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Node Life Time Enhancement Based Protocol for Hybrid WSN

Aamir Mohammad
Institute of Technology and Management
Gwalior, M.P., India

Kashif Mohammad
Shri Ram Institute of Technology,
Jabalpur, M.P., India

Abstract- Sensor nodes deployed in wireless sensor network have restrained battery power so the network lifetime is a paramount factor. Hence, energy efficient routing protocol should be adopted to increase the network life expectancy. PEGASIS is one of the best fundamental chain based hierarchical routing protocols which can be hired to lessen the energy diminution in the network. This paper describes a Multi-chain based Hybrid Routing Protocol (MHRP) which adopts a joint strategy of multi-chain concept and pre-chain leader (P-CL) selection procedure to realize the increased node lifetime in wireless sensor networks (WSN). The multi-chain concept aims to balance the network overhead due to less number of nodes comparatively in chains. It also minimizes data delivery delay in order to improve the network performance. The pre-chain leader modifies the greedy algorithm and aims to balance the workload of head node selected among the entire node by adopting another leader node in case when head node is far away from sink node. Simulation analysis shows that we achieve better overall performance of the network by using these two concepts in our hybrid protocol and can be used to attain delay-intolerant applications.

Keywords- Hybrid protocol, leade, pre-chain PEGASIS, multi-chain.

I. INTRODUCTION

The exposure of micro sensor nodes in a consequence of the recent advancement in Micro Electro-Mechanical Systems (MEMS) has introduced the wireless sensor networks. It comprises of thousands of tiny sensor nodes which are deployed densly and randomly to an area of interest and make network topology in order to attain a goal. In general, WSN [1] has predominantly two types of nodes i.e. sink and sensor nodes. Sink is also known as base station. It is the node where data are gathered and interpreted. Generally, it is presumed that sink node has adequate amount of energy which cannot be depleted throughout the network operation. Every sensor node performs sensing, processing and communication in order to attain its task. Wireless sensor networks have various applications in different areas like battlefield surveillance, tracking vehicles etc. In general, routing in wireless sensor networks fall into various groups such as flat based, hierarchical based, location based and QoS based. The main motive behind routing and data collection is to combine the data attaining from the different sources along the way which provide us the facility to minimize the number of transmissions and in turn, be parsimonious with energy consumption. But, hierarchical based routing is the best match for efficient communication and network scalability. LEACH, PEGASIS, DERP and HEED are typical hierarchical based protocols. In WSN, energy expenditure of a sensor node is due to either "serviceable" or "unserviceable" operations. The serviceable operations include receiving or transmitting data messages and handling requests. The unserviceable expenditure is due to the process of improvisation routing path, overhearing, retransmitting because of coarse environment, idle listening and dealing with redundant broadcast overhead messages. In PEGASIS [2], energy is being saved by improving the cluster configuration and the data delivery method. In comparison with LEACH protocol, it forms the chain instead of cluster formation. Every node communicates with its nearest neighbor node. The head node is chosen by turns and sends the fused data to the sink. Greedy algorithm is being implemented for the sake of chain formation as shown in Figure 1.

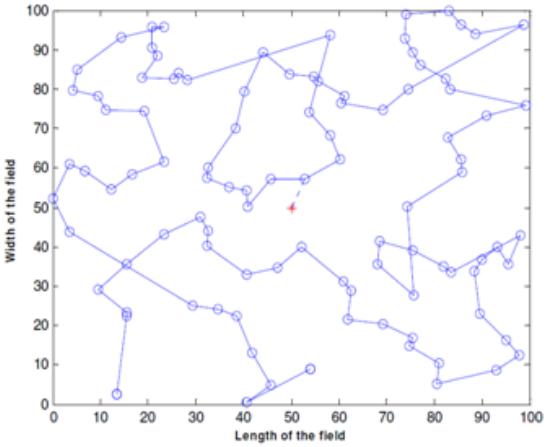

Figure 1. Illustration of Greedy Algorithm

But, the PEGASIS protocol may have few limitations as follows:

- There is no consideration about the energy of nodes and the location of sink during selection of head node.
- Bottleneck may occur due to single head node.
- Some delay may occur during chain formation due to implementation of greedy algorithm [2-3].

These limitations may cause the redundant transmission along the reverse flow from the sink when sensor nodes collect the data and deliver them to the head node in the chain as shown in Figure 2.

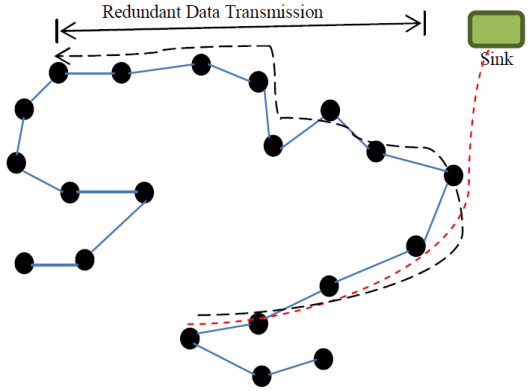

Figure 2: Redundant data transmission

In the Figure 2, node H is considered as head node which will pass the token to all sensor nodes in order to collect sensing data. Each node located in the chain aggregates the data and sends it to its neighbor node. Node C does the same and delivers the data along the chain from own to node H. however, the optimized path for the data transmission from C to the sink is pass through node M. Hence, it is required to modify the greedy algorithm in order to reduce the redundant data transmission and to minimize the data delivery delay. The remainder of the paper is organized as follows. Section II comprises of the related works about various routing protocols. Section III overviews the first order radio model. Section IV describes the proposed hybrid protocol. Section V shows the
simulation results which is followed by section VI i.e. conclusion.

II. RELATED WORK

There has been various data gathering routing protocols propounded to overwhelm the unbalanced energy consumption due to direct transmission. Hierarchical protocols [4] such as LEACH, PEGASIS, DERP, CCS [4] and MIEEPB can attain satisfactory solutions. In LEACH [5], for the whole network, nodes selected according to a design parameter P (fraction) from all nodes are preferred to serve as cluster heads. LEACH performs its operation in several rounds. Every round comprises of a set-up phase and a steady-state phase.

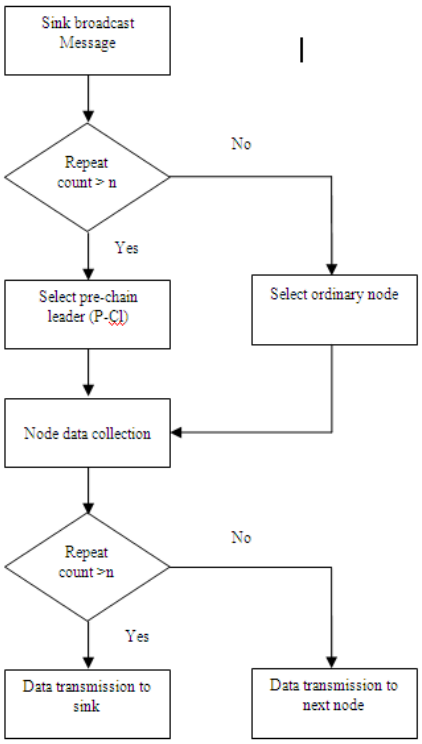

Figure 3: DERP flowchart

In set-up phase, cluster heads are chosen according to predefined criterion. Note that LEACH adopts randomization to rotate cluster heads for every round in order to uniformly distribute the energy expenditure. Consequently, other Non-Cluster Head (Non-CH) nodes select their own cluster head and form clusters. Cluster formation Hence, each node chooses the nearest CH. In steady-state phase, cluster heads fuse the information received from their members and transmit the fused information to sink by single hop communication. LEACH adopts randomization to rotate cluster heads for every round in order to uniformly distribute the energy expenditure. In DERP [6], the greedy algorithm is being improved by considering the distance between the head node to sink node. It appoints a pre-head node in order to balance the energy load among all sensor nodes. Apart from this, DERP extends to a multi-hop clustering protocol [7-10] by using relay node depends on the distance between the pre-head node [11] and Sink. The DERP flow chart is shown in Figure 3

to attain proficient energy utilization of sensor nodes. An algorithm is being proposed for trajectory of movable sink [13] where the sink moves along its trajectory and in order to achieve complete data gathering, the mobile sink stays at sojourn location for a sojourn time. As a result, it gives better performance in comparison to IEEPB [14] in terms of network lifetime.

III. RADIO MODEL

In our work, we assume a simple first order radio model where the considered radio characteristics are as follows:
Energy Dissipation at

Transmitter*(E_{TX}):*50 nJ/bit
Receiver *(E_{RX}):* 50 nJ/bit
Amplifier *(E_{amp}):* 100 pJ/bit/m^2
Let (E_{TX}=E_{RX}=E)
Energy loss due to channel transmission: l^2
If we transmit n-bit message a distance 1 using this model, it gives:
To transmit,

$E_{TX}(N,l) = E_{TX}(N) + E_{amp})(N,l)$
$E_{TX}(N,l) = E * N + E_{amp} * N*l^2$

To Receive

$E_{RX}(N) = E * T$

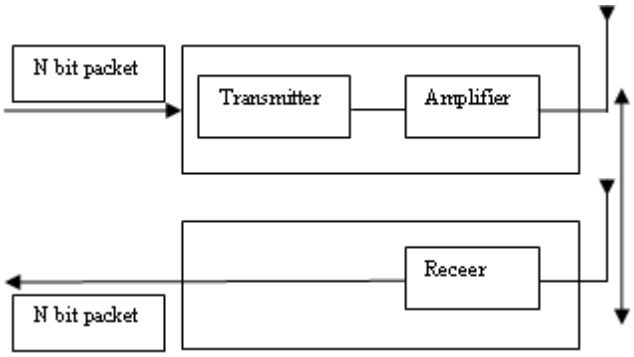

Figure 4: Block Diagram

IV. PROPOSED PROTOCOL

We propose a Multi-chain based Hybrid Routing Protocol (MHRP) which adopts both multi-chain and P-CL selection concept. It is an improved version of PEGASIS which is highly efficient in order to reduce energy expenditure and also solely responsible for WSN node lifetime enhancement.

A. Chain Formation in proposed protocol

The entire monitoring area is divided into four consecutive regions on the basis of its coordinates. Each region contains equal number of nodes which form a separate chain. Since, we are considering 100 nodes in the entire area, each region contain 25-25 nodes. Chain formation occurs in the same way as of PEGASIS. It uses greedy algorithm to form the chain. In process to form a chain, each node can communicate (transmission & reception) only with the closest neighbor. Each node will take data fusion in order and ultimately a designated node (Cluster head) sends the data to the base station. Each Node take turn transmitting to the base station so that the average energy consumed by each node per round is reduced. The same process of chain construction is applied in all four regions as shown in Figure 5

B. P-CL Selection and Data transmission **It mainly considers**

The distance between chain leader and sink. After the chain formation, sink broadcasts a message. The node which responds first is then selected as the P-CL node. Whenever any event occurs, the data is transmitted. The data is delivered from the source node to the sink via PCL. When the data reached to the P-CL node, which is present in data delivery path, the transmission of data stopped. The received

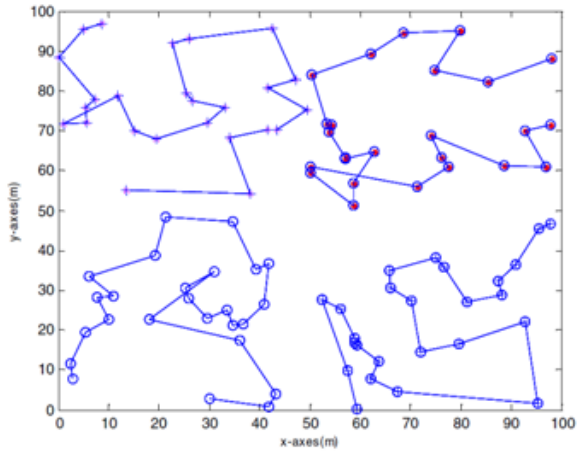

Figure 5: Multi-chain formation using greedy algorithm

data on the P-CL node is then forwarded to the sink. The selection of the new P-CL node depends on the energy content of that particular node. Therefore, P-CL concept is adopted to evenly distribute energy among the sensor nodes. The key idea of this MHRP protocol is to imbibe the properties of multi-chain formation as well as P-CL selection concept in order to enhance the efficiency of WSN in terms of lifetime and delay.

V. SIMULATION RESULTS

We have performed simulation in order to evaluate the proposed algorithm. We used MatLab as simulator to evaluate the performance of PEGASIS and MHRP using several random 100-node networks. The sink is located at (50,300) in a 100m X 100m field. The Simulation focuses on energy efficiency and number of sensor nodes alive which are important indicators to measure performance of different protocols.

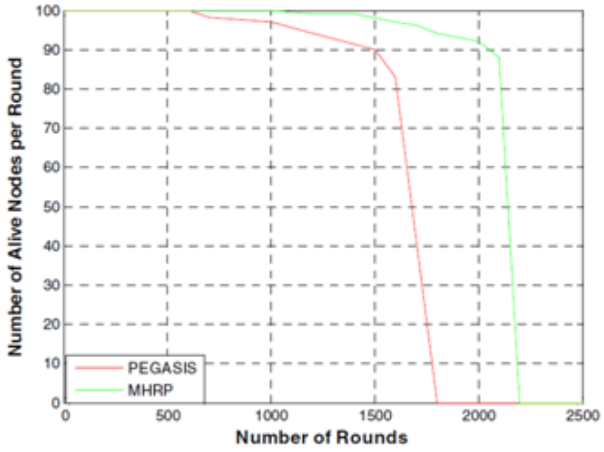

Figure 6: Number of nodes alive over time

Figure 6 shows the total number of nodes alive vary with the change of rounds, it can be seen that the number of nodes alive in MHRP is larger than the one in PEGASIS after each round ends, which demonstrates MHRP makes the energy consumption more balanced and the energy use more efficient. MHRP effectively prolong the network lifetime compared with PEGASIS.

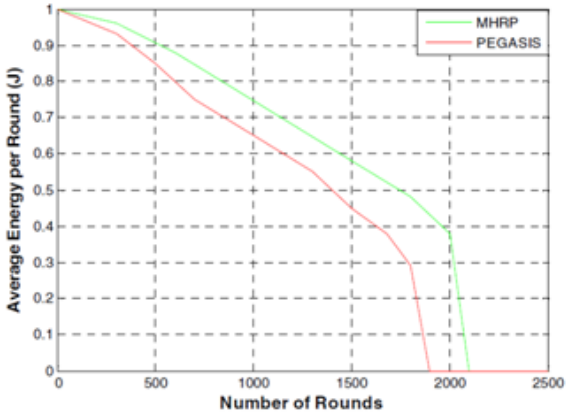

Figure 7: The average energy per round over time

As shown in Figure 7, the average remaining energy of all nodes per round in MHRP is higher than PEGASIS and the advantage is more obvious as the rounds increase. This proves that the energy efficiency of MHRP is better than PEGASIS.

VI. CONCLUSION

This paper proposes a Multi-chain based Hybrid Routing Protocol in order to improve the deficiencies of PEGASIS. Using this hybrid protocol, we can balance the data flow to the wireless sensor networks. Hence, it provides a way to avoid the redundant data transmission and save the energy about 30% in compare with the PEGASIS protocol. In the future, we wish to use mobile sink in the network and improved routing path in order to prolong the network life expectancy.

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