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An Improved PEGASIS Protocol to Enhance Energy Utilization in Wireless Sensor Network

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Abstract— **Wireless sensor network is an ad hoc network. Each sensor is defined with limited energy. Wireless sensor node deployed into the network to monitor the physical or environmental condition such as temperature, sound, vibration at different location. Each node collected the information than transmit to the base station. The data is transfer over the network each sensor consume some energy in receiving data, sending data. The lifetime of the network depend how much energy spent in each transmission. The protocol play important roll, which can minimize the delay while offering high energy efficiency and long span of network lifetime. One of such protocol is PEGASIS, it is based on the chain structure, every chain have only one cluster head, it is in charge with every note's receiving and sending messages who belong to this chain, the cluster head consumes large energy and the times of every round increasing. In PEGASIS, it take the advantage of sending data to it the closet neighbor, it save the battery for WSN and increase the lifetime of the network. The proposed work is about to select the next neighboring node reliably. For this it will combine few parameters such as Distance, Residual Energy and Response time. The proposed system will increase the overall communication and increase the network life.**

Keywords— **WSN, energy, node.**

I. INTRODUCTION

Wireless Sensor Networks [1], with the characteristics of low energy consumption, low cost, distributed and self organization, have brought a revolution to the information perception [2]. The wireless sensor network is composed of hundreds of thousands of the sensor nodes that can sense conditions of surrounding environment such as illumination, humidity, and temperature. Each sensor node collects data such as illumination, humidity, and temperature of the area. Each sensor node is deployed and transmits data to base station (BS). The wireless sensor network can be applied to variable fields. For example, the wireless sensor network can be used to monitor at the hostile environments for the use of military applications, to detect forest fires for prevention of disasters, or to study the phenomenon of the typhoon for a variety of academic purposes. These sensor nodes can self-organize to form a network and can communicate with each other using their wireless interfaces. Energy efficient self-organization and initialization protocols are developed in [3], [4]. Each node has transmit power control and an omni-directional antenna, and therefore can adjust the area of coverage with its wireless transmission. Typically, sensor nodes collect audio, seismic, and other types of data and collaborate to perform a high-level task in a sensor web. For example, a sensor network can be used for detecting the presence of potential threats in a military conflict. Most of battery energy is consumed by receiving and transmitting data. If all sensor nodes transmit data directly to the BS, the furthest node from BS will die early. On the other hand, among sensor nodes transmitting data through multiple hops, node closest to the BS tends to die early, leaving some network areas completely unmonitored and causing network partition. In order to maximize the lifetime of WSN, it is necessary for communication protocols to prolong sensor nodes' lifetime by minimizing transmission energy consumption, sending data via paths that can avoid sensor nodes with low energy and minimizing the total transmission power.

II. ARCHITURE OF WIRELESS SENSOR NETWORK

Figure.1 shows a typical schematic of a wireless sensor network (WSN). After the initial deployment (typically ad hoc), sensor nodes are responsible for self-organizing an appropriate network infrastructure, often with multi-hop connections between sensor nodes [5]. The onboard sensors then start collecting acoustic, seismic, infrared or magnetic information about the environment, using either continuous or event driven working modes. Location and positioning information can also be obtained through the global positioning system (GPS) or local positioning algorithms. This information can be gathered from across the network and appropriately processed to construct a global view of the monitoring phenomena or objects.

In general, the wireless sensor networks are deployed for monitoring at a large area so the wireless sensor networks need many sensor nodes. If the sensor node consumes completely energy, it is wasted. We do not consider to recharge and to reuse sensor node. Because of these reasons, the value of the sensor nodes must be inexpensive to practical use. Deployed in harsh and complicated environments, the sensor nodes are difficult to recharge or replace once their energy is drained.

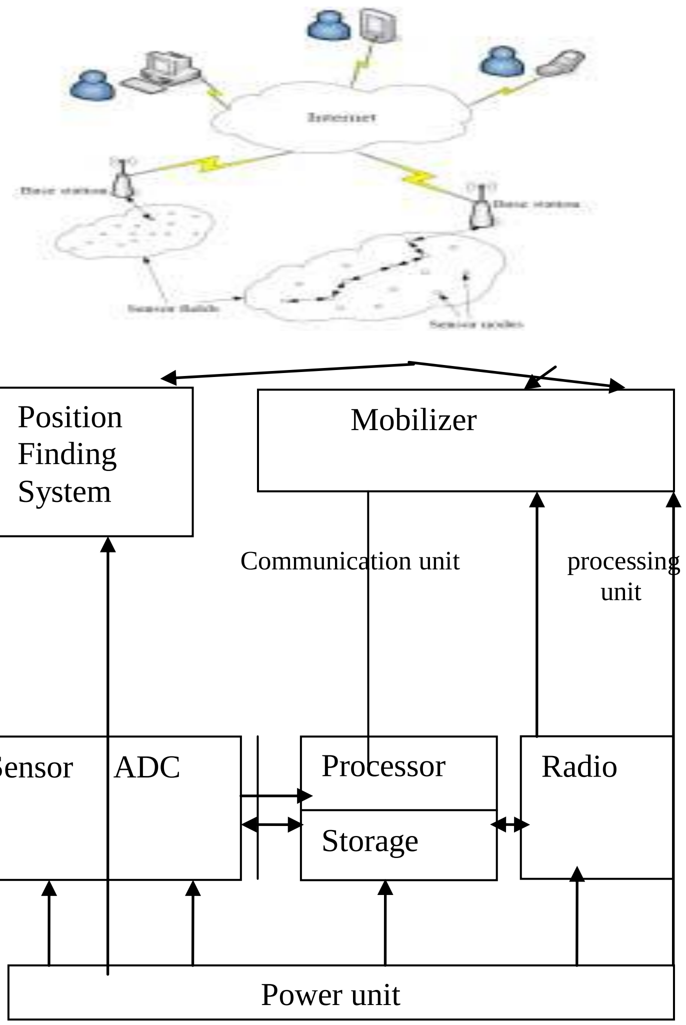

Fig. 1 Schematic of a Wireless Sensor Network Architecture

Mean while the sensor nodes have limited communication capacity and computing power. So how to optimize the communication path, 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. Hierarchical-based routing protocols [6] are widely used for their high energy-efficiency and good expandability. The basic idea of them is to select some nodes in charge of a certain region routing. These selected nodes have greater responsibility relative to other nodes which leads to the incompletely equal relationship between sensor nodes. LEACH (Low Energy Adaptive Clustering Hierarchy) [7], PEGASIS (Power-Efficient Gathering in Sensor Information System) [8] are the typical hierarchical-based routing protocols. As an enhancement algorithm of LEACH, PEGASIS is a classical chain-based routing protocol. It saves significant energy compared with the LEACH protocol by improving the cluster configuration and the delivery method of sensing data.

III. POWER CONSUMPTION MODEL FOR WSN

In order to understand the necessity of routing protocols and their benefits we briefly describe the power consumption model for WSN devices. The communications channel can be modeled by using the long distance path loss model [9] and ignoring more complex effects such as fading and multi-path. Thus, the power required by a node to transmit over a distance of d meters can be expressed as:

$$PT(d) = P0 \times (d0 / d)\alpha \qquad (1)$$

Where P0 represents the power of the signal received at distance d0 from the source and α is the path loss exponent which is dependent on the propagation environment and can take values between 2 and 5. Also, using the path loss model and the Friis model the power received at distance d from the node can be expressed as:

$$PR(d) = Ptx / (\beta \times d\alpha) \qquad (2)$$

where Ptx is the RF power delivered to the antenna of the transmitting node and β is parameter specific to the characteristics of the transmitting and receiving antennas. Therefore we can determine that the power required to make a single hop transmission between two nodes is equal to PT + PR. The power required to make a multi hop transmission between n nodes is (n-1) × (PT + PR).

IV. THE DETAILS OF IMPROVED PEGASIS PROTOCOL

It is possible that some nodes may have relatively distant neighbor 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.

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.

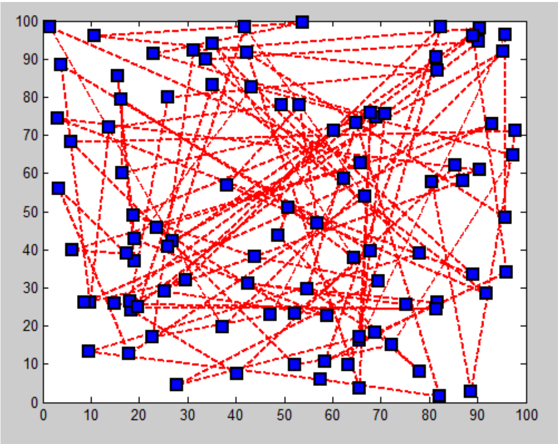

Fig.1The chain formed in exiting pegasis Protocol

In figure.1 is showing the aggregative path identified by the PEGASIS protocol based on distance and energy comparison. The communication is performed between the sender node 1 and receiver node 10.

The identified path is

47 39 99 96 7 55 36 22 45 35 69 56 44 75 97 86 31 48 80 98 71 76 83 33
63 95 94 42 17 19 89 57 74 29 88 78 50 3 40 14 21 11 73 100 59 4 43 16
20 34 18 41 91 46 67 60 38 62 93 13 28 65 15 27 9 26 30 85 2 66 81 49
87 70 51 1 82 79 54 5 32 25 12 10 24 84 58 37 64 23 8 90 72 6 92 53 52
61 68 77

Here Node 47 is the initial node and node 77 is the terminal node.

The total distance covered by the path is 6.3391e+006.

The total Energy Consumed by the path is 523.8336.

TABLE I. SYSTEM PARAMETERS VALUE

Parameter	Value
Number of Nodes	100
Probabilityof Selection	.1
Energy	0.5
Transmission Energy	50*0.000000001
Receiving Energy	50*0.000000001
Forwarding Energy	10*0.000000001
Topology	Random

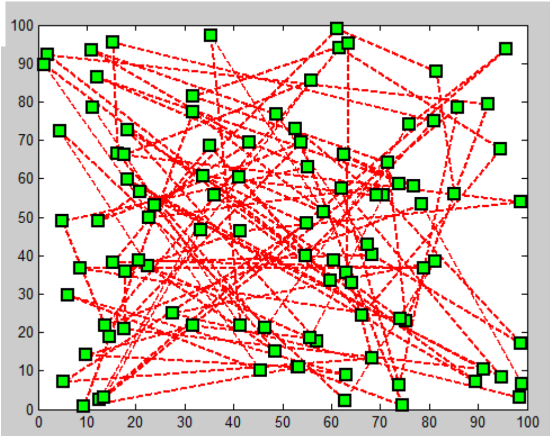

Fig.2 The chain formed in proposed pegasis protocol.

The figure.2 is showing the aggregative path identified by the PEGASIS protocol based on distance and energy comparision. The communication is performed between the sender node 1 and receiver node 10. The identified path is

70 11 65 58 37 77 54 8 12 39 68 16 80 20 23 98 18 74 48 19 14 46 34 56
31 100 45 22 6 97 53 72 42 29 76 7 64 94 89 61 24 41 50 83 67 63 51 3 25
73 27 99 28 55 75 21 32 10 4 33 47 81 60 13 38 93 35 5 26 91 62 88 84 95
92 69 79 9 90 59 49 44 86 30 66 87 96 36 43 52 82 85 15 1 71 57 17 40 78
2

Here Node 70 is the initial node and node 2 is the terminal node.

The total distance covered by the path is 8.7890e+006.

The total Energy Cons umed by the path is 508.8014.

TABLE 2. SYSTEM PARAMETERS VALUE

Parameter	Value
Number of Nodes	100
Probability of Selection	.1
Energy	0.5
Transmission Energy	50*0.000000001
Receiving Energy	50*0.000000001
Forwarding Energy	10*0.000000001
Topology	Random

V. SIMULATION RESULTS AND EVALUATION

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 algorithms.

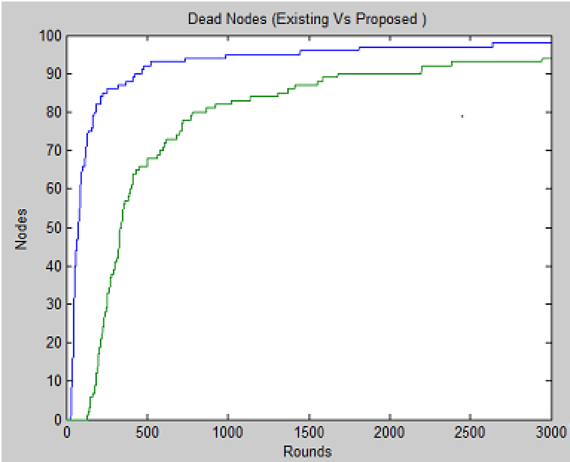

Fig. 3 Comparative Analysis (Existing Vs. Proposed) Dead Nodes

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.

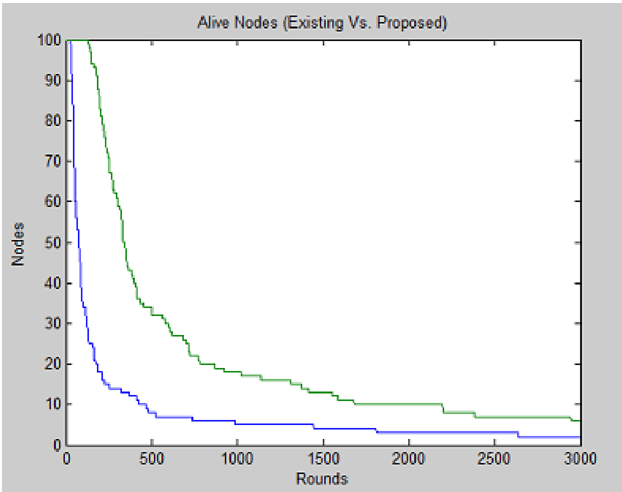

Fig. 4 Comparative Analysis (Existing Vs.Proposed) Alive Nodes

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

VI. CONCLUSION

In this paper, we describe PEGASIS, it is chain based protocol that is near optimal for a data-gathering problem in sensor networks. PEGASIS outperforms LEACH by eliminating the overhead of dynamic cluster formation, minimising the distance non leader-nodes must transmit, limiting the number of transmissions and receives among all nodes, and using only one transmission to the BS per round.The proposed system will improve 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 is to find the next neighbor for communication. Here the improvement is done for existing PEGASIS protocol. In this work we have include one parameter to select the next neighbor. The work is about to identify an energy efficient aggregative path to communicate over the network.

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