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Improvisation of Hole Detection and Healing In Wireless Sensor Network

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Abstract

A wireless sensor network (WSN) comprises of nodes, each node is connected to one or more sensors. This paper considers fault occurred in multiple nodes in a particular region which is called as hole. The region under monitoring is to be considered as region of interest (ROI). This paper deals with the hole detection and healing algorithm. The detection process is done with the help of stuck nodes found using TENT rule and healing process is done by relocating the neighbouring nodes. The simulation is done using NS2 software.

Keywords: Hole Detection, Hole Healing, Stuck Nodes, Failed nodes, Region of Interest.

Introduction

Wireless Sensor Network comprises of sensor nodes which collects information about its surrounding and its communicates with one and another. Each sensor node is responsible to collect particular information. The gathered information is then passed to the next node. This process continues till the sink node or the destination node is reached. The sensor nodes run on battery. The power of the battery last only for a particular period of time. Thus the nodes become inactive if the power of the battery drains out completely. This affects the data communication in the network. There are various algorithms to conserve the power of the battery and to increase its lifetime. But this is practically very difficult since there are numerous sensors in the network. In this paper we consider a particular area which is called as the region of interest. If multiple nodes fail in the ROI, it creates space in the network. This space creates a hole in the network. In this paper we detect the hole in the wireless sensor network and it is healed with the neighbour nodes.

The hole detection and healing process in wireless sensor networks (WSNs) is improved based on coverage range, decrease the movement of the nodes and the packet deliver ratio is increased. In this paper we detect the holes using stuck nodes and heal the holes by using the neighboring nodes. The hole size can be either large or small. This method is comparatively cheap and appropriate method for hole detection and healing.

Hole Detection and Healing

This paper is based on detecting the hole and healing the hole. The block diagram of the hole detection and healing is as shown below. This project is divided into three modules:

i) Network Formation.
ii) Hole Detection.
iii) Hole Healing.

The first block which is the network formation block is responsible for node creation to form a network. After the network is formed, the hole is detected. And it stops the data communication. Hence there is need for healing process.

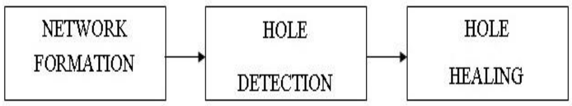

Figure 1: Block Diagram of the Module

A) Hole Detection

Hole detection is the process of finding the failed nodes at a particular of interest (ROI). The hole detection can be done using the TENT [4] rule. This chapter explains the TENT rule. There are three types of nodes that are considered in this chapter. They are: active node, stuck node, failed node. The active node is the node that involves actively in data communication. The stuck nodes are nodes that have the packets and are not able to transmit. The TENT rule is used to find the stuck nodes. The failed nodes are nodes that are in inactive state. The failed nodes are found by connecting all the stuck nodes.

The first step in the detection process is to find the stuck nodes. Then followed by generation of hole discovery packets. The final step in the detection process is boundary detection.

Algorithm:

Consider p as the node and u, v are the 1-hop neighbours of the node p. l1 and l2 are perpendicular bisectors of pu and pv respectively

i) To find the stuck nodes using TENT rule:

- Each node in the network should know its 1-hop neighbors of node counter clockwise.
- To check if the centre circumference of triangle vpu is inside the transmission range of p.

- If false, we call it a stuck angle and the node is called as stuck node.

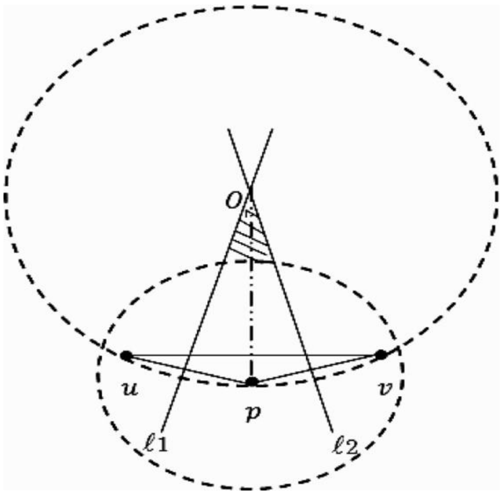

Figure 2: Geometric Representation

ii) Each stuck node gets updated information about its 1-hop neighbors and it launches HD packets. The HD packets contains the position (x , y) information of its 1-hop neighbors.
iii) The HD packets are send to BS and the BS compares these packets with the stored details(data base) and thereby, finds the failed nodes in a particular ROI.

B) Hole Healing

The hole healing is done using the relocation algorithm [10]. The relocation algorithm uses the virtual force idea. After the hole is detected, we describe the attractive force. This force attracts or pulls the nodes towards the centre. And a repulsive force is also defined to avoid overlapping.

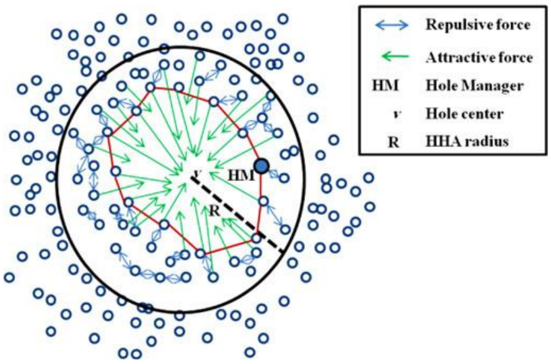

Figure 3: Attractive and Repulsive Force

And thus, the network healing is done by relocating the hole by neighbor nodes.

Algorithm:
The following steps are involved in the healing process.

i) By connecting all the stuck nodes the boundary of the hole can be found. The boundary information will be send to BS.
ii) With the boundary information, the hole manager, that is the BS will command the neighboring nodes of the hole to involve in the healing process, by sending its new position.
iii) Then, the neighbor nodes will move to the new position such that it covers the coverage area of the failed nodes.

Simulated Output

A) Network Formation
Here we are assuming 35 nodes in network where 35th node is considered as the base station (BS). The network is formed in a regular manner. And initially, all the nodes in the network are active nodes.

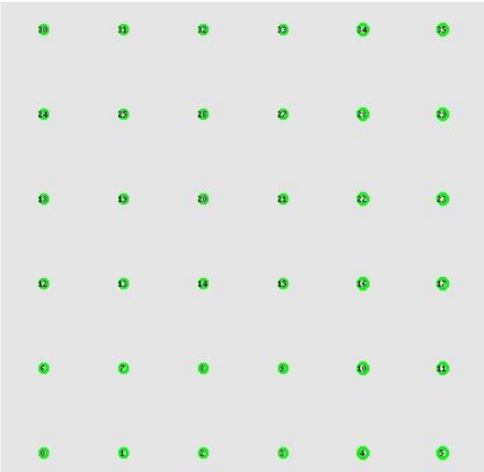

Figure 4: Network Formation

B) Node Failure Detection
The inactive nodes are the failed nodes. Here four failed nodes are shown. These failed nodes are in the same region and hence hole is created in that region.

The hole is detected using the TENT rule.

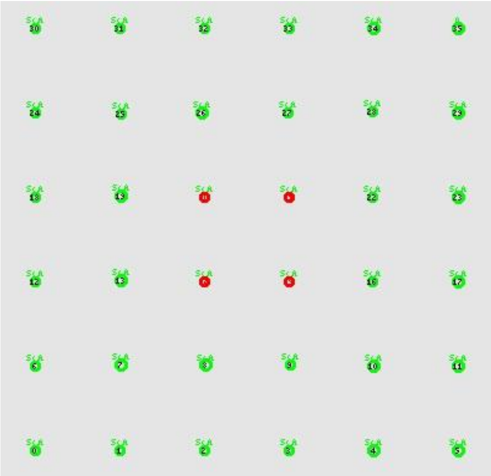

Figure 5: Hole Detection

C) Healing The Network

Once the hole is detected, the neighbouring nodes move such that it fills the coverage area of the failed nodes. The movement of the neighbouring nodes is shown in this snap shot. This snap shot depicts the healed network. Though the movement of neighbouring nodes has occurred, we can see that there is no enormous change in the network topology when compared with the original network.

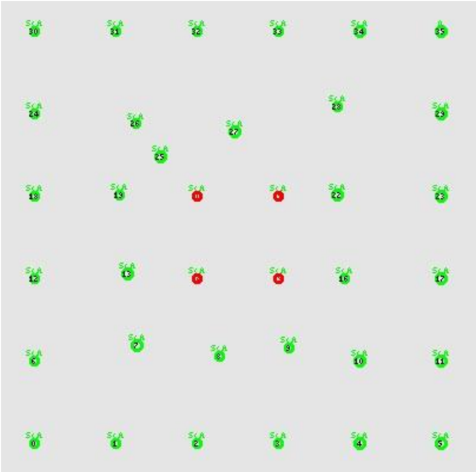

Figure 6: Hole Healing

Thus the network is healed and it behaves like a normal network which can facilitate data communication.

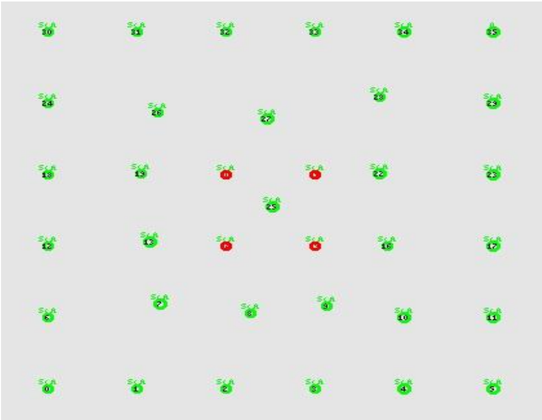

Figure 7: Healed Network

Results & Discussion

The NS2 software is used to generate the graphs that show the proposed algorithm is better than the existing system [13] is compared with the proposed system as a result of which the following graphs are obtained. The main criteria considered for comparison are

i) Delay
ii) Movement of Nodes
iii) Packet delay ratio (PDR)

a) Movement of the Nodes

From this below graph we can clearly see that the movement of nodes has been decreased to a great extent in the proposed system. In proposed system the neighbouring nodes are moved and the node movement is less when compared to the existing system.

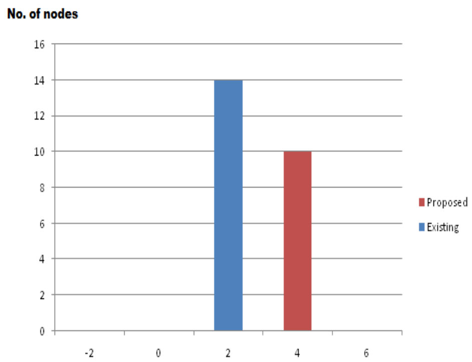

Figure 8: Node_Movement

b) Delay Comparison

When we compare the delay in the existing and the proposed system, we see that the delay in node movement is minimised in the proposed system which satisfies one of the objective of this project. The healing process used here takes places in on-demand manner. On-demand manner means that the healing process takes place as soon as the hole is being detected. Thus in the proposed system the delay is being reduced enormously.

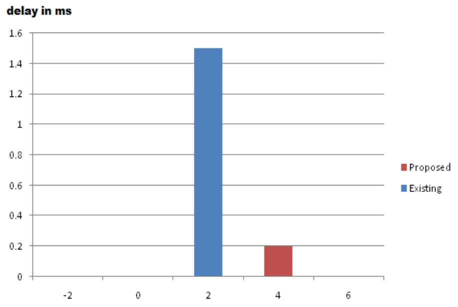

Figure 9: Delay_Comparison

c) Packet Delay Ratio

Here we can find the result obtained as a result of comparison between the packet delay in existing and the proposed system. Packet delivery ratio is the ratio of the number of data packets delivered to the sink. The larger the packet delivery ratio better is the performance of the protocol. The packet delivery ratio is expressed as,

$$PDR = \frac{\sum \text{Number of packet receive}}{\sum \text{Number of packet send}}$$

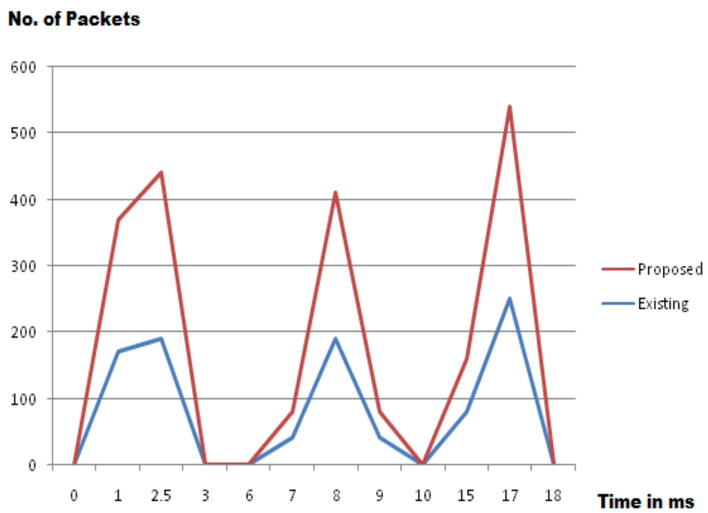

Figure 10: PDR_Graph

Conclusion

The goal of this project is to increase the coverage range, to minimize the delay and to decrease the number of nodes moved in order to heal the network. The advantage of this paper is that it is a centralized method. This algorithm can be used to detect holes of variety of forms and size. Thus this is an effective method for hole detection and healing in wireless sensor network. Simulation results and snap shots prove that the objective of this paper is satisfied**.**

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