Revival of Node Failure in Wireless Sensor Networks Using E3D Algorithm

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ABSTRACT: In wireless sensor network the main failure occurs due to the depletion of batteries. The FNR algorithm is used to reduce energy depletion and it creates a routing of data using the GD algorithm and replaces sensor nodes using the GA when the number of sensor nodes that are not functioning properly. The limitation, energy of neighbor node near to base station gets depleted quickly and sometimes it chooses a long path to reach the destination if node failure occurs. So the life time of nodes get reduced. This paper proposes E3D: energy efficient distributed dynamic diffusion algorithm instead of grade diffusion. E3D algorithm defines the energy level into two categories. To receive and transmit the E3D algorithm will take lower energy level. To sense and transmit it will take higher energy level. E3D algorithm identifies the energy depletion of neighbor node by stop sending of data to the sink node before the energy gets depleted completely. It increases the life time of wireless sensor networks and also reduce the energy depletion quickly. Then it reduces the use of same neighbor nodes more to route the data.

KEYWORDS: wireless sensor networks, E3D algorithm, genetic algorithm, node failure.

I. INTRODUCTION

In a wireless sensor network (WSN), sensor nodes are powered by batteries that can operate for only a limited period of time, which results in short wireless sensor network lifetime. The short lifetime disables the application of WSNs for long term tasks such as structural health monitoring, border surveillance, road condition monitoring, and so on. Hence, many energy conservation schemes were proposed to battle the constraint. With these schemes, the rate of energy consumption is slowed down, bur consumed energy cannot be compensated. Therefore, the effectiveness of these schemes is restrained by the amount of energy preloaded to sensor nodes. Fully addressing the problem requires that energy be continually replenished to sensor nodes.

One possible approach is to harvest energy from various environmental sources such as the sunlight. However, efficient harvesting are still absent. In particular the amount of energy that a solar cell can harvest can proportional to its surface area, but it is infeasible to equip a tiny sensor node with a large-size solar cell. The amount of available solar energy also depends on uncontrollable conditions such as cloudiness of the sky. Hence, it is very likely that the energy harvested is limited and unable to satisfy the needs of sensor nodes.

Another possible solution is to incrementally deploy new sensor nodes to take over wireless sensor nodes running out of energy. However, this approach is costly because sensor node hardware cannot be reused, and it causes pollution to the environment because dead batteries and hardware are left in environment. Seeking an effective and efficient way to guarantee long-term energy supply remains as a big challenge.

This paper proposes E3D algorithm combined with GD algorithm which identifies the energy depletion of neighbor node by stop sending of data to the sink node before the energy gets depleted completely. So we can replace another neighbor node before that particular node gets failed. It increases the lifetime of each node. Therefore here the lifetime of WSN gets increased and reduce the depletion of energy quickly.

II.RELATED WORK

The existing approaches for routing of wireless sensor network include grade diffusion algorithm, ladder diffusion, FNR algorithm and direct diffusion.

A. Ladder Diffusion algorithm

The locations of the sensor nodes deploy stable, and the routing table built by AODV is only a small portion of the entire WSN, energy consumption is increases by rebuilding the routing table for the deleted routes. In direct diffusion, the sink node can diffuse its interested query packets to other wireless sensor nodes by broadcasting to the whole network by adjusting the route weights does not decreases the energy consumption in creating circle results. First, the sink node transmits the ladder package with the node value of one, as shown in fig.2. A node value of one means that the sensor node receiving this ladder package transmits data to the sink node requires only one hop. In fig.2.the sensor nodes ''b'' and ''c'' obtain a ladder-package with a node value of one from sink node ''a''. Then sensor nodes ''b'' and ''c'' increase the node value of the ladder package to two and transmit the modified ladder package.
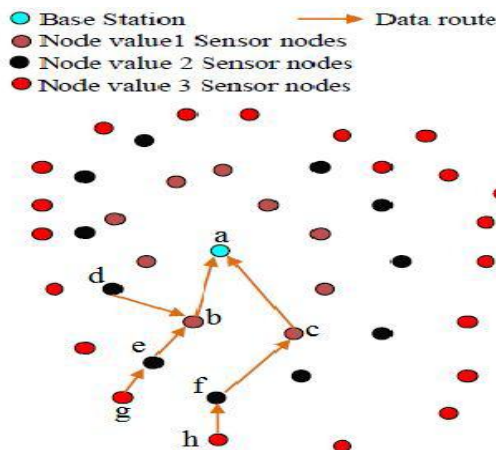

Fig. 1 Data transfer routes for sensor nodes

The sensor nodes ''d'', ''e'', and ''f'' receive ladder packages with a node value of two from nodes

''b'' and ''c''. Each sensor nodes increases node value continuously until it reaches the source node. Moreover, if many sensor nodes concurrently transmit ladder packages with the same node value, the sensor nodes receive and record the packages in their respective ladder tables as back-up nodes. But the sensor nodes discard the package because the sensor node value of the sensor nodes surrounding nodes is less than actual sensor node value.

B. FNR Algorithm

The FNR algorithm creates the grade value, routing table, a set of neighbor nodes, and payload value for each sensor node, using the GD algorithm and replaces sensor nodes using GA. The sensor nodes transfer the event data to the sink node according to the GD algorithm when event appear. Then, B is calculated in the FNR algorithm. If B is larger than zero, the algorithm will be invoked and replace nonfunctioning wireless sensor nodes by functional sensor nodes selected by the GA. Then the wireless sensor network can continue to work as long as the operators are willing to replace sensors.

$$\boldsymbol{B} = \sum_{i=1}^{\max\,[\,grade\,]} Ti \qquad (2)$$

Ti=1 when $\frac{N_i^{now}}{N_i^{original}} < \beta$

Ti=0 when otherwise

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.

C. Direct diffusion algorithm

Routing algorithms for WSN have been proposed. It is query driven transmission protocol The main goal of the direct diffusion is to reduce the data rely transmission counts for power management and to achieve energy saving by selecting good paths, by caching and processing data. The collected data is transmitted only if it matches the query from the base station. The sink node provides the queries to the other sensor nodes by broadcasting the query packets throughput the network. Then the sensor nodes send the data back to the sink node only when it fits the queries. It does not use continuous data deliver.

D. Grade Diffusion Algorithm

GD updates routing path in real time and the event data is thus send to the sink node quickly and

correctly. It used to create a routing of nodes based on the grade value. It identifies a set of neighbor nodes to reduce transmission loading.

GD used to eliminate redundant transmission. It can also record some information regarding the data rely. This algorithm gives energy level at particular range only. Then the battery power gets depleted soon. Therefore based on the energy level the node which is close to sink node will die sooner.

III. PROPOSED WORK

This paper proposes a energy efficiency distributed dynamic diffusion based algorithm combined with genetic algorithm for wireless sensor networks.

a. E3D algorithm

In addition to everything that the basic diffusion algorithm performs, each sensor node makes a list of suitable neighbor and ranks them in order of preference, similar to the previous approach. Every time that a node changes neighbors, the sender will require an acknowledgement for its first message which will ensure that the receiving node is still alive. If a time out occurs, the sending node will choose another neighbor to transmit to and the whole process repeats.

Once communication is initiated, there will be no more acknowledgements for any messages. Besides data messages, there is an introduce exception messages which serve as explicit synchronization messages. Only receivers scan issue exception messages, and are primarily used to tell the sending node to stop sending and let the sender choose a different neighbor. An exception message is generated in only three instances: the receiving node's queue is too large, the receiver's power is less than the sender's power, and the receiver has passed a certain threshold which means that it has very little power left. At any time throughout the system's lifetime, a receiver can tell a sender not to transmit anymore because the receiver's queues are full. This should normally not happen, but in the event it does, an exception message would alleviate the problem. In the current schema, once the sending node receives an exception message and removes his respective neighbor off his neighbor list, the sending node will never consider that same neighbor again. We did this in order to minimize the amount of control messages that would be needed to be exchanged between peer nodes.

However, future consideration could be to place a receiving neighbor on probation in the event of an exception message, and only permanently remove it as a valid neighbor after a certain number of exception messages. The second reason an exception message might be issued, which is the more likely one, is when the receiver's power is less than the sender's power, in which if the receiver's power is less than the specified threshold, it would then analyze the receiving packets for the sender's power levels. If the threshold was made too small, then by the time the receiver managed to react and tell the sender to stop sending, too much of its power supply had been depleted and its life expectancy thereafter would be very limited while the sending node's life expectance would be much longer due to its less energy consumption.

In order to avoid having to acknowledge every message or even have heartbeat messages, we introduce an additional threshold that will tell the receiving node when its battery supply is almost gone. This threshold should be relatively small, in the 5~10% of total power, and is used for telling the senders that their neighbors are almost dead and that new more suitable neighbors should be elected.

The synchronization cost of E3D is two messages for each pair of neighboring nodes. The rest of the decision will be based on local look-ups in its memory for the next best suitable neighbor to which it should transmit. By looking at the empirical results obtained, it is only towards the end of the system's lifetime that the sensor nodes decide to send directly to the base station.

The advantage of E3D algorithm is the near perfect system lifetime where most nodes in the network live relatively the same duration. The system distributes the lifetime and load on the network better than the previous approaches.

b. Genetic Algorithm

GA is used to replace the nodes. It uses the parameter B_{th} which is used to check the nodes is alive or not. If B>0 then replace the non functioning sensor nodes by functional nodes and the lower energy level is replaced by higher energy level.
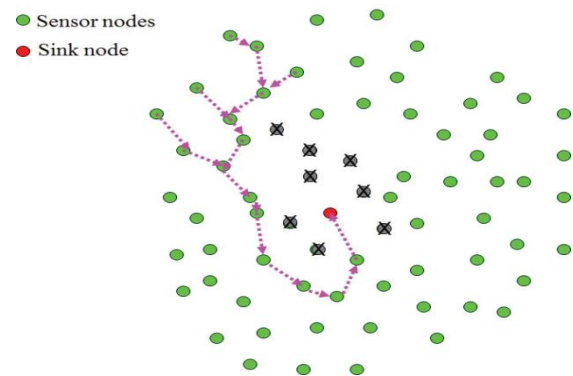

Fig . 2 WSN routing path when some nodes are not functioning

Genetic algorithm has five steps: initialization, evaluation, selection, crossover and mutation.

a.   Initialization

Generate random population of n chromosomes (suitable solutions for the problem) and assigning the values. The elements in the genes are represented either by 0 or 1. Whereas 0 denotes the nodes should be replaced, and 1 denotes the node will not be replaced.

b.   Evaluation

Evaluate the fitness f(x) of each chromosome x in the population.

$$f_n = \sum_{i=1}^{\max(Grade)} \frac{P_i \times TP^{-1}}{N_i \times TN^{-1}} \times i^{-1} \qquad (1)$$

In (1):

N_i = The number of replaced sensor nodes and their grade value at i.

P_i = The number of reusable routing paths and their grade value at i.

TN = Total number of sensor nodes.

TP = Total number of routing path.

c.   Selection

Select two parent chromosomes from a population according to their fitness value (the better fitness value, the bigger chance to be selected). It will eliminate the chromosomes with the lowest fitness values and retain the rest.

d.   Crossover

With a crossover probability cross over the parents which forms a new offspring (children). If no cross over was performed, then offspring is an exact copy of parents. A cross over point is selected between the first and last genes of the parent individuals.

e.   Mutation

With a mutation probability mutate new offspring at each locus. It prevents the genetic algorithm from converging too fast.

IV. SIMULATION RESULTS

Simulation of E3D algorithm as described in proposed work. The result was designed based on 3D space, the scale of the coordinate axis for each dimension was set at 0 to 100.
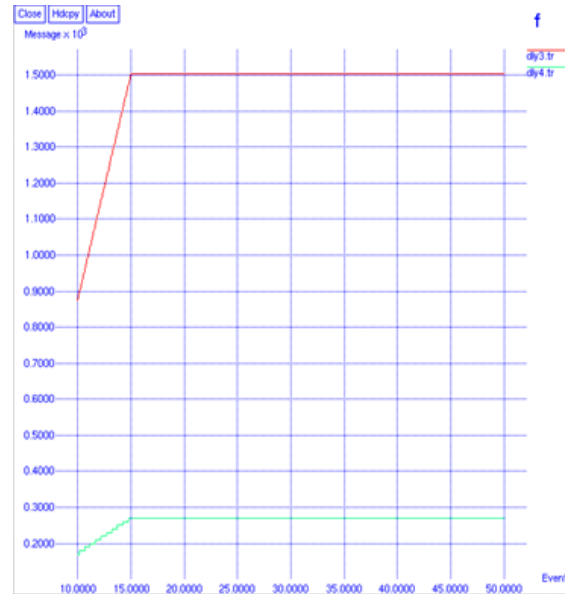

Fig. 3 Delay

Fig. 3 compares the delay of a WSN managed using the E3D algorithm to the delay using FNR algorithm. The FNR takes more time to transmit the message because the inside node energy gets depleted quickly compare to E3D.
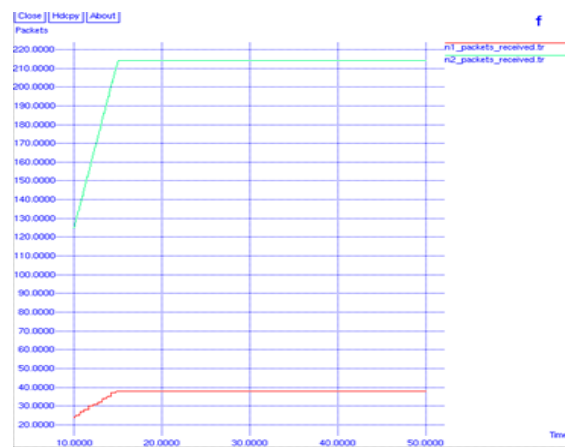

Fig. 4 Packet received

Fig. 4 concludes the more number of packets are received during the time period through E3D algorithm. That is packets are transmitted to their sink node successfully. The average number of packets received using E3D algorithm is higher than when using the other algorithms.

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V.CONCLUSION

This paper focused on failure occurring in wireless sensor networks due to the depletion of batteries. In existing system the FNR algorithm creates a routing of data using the GD algorithm and replaces sensor nodes using the GA. The energy of neighbor node near to base station gets depleted quickly. Therefore E3D algorithm identifies the energy depletion of neighbor node by stop sending of data to the sink node before the energy gets depleted completely. It increases the wireless sensor networks lifetime and also reduce the energy depletion quickly. It reduces the use of same neighbor nodes more to route the data.

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