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A SURVEY ON ENERGY EFFICIENT FAULT DETECTION AND ROUTING SCHEME FOR WIRELESS SENSOR NETWORKS

Gopal K[1], Ramalakshmi K[2], Priyadharsini C[3]

[1]Post Graduate Student, Department of Computer Science and Engineering,
[2]Assistant Professor, Department of Computer Science and Engineering,
[3]Assistant Professor, Department of Computer Science and Engineering,
Karunya University.

[1]gopalit88@gmail.com, [2] rramalakshmi@karunya.edu, [3] priyadharsini@karunya.edu

Abstract

Recent advances in wireless sensor networks have led to many new protocols specifically designed for sensor networks where energy awareness is an essential consideration. Most of the attention, however, has been given to the failure detection since they might differ depending on the application and network architecture. This paper surveys the energy efficient fault detection for sensor networks and presents a classification for the various approaches pursued. We classify the surveyed approaches based on their methodologies used into three categories: Vector based model, Cellular Automata based model and Cluster based model. Each routing protocol is described and discussed under the appropriate category.

Keywords: Energy, Fault Detection, Routing, and Faulty Nodes.

1. Introduction

Wireless sensor networks (WSNs) are distributed networks that encompass small inexpensive low power devices and widely distributed in large number of remote geographical region, in office buildings or in industrial plants. A WSN is used widely in such environments for monitoring the environment purpose, which includes air, soil and water, habitat monitoring, military surveillance inventory tracking, condition base maintenance and in many more cases .The main components of a sensor node (Figure 1 shows the components of Sensor Networks) are a microcontroller, transmitter circuits, receiver circuit, memory, power source and one or more sensors.

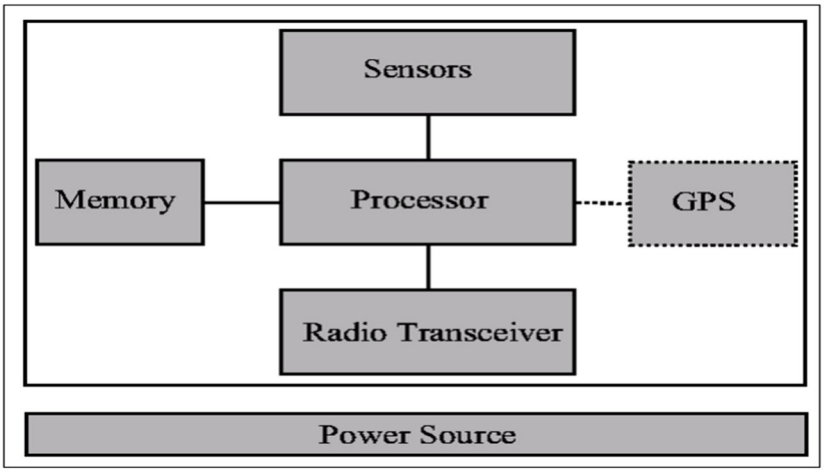

Figure 1 Component of Sensor Networks

The microcontroller is mainly responsible for data processing and managing other components of sensor nodes. Transmitter and receiver are combined in a single device known as transceiver. Transceiver is responsible for to receive the data from transmitter. The most relevant kind of memory is on-chip memory of a microcontroller. Here using Low capacity memory chip then it is used for data buffering. The power is stored in batteries it is the main sources of sensor nodes, both rechargeable and non-rechargeable batteries are available in wireless sensor networks. The sensor of a node is a hardware device that is responsible for measuring physical data of the parapet which is to be monitored in the WSN. As the sensor nodes are powered by battery and in turn they have limited power source and at the same time these nodes are deployed at harsh and different environment, the sensors nodes are prone to failure. Faulty sensor nodes may cause wrong data sensing, erroneous data processing and incorrect data communications. The faults in WSN nodes occur due to failure of any one of its hardware components as discussed above.

This paper is organized as follows. Section 2 includes a discussion about the hierarchy of Effective Fault Detection approaches; section 3 gives us a comparative study on various intelligent techniques of cluster forming, cellular automata and data routing mechanisms. Finally section 4 gives the conclusion of the paper.

2. Classification of Fault Detection Schemes

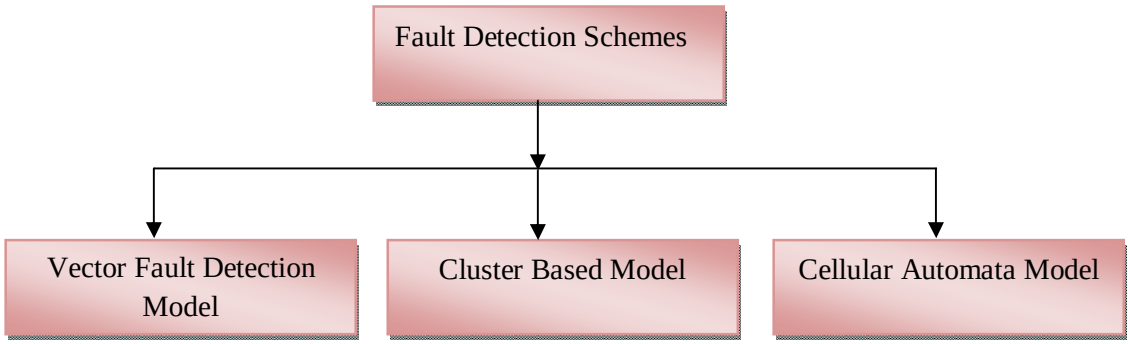

Figure 2 Fault Detection Scheme

2.1 Vector Fault Detection Model

In sensor network, all the sensor nodes deployed widely. When an event occurs in particular region, all the sensor nodes would be sensing the same information and forwarding to sink. But difference between this information is very small, because all the sensor nodes are closely deployed. If information sensed by a sensor node is y(t) and neighbour node sensing information is x(t), and two vectors for a given time interval t1–t2 and the component of x(t) along y(t) is cy(t), then information difference vector e(t), is represented by

$$e(t) = \begin{cases} x(t) - cy(t), & t1 \le t \le t2 \\ 0, & otherwise \end{cases} \quad (1)$$

If the neighbour node information are orthogonal, then the difference vector e(t) is more than threshold value, and node's sensor circuit is faulty[4].

2.2 Cluster Based Model

In Wireless Sensor Network, all the sensor nodes hold energy for data transmission. Due to involving in large number of data transmission all the sensor node energy will go empty. So considering of this, it is very important to detect the node which is going to fault and give the corresponding recovery actions. For that, we are using one fourth of the time consumed by fault tolerant clustering method [1]. A cluster will be formed based nodes remaining battery life time. By choosing the cluster we can achieve the saving energy, reduces the network contention by enabling locality of communication and quicker detection of faulty nodes and recovery process. This type of model processing has the following steps. That are,

2.2.1 Cluster Formation

After the successful creation of cluster, then only it involves fault detection and recovery mechanisms. This cluster formation is just like a parent and child tree format. In figure 3 shows the organization of nodes in the cluster. Suppose if the node size is 10 then the structure will be like,

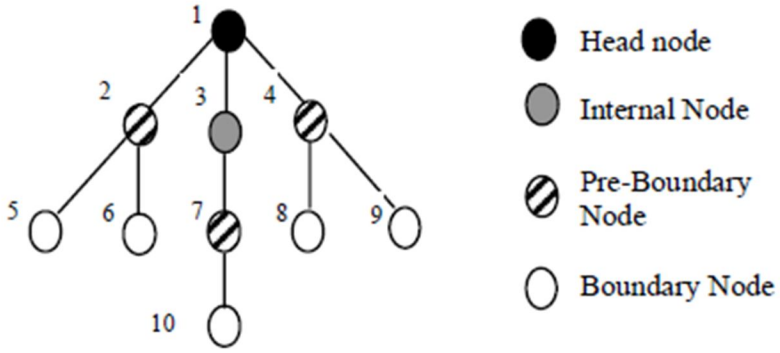

Figure 3 Cluster Topology

2.2.2 Failure Detection

This failure detection depicts that, shows failure only based on the energy constraint in the cluster. All the nodes in the cluster exchange the Remaining Battery Lifetime (RBL) to others nodes. Every node has a record of balance energy. The node which is not exchange any battery value, this node is considered as the faulty node. And this mechanism easily will find the faulty node in the cluster. The parent and children of the failing nodes are sufficient to invoke the failure recovery mechanism.

2.2.3 Failure Recovery

This mechanism carries only when the nodes involves in to the failure state. This recovery process works in the following ways,

i) Failure Reporting

If the node has the energy value below the threshold this node will be considered as the fault node and this fault node will forward this information in the form of failure report to its parent. Whenever the parent receives this report, it will analyse and matching the corresponding parent to handle the energy constraint problem.

ii) Procedure for finding a suitable healthy node

- ✓ Checks if the neighbour node is failure node or not.
- ✓ If the node is healthy then assume the node is declared as parent node.
- ✓ Otherwise to check the outside of the cluster values.
- ✓ All the nodes are the suitable for corresponding parent and healthy.

iii) Failure Recovery

In this Technique, we design techniques to maintain the cluster structure in the event of failures caused by energy-drained nodes. Initially, node with the maximum residual energy in a cluster becomes cluster heed and node with the second maximum residual energy becomes secondary cluster heed. Later on, selection of cluster heed and secondary cluster heed will be based on available residual energy.

3. Cellular Automata Model

To maintain the network is partitioned into virtual grid of cells to perform fault detection and recovery. The main advantage of this mechanism is, coverage node scheduling can reduce energy consumption and increase system lifetime. But this technique follows the disadvantage is, a cluster head failed to operate then no message will be forwarded to the base station and selection of the new cluster head is energy consuming.

i) Cellular Formation

In the sensor network all nodes automatically configured into the virtual grid structure, in the nodes are partitioned into several network cells each with a radius that is tightly bounded with respect to given value R. In that each cells consist of Primary Cell Manager and Secondary Cell Manager. The selection Cell manager will be based on comparison of energy values in each cell. The nodes that have the maximum energy value selected as the Primary Cell Manager and further follows Secondary Cell Manger. This Primary Cell Manager collects all the information about the nodes in each cell, by using that information they can communicate with neighbour cell. Figure 4 shows the typical diagram of virtual grid structure [4].

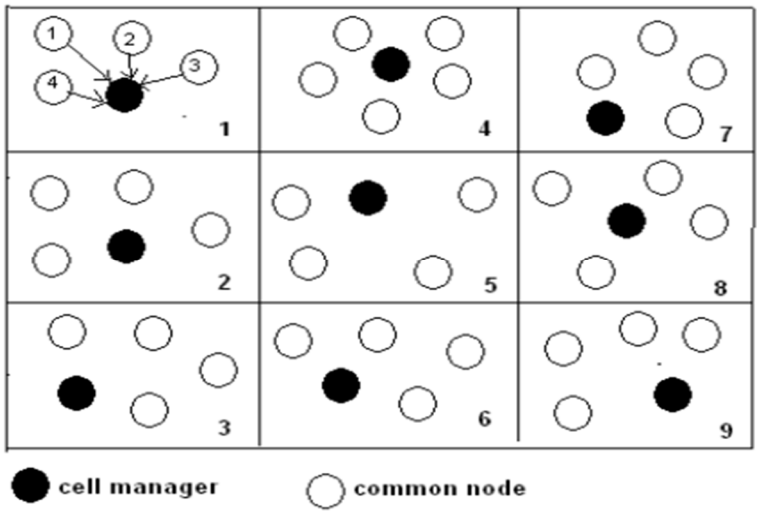

Figure 4 Structure of Virtual Grid

To verify the applicability of using cellular automata to simulate some aspects of sensor networks. And is to verify the applicability of simulate the behaviour of Wireless Sensor Networks. Cellular Automate can be useful to simulate this kind of network, because nodes of WSN have high cooperation degree and the behaviour and the state of sensor node is capable of modifying all network behaviour. The main advantage of this methodology is, to save energy by the schedule of nodes while monitoring an area as large as possible. But it could be difficult to visualize the simulation and as long as nodes die, the monitoring area will be decreased [7].

ii) Fault detection and recovery

Sensor Networks are usually large collection of sensing nodes collecting data from monitoring environment and transmit to base station by multi hop wireless communication. The occurrences of faults in wireless sensor network are very high due to wireless communication and random deployment policy. Energy conservation in sensor network is another challenge to improve applicability of wireless sensor networks based fault detection and recovery technique which is also energy competent sensor nodes are arranged into some clusters. Cluster head and sensor nodes are jointly detect the fault of sensor technique more capable to detect sensor nodes faults and recover the faulty nodes in an energy efficient manner. Energy loss and fault recovery time is very low in this technique compare to other popular fault detection and recovery techniques.

4. Data Routing Scheme

After completion of faulty detection mistreatment CA rule vectors, next section of concentrates on the shortest path based mostly economical knowledge routing. The L-system based mostly routing theme for knowledge routing from cluster head to base station via normal/traffic nodes. The L-system based mostly knowledge routing theme handles frequent modification in node hardware condition Associate in Nursing makes an economical knowledge routing path at intervals a faulty network atmosphere. Further, if a failure is detected regionally, the failure info may be propagated to any or all different clusters. However, the authors didn't address energy economical knowledge routing in their work. The on top of survey enlightens the requirement of fault detection and economical routing procedure for a distributed device network [8].

The base station (BS) derives knowledge routing path for cluster heads with the assistance of L-system rules. For knowledge routing in EFDR, principally traditional and traffic nodes are used. The derived path info is

then sent to the cluster heads. Cluster heads transmit their knowledge to the bottom station with the assistance of information routing path. Once base station derives knowledge routing path, BS station considers itself as axiom and different derived level nodes are elite from traditional node or traffic nodes that are accountable for knowledge transmission from cluster heads to the Base Station.

5. Conclusion

Sensor Networks hold a lot of promise in applications such as gathering and sensing information in remote locations. Survey has been done on various issues related to sensor networks like energy efficient fault detection and also various schemes proposed for the data routing schemes are also briefly described. As a result of the comparative study clearly shows that, all the existing mechanisms are less performance in energy efficient in terms of sensor node states. By enhancement, we can achieve better performance compared to all the fault detection and routing for sensor network existing techniques.

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