



A Review on Failure Node Recovery Algorithms in WSN

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Abstract — *In this article a survey on algorithms used for recovery of failure nodes in wireless sensor network has presented. Node recovery is a technique used to recover the failure of most used active nodes in WSN, when it becomes crucial to repair these nodes from failure and also from the situation where some part of covering area gets out of control and sight of the networks. The information flow gets heavily affected by the node failure. To solve this problem we are studying LEDIR algorithm and how it comes when compare with RIM, We are comparing the two algorithms on the basis of three parameters: No of nodes moved, total distance moved and total messages exchanged.*

Keywords— *wireless sensor network, failure node, node recovery, LEDIR, RIM.*

I. INTRODUCTION

In recent period there is huge advancement in Wireless Sensor Network, as the increase in the users of wireless communication. The advancement is done in micro processing, wireless and battery technology, sensor nodes are used for sensing has also advanced with the advancement in sensors used in the nodes. This all results in the vast interchanging or communicating the large data from one user to another, but a node is limited with power and range of transmission. Due to wireless communication nodes has limited computational task power to process and transmit the power to the base station. Therefore it is required to increase the sensor area and transmission area to cover the entire active area for which each area is covered with many sensor nodes.

- Failure of node:

There are two types of nodes in a WSN, sensor nodes and actor nodes. Sensor nodes are used to sense the conditions in WSN and serves as wireless data acquisition devices for more powerful actor nodes that process the sensor readings and put forward an appropriate response. The actor nodes may fail because of less battery power or due to any failure of modules (such as communication and sensing module) due to fabrication process problems, environmental factors; enemy attacks and so on; being out of the communication range of the entire network.

- Recovery of failure nodes:

Recovery from node fault is now a day's getting more attention in the sense of wireless sensor network. A failure node in WSN can be recovered through node repositioning, in which a healthy node will be repositioned to reinstate the network connectivity, by placement of relay nodes and by increasing battery power or battery backups of network.

- Recovery algorithms for node failure:

1) **Least Disruptive Topology Repair Algorithm (LEDIR) :**

The goal for LEDIR is to restore the connectivity without extending the length of the shortest path among nodes compared to the pre-failure topology.

The LEDIR algorithm first detects the faulty node and finds whether it is a cut vertex by using the partially populated Shortest-path Routing Table (SRT) and go to the recovery process. Then the block with least number of nodes are found out for relocation which limits the recovery overhead. Then the faulty node is replaced by the neighbor (parent node) of the failed node which belongs to the smallest block. After that the child nodes which are directly connected to the parent node are also relocated for recovering the connectivity.

Modules of LEDIR algorithm:

- Topology formation

Initially, topology is formed among the sensor nodes and actors. The sensors are devices which are used to monitor the conditions and to send the data to the actors. The actors are more powerful devices which are capable of responding and moving. If the actor node fails, it splits the topology in to different blocks. To overcome this problem, failed node must be replaced with healthy node.

- Failure detection

The periodical heartbeat messages are sent to the neighbor nodes by their corresponding actors. When the heartbeat message is missing, it indicates the failure of actors. After detecting the failed node, it is checked that whether the failed node is critical node or not. If it is a critical node then the failed node must be replaced.

- Smallest block identification

After detecting the failed node, the smallest block must be identified. And also, a node which is neighbor to failed node must be selected from the smallest block. The selected node is used to replace the failed node.

- Replacing faulty node

The main idea of this category of recovery schemes is to reposition some of the healthy nodes in the network to maintain strong connectivity. If node *J* is the neighbor of the failed node that belongs to the smallest block, then *J* is considered as the Best Candidate (BC) to replace the faulty node. Since node *J* is considered as the gateway node of the block to the failed critical node and the rest of the network, we refer it as “parent node”. A node is said to be “child”, if it is two hops away from the failed node. And node is called as a “grandchild”, if it is three hops away from the failed node. If more than one actor fits the characteristics of a Best Candidate (BC), the closest actor to the faulty node would be picked as a Best Candidate (BC). Further ties are resolved by selecting the actor with the least node degree. At last, the node ID would be used to resolve any other problems that occur during the selection of Best Candidate (BC).

- Children movement

When node *J* moves to replace the faulty node, some of its children will lose direct links to it. It is not efficient and children of node *J* should not lose its direct link due to that some data paths may be extended. There is no need to extend the link, if a child receives a message that the parent *P* is moving. Child then notifies its neighbors (grandchildren of node *P*) and travels directly toward the new location of *P* until it reconnects with its parent again.

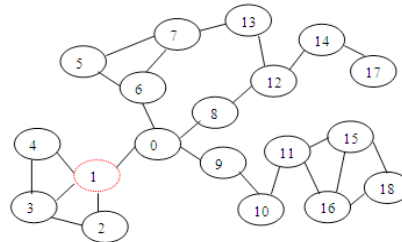


Fig1: node1 is a failure node.

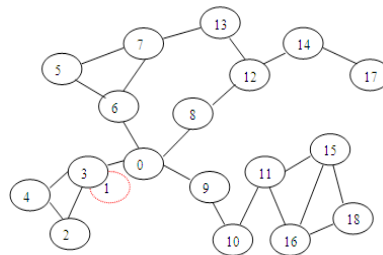


Fig.2: node3 from the smallest block replaced the failure node1.

2) Recovery by inward motion (RIM):

A node failure that results in a partitioned network is the most serious and challenging. The main issue for restoring connectivity in such case is that some nodes may not be able to reach others and a well-orchestrated non centralized recovery procedure becomes very difficult. The RIM method aims to move the healthy node towards the failure position and replace the failure node. In this approach each and every node must have a 1-hop neighbor list and be aware of their neighbor’s locality and proximity.

- Failure Detection

In wireless sensor networks the failure node detected in the following manner. Each node will send HELLO messages or Heartbeat messages to its neighbors. After a certain time period, the missing acknowledgement for HELLO message is used to detect the failure node. After detection of the failure node the recovery process is initiating.

- Node Relocation

Node ‘f’ is a failure node. Its neighbor’s node ‘g’ and ‘e’ send notification messages to its 1-hop neighbor’s entire node about failure, then initiating the recovery process. Node ‘g’ and ‘e’ is neighbor for failure node ‘f’. The failure node will be replaced by one of the Best Candidate (BC) node. The selection criterion for BC nodes is based on its healthy condition and distance from the failure position. The neighbor node moves toward the failure position. So node ‘g’ and ‘e’ send the notification messages to its children node about their movement. The children nodes (nodes ‘i’ and ‘h’ children node for ‘g’) are move according to their parents nodes. This movement is happen by individual cascade movement. If two nodes are best node, then use node id to select the BC node.

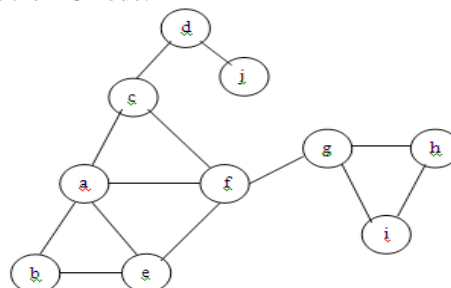


Fig.3: node 'f' is a failure node.

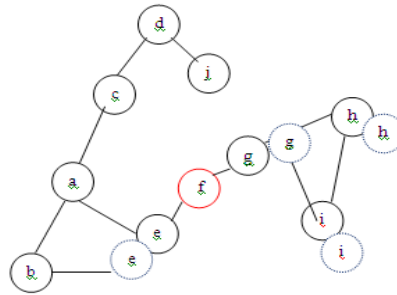


Fig.4: nearest neighbor node will replace the failure node and all children nodes of the neighbor node will move in same direction.

II. LITERATURE SURVEY

A cellular approach to fault detection and recovery in wireless sensor networks [1]

In this paper the author has explained the necessity of autonomous nature of nodes in unattended atmosphere as advancement of wireless sensor network in the field of disaster management, border protection, and combat field reconnaissance and security surveillance. Failures of nodes are in such applications cause the communication stop and in such conditions during unavoidable situation it is difficult to search the faulty node. So it is required to detect the node which has power failure. In this paper a new mechanism is prepared to sustain the network operation to detect the node. The grid based architecture is implemented in virtual way as it permits the detection of node and transmits its information cell by cell to destination.

Cluster-based and cellular approach to fault detection and recovery in wireless sensor networks [2]

In this paper the author has proposed another algorithm to recover nodes in the areas of security surveillance, disaster management, border protection, and combat field reconnaissance. In this paper the cellular architecture and cluster-based survey is done to sustain the failure cause of nodes. This proposed algorithm is based on clustering to address many issues like, energy efficiency, routing and management. These clusters are having a cluster head and rest members are required only to interact with only cluster members and cluster head. 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 are less energy consuming nodes and take no energy of network in order to recover cell manager failure. This algorithm shows 70% more better results in energy efficiency than virtual grid algorithm.

Recovering From a Node Failure in Wireless Sensor-Actor Networks with Minimal Topology Changes [3]

In this paper the author has proposed an algorithm to recover a faulty node. As in wireless sensor-actor networks the sensor nodes are to interact with surroundings and pass on the collected data to the actor node. If the actor node fails then the network breaks into disjoint blocks and results in loss of data. One of the effective recovery methodologies is to autonomously reposition a subset of the actor nodes to restore connectivity. This Contemporary recovery schemes either impose high node relocation overhead or extend some of the inter-actor data paths. This paper overcomes these shortcomings and presents a Least-Disruptive topology Repair (LEDIR) algorithm. The performance of this algorithm is verified through simulation.

Sensor Failure Detection and Recovery Mechanism Based on Support Vector and Genetic Algorithm [4]

In wireless sensor networks sensor nodes are to collect data from environment and forward it. So these sensor nodes are required to work in unpredictable conditions so it is must to check it for weather the node is not sending garbage data or it get fail. Therefore fault detection and recovery are prime aspects in WSN. So in this paper author has proposed an algorithm to recover a node which predicts the measurements of the sensor node on the basis of historical data. The proposed algorithm is SFDA which combines support vector regression prediction with credit levels division to reduce the energy and computation consumption and increase the fault detection rate. Besides, reusing the credit levels in fault detection CL-GA technique is proposed. Through initialization, evaluation, selection, crossover and mutation, CL-GA computes the optimal solution to recover the WSN with least replaced sensors and most re-usage of routing path.

Least Distance Movement Recovery Approach for Large scale Wireless Sensor and Actor Networks (LDMR) [5]

LDMR exploits node mobility and the availability of non cut-vertices in the network in order to minimize the distance that nodes collectively traveled during the recovery process. The idea is to use connectivity-uncritical nodes in restoring connectivity. The distinct feature of LDMR is the avoidance of the cascaded movement spread throughout the whole network.

A Distributed LeDiR algorithm for WSA Networks [6]

The goal for LeDiR is to restore the connectivity without extending the length of the shortest path among nodes compared to the pre-failure topology. Least Disruptive Topology Repair Algorithm overcomes the disadvantages of High node relocation overhead (because many nodes involve in the recovery process) and Extension of inter-actor data paths

relative to its pre-failure status. This algorithm is used to detect and recover a single node failure. It is a localized and distributed algorithm which makes use of the existing route discovery activities. This method relocates the smallest number of nodes and there is no extension of data path. The LeDiR algorithm first detects the faulty node and finds whether it is a cut vertex by using the partially populated Shortest-path Routing Table (SRT) and invokes the recovery process. Then the block with least number of nodes are found out for relocation which limits the recovery overhead. Then the faulty node is replaced by the neighbor (parent node) of the failed node which belongs to the smallest block. After that the child nodes which are directly connected to the parent node are also relocated thereby recovering the connectivity.

Distributed Fault Tolerant Algorithm for Identifying Node Failures in Wireless Sensor Networks [7]

While the transformation of data some of the nodes stop working which results in a cut. To avoid and detect this problem here we propose a distributed and asynchronous algorithm known as Distributed Cut Detection. The algorithm consists of nodes, updating their local state periodically by communicating with their nearest neighbors. The state of a node converges to a positive value in the absence of a cut. If a node is disconnected from the source as a result of a cut, its state converges to 0 (de-active). The state of node determines whether it is connected to source or not. The nodes that are still connected to the source will be able to detect that a cut has occurred somewhere in the network. It has not only fast convergence rate but also independent of size of the network, as the delay between the occurrence of a cut and its detection by all the nodes can be made independent of the size of the network.

An Implementation of Recovery algorithm for Fault nodes in Wireless Sensor Network [8]

In this project, the grade diffusion algorithm and fault node recovery algorithm are implemented. The various parameters such as energy consumption in mJ, power consumption in mW, number of hops, number of active nodes, number of dead nodes, time taken, node life time are calculated and comparison of grade diffusion algorithm with the fault node recovery algorithm with above parameters. Hence from the output result of comparison, the performance of fault node recovery algorithm is much better than the grade diffusion algorithm.

A Survey on Node Recovery from a Failure in Wireless Sensor Network [9]

From this survey, we studied, there is some common problems in all the above mentioned approaches and other previous method has been analyzed and discussed only single node failure and does not focus on multiple node failure. All the schemes do not have any idea about simultaneous node recovery. Another major thing is many of the approaches could not consider the topology management while recovering a node from a failure in WSNs. From this survey, we get some important points for future work. In future we discuss the chances of occurring the multiple node failure and analyze how to recover the all failure node at a time i.e. simultaneously in wireless sensor networks with the use of movable nodes.

Recovering from Multiple Node Failures in Wireless Sensor-Actor Networks with Minimal Topology Changes [10]

In the proposed system, we proposed TDMA (Time Division Multiple Access) MAC, which supports low duty cycle operations. In addition to that Time Division Multiple Access provides contention and collision free transmission. A new hybrid MAC protocol for wireless sensor network, called IH-MAC is used, which combines the strength of the Carrier Sense Multiple Access, link scheduling and broadcast scheduling. It guarantees shorter latency in critical condition like fire and delay-sensitive packets. Thus, recovery from multi node failure is made possible with minimal topology changes.

Multi Node Recovery in Wireless Sensor Actor Networks [11]

LeDiR can recover from a single node failure at a time. Simultaneous node failures will occurs when a part of the deployment area becomes subject to a major hazardous event, e.g., hit by a bomb. Considering such a problem with collocated node failure is more complex and challenging in nature. As a next level we will implement Enhanced LeDiR algorithm on Wireless sensor-actor network to overcome the multiple node failures problem with less amount of delay and to the system performance

III. PROPOSED WORK

The proposed system will work on two failure node recovery algorithms in WSN: LEDIR and RIM. We compare the both algorithms on the bases of three parameters: no. of nodes moved, distance moved and no. of messages exchanged and find which algorithm is better between two. We use criticality charts or graphs to easily locate the failure nodes. This system will give us sure recovery of failure nodes with lesser cost and lesser battery power consumption. For this we will use MATLAB.

IV. CONCLUSION

In this review paper an overview of the existing failure node recovery algorithms has discussed. Finally, it has concluded from the literature studies that most of techniques used for recovery process have some limitations with respect to time and cost. In this review paper two algorithms are compared to find which can work better with lesser cost. Graphs have produced to show the comparison between LEDIR and RIM. In this work, the differentiation between critical nodes and normal nodes in the network has also shown which will help to easily locate the failure nodes. In final result the better algorithm will recover the failure node with less battery power consumption and less cost.

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