REPLACEMENT OF DEACTIVATED SENSOR NODES IN WIRELESS SENSOR NETWORKS

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Abstract—In wireless sensor network consist of a large number of tiny sensor nodes that is capable to perform local computations based on gathering sensory information and communicating with other sensor nodes in the network. The sensor nodes in WSNs equipped with batteries for their energy source, but it is inconvenient to recharge or replace batteries because of the sudden giving off energy. Hence, maximizing the lifetime of the network through minimizing the energy is an important challenge in WSN.This paper proposes a fault node recovery algorithm to provide energy efficient and effective communication in WSN. The algorithm is based on the combination of grade diffusion algorithm and the genetic algorithm. The FNR algorithm can replace the deactivated sensor nodes and more reused routing paths. In the simulation the FNR algorithm reduces the rate of packet loss by approximately 98.8% and reduces the rate of energy consumption by 100-80%.

Keywords— Fault Node Recovery (FNR) algorithm, Genetic algorithm, Grade diffusion algorithm, Wireless Sensor Networks (WSN).

I. INTRODUCTION

New innovations in micro processing, wireless and battery technology, and smart sensors have improved the quality of data processing, wireless communication and detection capability. Each sensor node in WSN has a limited wireless computing power to process and transmitting live data to the base station in the network. Therefore, WSN contains many sensor nodes to enhance the sensor area and the transmission area. Each sensor node in WSNs is equipped with batteries for their energy source, but it is inconvenient to recharge or replace batteries because of the sudden giving off energy. Hence, maximizing the network lifetime through minimizing the energy is an important challenged in WSN. The energy efficient coverage problem can be solved by using the ant colony based scheduling algorithm. FNR algorithm is used to replace deactivated sensor nodes in WSN to improve network lifetime.

II. BACKGROUND

A series of routing algorithms and energy efficient algorithm for WSNs have been proposed in recent years. This paper carried out after the study of existing methodologies involved in provide energy efficient and effective communication in wireless sensor networks. Wireless sensor networks consist of several sensor nodes to transmit the data from the sensor node to the other nodes. When the data is transmitted to the sink node from the sensor node, large amount of energy will loss from the neighboring nodes in the transmission processing. Sensor nodes will be deactivated because of the energy loss. No reuse of routing paths in WSNs. The effective lifetime aware routing in wireless sensor networks is to solve the main challenges of lifetime aware routing and desired sensing spatial coverage. For the insufficient energy utilization and the shortened lifetime of the network relay node deployment strategies is used in WSN. The power consumption of the sensor nodes in WSN is inevitable. To the short lifetime of the WSN, the main objective is to optimize energy consumption while maintaining the full sensing coverage area. In the wireless sensor networks according to its application energy aware sensor node is designed.

A. Grade Diffusion Algorithm

Grade diffusion algorithm was proposed by H C Shih et al in 2012. The main goal of grade diffusion algorithm is to improve the ladder diffusion algorithm using ant colony optimization (LD-ACO). The GD algorithm is to reduce transmission loading. The GD algorithm identifies a set of neighbor nodes and creates the routing path for each sensor node. Regarding the data relay, the GD algorithm can record minute information. Then, a sensor node can select a node with the more availability of energy than the other sensor nodes to perform the extra relay operation. The GD algorithm can creates the routing path and sends the event data to the sink node correctly and quickly. The directed diffusion algorithm is a query driven transmission protocol, energy consumption is high and no reuse of routing paths.

B. Genetic Algorithm

The energy efficient algorithm in the WSN is genetic algorithm (GA).The genetic algorithm involves 5 steps:

1) Initialization of GA:

GA creates the chromosomes in the initialization step. The number of chromosomes is resolute in proportion

to the population size, which is defined by the user. The population size depends on the nature of the problem. The gene is the main concept and the elements in the genes are either 0 or 1. The length of the chromosome is the number of non-functioning sensor nodes. In this step, population is generated randomly according to the chromosome length.

2) Evaluation :

The next step in the GA is the evaluation. The fitness function is defined over the genetic representation and measures the quality of the represented solution. The fitness value is calculated according to the fitness function. The parameters of the fitness function are the chromosome genes but it is not directly put into the fitness function.

3) Selection :

Select the two chromosomes from a node according to their fitness value. The chromosome with the lowest fitness value is eliminated and the chromosomes with the highest fitness value is put them in the mating pool. The elitism strategy is used in this algorithm. The worse chromosome will be eliminated and the new chromosome will be selected to replace them after the next step.The next step is to generate a second generation population of solutions from those selected through genetic operators.

4) Crossover :

In the GA, crossover step is used to change the individual chromosomes. One point crossover strategy is used in this algorithm to create new chromosomes. From the mating pool, two individual chromosomes are selected to produce two new offspring. A crossover point is selectedbetween the first and last genes of the parent individualthen thefraction of each individual on either side of the crossover point is exchanged.

5) Mutation :

In this algorithm, mutation step is to flip a gene randomly in the chromosome. The chromosome with the genes of 1 replaces the sensor node to extend the network lifetime.

III. FAULT NODE RECOVERY ALGORITHM

The algorithm for the recovery of the fault node is called fault node recovery algorithm. The FNR algorithm is based on the combination of grade diffusion algorithm and the genetic algorithm. The grade value, neighbor nodes, routing table and the payload value for each sensor node is created by using the GD algorithm in the FNR algorithm. During the WSN operation, the number of nonfunctioning sensor nodes is calculated in the FNR algorithm. The flowchart of the fault node recovery algorithm is as shown in Fig. 1.

The FNR algorithm is based on the bandwidth calculation and the bandwidth Bthcan be calculated by using the equation,

$$Bth = \sum_{i=1}^{\max\{grade\}} Ti \quad (1)$$

Where,

$$Ti = \begin{cases} 1, & \frac{Ni_{now}}{Ni_{original}} < \beta \\ 0, & \text{otherwise} \end{cases}$$

{Grade}- Sensor nodes grade value.

Ni_now - Number of functioning sensor nodes.

Ni_original – Number of sensor nodes with grade value i.

B is the parameter, set by the user and have value between 0and 1.

The number of functioning sensor nodes to the total number of sensor nodes for each grade value is less than β, Ti become 1 and the Bth will be greater than 0, then call the algorithm and replaces the non-functioning sensor nodes by functional sensor nodes in WSN by using genetic algorithm.

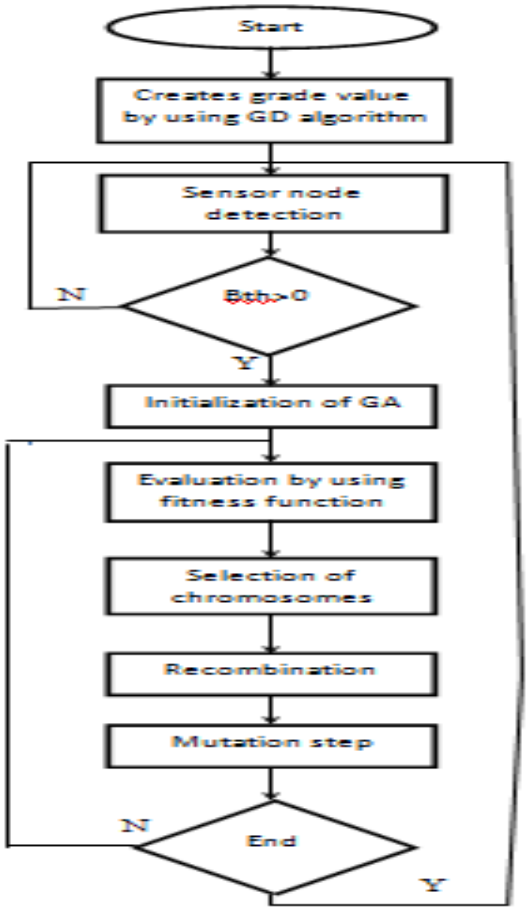

Fig. 1 FNR algorithm Flowchart

Fitness function can be calculated by using the equation,

$$fn = \sum_{i=1}^{\max\{grade\}} (Pi \times TP^{-1}) / (Ni \times TN^{-1}) \times i^{-1} \quad (2)$$

Where,

Ni - Number of replaced sensor nodes with grade value i.
Pi - Number of reusable routing paths from sensor nodes with grade value i.
TN - Total number of sensor nodes in WSN.
TP -Total number of routing paths in WSN.
The fault node recovery algorithm will replace the sensor nodes in the chromosome with genes of 1 to extend the WSN lifetime.

IV. SIMULATION

A deactivated sensor node in wireless sensor networks is replaced with the help of fault node recovery algorithm. A simulation of FNR algorithm is described as, considering 21 sensor nodes in the network. Sink position is fixed but all nodes position is changing, all node initialize energy 100kj. So the nodes sending or receiving data from the source node to sink node then it loses so much of energy, so that according to the GD algorithm creates a grade value and identifies a set of neighbor nodes to reduce the transmission loading. Then calculate the bandwidth according to the equation (1) in the FNR algorithm. If the total fraction of network is less than the user entered value then it will call to genetic algorithm, otherwise no need to call genetic algorithm. Then the GA computes the 5 steps and replaces the deactivated sensor nodes. The active nodes mean that the sensor node has enough energy to transfer data to other nodes, but some sensor nodes can be deleted from the active nodes list if their routing tables do not have a sensor node that can be used as a relay node. The FNR algorithm has the most active sensor nodes because the algorithm can replace the sensor nodes after the number of non-functioning nodes exceeds the threshold, by using genetic algorithm.

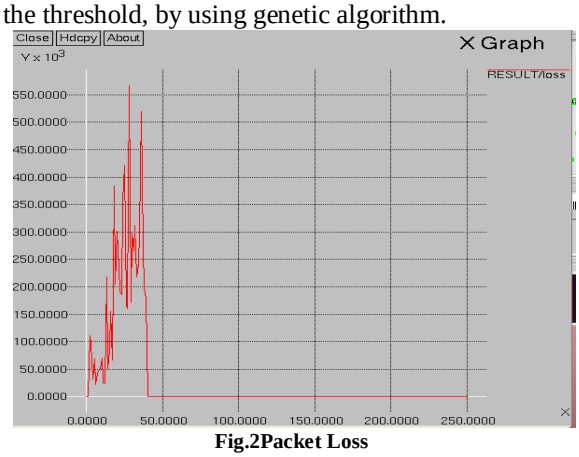

Fig.2Packet Loss

This graph is showing the packet loss in each and every second of the simulation of the FNRalgorithm. TheFNR algorithm exhibits smaller data losses because the algorithm can replace fewer sensor nodes and reuse of more routing paths if the number of sensor nodes that are nonfunctioning exceeds the threshold. This new algorithm can reduce the packet loss by 98.8%.

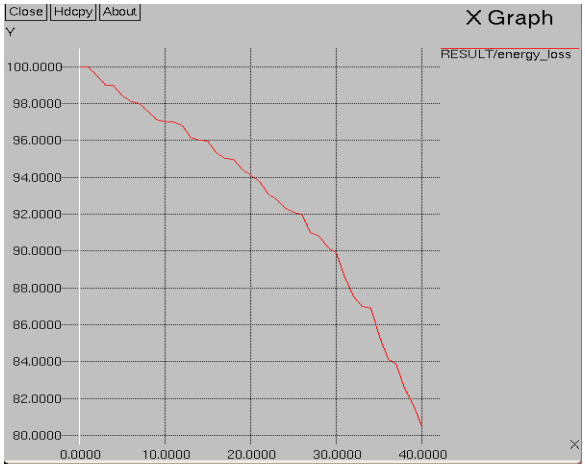

Fig.3 Energy Loss

The FNR algorithm increases the WSNs lifetime by replacing some of the sensor nodes that are not functioning. It can also reduce the relayed energy consumption by reducing the number of data relayed. The FNR algorithm reduces the rate of energy consumption from 100 to 80%.

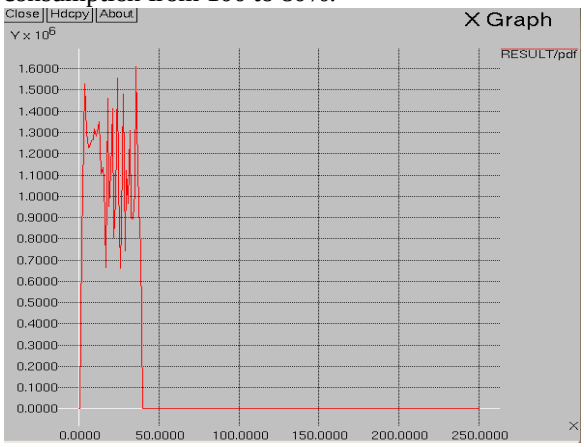

Fig.4Packet Delivery Fraction

This graph shows the packet delivery fraction of the simulation in the FNR algorithm. The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out by the sender.

CONCLUSION

This paper proposes the fault node recovery algorithm for wireless sensor networks to replace the deactivated sensor nodes and the reuses of more routing paths. Thus the algorithm can increase the WSN lifetime and reduces the replacement cost. The FNR algorithm is based on the combination of grade diffusion algorithm and genetic algorithm. In the simulation, the FNR algorithm increases the number of active nodes. The algorithm reduces the rate of packet loss by approximately 98.8% and also reduces the rate of energy consumption from 100 to 80%.In future, back up node concept is used in the FNR algorithm to improve the network lifetime.

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