An Approach for lifetime improvement in Wireless Sensor Network

Khushboo Manohar[1], A. I. Darvadiya[2]

[1] *Student, Electronics and Communication Engineering, C. U. Shah University, Gujarat, India*
[2] *Asst. prof., Electronics and Communication Engineering, C. U. Shah University, Gujarat, India*

Abstract - *wireless sensor network raise a growing interest among industries and civil organization where monitoring and recognition of physical phenomena are a priority. It consists of a large number of miniature devices called sensor nodes scattered over geographical area called sensor field. These nodes are attempted to collect information or data which is forwarded through gateways called base station. It has emerged as a result of recent advances in low-power digital and analog circuitry, low-power RF design and sensor technology. The communication scenario through sensor nodes leads to some amount of energy wasting. Our framework is to save energy for a long-lived sensor node which is based on clustering architecture and achieves a good performance in terms of throughput by reducing dead node and using residual energy. The approach is evaluated using MATLAB simulator. Simulation results show that it is an energy-efficient approach and able to achieve significant performance improvement as well.*

Key Words: wireless sensor network, Clustering, self-organization

1. INTRODUCTION

Wireless sensor network applications are expected to experience an enormous rise in the next few years, as well as the number and variety of sensors deployed in each WSN. They have wide range of applications. From homes to factories, from military surveillance to disaster prediction, WSN have attracted a lot of attention from researchers in the military, industry and academic fields.

WSN [1] consists of a large number of nodes which communicate over wireless channels and perform distributed sensing and collaborative data processing. By correlating their output, they can provide functionality that can individual node cannot. Sensor nodes are generally equipped with a radio transreceiver, microcontroller, memory unit and set of transducer using which they can obtain and process data from the deployed region. Wireless sensor nodes are normally less mobile and more compactly deployed than mobile ad hoc networks (MANETs), and they must be left unattended. Such as Environments, which makes it difficult or impossible to recharge or replace their batteries. This requires planning innovative energy-efficient solutions to some of the conventional wireless network problems, such as medium access control (MAC), routing, self-organization and bandwidth sharing. Thus, exploiting the tradeoffs among energy, scalability, and latency is crucial for prolong WSN's lifetime [2]. Hierarchical techniques can aid in reducing useful energy consumption [3]. Clustering is particularly useful for applications that require scalability to hundreds or thousands of sensor nodes. Thus, WSN is divided into several clusters, and in each cluster, one specific sensor node is dedicated to be CH which collects and compresses the data sensed by other nodes within that cluster, and then transmits the aggregated data to Base Station (BS). With the extending scalability of WSN, CH is inevitable to use up its energy, leads one dead cluster, and depresses network performance due to its per-hop energy consumption. Ideally, one would like to improve routing performance by reducing such unnecessary hops. Based on these reasons, it is necessary to apply some reasonable routing between CHs and BS in order to reduce average CHs energy consumption, adapt extensible scale and maintain a long lasting network lifetime. The remainder of the paper is organized as follows:

In Section 2, we discuss LEACH protocol and its working. The deficiencies in LEACH, techniques to overcome them and proposed protocol are introduced in Section 3. In Section 4, we provide simulation and analysis of LEACH and proposed LEACH. Finally, the paper is concluded in Section 5.

2. LEACH PROTOCOL

LEACH is a cross layered protocol architecture that combines medium access with routing to collect and deliver data to BS. The main goals of LEACH are: increasing network lifetime, decreasing network energy consumption, reducing number of communication messages by data aggregation. In order to achieve these goals, LEACH uses hierarchical approach and organizes the network into a set of clusters. Each cluster is administered by a selected CH. The CH does the task of creating TDMA-based schedule to assign a time slot to each Cluster Member (CM) for periodic data transmission to CH. CH then aggregates the data to remove redundancy among correlated values. Finally it transmits the aggregated data directly to BS. The function of LEACH is divided into rounds which are further organized in two phases as shown in Figure 1. The setup phase consists of

CH selection and cluster formation followed by steady-state phase in which selected CH does data collection, aggregation, and delivery to BS.

A. Setup Phase

It starts with the self-election of nodes to become CHs. The self-election algorithm ensures that CH role rotates among nodes to distribute energy consumption evenly across all nodes.

• CH selection and rotation algorithm

The CH selection algorithm is simple and lightweight using random choice for CH selection. This reduces the overhead for determining optimal CH. To decide if it is its turn to become a CH, a node, n, generates a random number, between 0 and 1. It then compares it with CH selection threshold, T(n) which is designed to ensure with high probability that a pre-determined fraction of nodes, P, is elected as CH for each round. Threshold also ensures that nodes which served in past 1/P rounds are not selected as CH. in the current round. To meet up these necessities, the threshold of a contending node n is articulated as follows:

$$T(n) = \begin{cases} \dfrac{P}{1 - P * (r \bmod \frac{1}{P})} & if\ n \in G \\ 0 & otherwise \end{cases} \quad \ldots\ldots\ldots\ldots (1)$$

Where P is desired percentage of nodes which are CH, r is current round, G is set of node that has not been CH in past 1/P rounds. The nodes for which random number is less than T(n), will become CH.

• Cluster Formation Algorithm

Every node that has opted to become a CH broadcasts its new role to the network using a non-persistent CSMA MAC protocol. On receiving the CH broadcasts, each non cluster head node decides a cluster to join. The decision may be based on received signal strength of CH broadcast message, among other factors. The non-cluster node, then inform selected CH their wish to become member of cluster. Once the cluster is formed, CH creates and distributes a TDMA based schedule to assign a time slot to each of its cluster member. To reduce inter cluster interference each CH selects a CDMA code, which is then distributed to all cluster member. The completion of setup phase triggers beginning of the steady-state phase.

B. Steady State Phase

During this phase, NCH nodes periodically collect sensor data and transmit it to CH in their allocated slots. The entire steady-state operation is broken into frames which are further broken into slots of constant duration. NCH nodes send collected sensor data to their respective CH at most once per frame during their allocated transmission slot and enter the sleep mode otherwise. Data transmissions are scheduled to avoid collisions and increase sleep time of each NCH node. With slots of constant duration, time to send a frame of data depends on the number of nodes in the cluster.

The major deficiency of LEACH is that it uses probabilistic approach to select a cluster head which only takes care that nodes that have not already been cluster head till recent round r, may become cluster-head in round r+1. The cluster-head selection algorithm does not consider node's residual energy and location with respect to BS. This kind of cluster head selection technique is not competent enough to ensure proper cluster-head selection and it is quite possible that nodes located at long distances from base station and the ones having less residual energy may be selected as cluster-heads. For efficient cluster-head selection, mechanisms that consider the node's distance from base station and its residual energy are required.

3. PROPOSED WORK

The lifetime of the wireless sensor network can be defined in many ways. i.e. may be in terms of until last node die, or the first node die, or a particular percentage of nodes die. The main unit in the wireless sensor network is the power unit that provides power to the other units which is limited by a battery. Since the battery limits the amount of energy available to the node, this affects the lifetime of the node, thus in the end it also affects the lifetime of the sensor network. So our main aim is to conserve the energy by any mean and enhance the lifetime of the wireless sensor network. So our modified protocol will enhance the network lifetime in the terms of alive nodes in the network. In the modified LEACH where the cluster head is chosen on the basis of the maximum residual energy and the minimum distance from the nodes.

Algorithm for proposed work

a. Firstly create a random sensor network.
b. Now in the first round the cluster head selection procedure is same as in the basic LEACH, in which a node choose a random number between the 0 and 1. If this random number is less than a threshold value, T(n), the node becomes a cluster head for the current round otherwise it join the cluster head. The threshold value is calculated using eq. 1.
c. Calculate the distance between the cluster head and the sensor node, which have the shortest distance that node join that cluster.
d. Now CH receives data from Non-CH nodes and aggregates them. And send to the BS. If the distance between the CH and the BS is more than here we used multi-hopping concept, according to this if the distance between the CH and the BS is more than one CH send data to the other CH which is closer to the BS.
e. Now energy dissipated is calculated and subtracted from the remaining energy of every node and if some nodes are having energy less than minimum than those nodes are deleted from the network and the life time close and we get the output. Hence this round will be completed.
f. After that by considering the mode of communication i.e. intra cluster communication

and inter cluster communication, we can save the energy of the node.

g. Now after simulation we would got the desired result.

When a sensor node becomes cluster head, it will radiates or use high power during amplification. Whereas, when a sensor node acts as a cluster member, it will radiates or use low power during amplification.

4. SIMULATION RESULT

All the simulations were carried out using MATLAB simulator. This experiment is performed in MATLAB simulator. MATLAB software is used to simulate different routing protocols. MATLAB (matrix laboratory) is a numerical computing environment and it developed by MathWorks and also it is fourth-generation programming language. In this section, we have evaluated the performance of our proposed scheme. The necessary parameters and their values are listed.

Table -1: Simulation parameters

Description	*Symbol*	*Value*
Number of nodes	n	100
Initial energy	Eo	0.5 J
Energy used up by the amplifier to transmit at short distance	Efs	10pJ/bit/m^2
Energy used up by the amplifier to transmit at longer distance	Emp	0.0013 pJ/bit/m^2
Energy used up in the electronics circuit to transmit or receive the signal	Etx/Erx	50pJ/bit
Data Packet	K	4000 bits
Data aggregation energy	Eda	5pJ/bit/report
Cluster probability	P	0.2
Area	Xm*Ym	100m*100m
Control packet	Lctrl	200 bits

A hundred sensor nodes are organized randomly in the field of 100m×100m sq. meters. The Base Station (BS) is situated at (50,50)m. and number of round is 4000. Figure 1 gives the result for alive node. Figure 2 provides the residual energy for each node, and figure 3 provides the increased network lifetime against the basic LEACH.

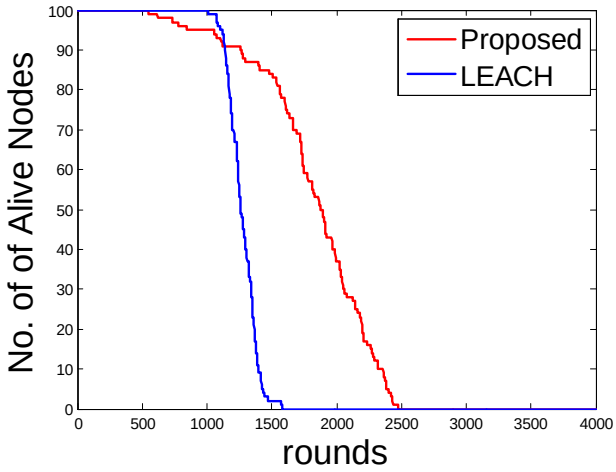

Fig.1: no. of alive node

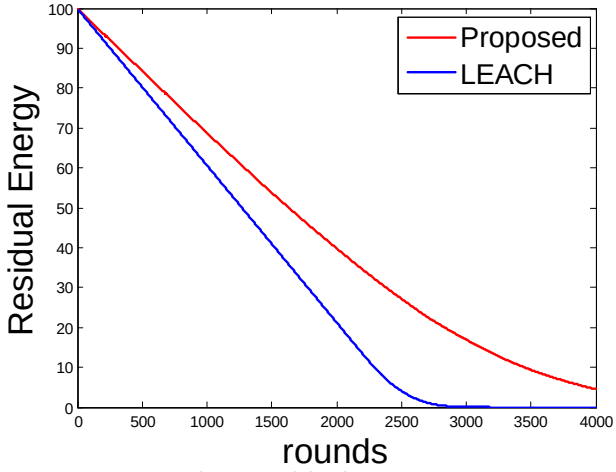

Fig.2: Residual energy

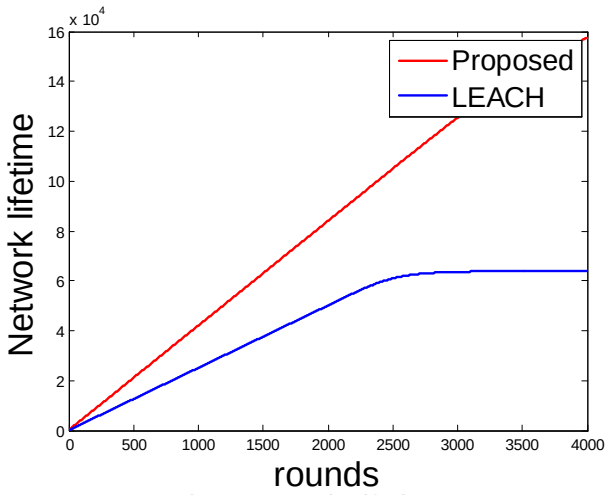

Fig.3: Network Lifetime

5. CONCLUSIONS

When designing a protocol architectures for WSN, it is important to consider the simple energy constraints of the nodes, data aggregation, ease of deployment, self-configuration of nodes and constraints of wireless channel. From the simulations results we had concluded that the proposed clustering approach is more energy efficient and hence there is enhancement in the sensor network lifetime as there are more alive nodes in the network if we compare the results of basic LEACH and proposed LEACH. In the existing system data transmission depends on current energy of nodes and distance between nodes whereas the modified-LEACH algorithm works on the additional parameter i.e. minimum distance, maximum residual energy of node and minimum energy transmission. In future it can be again modified by using some other parameters for selecting a cluster-head to enhance wireless sensor network.

REFERENCES

[1] Wendi Rabiner Heinzelman, Anantha Chandrakasan, and Hari Balakrishnan,"EnergyEfficient Communication Protocol for Wireless microsensor network", Proceedings of 33rd Hawaii International Conference on the system science-2000.

[2] D. Estrin, L. Girod, G. Pottie, and M. Srivastava, "Instrumenting the World with Wireless Sensor Networks," in International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2001), Salt Lake City, Utah, May 2001. [Online]. Available: http://citeseer.nj.nec.com/estrin01instrumenting.html.

[3] Wendi B. Heinzelmaan, Anantha P. Chandrakasan, Hari Balakrishnan,"An Application Specific Prptocol Architecture for Wireless microsensor Network", IEEE transactions on wireless communications, vol. 1, no. 4, october 2002.

[4] Kemal Akkaya , Mohamed Younis ,"A survey on routing protocols for wireless sensor", networks Ad Hoc Networks 3 (2005),pp 325–349.

[5] AnkitJoshi,LakshmiPriya.M. "A Survey of Hierarchical Routing Protocols in Wireless Sensor Network", In Second International Conference on Information Systems and Technology, pp. 67.

[6] Qian Liao, Hao Zhu, "An Energy Balanced Clustering Algorithm Based on LEACH Protocol" Proceedings of the 2nd International Conference On Systems Engineering and Modeling (ICSEM-13)

[7] Xiaobing Wu and Guihai Chen," Dual-Sink: Using Mobile and Static Sinks for Lifetime Improvement in Wireless Sensor Networks", IEEE, 1-4244-1251-X/07,2007.

[8] C. Divya, N. Krishnan & A. Petchiammal," Increase the Alive Nodes based on the Cluster Head Selection Algorithm for Heterogeneous Wireless Sensor Networks", Global Journal of Computer Science and Technology Network Web & Security Volume 13, Issue 9 Version 1.0 Year 2013.

BIOGRAPHIES

Khushboo Manohar is student of M.Tech in Electronics and Communication department at C. U. Shah University, Wadhwan City, Gujarat, India. She has done B.Tech from MGITER, Surat, Gujarat, India.

A. I. Darvadiya is an Assistant Professor, Electronics and Communication department at C. U. Shah University, Wadhwan City, Gujarat, India.

