Improvement in Leach Protocol

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Abstract – Wireless Sensor Network (WSN) subsist of low capacity devices that are dispersed in geometrically remote areas. Sensors are organized in clusters. Each cluster designates a crucial node which is known to be cluster head(CH). Each CH accumulates the sensed data from its sensor nodes to be broadcasted to the base station (BS). Sensors are deployed with batteries which cannot be substituted. The consumption of energy is an vital worry for WSN. We suggest an improvement approach to lessen the energy utilization and expand the network lifespan.

The enhanced technique is built on a cluster head election procedure. In inclusion, an improved schedule of the TDMA has been executed. Finally, the evolution approach show the advancement in terms of network lifespan, amount of cluster head, energy expenditure and quantity of packets shifted to BS in contrast to LEACH and other associated protocols. Mathematical study and MATLAB simulation results unveil the success of the proposed approach.

Index Terms – Wireless Sensor Network, Cluster, Leach.

1. INTRODUCTION

Wireless sensor network are of hundreds and thousands in number which consist of minute devices which hold the capability of communicating with other sensor node with restricted power. Wireless sensor node is located in a real world habitat for sensing of numerous environmental outcomes. Sensor nodes which have restricted power, so the accumulated data from the target surroundings is directly sent to the base station. Base station is a node that has interest in collecting data from a group of sensor nodes. It examines and minimizes the alikeness between the data, which is utilized in decision making. In addition to this the data is not been used locally only by the base station, but they are also able to dispatch these data to different networks which are situated in a distant location still, this would be causing elevated communication overhead, which are not been allowed by the sensor nodes. In WSN the procedure of assembling data from entire sensor and reporting of them to the base station are known as data aggregation.

WSN suffers from boundless constraints such as power, less computational ability, battery which is limited and not rechargeable, creating security and global addressing for every sensor node. The main role in WSN is played by the batteries, which is the measure of the lifespan in WSN; maximum energy is consumed in the procedure of transmission. Thus, the energy efficiency routing protocol required for saving of energy there is an introduction of various types of investigation. Many researches are attacked by clustering based protocol. It consist of two phases set-up phase and steady state phase .In set up phase WSN is diverged into clusters. In every cluster, there is a main node that represents as a cluster head [1][2]. In steady state phase members in the cluster sense and transfer their data to the cluster head systematically. Every sensor node in the cluster has its own duration to send sense data to its cluster head. In accordance to TDMA schedule the sending procedure is being performed. Establishment of this schedule by each CH and sending it to all members of the cluster see fig 1.

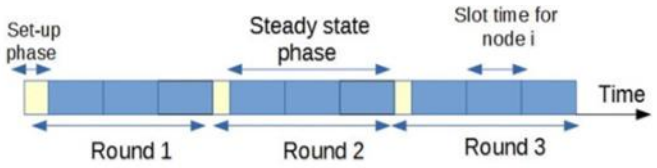

Fig 1. Time Division Multiple Access schedule for Leach operation.

The CH being accountable for minimizing unnecessary data and apply aggregation method that reduces the data's magnitude and move it further to the base station[3][4].

2. LEACH PROTOCOL

LEACH protocol is a major protocol i.e. applied for micro sensor network application. It combines both idea of energy efficient cluster based routing [5][6] and media access together. The concept at the back of leach is to conserve energy of sensors as feasible to upgrade the lifespan of the network. In the setup phase, the node constitute the CH have chosen in a haphazardly after situating every sensor node [7]. The selection of CH has being executed at the start of each round. All sensor nodes chose a random number between 0 & 1. If the random number is similar than the threshold, that node is selected as CH for the present round [8].

The T(n) is given in the following equation (1).[9]

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

Where:

P: is the percentage of choosing cluster heads.

r: is the current round

G: is the set of sensor nodes that have not been cluster heads in 1/p rounds.

2.1. Limitations of Leach Protocol

Although presentation of energy takes place in sensor nodes by the leach protocol, and reduces the size of the routing table. There is still some drawbacks .when irregular choice of CH takes place then the residual energy of the node is not taking into consideration.

- As the size of network is increased, consumption of energy is rapid when the CH is situated at a distant place from the base station. When the deployment surrounding are small the leach protocol work well.
- There are some limitations in TDMA. Each CH has a designated slot and has their overtime to send data. Although there is no ongoing data.
- Few clusters may include additional sensor nodes than other clusters which are overdone on the frequentness of sending data to the base station nodes which are in a compact cluster will extract energy rapidly then nodes that are owned by a layer cluster.
- Random number is generated by the sensor nodes between 0 and 1.if the node number is less than the threshold then the node number will become the cluster head.so there is no restriction in production of CH. The amount of sensor node affects the energy efficiency which is used as a CH.
- It is assumed by the leach protocol that every sensor node is having enough energy for communication with the sink.so the energy consumed is more if the sensor node as far away from sink.
- It is assumed by leach that every node in a network are same, which is not true in many of the applications, so improvement is needed for handling heterogeneous nodes.
- Leach does not conserve data privacy amid sensor node and more security is needed.

2.2. Radio Signal Propagation Model

This paper is concerned with the first order radio frequency energy consumption model to which describes energy decomposition of the communication. The first order radio model is separated into free space model and multipath fading model in relation to the interval linking the sending node and receiving node. It is presumed by the protocol that the transmission channel is uniform, the energy utilization of l bit message linking the two nodes with a span of d which can be shown in equations (2) and (3)

$$E_{Tx}(l,d) = \begin{cases} E_{elec}*l + \varepsilon_{fs}*l*d^2 & d<=d_0 \\ E_{elec}*l+\varepsilon_{mp}*l*d^4 & d>d_0 \end{cases} \quad (2)$$

$$E_{Rx}(l) = E_{elec}*l \quad (3)$$

Where $E_{Tx}(l,d)$ is the energy consumed in broadcasting l bits data to a node with a distance of

d, $E_{Rx}(l)$ is the energy consumed in acquiring l bits messages. E_{elec} equals the per bit energy

Consumption for transmitter and receiver circuit. ε_{mp} and ε_{fs} are the amplifier parameters of transmission in accordance to the multi-path fading model and the free-space model respectively. d_0 is the threshold distance between multi-path fading model and the free-space model,

$d_0 = (\varepsilon_{fs}/ \varepsilon_{mp})^{1/2}$ .If $d <= d_0$, the channel approximates free-space model, the energy dissipation in transmitter amplifier is in direct ratio to d^2 . If $d > d_0$, the multi-path fading model will be and the energy dissipation is in direct ratio to d^4 .

3. IMPROVED LEACH PROTOCOL

3.1. Cluster Head Threshold Optimization

In the procedure of cluster head election, we initiate the idea of current Energy. Assuming that the initial energy of every node is equal. There are number of improved technique of the cluster-head election on the basis residual energy, the threshold in equation [4] is shown as the following equation:

$$T(n)=p/(1-p*(rmod1/p))*(E_{cur}/E_{total}) \quad (4)$$

E_{total} -> total energy of network

E_{cur} -> is the current energy of node

E_0 is the node initial energy. This upgradation takes the present energy into thought, and elevates the chances of the node with high-energy nodes to become cluster-head.

In leach algorithm, the chances of becoming a cluster head is same for all node. A node on being determined as cluster head, it will transmit the message, which has the inclusion of the id of the cluster head. It is determined by other nodes which cluster should take part, in accordance to the power of received signal. Then a join request message is send, which consists id of cluster head and their selves' id and current energy(E_{cur}).In accordance to different nodes current energy, cluster head could add up to the average energy of cluster(E_{ave}).Then, transmission of E_{ave} and TDMA time slice allocating table to all node in the cluster. When electing cluster head next time, if one node's randomly produced number between 0 and 1 is less than T(n), it could not be chosen as cluster head immediately. Only if this node's current energy (E_{cur}) is greater than average energy (which would be updated every round) that it could be selected as cluster head.

3.2 Choosing inter-cluster multi-hop route

According to wireless communication energy model, If sending 1 bit data in distance of d, the energy will be consumed for the sender is:

$E_{tx}(l,d) = E_{tx\text{-}elec}(l)+E_{tx\text{-}amp}(l,d)$

Energy will consumed for the receiver is:

$E_{Rx}(l) = E_{Rx\text{-}elec}(l) = lE_{elec}$

E_{elec} states the energy consumption in broadcasting or acquiring bit of data . d_0 is the threshold value. If the value of d is not greater than d_0,friss free space model can be used ,else multi path attenuation model can be used . Although, it is known that the node which is nearer of two nodes, energy consumption will be minimized and the lifespan will be increased. So in comparison to single –hop routing in leach, multi – hop routing is proposed. In case of multi hop routing algorithm, every cluster head is not attached to the base station, so to the cluster head which is nearest to A(for example B) will be elected to get connected to A and so on, until and unless all the clusters adds up to the multi hop route.

4. SIMULATION AND RESULTS

Description	**Symbol**	**Value**
Number of Nodes	N	50
Initial Energy Node	E_o	0.1
No of Rounds	Rmax	2000
Energy consumed by the amplifier to transmit at short distance	ε_{fs}	10*0.00000000001
Energy consumed by the amplifier to transmit at longer distance	ε_{mp}	0.0013*0.0000000000001
Data Aggregation Energy	E_{DA}	5*0.000000000001
Cluster Probability of LEACH	P	0.1

In order to execute the discussed enhanced algorithm, we use (E_x,E_y,E_{cur},) for representation of node.

E_x,E_y is represented by the position of E. E_{cur} is the present energy left. E_{ave} is the average energy of nodes in one cluster .In the procedure of electing cluster heads, the nodes are abruptly produced number should not be greater than T(n), and its E_{cur} is greater than E_{ave}. As the depth of the acquired signal has a negative impact with distance, we elect the nodes which are near to cluster head. On the basis of positioning of the (E_x,E_y) the distance can be worked out. After the formation of cluster, Eave can be worked out on the basis of E_{cur}, and E_{cur} and E_{ave} have to be updated in every round. When E_{cur} is 0 , it symbolize that the node is dead.

We see that in improved algorithm the first node dies in the 203th round and all nodes were dead after 1118 rounds while the first node was dead in 82th round and all nodes died after 738 rounds in Leach. Same rounds as before, the number of nodes which died in improved leach algorithm was less, which demonstrated that improved leach prolonged the network's lifespan and energy was even among nodes.

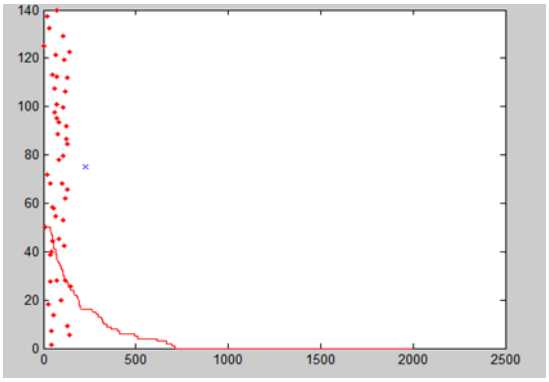

Fig.3 The graph between round and number of nodes by leach protocol

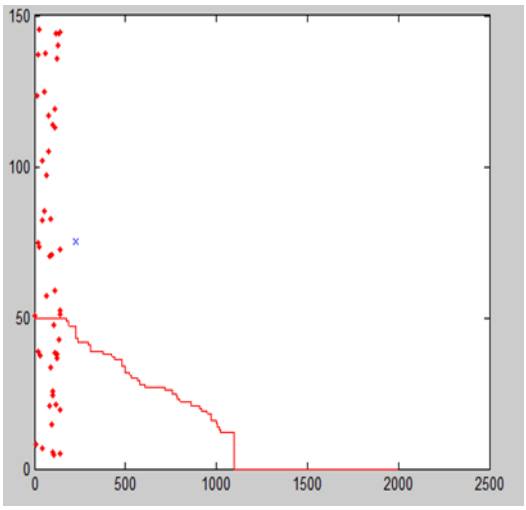

Fig. 4 The graph between round and number of nodes by improved leach protocol

From the Fig. 4, we could see that following the identical number of rounds, in upgraded LEACH algorithm the complete energy consumed is not greater than in authenticated LEACH algorithm.

Moreover, the energy expenditure after 249 rounds in original algorithm and it is after 623 rounds in enhanced algorithm. So the network's lifespan is extended, and the energy is used more efficiently. ns should be numbered as shown above.

5. CONCLUSION

In this paper, to overpower the fragility of LEACH protocol in cluster head electing algorithm and single-hop routing algorithm, we offer an enhanced algorithm on the basis of LEACH. As demonstrated in simulation in MATLAB, the upgraded algorithm extends the lifespan of network and increases the energy constructively.

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