Sensor Node Failure Detection and Isolation using Distributed Bayesian Algorithm in Wireless Sensor Networks

Mr. K. Venkatchari
M.Tech (PC&I), Dept. of EIE,
Hindustan University, Chennai, India

Mr. J.S. Prasath
Asst. Professor, Dept. of EIE,
Hindustan University, Chennai, India

Abstract **- Wireless Sensor Networks (WSNs) are emerging as one of the most popular research areas among the scientists, with insight impact on technological development. Reliability and fault tolerance is of the primary concern in Wireless Sensor Networks (WSNs). Fault tolerance in WSN is the quality or ability of a functional unit to perform a required task in the presence of some number of faults or errors. Fault tolerance is applied to increase the reliability of a system. Faults occurring to sensornodes are common due to the sensor device itself and the harsh environment where the sensor nodes are deployed. In order to ensure the network quality of service it is necessary for the WSN to be able to detect the faults and take actions to avoid further degradation of the service.**

Index Terms - Wireless Sensor Networks, Distributed Bayesian Algorithm

I. INTRODUCTION

A WSAN consists of a set of miniaturized low cost sensors that are spread in an area of interest to measure ambient conditions in the vicinity. The sensors serve as wireless data acquisition devices for the more powerful actor nodes that process the sensor readings and put forward an appropriate response.

Actors usually coordinate their motion so that they stay reachable to each other. However, a failure of an actor may cause the network to partition into disjoint blocks and would thus violate such a connectivity requirement. The remote setup in which WSANs often serve makes the deployment of additional resources to replace failed actors impractical, and repositioning of nodes becomes the best recovery option. In addition, tolerance of node failure cannot be orchestrated through a centralized scheme given the autonomous operation of the network. On the other hand, distributed recovery will be very challenging since nodes in separate partitions will not be able to reach each other to coordinate the recovery process. Therefore, contemporary schemes found in the literature require every node to maintain partial knowledge of the network state. To avoid the excessive state-update overhead and to expedite the connectivity restoration process, prior work relies on maintaining one-hop or two-hop neighbor lists and predetermines some criteria for the node's involvement in the recovery. However, one-hop-based schemes often impose high node repositioning overhead, and the repaired inter-actor topology using two-hop schemes may differ significantly from its pre-failure status.Li Yaet. al [1] proposed Reliable Energy-Aware Routing Protocol for Heterogeneous WSN Based on Beaconing.

The present work considers the connectivity restoration problem subject to path length constraints. Basically, in some applications, such as combat robotic networks and search-and-rescue operation, timely coordination among the actors is required, and extending the shortest path between two actors as a side effect of the recovery process would not be acceptable. For example, interaction among actors during a combat operation would require timeliness to accurately track and attack a fast moving target. K. Shaet. al [2] proposed the Multipath routing techniques in wireless sensor networks.

II. WIRELESS SENSOR NODE ARCHITECTURE

A functional block diagram of a versatile wireless sensing node is provided in Figure.

Modular design approach provides a flexible and versatile platform to address the needs of a wide variety of applications. For example, depending on the sensors to be deployed, the signal conditioning block can be re-programmed or replaced. This allows for a wide variety of different sensors to be used with the wireless sensing node. Similarly, the radio link may be swapped out as required for a given applications wireless range requirement and the need for bidirectional communications. Qinghua Li et. al [3] addressed the Mitigating Routing Misbehavior in Disruption Tolerant Networks.

The use of flash memory allows the remote nodes to acquire data on command from a base station, or by an event sensed by one or more inputs to the node. Furthermore, the embedded firmware can be upgraded through the wireless network in the field.

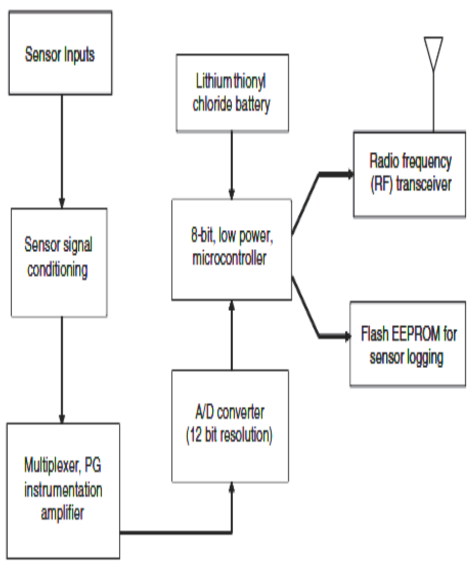

Figure. Functional Block Diagram of Wireless Sensor Network

A key feature of any wireless sensing node is to minimize the power consumed by the system. Generally, the radio subsystem requires the largest amount of power. Therefore, it is advantageous to send data over the radio network only when required. This sensor event-driven data collection model requires an algorithm to be loaded into the node to determine when to send data based on the sensed event. Additionally, it is important to minimize the power consumed by the sensor itself. Therefore, the hardware should be designed to allow the microprocessor to judiciously control power to the radio, sensor and sensor signal conditioner.

III. NODE FAILURE

Wireless sensor and actor networks (WSANs) refer to a group of sensors and actors linked by wireless medium to perform distributed sensing and actuation tasks. In such a network, sensors gather information about physical world, whereas actor takes decisions and perform appropriate actions upon the surroundings thatallow remote and machine-controlled interaction with the surroundings. Since Actors have to coordinate their motion in order to keep approachable to every node, a strongly connected network is needed all the time. However, a failure of an associated actor might cause the network to partition into disjoint blocks and would therefore violate such a connectivity requirement. I.Chenet. al [4] proposed Adaptive fault tolerant QoS control algorithms for maximizing system lifetime of query-based wireless sensor networks.

The sensors probe their surroundings and forward their data to actor nodes. Actors collaboratively respond to achieve predefined application mission. Since actors have to coordinate their operation, it is necessary to maintain a strongly connected network topology at all times. The length of the inter-actor communication paths may be constrained to meet latency requirements. However, a failure of an actor may cause the network to partition into disjoint blocks and would, thus, violate such a connectivity goal. P. Jiang [5] proposed a new method for node fault detection in wireless sensor networks. One of the effective recovery methodologies is to autonomously reposition a subset of the actor nodes to restore connectivity.

IV. DISTRIBUTED BAYESIAN ALGORITHM

Distributed Bayesian Algorithm (DBA) is used in this work for detecting the faulty nodes. This algorithm contains three steps. The first step is that the sensor nodes exchange readings with neighbor nodes to calculate the probability of fault. Due to the probability of fault calculated in the first step may be incorrect, it need to be adjusted in the second step. In the third step, if a sensor node’s probability of fault is higher than the probability threshold, the sensor node will be considered as a faulty node and it will send a warning message to the sink node.

V. PERFORMANCE

The NS2 is used to simulate the algorithm by using 30 nodes and each nodes are differentiated the faulty nodes and normal nodes with different colors. Each node is placed in a random distance between 1000x1000 meters square region for 120 seconds and each nodes are assumed to move in a average speed and the simulated traffic is Constant Bit Ratio(CBR).

A. Node creation

The following Figures shows the creating of nodes and indicates the normal nodes and faulty nodes.

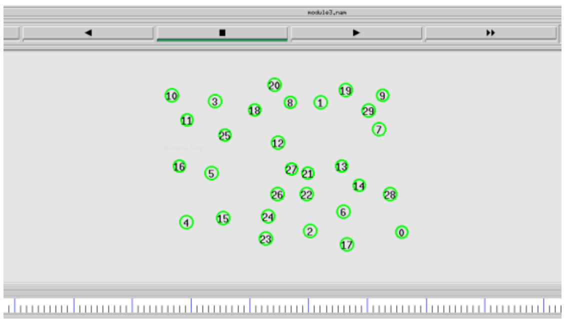

Figure 1:. Creating of nodes

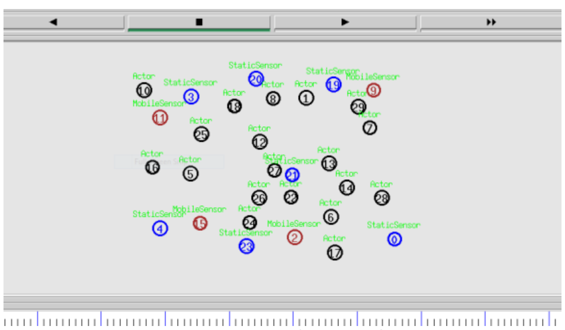

Figure 2: Unique specification of each node

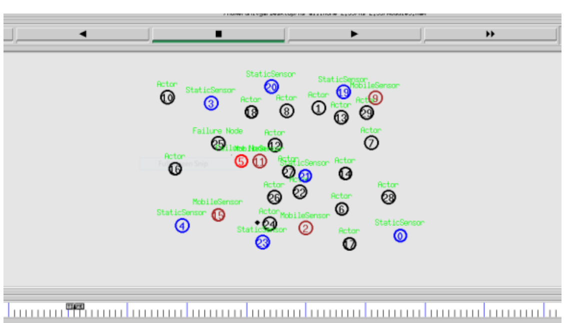

Figure 3: Failure detection of nodes

B. OUTPUT GRAPHS

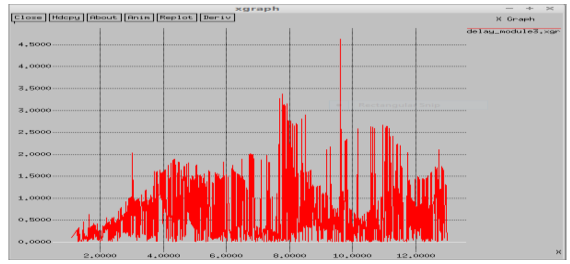

Figure 4: Delay Graph

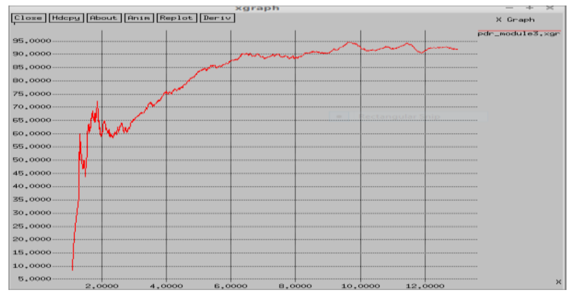

Figure5: Packet Delivery Ratio Graph

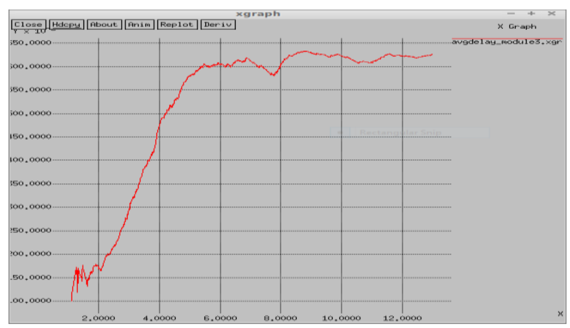

Figure 6: Average Delay Graph

VI. CONCLUSION

The algorithm was coded with help of NS2 and its results shows the time delay for finding the faulty nodes and transmission of data is slow and loss of data packets are more at the time of data transmission on faulty nodes. In order to overcome the drawbacks of the existing system, it is essential to detect the energy drain in a node before the node fails using dynamic sensor nodes.

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Authors Profile

Venkatchari.K has received the **B.E** in Electrical and ElectronicsEngineering fromSRI CHANDRASEKHARENDRA SARASWATHIVISWA MAHAVIDYALAYA ,Kanchipuram in 2014. Now doing my **M.Tech** in Process Control and Instrumentation from Hindustan University , Padur , Chennai. Research interest is Wireless Sensor Networks and Instrumentation.

Mr. J.S.Prasathis an Assistant Professor in Department of Electronics and Instrumentation Engineering at the Hindustan University, Chennai. He got a Bachelor degree in Electronics and Instrumentation from Madurai Kamaraj University, 2002. He got a Master degree in Process control and Instrumentation from Annamalai University, 2007. He presented and published the research papers in the area of underwater sensors, process control, industrial automation, Wireless Sensor Networks and Micro-Electro Mechanical Systems. He is a member of ISTE. His research interests include Process Control, Microprocessor, Microcontroller, Wireless Sensor Networks and Industrial Automation.