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An Improved Method for Energy Utilization in Wireless Sensor Network

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Abstract

Sensor webs consisting of nodes with limited battery power and wireless communications are deployed to collect useful information from the field. Each node collects the information and then transmits it to the base station. The lifetime of the network depend upon how much energy spent in each transmission. The protocol plays an important role, which can minimize the delay while offering high energy efficiency and long network lifetime. One of such protocol is LEACH. LEACH protocol presents good solution where clusters are formed to fuse data before transmitting to the base station by randomizing the cluster heads chosen to transmit to the base station. Another protocol PEGASIS (Power-Efficient Gathering in Sensor Information Systems), a near optimal chain-based protocol that is an improvement over LEACH. In PEGASIS, it take the advantage of sending data to its closet neighbour, it saves the battery for WSN and increases the lifetime of the network. The proposed work is an improvement over existing PEGASIS protocol in terms of energy efficiency. The basic idea is to select the next neighbouring node reliably. For this it will combine few parameters such as Distance, Residual Energy and Response time. The proposed system will increase the life time also.

1. Introduction

Wireless Sensor Networks [1], with the characteristics of low energy consumption, low cost, distributed and self organize network, have brought a revolution to the information perception. However, the energy of nodes in WSN is extremely restricted. Deployed in harsh and complicated environments, the sensor nodes are difficult to recharge or replace once their energy is drained. Meanwhile in the sensor nodes improve the energy-efficiency as well as load balance and prolong the network lifetime has became an important issue of designing routing protocols for WSN. In sensor networks, data fusion helps to reduce the amount of data transmitted between sensor nodes and the BS [2]. Data fusion combines one or more data packet to produce a single packet as described in. The LEACH protocol presented in [3] is an elegant solution to this data collection problem, where a small number of clusters are formed in a self-organized manner. A designated node in each cluster collects and fuses data from nodes and transmits the result to the BS. LEACH uses randomization to rotate the cluster heads and achieves a factor of 8 improvement compared to the direct approach, before the first node dies. Further improvements can be obtained if each node communicates only with close neighbours, and only one designated node sends the combined data to the BS in each round. In this paper we present an improved protocol called PEGASIS (Power-Efficient Gathering in Sensor Information Systems), the key idea in PEGASIS is to form a chain among the sensor nodes so that each node will receive from and transmit to a close neighbour. Gathered data moves from node to node, get fused, and eventually a designated node transmits to the BS. Nodes take turns transmitting to the BS so that the average energy spent by each node per round is reduced however, with the radio communication energy parameters; a simple chain built with a greedy approach performs quite well. The PEGASIS protocol achieves between 100 to 300% improvement when 1%, 20%, 50% and 100% of nodes die compared to the LEACH protocol.

2. Radio Model for PEGASIS

In this model, a radio dissipates = 100pJ/m for the transmitter amplifier . Transmitter and Receiver dissipates 50nJ/bit.The radios have power control and can expend the minimum required energy to reach the intended recipients. The radios can be tumed off to avoid receiving unintended transmissions. d^2 energy loss is used due to channel transmission. The equations used to calculate transmission costs and receiving costs for a k-bit message and a distance d are shown below:

Transmitting and Receiving is also a high cost operation, therefore, the number of receives and transmissions should be minimal.

In our stimulations,

Transmitting

$$E_{TX}(k, d) = E_{TX\text{-}elec}(k) + E_{TX}\text{-}amp(k, d) \qquad (i)$$

$$E_{TX}(k, d) = E_{elec} \times k + \epsilon amp \times k \times d^2 \qquad (ii)$$

Receiving

$$E_{RX} = E_{RX\text{-}elec}(k) \qquad (iii)$$

$$E_{RX}(k) = E_{elec} \times k \qquad (iv)$$

It is assumed that the radio channel is symmetric so that the energy required to transmit a message from node i to node j is the same as energy required to transmit a message from node j to node i for a given signal to noise ratio.

3. Energy Cost Analysis for Data Gathering

Here cost means the cost of data gathering from a sensor web to the distant BS. so for send a k-bit packet from each sensor node in each round. Of course, the goal is to keep the sensor web operating as long as possible. A fixed amount of energy is spent in receiving and transmitting a packet in the electronics, and an additional amount proportional to d^2 is spent we transmitting a packet. There is also a cost of 5nJ/message for data fusion. With the direct approach, all nodes transmit directly to the BS which is usually located very far away. Therefore, every node will consume a significant amount of power to transmit to the BS in each round. Since the nodes have a limited amount of energy, nodes will die quickly, causing the reduction of the system lifetime. As observed in [3], the direct approach would work best if the BS is located close to the sensor nodes or the cost of receiving is very high compared to the cost of transmitting data. For the rest of the analysis, we assume a 100-node sensor network with the BS located far away. In this scenario, energy costs can be reduced if the data is gathered locally among the sensor nodes and only a few nodes transmit the fused data to the BS. This is the approach taken in LEACH, here clusters are formed dynamically in each round and cluster-heads (leaders for each cluster) gather data locally and then transmit to the BS. Cluster-heads are chosen randomly, so all nodes have a chance to become a cluster- head in LEACH, to balance the energy spent per round by each sensor node. For a 100-node network in a 50m x 50m field with the BS located at (25 & 150), which is at least l00m from the closest node, LEACH achieves a factor of 8 improvement compared to the direct approach in tams of number of rounds before the fist node dies. Although this approach is about 8x better than the direct transmission, there is still some room to save even more energy. The cost of the overhead to form the clusters is expensive. In addition, several cluster-heads transmit the fused data from the cluster to the distant BS. Further improvement in energy cost for data gathering can be achieved if only one node transmits to the BS per round and if each node transmits only to local neighbours in the data fusion phase. This is done in the PEGASIS protocol to obtain an additional factor of 2 or more improvement compared to LEACH. For the 100-node network shown in Figure 1, we can determine a bound on the maximum number of rounds possible before the first node dies. In each round, every node must transmit their packet to next node and next node fuses data and send to next node.This process goes on and node near base station send data to base station.

4. Detail of Improved PEGASIS

It is possible that some nodes may have relatively distant neighbour nodes along the chain in PEGASIS. On one hand, nodes already on the chain cannot be revisited. On the other hand, when a node dies, the chain is reconstructed in the same manner (greedy algorithm) to bypass the dead node

4.1 A Chain Construction Phase

The algorithm uses the following steps to form a chain:
a) Initialize the network parameters. Determine the number of nodes, initial energy, BS location information et al. Then chain construction starts.
b) BS broadcasts the whole network a hello message to obtain basic network information such as ID of nodes alive and distance from each node to BS.
c) Set the node which is farthest from BS as end node, it joins the chain first and is labeled as node 1.
d) End node of the chain obtains the information of distance between itself and other nodes which have not joined the Chain yet, finds the nearest node and sets it as node I waiting to join the chain, i represents the i-th node joined.
The chain-building methods in exiting protocol and proposed protocol are respectively used to the same network of
100 nodes randomly arranged. The results are shown as Fig.1 and Fig.2.

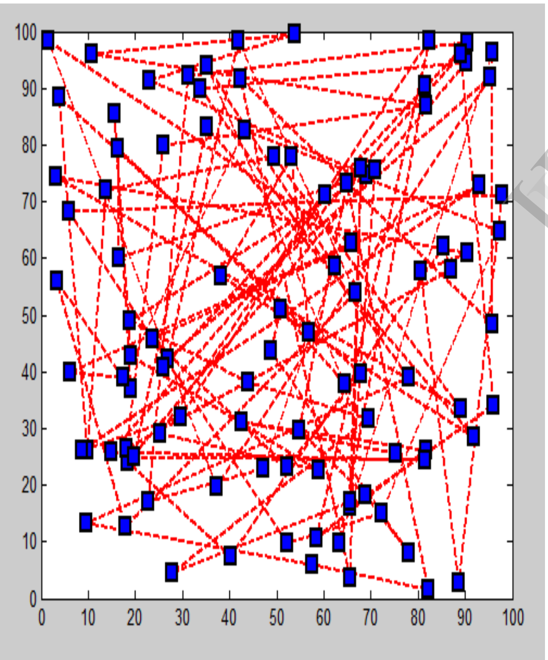

Figure.1The chain formed in exiting PEAGASIS Protocol

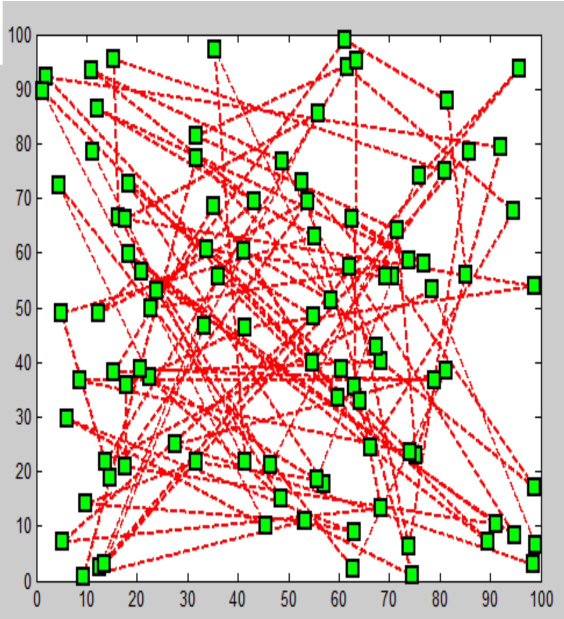

Figure.2 The chain formed in proposed PEGASIS Protocol

5. Simulation Result

This paper uses Matlab as simulator to evaluate the performance of exiting PEGASIS protocol comparing with improved PEGASIS. The simulation focuses on number of sensor nodes alive and dead node, lifetime of network and energy efficiency which are important indicators to measure performance of different algorithm

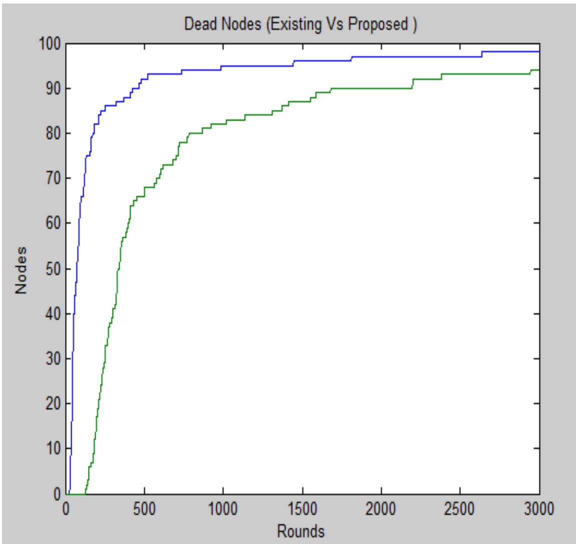

Figure 3

Here in figure 3, the dead nodes are shown over the network As we can see there are about 98 nodes get

dead after 3000 rounds in case of existing PEGASIS protocol and around 92 nodes dead after the Proposed Improved PEGASIS protocol.
We can see the more number of nodes are dead after 3000 rounds in case of existing PEGASIS protocol.

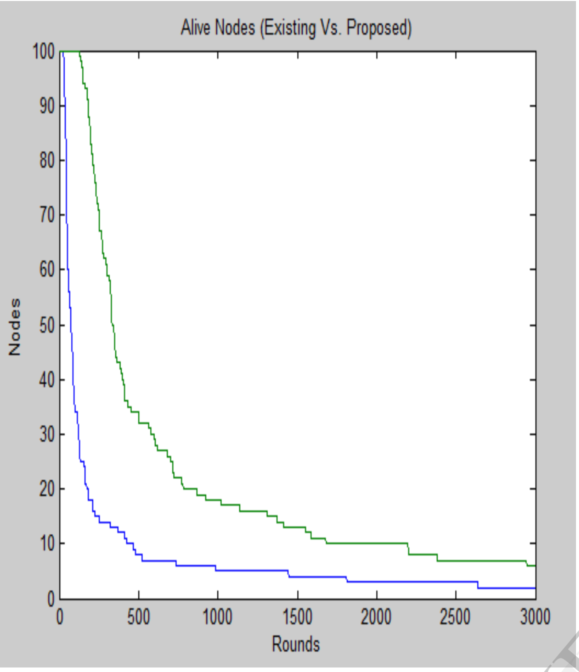

Figure. 4

Here in figure. 4, the dead nodes are shown over the network As we can see there are about 2 nodes left alive after 3000 rounds in case of existing PEGASIS protocol and around 8 nodes left alive after the Proposed Improved PEGASIS protocol. We can see the more number of nodes are dead after 3000 rounds in case of existing PEGASIS protocol

6. Conclusion

The proposed system outlays an improvement over the existing PEGASIS protocol. The proposed work is implemented on Wireless Sensor network to improve the network life in case of chain based protocol. The main problem with cluster network was to find the next neighbour for communication. Here the improvement is done for existing PEGASIS protocol. In this work we have included one parameter to select the next neighbour. The work is about to identify an energy efficient aggregative path to communicate over the entire network.

7. References

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