Extended Q-LEACH Protocol using Intermediate Gateway Nodes for WSN

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ABSTRACT
WSN is built of various nodes – from a few to several hundreds or even thousands, where each node is connected to one or several sensors that is why the nodes are called the sensor nodes. These sensor nodes collect the physical or environment related data and sends to the sink node. All of these sensor nodes have limited energy power, so energy efficiency is the main factor that we have to consider while designing a wireless sensor routing protocol. Study shows that LEACH routing protocol and its different variants are energy efficient. Q-LEACH is a descendent of LEACH protocol which improve the lifetime of wireless sensor network by dividing the whole network in four equal quadrants. In this paper proposed extended Q-LEACH protocol using intermediate gateway nodes is discussed.

General Terms
Q-LEACH protocol with intermediate gateway nodes to improve lifetime of WSN

Keywords
Wireless sensor network, energy efficiency, LEACH, Q-LEACH, gateway nodes.

1. INTRODUCTION
The development of wireless sensor networks was motivated by military applications like battlefield surveillance; now a days these networks are used in many consumer and industrial fields, like in industrial process monitoring and control, machine health monitoring, and so on [5]. Wireless sensor network is a network with typically no infrastructure and have many homogeneous or heterogeneous sensor nodes. Wireless sensor network consist different of nodes which consist of sensors, analog to digital converter (ADC), micro-controller, memory, radio electronics and battery [6], [7].

All the sensor node can communicate with the other sensor node and the base station. In the wireless sensor network a sensor node will sense the physical data and send the same directly to base station or through the other sensor nodes. All the sensor nodes have limited energy resources so the lifetime of WSN is depends upon the energy consumption of these sensor nodes.

2. RELATED WORK
There are various routing protocols which are energy efficient. LEACH is a clustering based energy efficient protocol which improves the lifetime of the WSN by distributing the load equally among the sensor nodes and minimize the overall energy consumption in the network [3]. There are various variants of LEACH protocol which Improve the lifetime of the WSN[8].

Q-LEACH is a descendent of LEACH protocol is an energy efficient protocol. In the Q-LEACH protocol the whole network is divided into four equal quadrants, firstly all the sensor nodes send their location to the base station, based on their location information base station divide the network field in four parts, after that cluster head selection is done [4]. Procedure of cluster head selection is same as that in conventional LEACH protocol. After the cluster head formation a CH advertisement is sanded to all the sensor nodes, nodes after receiving the advertisement select their cluster head according to their signal strength. All the sensor nodes sense the environmental data and send to their respective cluster head node within their assigned TDMA schedule. Cluster head nodes than send to the base station.

3. ENERGY MODEL
According to the first order radio energy model energy consumed in transmitting a message [1], [2]

$$Etx = k\,(E_{lec} + \in_{fs} d^2) \qquad (1)$$

Where, k is the length of the message, d is the transmission distance between the transmitter and the receiver, E_{elec} is the electronic energy (energy consumed to transmit one bit) $\in_{fs}$ is the amplification coefficient. Also, the energy consumed in message reception [1], [2] is given by,

$$Erx = k.\, E_{lec} \qquad (2)$$

It can be inferred that, with the size reduction of the message and the number of messages that are exchanged, energy consumption can be reduced. Routing techniques use this approach to maximize the network lifetime. A standard radio model is shown in figure 4. K bit packet is transmitted and received. Figure clearly shows that transmission energy and the receiving energy depends upon the distance parameter, so we can improve the lifetime of the network by minimizing the distance between the sender and receiver.

Table-1-Radio characteristics

Operation Energy	Dissipation
Transmitter Electronics (EelectTx)	50 nj/bit
Receiver Electronics (EelecRx)	50 nj/bit
Transmit amplifier (Eamp)	100 pj/bit/m2

4. PROPOSED WORK

In Q-LEACH network is distributed into four equal quadrants which resulted in better coverage than the conventional LEACH but still the lifetime of the cluster heads which are located far away was lesser than the lifetime of the cluster heads located nearby the base station.

The decreased lifetime of the far away cluster heads degrades systems performance so it was suggested to improve the system's performance by increasing the lifetime of the cluster heads located far away, so by improving the lifetime of those cluster head the lifetime of the network can be improved.

So in this work additional five nodes are introduced, one on each quadrant boundary and one at the center position. These nodes would work as an intermediate to help in communication of sink with the far away cluster heads. Firstly the random selection of cluster heads would be done. The distance of the cluster heads will then be measured from the sink.

The cluster heads which have higher distance from the base station will then check their distance from the intermediate nodes and then the distance between the intermediate nodes and sink will be checked.

The intermediate nodes of the surrounding boundaries will only be preferred that means for each cluster head we will probably have five intermediate nodes which are located at the boundaries of each quadrant. Then the distance of the all intermediate nodes from the base station is compared and the node which have less distance from the base station will be selected. The selected node then transfer the load of cluster head, which will then pass to the base station.

This will reduce the load on the far away cluster heads which slows down energy drainage and in result results in better system performance. The problem of the degraded system's performance can be achieved by using the intermediate nodes.

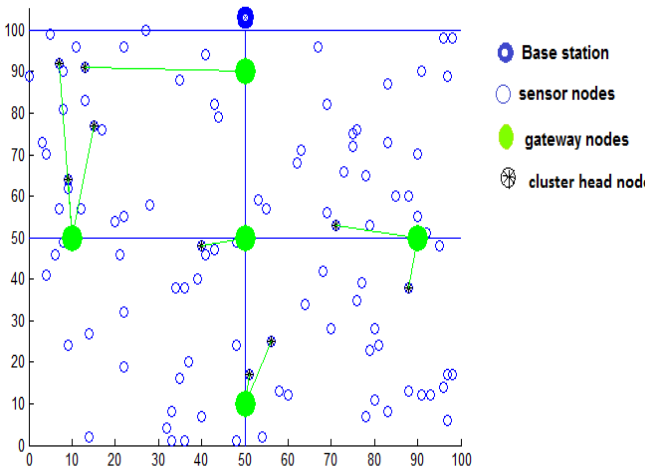


Fig 1 Q-LEACH with intermediate gateway nodes

4.1 Important Points and Assumptions

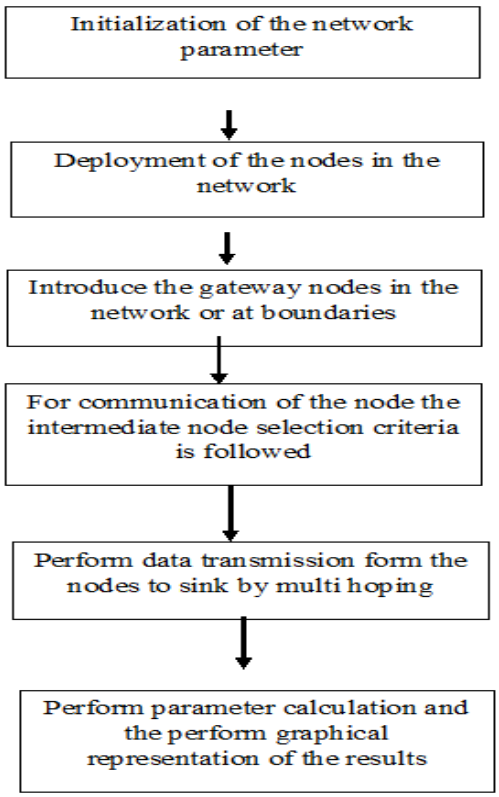
1. The location of the base station is fixed and it is deployed far away from the sensor nodes location
2. All the sensor nodes are deployed in a 2D space and the batteries of the sensor nodes cannot be recharged after their deployment.
3. The base station has the information of the sensor nodes and the gateway nodes
4. All the sensor node got the information about the gateway nodes using the initial broadcast message.
5. All the sensor nodes can send data to the other sensor nodes and to the gateway nodes also
6. Five gateway nodes are dispersed in the network one at each boundary of the quadrant and another one in the center.
7. All the gateway nodes have location information of the base station
8. Gateway nodes have two functionality one is receiving the data from the cluster head nodes and other is send the same data to the sink node
9. Gateway nodes are the intermediate nodes with unlimited battery power that is the battery of the gateway nodes can be recharged.
10. Data transmission energy depends on the distance to the base station and all the sensor node have equal initial energy.

4.2 Methodology

The main aim of the proposed algorithm is to reduce the energy consumption of the network so that the life time of the network is increased. The methodology of the proposed algorithm is defined below:

1. Initially the network is created and the parameters of the network are initialized. These parameters are used for performing the communication between the source and the destination.
2. After the initialization of the network parameter, next step is to deploy the nodes in the network. These sensor nodes further perform the communication.
3. Next step after the deployment of node is to introduce the gateway nodes in the network, these gateway nodes will receive data from the nodes and will transmit it to the sink. Thus the distance of communication is reduced, that will increase the efficiency of the system.
4. After the deployment of the gateway node, next step is to apply the intermediate node selection criteria for further communication, according to this criteria the node communicate with the gateway nodes.
5. In this step the communication is performed, the data is send from the nodes to the gateway node and then to the sink, in this way a multi hop network is designed, in which data transfer at various level before reaching to the destination.
6. Finally the calculation of the parameters is done. The performance of the network is described by using these calculate parameters. The result obtained as represent graphically.

4.3 Block Diagram



5. IMPLEMENTATION DETAILS

Proposed approach of extended Q-LEACH with the intermediate gateway nodes is accurately simulated in the MATLAB. It is assumed that the network has 100m×100m dimension and all the sensor nodes are deployed randomly in a 2-dimensional space.

Parameter used for the energy calculation are distance of the normal nodes to the cluster head nodes and the distance between the cluster head and the gateway node (intermediate node) or base station. It is assume that all the sensor nodes have 0.5 joule initial energy.

Table-2- Simulation Parameter

Parameters	Value
Network size	100m×100m
Number of nodes in the network	100
Number of rounds	7000
Number of gateway or intermediate node	5
Energy dissipation (Efs)	10*0.000000000001 Joule
Energy for Transmission (ETX)	50*0.000000000001 Joule
Energy for Reception (ERX)	50*0.000000000001 Joule
Initial node power	0.5 Joule
CH probability	0.1

5.1 Simulation Results

Number of alive nodes are checked after performing the 7000 rounds. Lifetime of the whole wireless sensor network is depends upon the lifetime of the sensor nodes that is on the battery power of the sensor nodes. In our work we have done simulation up to the 7000.

The number of alive nodes start decreasing after 5000-6000 rounds so overall network lifetime improved. More alive node will be result in enhancement of the lifetime of the wireless sensor network.

Fig 2 shows the number of alive nodes after the each round of simulation.

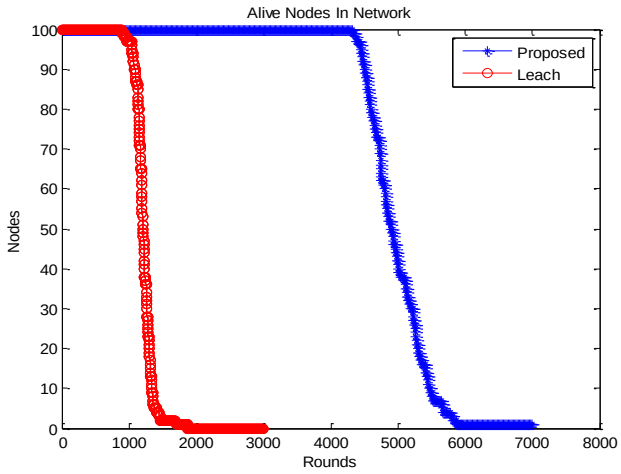


Fig-2- Number of Alive Nodes

Number of dead nodes are checked after simulation. The dead nodes are those sensor node whose battery power is finished. If a single sensor node is dead in the network it will also affect the lifetime of the network.

In our simulation result we have founded that no dead node is founded up to 4000 rounds. The nodes start founding dead after the 4000 rounds, means mostly nodes are dead after 7000 round which shows improvement of the lifetime of the network. More the number of dead nodes result in lesser the lifetime of the network.

Fig 3 shows the number of dead nodes after the each round of simulation.

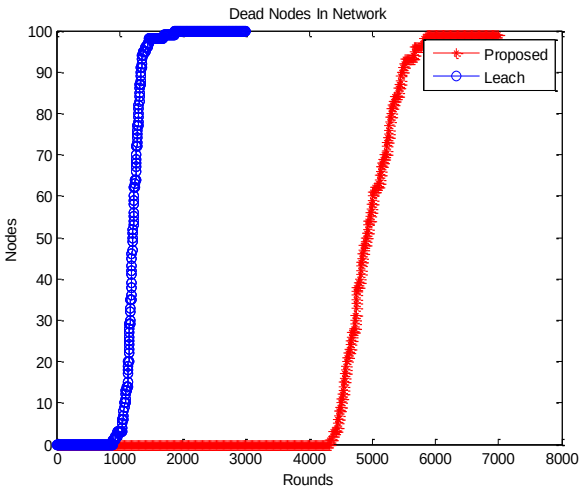


Fig.-3- Number of Dead Node

Fig 4 shows the throughput of the network. Throughput is defined as the number of packets being sanded per simulation round.

Fig 4 shows the number of data packets sent to the base station in each round.

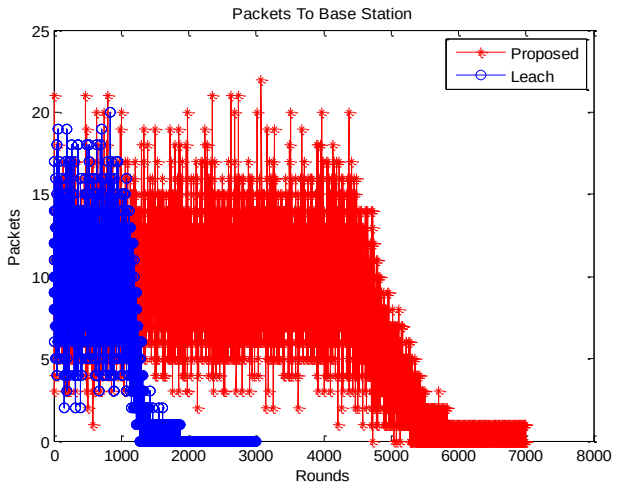


Fig-4- Packet to Base Station

Fig 5 shows the number of cluster head selection in each round. The procedure of cluster head selection is same as that in conventional LEACH. The pattern obtained is also same as that of LEACH protocol

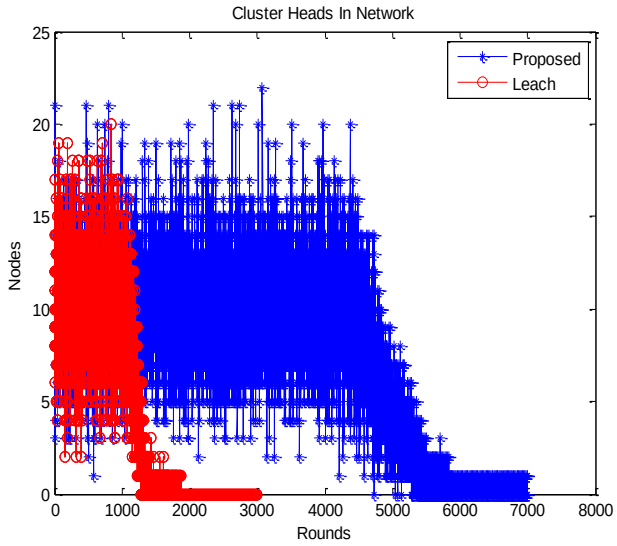


Fig-5- Cluster Head In The Network.

6. CONCULSION

Energy efficient protocols are designed for the Wireless sensor network. These protocols are used for enhancing the efficiency of the network. Energy utilization of the sensor nodes is the major challenge in the wireless sensor network. In this proposed method a new approach is proposed for minimizing the energy consumption of the network in order to enhance the lifetime of the network. In this the gateway nodes are introduced for communication by making multi hop network. Form the results obtained it is concluded that this proposed algorithm is better and efficient than the traditional used algorithm. The performance of the

System is increased as the less energy utilize by the node there by increasing the life time of the network.

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