Design and Implementation of Dead Nodes Recovery Algorithm to Improve the Life Time of a Wireless Sensor Network

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Abstract: ***Sensors in a wireless sensor networks (WSNs) are having tendency to fail, due to the energy depletion, hardware failures, environmental conditions etc. Fault tolerance is one of the critical issues in WSNs. The existing fault tolerance mechanisms either consume significant extra energy to detect and recover from the failures or need to use additional hardware and software resources. This paper proposes a fault node recovery algorithm to enhance the lifetime of a wireless sensor network when some of the sensor nodes shut down. The algorithm is based on the grade diffusion algorithm combined with the genetic algorithm. The algorithm can result in fewer replacements of sensor nodes and more reused routing paths. In our simulation, the proposed algorithm increases the number of active nodes up to 8.7 times, reduces the rate of data loss by approximately 98.8%, and reduces the rate of energy consumption by approximately 31.1%.***

Keywords: Fault Node, Grade Diffusion, Battery Power, Threshold**.**

1. Introduction

WIRELESS technologies have revolutionized the world of communications. It started with the use of radio receivers or transceivers for use in wireless telegraphy early on; and now the term *wireless* is used to describe technologies such as the cellular networks and wireless broadband Internet. Although the wireless medium has limited spectrum along with a few other constraints as compared to the guided media, it provides the only means of *mobile communication*. Wireless networking is used for random and rapid deployment of a large number of nodes, which is a technology with a wide range of applications such as tactical communications, disaster relief operations, health care and temporary networking in areas that are not densely populated. A mobile WSN network (WSN) consists of mobile hosts equipped with wireless communication devices. The transmission of a mobile host is received by all hosts within its transmission range due to the broadcast nature of wireless communication and Omni-directional antennae. If two wireless hosts are not within the transmission range in WSN networks, other mobile hosts located between them can forward their messages, which effectively build connected networks among the mobile hosts in the deployed area. The use of wireless WSN networks also introduces additional security challenges that have to be dealt with.

A wireless sensor network (WSN) often contains hundreds or thousands of sensor nodes equipped with sensing, computing, and communication devices such as short-range communication devices over wireless channels. These nodes may be distributed over a large area; e.g., WSNs can do area monitoring for some phenomenon of interest. In such an application, the main goal of the WSN is to collect data from the environment and send it to a sink node. In the previous approaches two algorithms were considered namely Grade Diffusion algorithm and Direct Diffusion algorithm.

In the Grade Diffusion algorithm the source node will broadcast the RREQ packets to all its neighbours and then the neighbours will broadcast it its neighbours and the process repeats until the RREQ packet is received by the destination node. Therefore such a huge transmission of data will consume lot of power and decrease the battery life by which the nodes in the network will become no longer functional.

The Directed Diffusion algorithm overcomes the disadvantages of Grade Diffusion algorithm by broadcasting the neighbours to only first neighbour set. After that nodes are picked up based on hop count or rules and the amount of RREQ exchange is reduced hence amount of power required is less as compared to Grade Diffusion. However problem still persist as the number of routes discovered increases the battery power decreases and node becomes obsolete sooner.

2. Related Work

2.1 Literature Survey

In [1], Author has been devoted to aggregation in sensor networks with the purpose of optimizing its performance. Author has mostly concentrated on maximizing network lifetime within a user-given error bound. In general, the greater the error bound, the longer the lifetime. Aggregation protocol and related algorithms are used to increase the life time of a WSN.

In [2], An Enhancement Grade Diffusion (EGD) Algorithm for composite event aggregation is proposed to solve the problem of detecting composite events in wireless sensor networks. The EGD algorithm extends the traditional data aggregation algorithm to detect composite events, and this algorithm can eliminate redundant transmission and save energy consumption, thereby extending the lifetime of the entire wireless sensor network.

In [3], the energy efficiency is the foremost requirement of a sensor network. The network life, communication and the QOS are the factors that all are affected based on energy requirements of a network. To improve the network life there are number of existing routing mechanism to improve the QOS. Cache improvement in WSN has been defined by author to satisfy all these goals.

In [4], Author proposes a solution to fault management for Wireless sensor networks because of their own limitations and the scalability issue. By introducing new network equipments, one can improve the traditional distributed hierarchical management structure, the equipment can quickly locate the failure and analyze the cause of the failure, therefore can greatly improve the efficiency of network maintenance.

In [5], the author has proposed the topology control process for application node and base station which maximizes the topological network lifetime of the WSN by arranging BS location and inters-AN relaying optimally

In [6], Author proposes an algorithm based on ladder diffusion and ACO and is proposed to solve the power consumption and transmission routing problems in wireless sensor networks. The proposed ladder diffusion algorithm is employed to route paths for data relay and transmission in wireless sensor networks, reducing both power consumption and processing time to build the routing table and simultaneously avoiding the generation of circle routes.

In [7], the proposed algorithm considers recovery of each node based on the distance of each node from cluster heads, remained energy of cluster heads and member number of each cluster head and selects the best cluster head to recovery.

In [8], Author proposes a new scheme for fault management in wireless sensor networks. The new technique is hierarchical-based; however, it applies the cellular concept as well. The proposed scheme is energy-efficient, accurate, highly scalable, and dynamic and avoids bottlenecks in the network.

3. Proposed Work

In this, a route discovery approach is proposed which reduces amount of power consumption and number of nodes becoming obsolete (dead) will be less as compared to previous algorithms. The proposed algorithm will also determine set of nodes known as "grades" which has two values namely 0 or 1. Each node will become 1 if battery is greater than threshold otherwise it will be 0. This process of finding the set of nodes whose battery power is less than threshold is called Fault Node Determination. The nodes will be replaced with new nodes of same node id this process is called Fault Node Recovery.

3.1 System Design

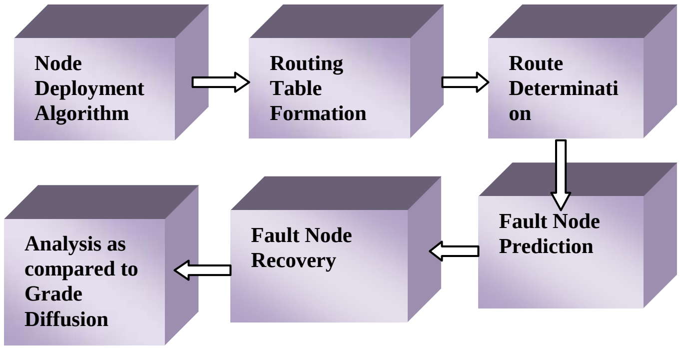

Figure 1: System Design

- **Node Deployment Algorithm**

This algorithm is responsible for deployment of nodes in a particular area. This will position the nodes in the given area

- **Routing Table Formation**

This is the algorithm which is used to form routing tables for each of the nodes. The routing table will contain information about other nodes in the network in terms of node id and distance of each node w.r.t other nodes in the network.

- **Route Determination**

This is the process which involves determining the route from the source node to destination node with the aid of using the control packets and the route must be found in such a way that battery consumption is reduced and overall network lifetime is also increased.

- **Fault node Prediction**

This is the process in which the node's whose battery power is below than certain threshold is determined

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- **Fault Node Recovery**

This is the process by which the nodes whose battery power is below threshold are determined and replaced with the new nodes but with same node id.

3.2 Flow of work

This paper proposes a fault node recovery (FNR) algorithm for WSNs based on the grade diffusion algorithm combined with the genetic algorithm. The flow chart is shown in Fig. 2.

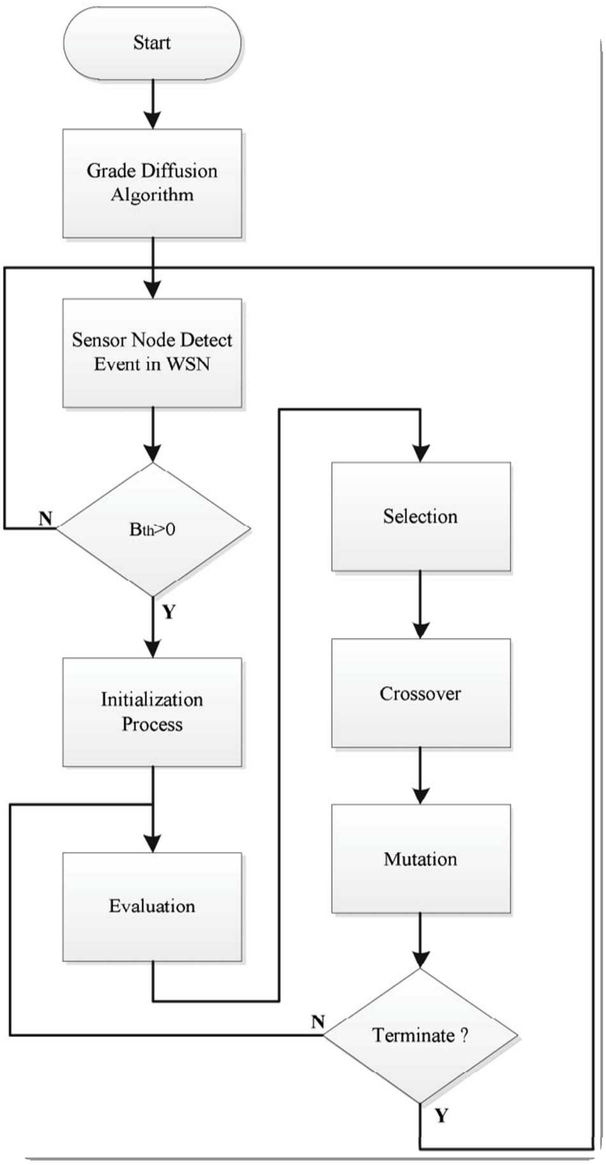

Figure 2: Flow Chart

The FNR algorithm creates the grade value, routing table, neighbor nodes, and payload value for each sensor node using the grade diffusion algorithm. In the FNR algorithm, the number of non-functioning sensor nodes is calculated during the wireless sensor network operation, and the parameter *B*th is calculated according to (1). The FNR algorithm creates the grade value, routing table, a set of neighbor nodes, and payload value for each sensor node, using the grade diffusion algorithm. The sensor nodes transfer the event data to the sink node according to the GD algorithm when events appear. Then, *B*th is calculated according to (1) in the FNR algorithm. If *B*th is larger than zero, the algorithm will be invoked and replace non-functioning sensor nodes by functional nodes selected by the genetic algorithm. Then the wireless sensor network can continue to work as long as the operators are willing to replace sensors.

Max{grade}
Bth =∑ Ti
i=1

$$T=\begin{cases}1, & N_i^{Now}/N_i^{Original}<\beta \\ 0, & \text{Otherwise}\end{cases} \qquad (1)$$

In (1), Grade is the sensor node's grade value. The variable $N_i^{Original}$ is the number of sensor nodes with the grade value i .The variable N_i^{Now} is the number of sensor nodes still functioning at the current time with grade value i . The parameter β is set by the user and must have a value between 0 and 1.If the number of sensor nodes that function for each grade is less than β, *Ti* will become 1, and *B*th will be larger than zero.

4. Simulation and Result

A simulation of the fault node recovery algorithm is performed to verify the method. The experiment was designed based on 3-D space, using 100×100 × 100 units, and the scale of the coordinate axis for each dimension was set at 0 to 100. The radio ranges (transmission range) of the nodes were set to 15 units. In each of these simulations, the sensor nodes were distributed uniformly over the space. There are three sensor nodes randomly distributed in 10 × 10 × 10 space, and the Euclidean distance is at least 2 units between any two sensor nodes. Therefore, there are 3000 sensor nodes in the 3-D wireless sensor network simulator, and the centre node is the sink node. The data packages were exchanged between random source/destination pairs with 90 000 event data packages. Total data loss, the energy of each sensor node was set to 3600 Ws that is the actual available energy.

5. Result

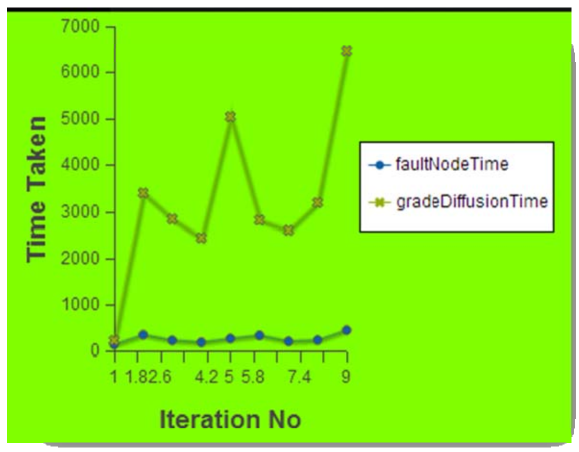

Figure 3: Comparison between Fault Node and Grade Diffusion with respect to time

In the fig 3 the blue dots shows the route discovered from the fault node algorithm and green dot shows the route discoverd from grade diffusion approah .from the above figure we can say tat the time taken for node transmission will be less in fault node approach than compared to grade diffusion.

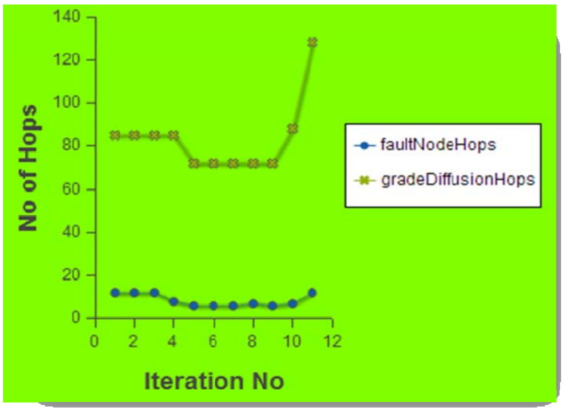

Figure 4: Comparison between Fault Node and Grade Diffusion with respect to Hops

In the fig 4 the blue dots shows the route discovered from the fault node algorithm and green dot shows the route discoverd from grade diffusion approah .from the above figure we can say tat the number of hops taken for node transmission will be less in fault node approach than compared to grade diffusion.

6. Conclusion

In real wireless sensor networks, the sensor nodes use battery power supplies and thus have limited energy resources. In addition to the routing, it is important to research the optimization of sensor node replacement, reducing the replacement cost, and reusing the most routing paths when some sensor nodes are non-functional. The various simulations demonstrate that the round trip time, Number of Hops. Power Consumption in mw, Energy Consumption in mJ, Number of Alive Nodes, Number of Dead Nodes the proposed approach performs better.

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