Distributed Error Handling System with Shortest Path Routing in Wireless Sensor Networks

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Abstract: This paper will cover a fault management system in wireless sensor network (WSN)which provides a shortest path between sender to receiver even in presence of faults. In DFD algorithm when the sensor fault probability increases the fault detection accuracy decreases and the false alarm rate (FAR) increases rapidly. Sensor nodes are prone to failure due to energy depletion and their deployment in an uncontrolled or even hostile environment. It is thus desirable to detect and locate faulty sensor nodes to ensure the quality of service (QoS) of sensor networks. Here an improved DFD scheme is proposed to detect intermittently faulty sensor nodes and to stringent power budget. Simulation results will demonstrate that the improved DFD scheme performs well in the above situation and increase the fault detection accuracy by using the new approach and reduce energy consumption in comparison with previous algorithm. Accordingly, Node-disjoint paths and an automatic diagnosis scheme are utilized to identify the faulty sensor nodes. The proposed mechanism was implemented with MATLAB. The evaluation results should demonstrate the ability of the mechanism to identify faulty nodes anciently and with limited overheads.

Keywords: Wireless sensor network (WSN), Quality of service (QoS), Distributed fault detection (DFD), False alarm rate (FAR).

I.   Introduction

Wireless sensor network (WSN) is a self-organized network that consists of a large number of low-cost and low powered sensor devices, called sensor nodes, which can be deployed in harsh environment. Sensing is a technique used to gather information about a physical object or process, including the occurrence of events (i.e., changes in state such as a drop in temperature or pressure). An object performing such a sensing task is called a sensor. For example, the human body is equipped with sensors that are able to capture optical information from the environment (eyes), acoustic information such as sounds (ears), and smells (nose). These are examples of remote sensors, that is, they do not need to touch the monitored object to gather information. From a technical perspective, a sensor is a device that translates parameters or events in the physical world into signals that can be measured and analyzed. Another commonly used term is transducer, which is often used to describe a device that converts energy from one form into another [1].

Due to recent technological advances, the manufacturing of small and low cost sensors became technically and economically feasible. The sensing electronics measure ambient conditions related to the environment surrounding the sensor and transform them into an electric signal. Processing such a signal reveals some properties about objects located and/or events happening in the vicinity of the sensor. A large number of these disposable sensors can be networked in many applications that require unattended operations. A Wireless Sensor Network (WSN) contains hundreds or thousands of these sensor node. A wireless sensor network consists of sensor nodes deployed over a geographical area for monitoring physical phenomena like temperature, humidity, vibrations, seismic events, and so on. A WSN is a collection of millimeter-scale, self-contained, micro-electro-mechanical devices.

These tiny devices have sensors, computational processing ability (i.e. CPU power), wireless receiver and transmitter technology and a power supply. One reason behind the growing popularity of wireless sensors is that they can work in remote areas without manual intervention. All the user needs to do is to gather the data sent by the sensors, and with certain analysis extract meaningful information from them. Usually sensor applications involve many sensors deployed together. These sensors form a network and collaborate with each other to gather data and send it to the base station. The base station acts as the control center where the data from the sensors are gathered for further analysis and processing. In a nutshell, a wireless sensor network (WSN) is a wireless network consisting of spatially distributed nodes which use sensors to monitor physical or environmental conditions. These nodes combine with routers and gateways to create a WSN system [8].
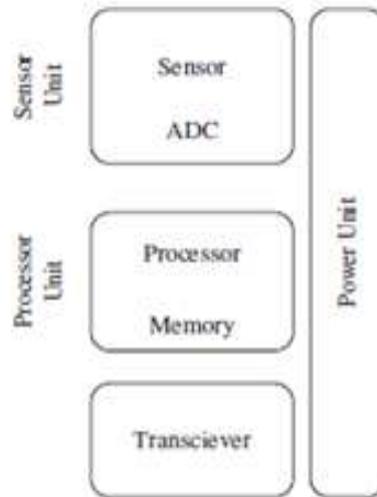
Fig. 1 : Components of a Typical Sensor Node

II.   Causes of faults in WSN

It is obvious that sensor networks are vulnerable to failures mainly because of two reasons such as node failures and/or communication failures. Since low-cost sensor nodes are often deployed in an un controlled or even harsh environment, they are prone to have faults. A deployed sensor network may suffer from many faults due to several reasons such as environmental impacts, hardware defects, and software bugs). These faults can cause high loss rates, long transmission delays or even network disconnection, and hence severely affects the normal operations of the network. Consequently, failures of nodes become an inevitable phenomenon which can reduce dramatically the overall network lifetime and make the communication infrastructure unusable) [3].

There is a need to design an effective architecture and techniques to monitor the health of the network and quickly detect such faults. It is thus desirable to detect, locate the faulty sensor nodes, and exclude them from the network during normal operation unless they can be used as communication nodes. One of the effective methods to identify and locate the faults in a network is to monitor the status of every node in the network, whether the node is in active or in active status. Primary components to assess whether anode is in active or in active state are its battery powerlev eland interference effects from its neighbor nodes [6].

III.   Related Works

The traditional approaches to sensor network routing include the directed diffusion (DD) algorithm and the grade diffusion (GD) algorithm. The algorithm proposed in this paper will replace fewer sensor nodes that are inoperative or have depleted batteries, and reuses the maximum number of routing paths. These optimizations will ultimately enhance the WSN lifetime and reduce sensor node replacement cost.

A. Directed Diffusion Algorithm:

A series of routing algorithms for wireless Sensor networks have been proposed in recent years. C. Intanagonwiwatet al. presented the Directed Diffusion (DD) algorithm in 2003. The goal of the DD algorithm is to reduce the data relay transmission counts for power management. The DD algorithm is a query-driven transmission protocol. The collected data is transmitted only if it matches the query from the sink node. In the DD algorithm, the sink node provides the queries in the form of attribute-value pairs to the other sensor nodes by broadcasting the query packets to the whole network. Subsequently, the sensor nodes send the data back to the sink node only when it fits the queries [1].

B. Grade Diffusion Algorithm:

There exists a Grade Diffusion (GD) Algorithm to improve the ladder diffusion algorithm using ant colony optimization (LD-ACO) for wireless sensor networks. The GD algorithm not only creates the routing for each sensor node but also identifies a set of neighbour nodes to reduce the transmission loading [1]. Each sensor node can select a sensor node from the set of neighbour nodes when its grade table lacks a node able to perform the relay. The GD algorithm can also record some information regarding the data relay. Then, a sensor node can select a node with a lighter loading or more available energy than the other nodes to perform the extra relay operation. That is, the GD

algorithm updates the routing path in real time, and the event data is thus sent to the sink node quickly and correctly. Whether the DD or the GD algorithm is applied, the grade creating packages or interested query packets must first be broadcast. Then, the sensor nodes transfer the event data to the sink node, according to the algorithm, when suitable events occur. The sensor routing paths are shown in Fig. 2.
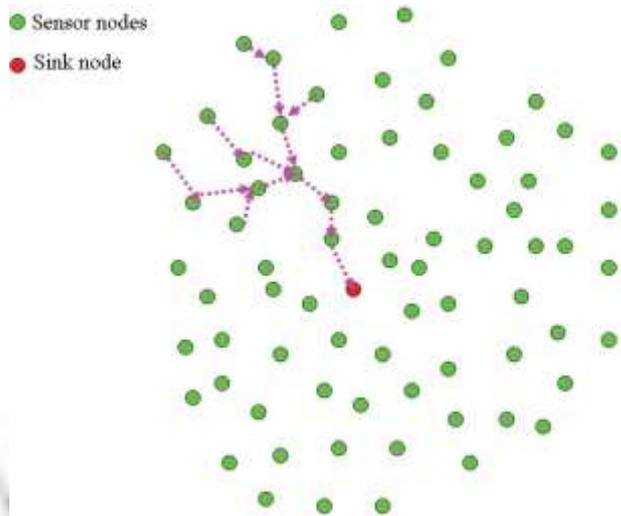

Fig. 2. Wireless sensor node routing

The WSN may fail due to a variety of causes, including the following: the routing path might experience a break; the WSN sensing area might experience a leak; the batteries of some sensor nodes might be depleted, requiring more relay nodes; or the nodes wear out after the WSN has been in use a long period of time. In Fig. 3, the situation in which the outside nodes transfer event data to the sink node via the inside nodes in a WSN illustrate the accommodation measures for non-working nodes. The inside nodes thus have the largest data transmission loading, consuming energy at a faster rate. If all the inside nodes deplete their energy or otherwise cease to function, the event data can no longer be sent to the sink node, and the WSN will no longer function [1].
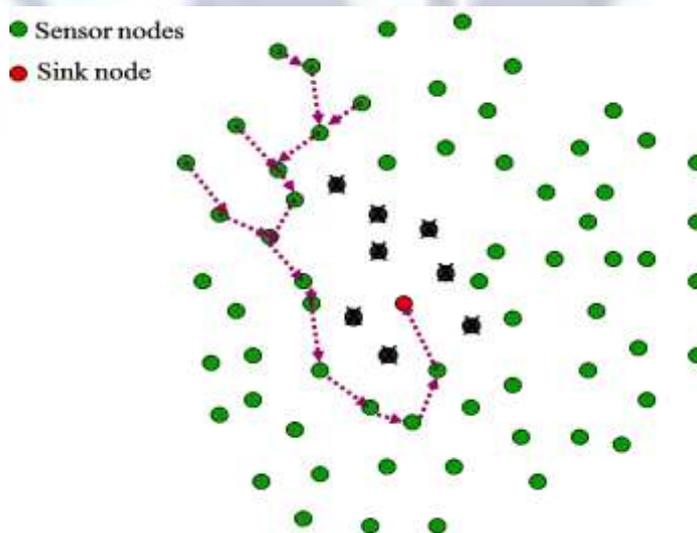

Fig. 3. Wireless sensor node routing path when some nodes are not functioning

IV.   Proposed System Architecture
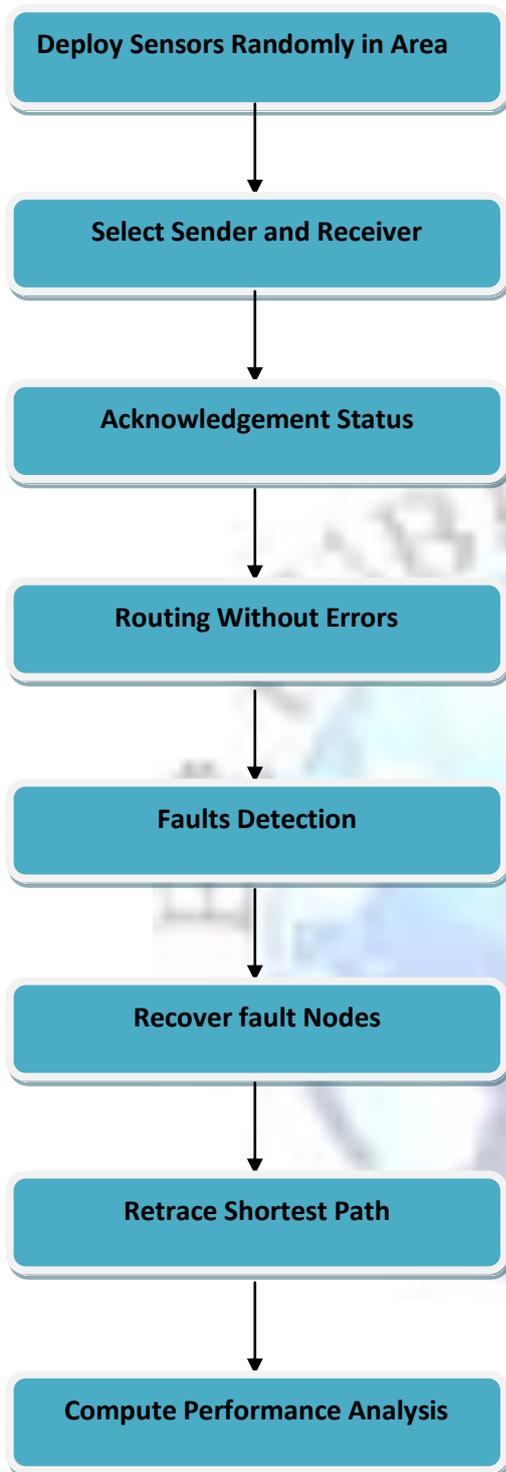

Fig. 4.   Flow Chart for Proposed Mechanism

V.   WSN Applications

Wireless Sensor Networks may consist of many different types of sensors such as seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar. They are able to monitor a wide variety of ambient conditions that include   temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, and the current characteristics such as speed, direction and size of an object. The main applications are:

- **Area Monitoring**: It is a common application of WSNs. Here the WSN is deployed over a region where some event is to be monitored. When the sensors detect the event being monitored, the event is reported to one of the base stations, which then takes relevant action. Similarly, wireless sensor networks may use a range of sensors to detect the presence/absence of vehicles ranging from motorcycles to train cars.

- **Environmental Monitoring**: Wireless sensor networks have been deployed in several cities to monitor the concentration of dangerous gases for citizens. Wireless sensor networks can also be used to reduce the temperature and humidity levels inside greenhouses.

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- **Medical Application**: Sensor networks may also be broadly used in health care centers. In some modern hospital sensor networks are designed to supervise patient physiological data, to reduce the drug administration track and monitor patients and doctors inside the hospital.

- **Structural monitoring:** Wireless sensors are used to monitor the movement within large buildings and infrastructure such as bridges, flyovers, embankments, tunnels etc [5].

Conclusion

In this paper, we designed a Distributed Fault Detection (DFD) algorithm to determine the faulty nodes. It assumes the case of power failure as there is to recovery techniques in that area. Therefore it has to change the direction of information when transmitted from a Sender Node to the Receiver Node. As the deployment of Thousand Numbers of Sensor Nodes in Area needs Energy Performance and better Packet Delivery from the Sender to the Receiver. The new approach will provide a methodology for the Retracing of Path having good Packets with an Energy Efficiency and Accuracy. This assessment will become the power performance booster among the previous workout as it automatically determines the shortest path after path hopping is traced. A self-Management approach will link the sensor nodes from the source to the destination with in a shortest path and shows distributed accuracy.

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