Volume 4, Issue 11, November 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Reduction of Energy Dissipation in WSNs Using Multi-Chain PEGASIS

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Abstract— In wireless sensor networks, sensor nodes have limitation of energy so the lifetime of the networks is very important design factor. The chain-based routing scheme is one of the famous routing schemes that are proposed for reducing energy dissipation of communication in the networks. The chain-based routing schemes construct the chains for routing path. The chain-based routing schemes can reduce energy dissipation of transmitting data to base station by using the concept of multi-hop routing. Major Routing protocol, power-Efficient Gathering in Sensor Information System (PEGASIS) presents the notion of chain formation among sensors and conveys the data to base station. The leader node collects data of all other chain nodes and sends it to the sink. It is challenge to achieve well-organised energy utilisation of the leader node of chain in PEGASIS. The proposed approach decreases the network overhead due to fewer numbers of nodes in chains. There is a major load on the single chain leader due to larger distance between chain leader and the sink. Minimization of data delivery delay is also an important requirement to improve network performance. The nodes are divided in several regions and make different chain for each region, it reduces the delay between nodes to BS, and hence energy load is distributed uniformly among the chains. Overall performance is analysis in terms of network lifetime with number of rounds. We compare the PEGASIS and proposed method with respect to 1%,20%,50% and 100% of dead nodes with number of rounds. Proposed method is approx. 20% better perform than PEGASIS.

Keywords— Wireless sensor network,PEGASIS,Multi-Chain PEGASIS,Energy dissipation,Number of dead nodes and Rounds

I. INTRODUCTION

Wireless sensor networks are set of hundreds or thousands of micro sensor nodes that have capabilities of sensing, establishing wireless communication between each other and doing computational and processing operations. In fact, these sensor nodes sense their environment and can provide information about environments which are far from us via wireless communications. These networks have many applications and appeals but because of their limitations of energy and bandwidth, actual applications of them are difficult. Since to achieve these capabilities, we must use many numbers of these micro sensor nodes, the cost for these nodes should be very low. The power of nodes is depend on the power which is embedded in nodes, so we always have the limitation for the cost and the size of the nodes. There are many energy efficient protocols designed for wireless sensor networks ([1], [2]). When sensor networks are considered, those data routing algorithms can maximize the system lifetime for the different method. In this paper, we propose a new method for reducing the energy consumption in the nodes routing. This energy reduction will cause changes in some of the other dependent parameters such as delay. Among the hierarchical protocols, Low-Energy Adaptive Clustering Hierarchy (LEACH) [3] and Power Efficient Gathering in Sensor Information Systems (PEGASIS) [4] are the most famous.We simulate our new method using MATLAB R2014a software and we will see the improvement in proposed protocol gives up to 50% better performance till the first node dead and overall performance is 20% in terms of energy consumption compare to PEGASIS.

II. RELATED WORK

In the recent years many energy efficient routing protocol has been proposed some of the major protocols are given below.

A. PEGASIS

The main idea in PEGASIS is for each node to receive from and transmit to close neighbours and take turns being the leader for transmission to the BS. This approach will distribute the energy load uniformly among the sensor nodes in the network. We initially place the nodes randomly in the field, and therefore, the *i* –th node is at a random location. The nodes will be organized to form a chain, which can either be accomplished by the sensor nodes themselves using a greedy algorithm starting from some node. Alternatively, the BS can compute this chain and broadcast it to all the sensor nodes. We used random 100-node networks for our simulations. We placed the BS at a far distance from all other nodes.

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For a 100m x 100m plot, our BS is located at (50, 50) . For constructing the chain, we assume that all nodes have global knowledge of the network and employ the greedy algorithm. Chain construction in PEGASIS protocol is shown in Fig.1 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. Building a chain to minimize the total length is similar to the travelling salesman problem, which is known to be intractable. In PEGASIS each node will receive and transmit one packet in each round and be the leader once every 100 rounds. With our simulation experiments, we found that the greedy chain construction performs well with different size networks and random node placements.

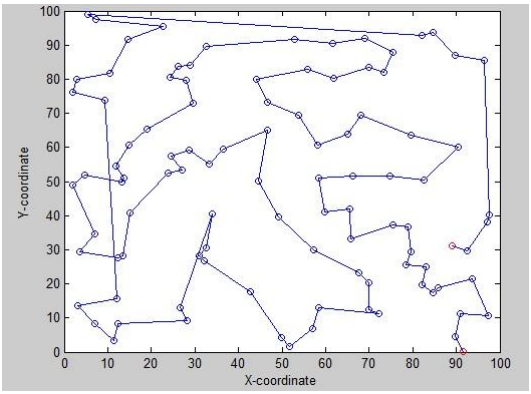

Fig. 1 Chain Construction in PEGASIS protocol

Data Aggregation: For gathering data in each round, each node receives data from one neighbour, fuses with its own data, and transmits to the other neighbour on the chain. Note that node *i* will be in some random position *j* on the chain. Nodes take turns transmitting to the BS, and we will use node number *i* mod N (N represents the number of node) to transmit to the BS in round *i*. Thus, the leader in each round of communication will be at a random position on the chain, which is important for nodes to die at random locations. The idea in nodes dead at random places is to make the sensor network robust to failures. The node which is died during communication that node be bypassed in reconstructing in chain.

B. Chain-Based Routing Scheme

The BS is located far away from sensor nodes. In the wireless communication, an energy consumption increases in proportion to square of the transmission distance. If the number of transmitting data to the BS is decreased, the total energy dissipation is decreased. The minimum transmission-energy is saving energy for signal amplifying [5,6,7]. The head node has responsibility to transfer data of every sensor nodes to the BS. Only the head node communicates with the BS so this scheme can save energy dissipation.

III. MULTI-CHAIN PEGASIS(PROPOSED) PROTOCOL

We propose Multi-chain PEGASIS protocol for reduction of energy consumption in WSNs. It is the modified version of PEGASIS. It is approximate 20% more efficient than existing PEGASIS protocol.

A. Chain Formation in proposed protocol

In multi chain PEGASIS the chain formation is same as the PEGASIS except in multi-chain PEGASIS nodes are distributed in four region and each region contain a separate chain i.e 100 nodes area is divided in each 25-25 nodes. Chain construction of proposed algorithm is shown in Fig.2.

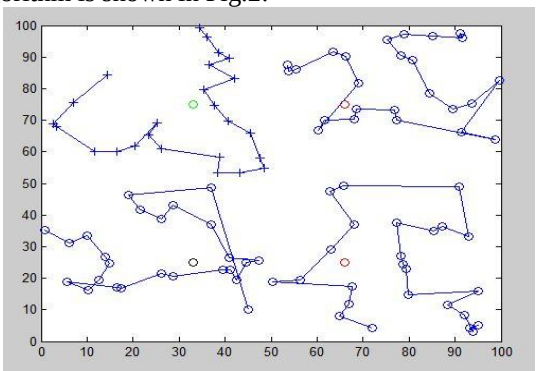

Fig. 2 Chain Construction in Proposed protocol

- Sink find the far node by comparing the distances of all nodes from itself in first region.
- The chain construction is start from end node which is far from the sink.
- The end node find the most near neighbor and make the chain between end node and nearer node.

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- Each node find the distance between itself and the nearest node not connected in chain and connect it with the same method which mention above.
- The same procedure of chain formation is apply in all four region.

B. Energy Cost

The following equations used to calculate transmission cost and receiving cost for a k-bit message and a distance d are:

- Transmission cost:

$$E_{TX}(k, d) = E_{TX\text{-}elec}(k) + E_{TX\text{-}amp}(k, d) \quad (1)$$

- Receiving cost:

$$E_{RX}(k, d) = E_{RX\text{-}elec}(k) \quad (2)$$

- Data Aggregation cost: Data aggregation cost is calculated based on fusion of all data at a node of k-bit message

$$E_{DA}(k) = E_{DA\text{-}elec}(k) \quad (3)$$

IV. SIMULATION AND COMPARATIVE ANALYSIS WITH EXISTING PROTOCOL

To evaluate the performance of the multi-chain PEGASIS protocol it has been simulated in 100 node network and the nodes are randomly distributed in a 100m* 100m square. In this model, a radio dissipates the energy in sending or receiving 1bit: *Eelec* = 50nJ/bit. Nodes having initial energy is *E* = 0.5J/Node**.** In order to show the performance of the protocol it is simulated using MATLAB R2014a. The results are shown under and comparison between them.

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A. Parameters Used:

The following parameters used for simulation of proposed and existing protocol.

Table I. Parameters used for simulation

Rounds	2000
Network Size	100m*100m
Number of Nodes	100
Base Station Location	PEGASIS:(50,50) Proposed:(33,25),(33,75),(66,25),(66,75)
Initial Energy of Nodes	0.5J
Packet Size	2000bits

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B. Comparison between proposed and existing PEGASIS protocols:

We simulate the protocol for determine the percentage of dead nodes per round in proposed and PEGASIS protocol. We compare the results of both protocol based on above parameters mention in *Table I*.

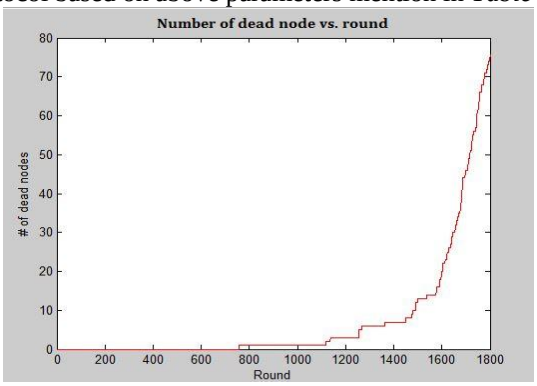

Fig. 3 Number of dead nodes v/s Number of Rounds in PEGASIS protocol

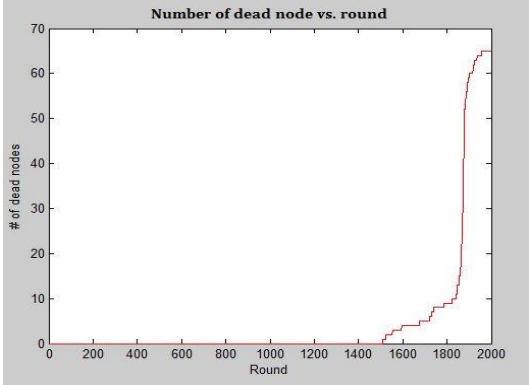

Fig. 4 Number of dead nodes v/s Number of Rounds in proposed protocol

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Table II. % of dead nodes per number of rounds

	1%	20%	50%	100%
PEGASIS Protocol	770	1600	1708	1967
Proposed Protocol	1520	1863	1908	2241

We can seen from Fig.3 and Fig.4 that after 20% node dead it will reduces its energy level rapidly because of extra overhead due to bypassed the dead node and selection of leader nodes.

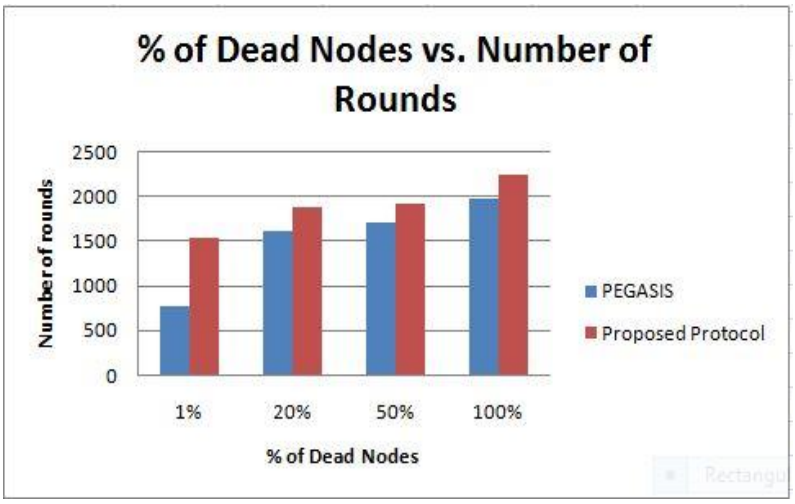

Fig. 5 Comparative Analysis of Percentage of dead nodes v/s Number of Rounds in proposed and existing protocol

We can observe from Fig.5 that proposed algorithm give better performance than existing PEGASIS protocol. It gives 50% better performance than PEGASIS till the first node dead and its overall performance is approximate 20% better than existing PEGASIS protocol.

V. CONCLUSIONS

This paper proposes a multi-chain PEGASIS routing approach for increase lifetime of sensor networks. Our scheme achieves balance of energy dissipation among the chains unlike of a single chain in PEGASIS. We proved performance of our scheme by using simulation on MATLAB R2014a. This proposed approach gives better performance than existing PEGASIS protocol in terms of energy consumption.

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