

# An Enhanced Energy Efficient Clustering Protocol to Extend the Lifetime of the WSN

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Abstract - Wireless Sensor Network plays a key role in many of the applications like traffic, agriculture, military, home, medical, vehicle detection. WSN consists of multiple number of nodes. Sensors are used to sense the temperature, humidity, physical and environmental conditions. Sensors are battery powered and they cannot be replaced. Hence energy efficiency is major problem in the network. Many routing techniques came in to existence in order to increase energy efficiency and to increase the network lifetime. Among those routing technique clustering algorithm is one which can increase the energy efficiency and network lifetime. Because this algorithm mainly concentrates in minimizing the energy dissipation and delay in the network. Firstly, LEACH (Low-Energy Adaptive Clustering Hierarchy) came in to existence, but it has some disadvantages and work good for small network with small no. of nodes. In order to overcome the limitations in LEACH, LEACH protocol is enhanced in three ways. Firstly, the BS is chosen based on the distance between nodes. Secondly, a node chooses a cluster head based on the shortest distance between the sink and the CH, as well as the shortest distance between the CH and the node. Thirdly, Average energy of node is also considered to avoid dead nodes in the network, as dead node decreases network lifetime and increase consumption of energy. Simulation results in this paper will show that enhanced energy efficient protocol has got better results when compared to LEACH and Modified LEACH protocols.

Keywords: Base station, Cluster head, LEACH, WSN.

# I. INTRODUCTION

The network is a collection of large number of sensor nodes which are deployed in the area. They are powered by batteries and cannot be replaced. These sensor nodes are used for sensing the data, processing and communicating the data with other sensor nodes. WSN plays a key role in in Engli remote and inaccessible environments [1][2]. Energy plays a major role in WSN. Energy consumption is more in processing the data transmission from sensor to the destination. So the energy efficient protocols are implemented in the algorithm. Thus Clustering based protocols came in to existence [3]. In clustering techniques, the network is divided in to clusters. In each cluster, a node is chosen as Cluster Head (CH) based up on its energy level. So that CH receive the data, aggregate and transmit it to the Base station (BS) There will be two phases in clustering technique a) Set up phase b) steady phase [4]. Homogenous network is those which are having similar characteristics of nodes. Since some networks place in hostile environment, the battery of sensor nodes relies on its own battery. So that it may limits network lifetime. Therefore, algorithm should be designed in the order which increases the efficiency of energy and to increase the network lifetime. In this paper LEACH protocol is enhanced in three ways, such that

energy efficiency is improved thereby increases the network lifetime.

# II. <sup>(2)</sup> LITERATURE REVIEW

#### 1.1 Partitional clustering based CH selection technique.

Clustering is a technique for segregating the network in to areas Arghavani et al. [6] has implemented OCCN (Optimum clustering in circular networks) the main concept of this network is to improve the energy efficiency and to increase the network lifetime. Here it has provided with 35% improvement in energy gain, relative to other clustering techniques. But the drawback here is that, network is not stable while concentrating on energy issue, because behavior of energy loss in network is easily predictable. Su et al. [7] he implemented energy efficiency Fuzzy C means clustering technique for WSN in this method he partitioned the no. of nodes in to some clusters this method takes consideration of entire network energy loss and find optimal solutions to CH. But Drawback here is even though there is a perfect load and energy balance in the network, this clustering method is not suitable for the original applications of WSN. Saadi et al. [8] he proposed an energy aware selection of cluster head technique to increase the stability and to increase residual energy. An



OEAS (Oriented energy awareness scheme) algorithm is implemented at each selection round to manage the energy consumption of sensor nodes.

Though this technique has advantages it has following disadvantages

- It has huge sensitivity in the initial stage as it depends upon the user to know the available no. of clusters well ahead.
- It fails in dealing with inconsistent clusters so this algorithms using in this techniques are impractical in real world sensor network.

#### 1.2 Optimization based CH selection technique

Srinivasa et al. [9,3] proposed an energy efficiency technique which is selection of CH based on particle swarm algorithm (PSO-ECHS) the algorithm was developed with the fitness function and particle encoding. Based up on the no. of nodes here he considered four different scenarios of WSN and observed the simulation result. This technique hasn't taken the consideration of fault tolerance, load balancing and energy balancing. Mann et al. [10] proposed iABC (improved Artificial Bee Colony) which overcomes the problem faced in ABC, this algorithm is to enhance the search equation in the network. The cluster has decreased the consumption of energy and increased the network lifetime. while distributing the packets in different WSN environments in end-to-end delay distribution. Drawback here is, it is not able to execute actual testbed in the sensor nodes. Li et al. [11] here he investigated the issue of unequal clustering strategy in the equal distribution of sensor networks. He proposed a COCA to reduce the loss of energy in the whole network. It can be achieved by the protocols distribution for energy aware CH routing and rotation. But this solution was not exact enough and it deviates from the present world. Singh et al. [12] he implemented particle swarm optimization semi distributed (PSO-SD) this method is used to reduce the intra cluster distance the retransmission calculation for data packets thus assisted all the energy loss in the entire network. But this method is ineffective for implementing sensor nodes in the highest- dimensional area and in heterogeneous network.

Though this technique has advantages it has following disadvantages

• This method is inappropriate to the real world due to optimization problems in the design of the network. To increase the lifespan of the network this technique relay on the energy consumption, so this technique is not suitable in the sensor network.

In order to avoid above disadvantages LEACH protocol came into existence.

**1.3 Low Energy Adaptive Clustering Hierarchy** (LEACH) routing PROTOCOL-

LEACH is a technique, where energy efficiency is increased by random selection of CH [13].

**Set-up phase:** During setup process CH selection, cluster creation and TDMA (Time Division Multiple Access) schedule for non-CH nodes in a cluster and performs according to the schedule. Any node can select as CH node. First node need to send 0 and 1, which is a random priority number. If the selected node has less than the value of threshold value T(n). Then corresponding node can select has CH node. T(n) is given by following equation:

T(n)

$$= \begin{cases} \frac{p}{1 - p\left(rmod\frac{1}{p}\right)} & if \ n\varepsilon G \\ otherwise & 0 \end{cases}$$
(1)

Where 'p' denotes node percentage among all nodes to be participated in the selection of CH. 'r' denotes current round. Nodes can be participated for a CH selection if and only if the node is not taken part in the past 1/p rounds, it can be distinguished by 'G' in above equation. Where G is the set of nodes which haven't taken part in past 1/p round.





By considering this method each node has equivalent chance to become CH node in each round. So that energy dissipation is done uniformly among sensor nodes. After the node selection as CH node, it will send an advertisement message to all the corresponding nodes. After receiving this message from the CH the other nodes based up on its received signal strength make a decision for the current round to join CH and send back a joint message. By generating new message based on Equ. 1 CHs rotate in every round to disperse the energy evenly. After formation of clusters in order to avoid collision among the data sent by member nodes CH generates a TDMA schedule and sends it to the member nodes of the cluster.so that it avoid collisions and permits the data members in to sleep mode. After knowing the schedule to each and every node for the transmission of data to CH. The set-up phase is completed, later it will come in to steady phase.

**Steady phase:** In this process nodes will transmit sensed data to CH and CH to BS in allocated time slot through TDMA schedule. By this if one node is in transmission mode then rest all nodes will be remaining in sleep state. By this process intra collision decreases and improves energy



efficiency. CH transmit it to the BS through channel after aggregating the data.

It detects the channel, if it is busy it will wait for some time for its chance otherwise it will send the information to the base station directly.

#### **Features of LEACH**

- > For every round CH is chosen randomly.
- Communication between nodes and CH is done through TDMA schedule.

#### Advantages of LEACH

- ➢ LEACH, by aggregating data in the steady phase energy consumption can be decreased.
- Here by using TDMA schedule collisions can be avoided.
- It will increase the lifetime of the network by having less communication between BS and nodes.

#### **Disadvantages of LEACH**

In each and every round CH is selected randomly, so after several rounds node with less energy can also be selected as CH if it happens then the network dies quickly and effected, thereby decreasing in lifetime of the network.

#### **1.4 Modified LEACH**

It is another cluster based algorithm which differs from LEACH. Firstly, threshold value is set in this protocol and there is no need to change cluster head in each and every round, if a particular CH has more than threshold value it can be continued as CH in next round also. By this energy consumption is saved in cluster formation and while sending packets in order to find new CH. Secondly there is no need to amplify all the signals [14]

In this protocol T(n) is modified according to the in Engine threshold limit as shown below

$$T(n) \qquad \begin{cases} \frac{p * a}{1 - a * p * (rmod(\frac{1}{p * a}))}, & n \in G\\ 0, & otherwise \end{cases}$$
(2)

Where a=1 or 5 depends up on whether a particular node belongs to normal node or advanced node respectively.

#### **Disadvantages of Modified LEACH**

By modifying leach protocol energy efficiency is improved but it has some amplification problem between two different nodes and their synchronization.

# III. PROPOSED METHOD

The proposed protocol is similar to LEACH but we enhanced the protocol in three ways.

The three sections of proposed protocol are as follows:

It has two stages: i) setup phase and ii) steady phase

(I) **Setup phase**: CH is selected in setup phase based on random number 0 and 1. It will be continued until all CH is chosen. The selection of CH is on the basis of distance between node and itself, it also calculates the distance between BS and CH, because CH plays a major role by sending data to BS. If it is far from CH then energy consumption will be more and network lifetime decreases.

Distance is calculated by using Euclidean formula as shown below

 $D(p,q) = \sqrt{(p_1-p_2)^2 + (q_1-q_2)^2}$  (3)

After the node selection as CH node, it will send an advertisement message to all the corresponding nodes. After receiving this message from the CH the other nodes based up on its received signal strength make a decision for the current round to join CH and send back a joint message. CH after getting message from nodes it will form clusters with the nodes. After formation of clusters in order to avoid collision among the data sent by member nodes CH generates a TDMA schedule and sends it to the member nodes of the cluster.so that it avoid collisions and permits the data members in to sleep mode. After knowing the schedule to each and every node for the transmission of data to CH. The set-up phase is completed, later it will come in to steady phase.

**Steady phase**: This steady phase of proposed protocol is similar to LEACH protocol.

#### (II) Selection of BS:

Selection of BS plays a major role in WSN, because if a BS is at longer distance then the energy consumption of CH will be more while aggregating and transmitting data. Optimum position of BS should be selected using mathematical equation in order to reduce consumption of energy in the network. let us assume there are n number of nodes, then the function is given as

$$F(\mathbf{x},\mathbf{y}) = E[\sum_{k=1}^{n} Etx(Dk)]$$
(4)

Where  $D_k$  is nothing but distance between node and sink and can be calculated using equ-3

Etx is transmitting energy [13]. At node point (r, s) is given by

$$F(x, y) = E[\sum_{k=1}^{n} Etx(\sqrt{(x - rk)^2 + (y - sk)^2})]$$
(5)

After differentiating above equation for minimization process we get following equations

(6)



# Y= ∶∬ s\*f(r,s)drds

This makes optimum position of BS, such that CH consume less amount of energy while transmitting data to the BS. Because we selected BS by measuring its distance with nodes, it is not that much longer distance to the nodes to consume more energy while transmitting data. This method is made compared with existing protocols like LEACH and Modified Leach and this proposed method has got better results compared to those existing protocols as shown in results.

Energy consumption is more while transmitting data from one to another. If they are placed at longer distance, then energy loss will be more due to this network will be degraded and lifetime decreases in the network. Hence we considered distance and average energy for selecting CH.

#### (III) Average energy calculation

It is given by

$$Et = \sum_{k=1}^{n} Ek$$
  
Ea = Et/n (8)

(7)

Where Et is total energy, Ea is average energy, Ek is particular node k energy, n is total nodes.

By considering average energy in selection of CH, the number of dead nodes is reduced in the network thereby increases the network lifetime.

### **IV.** SIMULATION RESULTS

Simulation was done in MATLAB with 200 nodes in 500\*500m area where nodes are dispersed randomly. In below figures nodes are represented as green dots and the BS which is elected by a distance in each case is represented in the form of blue dot. In Fig 2,3 BS is at the end and energy consumption is more in these two cases of LEACH and Modified LEACH, whereas in Fig 4. BS is elected based on distance, Average energy of node, so BS is available equally to all the corner of nodes and CH, which decreases the consumption of energy and increases the lifetime of the overall network.



Fig.2 Nodes formation in LEACH



Fig.3 Nodes formation in Modified LEACH



Fig.4 Nodes formation in proposed method

From the above figures it is observed that in LEACH and modified leach there is no condition for the placement of BS, it is placed at the end, if a node from another end wants to send a data to BS it consumes more energy which decreases the network lifetime. But from Fig4 we can observe that placement of BS is done based up on the distance of CH and node, so that if a CH from any end wants to transmit energy to BS, there will be less energy consumption in CH and it will be alive for longer time.





From the Fig.5 it is known that no. of live nodes in proposed method is more when compared to other protocols. Here we have taken distance while selecting CH, due to that no. of



live nodes are more in the network. There will be no longer distance communication in network.



Fig.6 Rounds vs dead nodes

From the Fig.6 it is known that no. of dead nodes in proposed method is less when compared to other protocols, which increases the lifetime of the network. As live nodes are more dead nodes decreased in area.



Fig. 7 Average energy

From the Fig.7 it is known that Average energy of proposed method is more when compared to other protocols, by this it increases the energy efficiency. It is done so because average energy is also taken in to consideration while selecting CH in the network. Energy saving is more in this type of network.

# V. CONCLUSION

Many researchers have done on WSN in order to improve energy efficiency, network lifetime. Because WSN consists of nodes which are battery powered and cannot be replaceable. The main aim here is to minimize the energy consumption and to increase the network lifetime. Many technologies, protocols, Algorithms came in to existence to analyze the problem and to find solutions. In this paper LEACH is enhanced to increase the network lifetime. Selection of CH and BS plays a major role in this protocol. Based upon the distance and average energy CH is selected. Simulation results shows that the proposed method outperforms better results compared to existing protocols of LEACH and Modified LEACH. in terms of energy and network lifetime.

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