



Design and Implementation of Energy Efficient Routing Protocol for Wireless Sensor Networks

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ABSTRACT:

A wireless sensor network is a static ad hoc network which consists of hundreds of sensor nodes arranged in random manner in a predefined or affected area. It is a specialized wireless network that composes of number of sensor nodes deployed in a specified area for monitoring environment conditions such as temperature, air pressure, humidity, light, motion or vibration. The main design issue for a sensor network must be conservation of the residual energy available at each sensor node so to increase residual energy of each node in distributed clustering Modified protocol is used. By using Modified protocol residual energy of sensor node and No. of alive nodes may be increased. Complete code is verified and run in Mat Lab.

Keywords: WSN; Energy efficiency, Cluster, Sensor, LEACH.

I. INTRODUCTION

Wireless sensor networks (WSN) have become progressively more attractive and have found their way into huge variety of applications because of their self organizing behaviour, low cost and sensing ability in easy or hard environments. A WSN is a collection of nodes organized to form a network. The energy efficiency and network lifetime are the two important performance parameters in designing of WSN. A sensor network is one of the major rising technologies that required the data transmission at high rate with higher reliability ratio. The wireless sensor network has many sensor nodes these nodes can forward the information and cooperate with each other to accomplish some specific tasks through the application of communication with wireless self organization. The application of sensor nodes can be used in many areas such as the military monitoring, environmental, industry, medical, and agriculture[1].

The sensor nodes are usually programmed to monitor or collect data onto surrounding environment and pass the information on the base station for remote user access to various communication technologies. A sensor node is a small device that consists of four basic components:

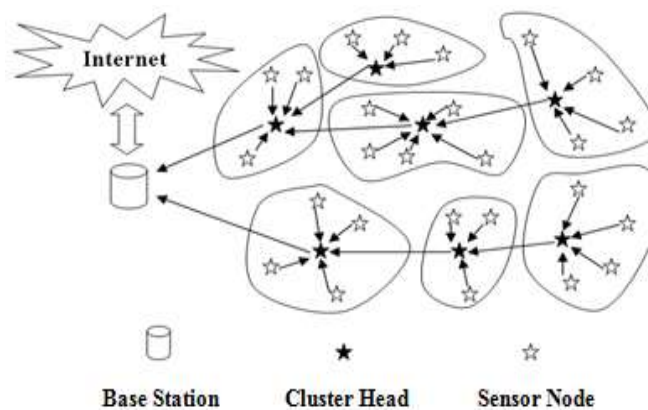


Figure1.1: Architecture of Wireless Sensor Networks

1. Sensing subsystem for data gathering from its environment.
2. Processing subsystem for data processing and data storing.
3. Wireless communication subsystem for data transmission.
4. Energy supplies subsystem which is a power source of the sensor node.

2. LEACH

Low Energy Adaptive Clustering Hierarchy is designed for sensor networks where an end-user wants to remotely monitor the environment. In such a situation, the data from the individual nodes must be sent to a central base station, often located far from the sensor network, through which the end-user can access the data. There are several desirable properties for protocols on these networks:

- Use 100's - 1000's of nodes
- Maximize system lifetime
- Maximize network coverage
- Use uniform, battery-operated nodes

Conventional network protocols, such as direct transmission, minimum transmission energy, multi-hop routing, and clustering all have drawbacks that don't allow them to achieve all the desirable properties. LEACH includes distributed cluster formation, local processing to reduce global communication, and randomized rotation of the cluster-heads. Together, these features allow LEACH to achieve the desired properties. Initial simulations show that LEACH is an energy-efficient protocol that extends system lifetime

The operation of LEACH is broken up into rounds, where each round begins with a setup phase, when the clusters are organized, followed by a steady state phase, when data transfers to the base station occur. In order to minimize overhead, the steady-state phase is long compared to the set-up phase.

2.1 Cluster Setup Phase

After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits this information back to the cluster-head again using a CSMA MAC protocol. During this phase, all cluster-head nodes must keep their receivers on.



2.2 Schedule Creation

The cluster-head node receives all the messages for nodes that would like to be included in the cluster. Based on the number of nodes in the cluster, the cluster head node creates a TDMA schedule telling each node when it can transmit. This schedule is broadcast back to the nodes in the cluster.

2.3 Data Transmission

Once the clusters are created and the TDMA schedule is fixed, data transmission can begin. Assuming nodes always have data to send, they send it during their allocated transmission time to the cluster head. This transmission uses a minimal amount of energy (chosen based on the received strength of the cluster-head advertisement). The radio of each non-cluster head node can be turned off until the node's allocated transmission time, thus minimizing energy dissipation in these nodes. The cluster-head node must keep its receiver on to receive all the data from the nodes in the cluster. When all the data has been received, the cluster head node performs signal processing functions to compress the data into a single signal. For example, if the data are audio or seismic signals, the cluster-head node can beam form the individual signals to generate a composite signal. This composite signal is sent to the base station. Since the base station is far away, this is a high energy transmission. This is the steady-state operation of LEACH networks. After a certain time, which is determined a priori, the next round begins with each node determining if it should be a cluster-head for this round and advertising this information. In our work, we assume a simple model where the radio dissipates $E_{elec} = 50$ nJ/bit to run the transmitter or receiver circuitry and $\epsilon_{amp} = 100$ pJ/bit/m² for the transmit amplifier to achieve an acceptable E_b/N_0 . These parameters are slightly better than the current state of- the-art in radio design¹. We also assume an r^2 energy loss due to channel transmission. Thus, to transmit a k -bit message a distance d using our radio model, the radio expends:

$$E_{Tx}(k, d) = E_{Tx-elec}(k) + E_{Tx-amp}(k, d)$$

$$E_{Tx}(k, d) = E_{elec} * k + \epsilon_{amp} * k * d^2$$

And to receive this message, the radio expends:

$$E_{Rx}(k) = E_{Rx-elec}(k)$$

$$E_{Rx}(k) = E_{elec} * k$$

3. DESIGN OF WSN USING MODIFIED LEACH PROTOCOL

3.1 Configure the network:

In the initial phase of protocol base station transmit signal at different transmission power starting with minimum transmission power as level 1, nodes in the network which can hear that signal set their level L1 and calculate the distance to base station with received signal strength. Base station increased its transmission power to attain the next level And so on up to its predefined ability to transmit at different power level. Nodes which could not hear previous signal set its level according to corresponding signal level. Base station broadcast message containing information about level of that signal, receiving that information all nodes in the network sets their level of transmission. After dividing the network into different transmission level cluster formation is done In this part the network will be configure by heterogeneous nodes. There may me same type or different type of nodes which will arrange in a network in random manner. In proposed work we will take 300 no. of nodes and assign an area of 100 x 100.

3.2 Clusters Formation :

In the cluster formation step clusters Heads are formed using the basic clustering protocol (in our case we have taken it as Modified LEACH) After cluster formation all sensor nodes transmits data sensed to corresponding cluster head. That aggregates all data received. These part different clusters will assign in the area in random manner. Clusters will define in such a manner that there will be minimum one node in a cluster and a maximum of five nodes in a cluster. The nodes regularly update their sets of neighbors.

3.3 Selection of Cluster Head

Single cluster head will be selected based on residual energy and intra cluster communication. This cluster head will be responsible to take information from other nodes and transmit to base station or other cluster head. The information may be of any type for example temperature, pressure, humidity, sound etc.

3.4 Routing based on Modified Leach Algorithm

In this step multi-hop routing between cluster heads of different level take place. Multi hop data forwarding has two key elements. Optimal transmission radius and Forward transmission area

OTR (optimal transmission radius): OTR for different cluster heads OTR is the difference between transmission level of that cluster head and next higher level.

$$OTR_{ci} = | level_{i+1} - level_i |$$

Where OTR_{ci} is the optimal transmission radius of the cluster C_i , $level_i$ is the transmission level of that cluster head and $level_{i+1}$ is the next higher transmission level.

Forward Transmission Area: Forward Transmission Area is subset of Transmission region of a node which eliminates the data transmission in backward direction resulting saving efficient amount of energy which prolongs the network lifetime

4. RESULTS AND DISCUSSION

Network size is considered as 100m X 100m and the number of nodes is 300 which are deployed randomly in the sensor field.

Table 4.1: Simulation Parameter

Parameter	Value
Simulation Area	xm=100 ym=100
No. of Nodes	300
Distance of base station from the network	sink.x=110 sink.y=110
Probability of a node to become cluster head	p=0.1
No. of Rounds	1200
Initial Energy	0.1J
Data packet size	400 bits
Control Packet Size	100 bits

4.1 Number of Dead nodes:- The result of effect on dead nodes with increase of no. of rounds is shown in figure 4.1. It is clear from the figure that dead nodes are continuous increases with the increase of no. of rounds. At the initial

state the dead nodes are nil but it starts increasing when no of rounds is 800. When the no. rounds reaches to 900 the dead nodes becomes 24. When the no rounds reaches to 1000 the dead nodes become 66. When the no. of rounds reaches to 1100 the dead nodes become 131 and finally reached to a value of 227 when the no. rounds become 1200.

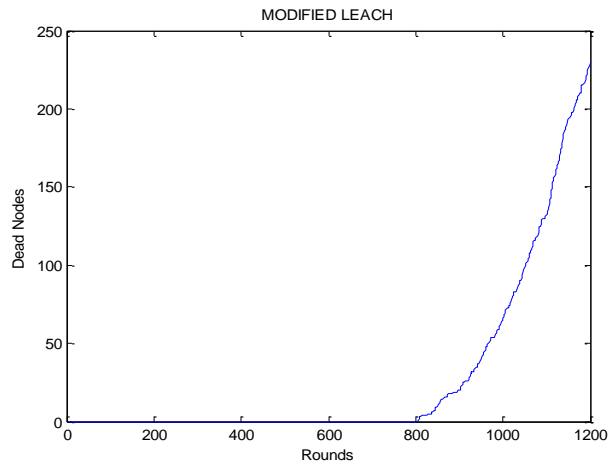


Figure 4.1: Graph showing the no. of dead nodes with no. of rounds

4.2. Packets to BS:

The results of energy packets to base station is described in figure 4.2. At the starting time the value of packets send to base station is zero that means there is not any data transfer between nodes and base station. As we increases the no of rounds the packets will also increased. When the rounds become 200 the packets reach to a value of 6000. At the value of 600 rounds packets reach to 18000 and reach to a final value of 33000 at 1200 rounds.

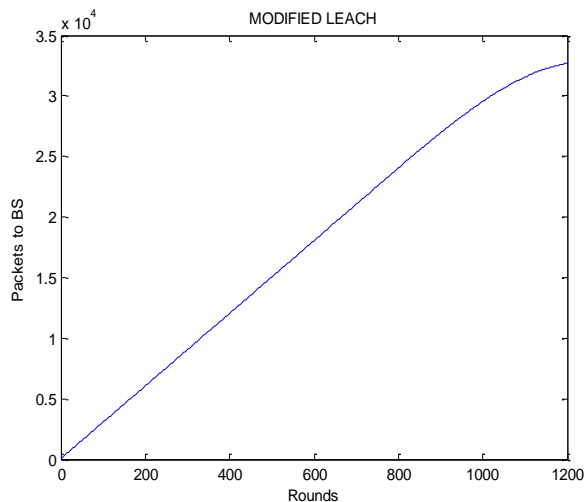


Figure 4.2 Graph showing packets to BS with no. of rounds

4.4.3. No of Cluster Heads:- No of cluster heads vary with no of rounds shown in figure 4.3.. Their average value is varying between 20 to 40 with rounds. Overall no. of cluster head decreases with no. of rounds and goes to a very low value at the end of 1200 rounds.

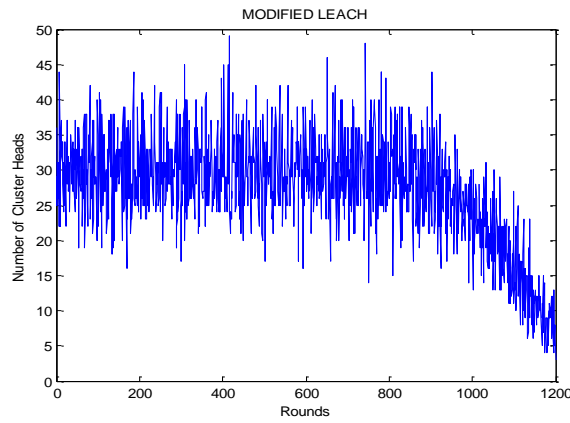


Figure 4.3 No. of Cluster Heads with No. of Rounds

4.4 Residual Energy:- Residual energy is the remaining energy of a node after it send information to base station. It will always decreases with no of rounds. As when a node is collecting information from surrounding area and send to base station it will consume some enrygy. At the stating of rounds they have maximum residual energy and its value if 150. With the increase of rounds the residual energy will decreases and reach to a value of 128 when the no of rounds become 200. Its value become 72 at 600 no of rounds and 21 at 1000 rounds.

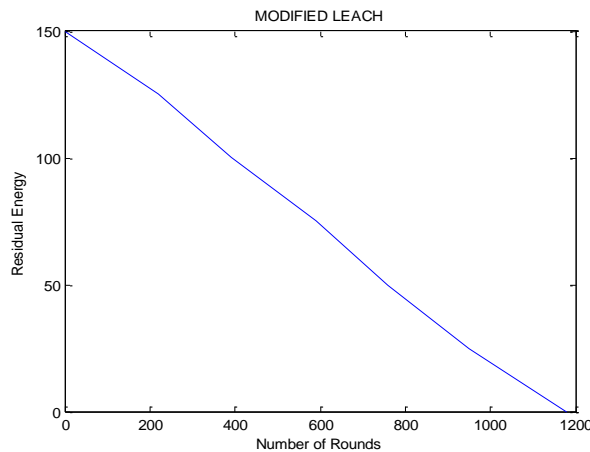


Figure 4.4 Residual Energy with No of Rounds

4.4.5 Packets to CH:- The results of Energy Packets to Channel is described in Figure. 4.2. At the starting time the value of packets to channel is zero and is continue increases with number of rounds and reach to a value of 150000 when the no. rounds become 600 and 293000 at the end of 1200 rounds.

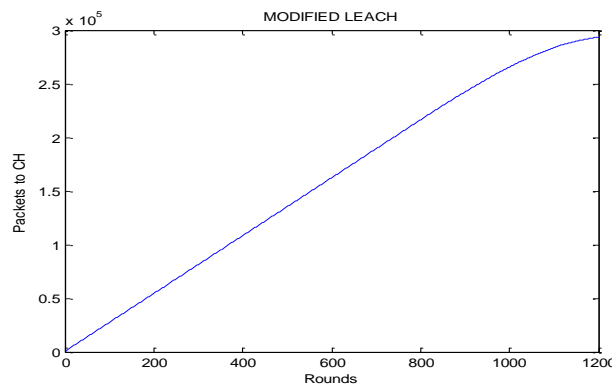


Figure 4.2: Graph showing the Packets to CH with Rounds

4.6 Number of Alive nodes:- The result of effect on alive nodes with increase of no. of rounds is shown in figure 4.3. It is clear from the figure that alive nodes are continuous decreases with the increase of no. of rounds. At the initial state the alive nodes are maximum (300) but it starts decreasing when no of rounds is 800. When the no. rounds reaches to 900 the alive nodes becomes 276. When the no rounds reaches to 1000 the alive nodes become 240. When the no. of rounds reaches to 1100 the dead nodes become 168 and finally reached to a value of 68 when the no. rounds become 1200.

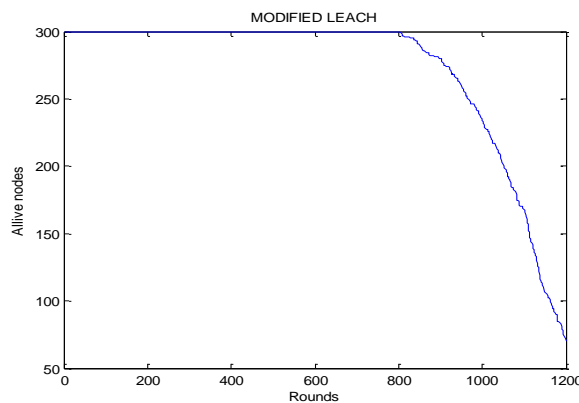


Figure 4.6: Graph showing the Alive Nodes with No. of Rounds

5. CONCLUSION AND FUTURE SCOPE

In proposed work, a level based clustering approach protocol has been proposed with is based on Modified LEACH. The network model based on power levels is being developed. The mathematical formulae for choosing the cluster head are provided. The study of clustering, cluster head selection and inter cluster routing of WSN is presented here, since it was earlier proposed that clustering improves the network lifetime. The model developed is simulated in MATLAB. The simulation results of Residual Energy cluster heads, No. of Alive Nodes, No. of Packets to BS and CH and no. of dead nodes are provided. It has been observed that the Residual Energy for Cluster head for each round in Modified LEACH is more than compared to Hierarchical Routing. Finally, it is concluded that the Modified LEACH performs better than Hierarchical Routing Scheme in case of No. of Alive Nodes and Residual Energy.

In future research, proposed scheme can be extended to optimize the number of levels to efficiently consume the energy of network and improve the network lifetime, to implement wider network.

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