A localized self-healing algorithm for networks of moveable sensor nodes," in Proc. IEEE GLOBECOM, New Orleans, LA,Nov. 2008, , pp. 1–5,.
20. A. Abbasi, M. Younis and U. Baroudi, "Recovering from a Node Failure in Wireless Sensor-actor Networks with Minimal Topology Changes", IEEE Transactions on Vehicular Technology, Vol. 62,No. 1, January 2013.
21. S. Jessica, B. Dirk,D. Glenn, "Efficient Tracing of Failed Nodes in Sensor Networks." in First ACM International Workshop on Wireless Sensor Networks and Applications.. Altanta, GA, USA: ACM. 2002