

ENERGY OPTIMIZATION OF CLUSTER BASED ROUTING PROTOCOL IN WSN

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Abstract : WSN (wireless sensor network) is a combination of huge number of sensor nodes that are operating at low power. These nodes sense the data and transmit to the base station through other nodes. The clustering protocol is necessary to handle the processing power and energy that are limited. The cluster based sensor networks plays a prominent role in decreasing delay and reducing consumption of energy. One such clustering protocol is LEACH that operates in micro sensor networks. LEACH attains creation of cluster and cluster head (CH), number of dead nodes, energy of the nodes in the respective rounds. The simulation is carried out in MATLAB with random distribution of 100 nodes in network of size 100m*100m. The objective of this paper is to overcome the demerits of conventional routing protocol in lights of energy wastage and dead nodes by using LEACH algorithm.

Index Terms - WSN , sensor nodes, LEACH, steady phase, setup phase, cluster, CH, dead nodes, energy model.

I. INTRODUCTION

Wireless Sensor Networks is an abbreviation of comprises of WSN . It comprises of numerous number of sensor nodes. The classical configuration of such a sensor node in a wireless network is incorporated with single or multiple sensing elements, a data processor, communicating components and a power source. Typically, the detecting or sensing components perform estimations identified with the conditions existing at its surrounding environment .The measure signals or data are converted into equivalent electric signals and are handled by the data processor[1]. A sensor node utilizes its communicating components in order to transmit the data to the base station.

By utilizing such a configuration, sensor nodes in such WSNs have resource constraints like limited energy, low storage capacity, and less power. Furthermore, due to unsafe working environment, power resources importantly the energy or power of sensor nodes, would not be sub planted or recharged. Thus, an energetic and efficient wireless protocol is required to prolong the network life time. In this paper, we propose an energy-optimizing routing protocol which based on clustering technique. The technique having two considerations: first consideration it boost the lifetime of the network. Second consideration is it increases the number of data message received by the sink node. Instead of enforcing transmission energy constraints on every individual node, the total energy consumption of the network should be considered [4]. The cluster coordinator called as cluster head node which collects the data from its own cluster neighboring nodes, then its aggregates all the collected data and sends those data to the base station. This article formulates a new technique to select the optimal nodes as cluster heads and change the round time in every round.

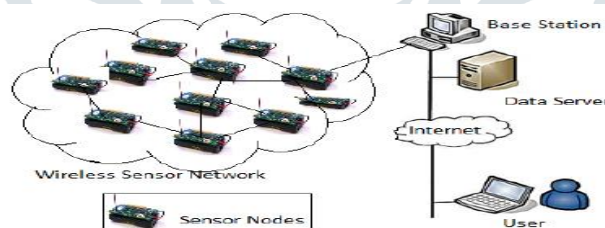


Figure 1: Architecture of Wireless Sensor Network

The infrastructure of the wireless sensor network is shown in figure 1. The Different utilizations of Wireless Sensor Networks incorporate Home Applications, Civil Applications, Ecological Applications, Industrial Applications, and Military Applications.

Problem statement

The basic function of the sensor based network is to forward or transmit the data packets to the destination without losing the data without any losses .The destination or the end system is a base station is located at remote environment .In the matter of energy constraint in sensor based network, the routing protocol is then used to tract and recognize the way to the end station. Once the path is established then it enables the transmitter and receiver to exchange the data packets. Where the sensed data is only available to particular segments that are unable to forward it to the desired destination due to energy constraint or depletion in the sensor nodes in those segments.

II. LITERATURE REVIEW

A popular protocol known as LEACH is discussed for WSN. The mechanism of broadcasting on the basis of cluster is incorporated in LEACH protocol. The author proposed LEACH-sub-CH protocol. In this paper, a comparison is made between the former LEACH and proposed one. It is inferred that the length of message transmitted by the sub-CH-LEACH protocol is less than the message length produced by the former LEACH[1].

The author analyzed the CH at various percentages. The energy consumed, throughput and dead nodes count are simulated at different percentages of probability of CH[2]. The modeling of clusters depending upon sensor node distribution and base station position. If base station is positioned far away from the sensor, then there is increase in the number of clusters to be formed[3]. A comparative analysis is conducted for the cluster based routing protocols, viz., LEACH, TEEN and SEP for WSN comprising of nodes, where each node in the sensor network possess unique energy in the unit of Joules. These methods are simulated using a tool MATLAB[4].

The network comprises of 100 sensor nodes. Generally, the 5 % of 100 nodes are taken as CH[5]. In this proposed scenario, a new routing protocol known as N-LEACH, which is an improvement over the former LEACH. In this case, the 4 % of the 100 nodes are taken as CH[6]. It leads to the minimization of number of clusters in the network by 1 %, thereby decreasing the consumption of energy and increasing the lifetime of the network[7]. This scenario is simulated in NS-2 tool.

III. METHODOLOGY

LEACH Protocol

LEACH was proposed by Heinzelman, Chandrakasan and Balakrishnan[6]. It is cluster based hierarchical routing protocol for WSN. This protocol segments available node in the network into bunches called clusters. LEACH randomly selects the CH and performs periodical reselection. Cluster Head (CH) is authoritative for designing and controlling a TDMA (Time division multiple access) schedule and sending cumulative information from nodes to the BS. The rest of the node in the network is stated as CM. The operation is divided into two phases: Set-up and Steady. Cluster head, it promotes his selection to every single node in the cluster. All the nodes in the network select nearest CH when they receive advertisement based on signal strength. Once the CH and CM are formed as a cluster the CH will assigned TDMA slots to each of his CM in the network.

Phases of LEACH

LEACH operation is divided into two rounds, Setup and Steady phase

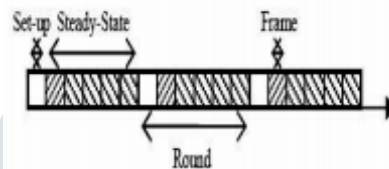


Figure 2: LEACH protocol phases

Set-up phase

The initial step is to selection of cluster head (CH). At the first of each round, every node chooses a random number somewhere in the range of 0s and 1 and analyzes it to the threshold as shown in the equation[9,10]. The Threshold $T(n)$ is calculated as:

$$T(n) = \begin{cases} \frac{P}{1 - P(r \cdot \text{mod}(1/P))} & ; n \in G \\ 0 & ; \text{else} \end{cases}$$

Where,

P = The probability to become cluster head.

r = The current round.

n = Node.

G = Node become cluster head at $1/P$ rounds.

Here P is the ideal level of the nodes which are CH, current round is denoted as r , and G is the set of nodes that has not been selected as cluster-heads in the past $1/P$ rounds. This equation proves that all sensor nodes derive equal energy for operation. After determination of cluster head, it promotes his selection to every single node in the cluster. All the nodes in the network select nearest CH when they receive advertisement based on signal strength. Once the CH and CM are formed as a cluster the CH will assigned TDMA slots to each of his CM in the network.

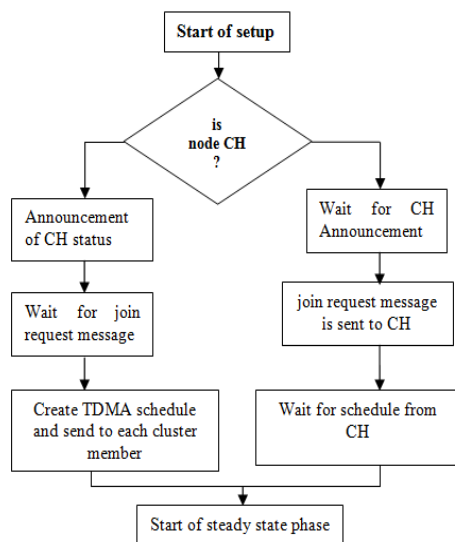


Figure 3: Flowchart

Steady Phase

The data transmission step is called as Steady Phase. During Steady Phase, the each node in the cluster sends their data to their nearest cluster head (CH) based on allocated TDMA slots. The entire CM in the network will be on sleep mode other than CH to save the certain amount of power. Once the CH receives all the data from their CH it then aggregates all the data and transfers it to the base station.

Energy dissipation model

The radio hardware energy dissipation is having two models: free space and multipath fading where the transmitter dissipates power or energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio hardware. Both the FS(free space) and the MPR(multipath routing channel concept are implemented in this paper, it's depends on the distance between TX and RX . The free space model is come in to the picture when the distance is less than d_0 ; otherwise the multipath model is implemented. Thus, to transmit a k bit message a distance d, the radio expends [3].

$$E_{TX}(k, d) = \begin{cases} K \times E_{elec} + K \times E_{fs} \times d^2, & \text{if } d \leq d_0 & (1) \\ K \times E_{elec} + K \times E_{mp} \times d^4, & \text{if } d \geq d_0 & (2) \end{cases}$$

Where
$$d_0 = \sqrt{\frac{E_{mp}}{E_{fs}}} \quad (3)$$

E_{elec} is abbreviation for electronics energy, it relies on factor such as binary coding and decoding, amplifying, spreading signals, where as the other signal called amplifier energy signal the value depends on the distance from or to the receiver and bit-error rate.

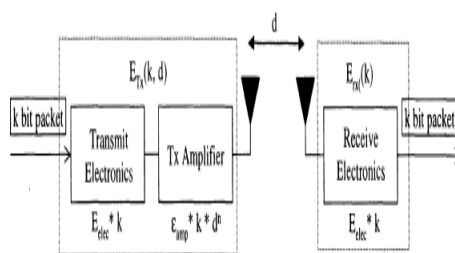


Figure 4: Radio energy dissipation model.

IV. SIMULATION RESULTS

In this part, we evaluated the performance of the algorithm by making the simulation of the source code. Matlab is the tool used to simulate the code.

Simulation setup

The essential simulation parameters of model are referenced in Table I. In the experiment the initial energy of the all nodes are same i.e. 0.5J and the number of nodes are initialized as 100 in the area of 100*100. The fusion coefficient is 0.5. Every node transmits a k bits data packet per round to its cluster head.

Description	Symbol	Value
Number of nodes	N	100
The initial node energy	$E_{initial}$	0.5J
Energy consumed by the amplifier to transmit at a short distance	E_{fs}	10pJ/bit/m ²
Energy consumed by the amplifier to transmit at a longer distance	E_{mp}	0.0013pJ/bit/m ⁴
Energy consumed in the electronics circuit to transmit or receive the signal	E_{elec}	50pJ/bit
Data packet	k	4000 bits
Control packet	L_{ctrl}	100 bits
Data aggregation energy	E_{da}	5pJ/bit/report
The cluster probability of LEACH	p	0.05
The Sensing area	$M \times M$	100m × 100m

Table 1: Transmission parameters values

Simulation analysis

In the field of 100*100 square meters, one hundred sensor nodes are randomly positioned as shown in the figure 5. At the position of (50,120), the sink node is aligned. Until the mobile nodes are set in a fixed position, they remain static.

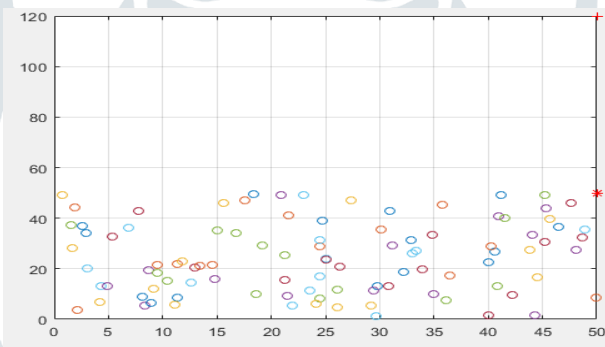


Figure 5: Random positioning of sensor nodes

The analysis of network life cycle for LEACH algorithm is shown in figure 6. The figure 6 shows the demise i.e. death of nodes at 1051th round under the implementation of LEACH algorithm. The first dead node is always a cluster head CH) that loses all its energy and after that all other nodes which lose its energy in respective rounds.

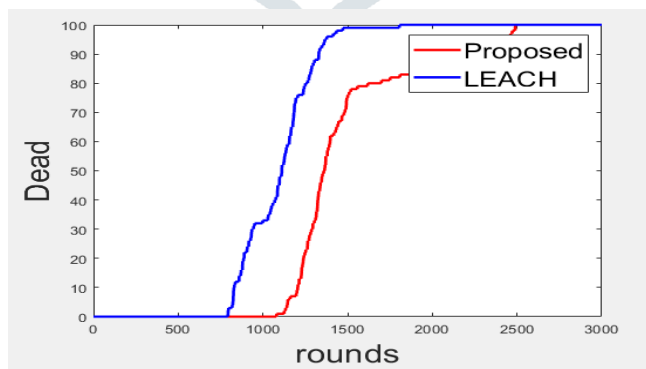


Figure 6: plot of dead nodes

The figure 7 shows the plot of energy of nodes with respect to nodes. The initial energy of the node is assigned as 0.5j and total number of rounds is 3000. The energy of node decreases gradually with increase in number of rounds. The energy of the nodes lost completely i.e. 0j at 2200 odd round in proposed LEACH algorithm.

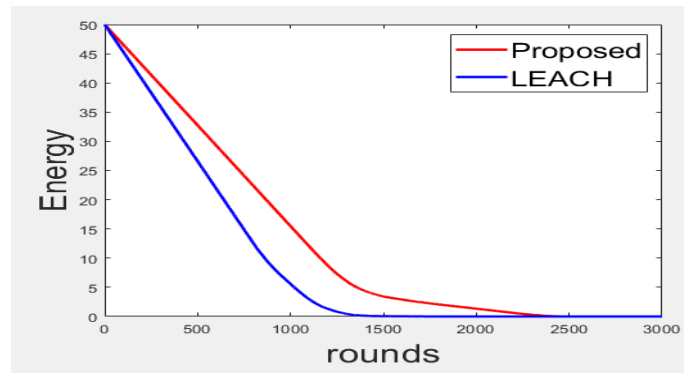


Figure 7: Energy plot

V. CONCLUSION

Clustering is the proficient plan for performing data packets aggregation over the information obtained from the nodes in the sensor network. The sensor node transmits data to the CH in cluster after that CH achieve data packet aggregation on the received data and then transmits aggregated data packet to the BS. This results in wastage of energy. The proposed LEACH in this paper reduces energy wastage by circulate the load to all the nodes at various time intervals. The LEACH protocol for sensor nodes is simulated in MATLAB. The various simulation parameters are creation of cluster network and cluster head, number of dead nodes, energy of the nodes in the respective rounds. The performance of proposed LEACH algorithm is better compared to the conventional routing protocols.

REFERENCES

- [1] Nitin Mittal and Davinder Pal Singh, "improved leach communication protocol for WSN," National Conference on Computational Instrumentation CSIO Chandigarh, India, 19-20 March 2016
- [2] Prashanth Maurya and Amarpreeth Kaur, " Behaviour analysis of LEACH protocol", International Conference on Parallel, Distributed and Grid Computing, 2015
- [3] Malka N. Halgamuge and Andrew Jennings, " Energy Efficient Cluster Formation in Wireless Sensor Networks", School of Electrical and Computer Systems Engineering, RMIT University, Melbourne, Australia *Department of Mech. and Manuf. Engineering, University of Melbourne, VIC 3010, Australia,2016.
- [4] Mr.Muruganandam.K, Dr.Sibaram Khara," Performing Efficient protocol for reducing energy consumption in wireless sensor Networks", International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 6 Issue 7 July 2017.
- [5] Yuling Li and FengLiu," The Improvement of LEACH Protocol in WSN", 2017 International Conference on Computer Science and Network Technology.
- [6] Heinzelman W, Chandrakasan A, Balakrishnan H. Energy-Efficient Communication Protocol for Wireless Microsensor Networks. [C]. Proceedings of the 33rd Hawaii International Conference on System Sciences, 2017.
- [7] A review on wireless sensor networks routing protocol: Challenge in energy perspective" Ismail Ahmedy, Md. Asri Ngadi, Syaril Nizam Omar and Junaid Chaudhry, Scientific Research and Essays Vol. 6(26), pp. 5628-5649, 9 November, 2017.
- [8] A survey on clustering algorithms for wireless sensor network, Ameer Ahmed Abbasi, Mohamed Younis, Computer Communications 30 ,2017.
- [9] Energy Efficient Multi Hierarchy Clustering Protocol for Wireless Sensor Network, Babar Nazir, Halabi Hasbullah, 2010 International Conference on Intelligence and Information Technology (ICIIT 2018) .
- [10] Energy efficient clustering and routing scheme for Wireless Sensor Networks, Wenjun Liu, Jiguo Yu, 978-1-4244-4738-1/09, 2018IEEE.