Cluster head selection method for Energy efficient wireless sensor network

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***Abstract*- In this paper we have refer and analyze different energy efficient routing protocol to improve the lifetime of wireless sensor network. Wireless senor network consist of large number of sensor nodes that have limited energy. Energy conservation is the big issue to design energy efficient routing technique in wireless sensor network. In this paper we have reviewed many energy efficient routing protocol to improve "cluster head selection method. In the proposed work" the sensor node consider the residual energy, threshold value to select the cluster head for the next round of the cluster head selection algorithm. The prosed work will improve the network lifetime, reduce energy consumption. And balanced the energy distribution over the network.**

***Index Terms*- Wireless sensor network, Energy efficiency, network lifetime, Cluster head selection, LEACH**

I. INTRODUCTION

Wireless Sensor Network (WSN) consists of many nodes. Nodes in the WSN sensed the surrounding and transfer the sensed data to Base Station. Sink receive sensed data, aggregate that data and take decision for particular action on application [2]. There are various application based on WSN like Disaster Recovery, Fire Detection, Animal Tacking. In these kind of applications sensor node require energy for various operations, but at some place battery cannot be replaced or recharged; so energy consumptions is the major issue now a days[2].

A sensor node includes three major modules, namely sensing, processing and communication. The sensing node consists of a sensor and an ADC (Analog to Digital Converter) which senses the environment. ADC converts the sensed analog data to digital form. The power unit consists of a battery which provides energy for sensing module and processing module [1].

To minimize the energy consumption in WSN, various techniques have been proposed by the researcher [1].The energy required for transmission is more than energy required for reception [1]. In case of single hope transmission the sensor sends the data directly to base station. The nodes which are far away from the base station need more energy than the nodes which are nearer to the base station. In this context Clustering approach is used to reduce energy consumption.

In the clustering approach sensor node is selected as a Cluster Head (CH). There are two approaches to elect CH i.e. self-elected or elected based on certain factors like

threshold value, residual energy, distance from nodes etc. Cluster Head selection plays an important role in minimization of energy consumption in WSN.

LEACH (Low Energy Adaptive Clustering Hierarchy) is a clustering algorithm that allows dynamic selection of Cluster Heads for energy utilization in WSNs. LEACH is divided into number of rounds for selecting CH.

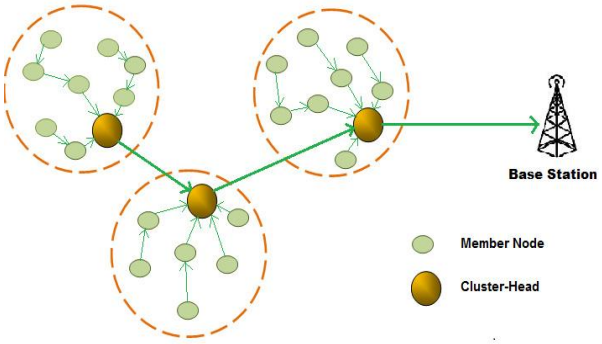

Fig: 1 Clustering Scenario in WSN [3]

At the beginning of each round of CH selection normal node chooses random number x between 0 and 1 and check with certain threshold value and then convert from normal node to Cluster Head. The threshold value is calculated as follow [3]:

$$T(n) = \begin{cases} \dfrac{1}{1 - p * \left(r \bmod \left(\frac{1}{p}\right)\right)}; & if\ n \in G \\ 0, & \text{Otherwise} \end{cases} \qquad (1)$$

Where P is the desired percentage of CH which is predefined value, r is the current round number and G is the set of nodes that have not selected as a CH in last (1/p) rounds.

The main purpose is to design and develop energy efficient technique for WSN to increase the network lifetime. And increase the overall performance of the network. There are number of energy efficient approaches available based on the different parameters like CH selection approach, Inter cluster communication etc.

LEACH is better routing protocol as the responsibility of CH is distributed around all sensor nodes, and also data aggregation to reduce energy consumption [7]. But still LEACH ignores the residual energy at each node during the CH phase. There are various ideas have been proposed to overcome the deficiencies of this which is discuss in next section

II. RELATED WORK

With respect to network topology, the routing protocols in the WSNs may be classified in two categories such as clustered routing and Flat Routing. In the case of Flat routing protocol, the status of all nodes is equal. It generates the route by local operations and information feedback among nodes. The typical Flat routing algorithms are DD (Direct Diffusion) protocol [8], SAR (Sequential Assignment Routing) [9], SPIN (Sensor protocol for information via Negotiation) [10], Rumor Routing [11] and so on.

In 2014, V.K. Subhashree, C. Tharini, in their work they present Modified LEACH protocol for proper selection of CH using three phases. The three phases of this papers are (1) Setup phase (2) Steady setup phase (3) Reclustering Phase. In this Paper they have consider the QoS related parameters like throughput, delay, network lifetime[3].According this paper it reduce the failure of cluster head due to the energy depletion which will increase the network lifetime.

In the set up phase nodes in the network send their energy and location to base station. In the starting period each nodes have same energy level. Once the cluster is created the base station calculates the energy for normal nodes to find next heads for each cluster. Based on threshold value this is calculated. After that ACK and join message is send to every CH to join cluster. In the second phase that is steady setup phase after receiving JOIN message the Cluster head sends TDMA schedule to transmit data. After that data gathering and data forwarding functions is performed. After that it will send CDMA schedule which indicates completion of first round. In the third phase that is Re- clustering phase, if the residual energy of the CH is less than threshold value than the next head with the higher energy than the threshold value will be selected as a CH for the next round. The main part in the modified LEACH protocol is the Fault tolerance. To remove fault tolerance in the network, the node with the less energy than the threshold value will never select as a CH , so it will prevent the data gathering, data forwarding functions will not performed. Due to this communication overhead will be reduced in the modified LEACH protocol.

In 2013, Geon Yong Park, Heeseong Kim, Hwi Woon Jeong, present a novel cluster head selection approach using K-mean algorithm. It is based on the concept of finding the cluster head minimizing the sum of Euclidean distance between the head and the member nodes [4]. This will select cluster head in three phases. (1) Initial Clustering (2) Reclustering (3) Choosing CH. K-mean algorithm is used for Cluster formation[4].Due to cluster formation energy of the network is improved compare to LEACH protocol [4]. One issue in this paper is time taken clustering.

In the first phase that is in the Initial clustering phase K-mean algorithm is executed for cluster formation. The assumption is taken that n nodes is divided in to k cluster, then k out of n clusters are selected as a CH. Nodes will select their CH based on the Euclidean distance. In the Reclustering phase each nodes is assigned k cluster and the centroid of the cluster is calculated. In this centroid of the cluster is virtual node that is located in the center of the cluster. After that third phase will be executed that is Choosing the CH. In this selection of CH will be done. Once the clusters are formed ID number will be assigned to each node according Euclidean distance. The ID number of a node indicate the order of CH to be chosen for the operation.so this ID number play major role in the choosing CH.

In 2015, Sujee R, Dr. Kannammal K.E. compare the behavior of LEACH protocol in Homogenous and and Heterogeneous environment. In this paper author have just compare LEACH in heterogeneous and homogeneous environment. LEACH protocol normally works in two phase (1) Setup Phase (2) Steady Phase. And according to simulation results LEACH in Heterogeneous environment significantly reduce energy consumption and increase network lifetime [5].

In the set up phase sensor nodes are randomly placed in the network area. Then it will check whether it can become a cluster head or no, according to equation 1 which is mention earlier in introduction. Node with the higher energy then the threshold value will be selected as a CH for the process. Then TDMA schedule will be given and steady setup phase will be conducted. In the steady setup phase as soon as nodes receive TDMA schedule CH will aggregate the data which was previously send by the member nodes. Aggregation lead to reflection in the energy consumption. From various result author have proved that LEACH in the heterogeneous environment significantly reduce the energy consumption and increase network lifetime.

In 2015, S. Potthuri, T. Shankur present the cluster head selection algorithm based on the Huffman coding. In this paper they have mention how the cluster head will be elect for the cluster. According to this paper the nodes having the least weight will be chosen to be cluster head [6]. This technique will enhance the performance by increasing the lifetime so energy will be optimized [6]. Throughput, number of alive nodes and number of dead nodes are taken in consideration for comparison.

In this work using Huffman coding cluster head will be select. First the probabilities of node to become a cluster head will be arrange in the descending order. After that using binary fusion a new source symbol and arrange them in descending order by removing the last two probabilities. This process will be continue until two elements left. After that zero and one will be assign to last two elements respectively. Then move backward and assign zero and one. Then find weight of the code. Then this code will be checked with the kraft Machine milan condition to check wheatear it is prefix code or not and if not then again process will be started from step 1.This is how Huffman algorithm is work. Now for CH selection following procedure will be followed.

First the probability of each node will be calculated by multiplying the energy of the node with a random number between the range of 0 and 1. After that sum of all probabilities of nodes will be calculated and arrange them in to descending order. Now on this huffamn coding will be apply to obtain code for each sensor. And weight of the code for each and every sensor nodes will be calculated. Then nodes with the less weight will be select as a Cluster Head and other will be member nodes. This procedure is for first round. For second round remaining energy will be calculated and again process will be started.

In 2014, Basanta K. Nayak, Monalisa Mishra, present novel cluster head selection algorithm for increasing energy of the network. They make Front Leading Energy Efficient Cluster Head (FLEECH) for choosing Cluster Head. They have improved network lifetime, and reduce energy consumption [1].

In this paper selection of cluster head will be depend on the (1) Distance to base station (2) Average distance to other nodes in the same cluster (3) Residual Energy of the node. In this method process will be done in three phase i.e. Setup Phase, CH selection phase, Steady setup phase. In the setup phase it performs two jobs, first form different region in the network. This process is continue upto P number of region. Once the regions are created K number of clusters are created. K mean algorithm will applyand after that JOIN-REQ message will be send to the BS to send their location.CH will be selected as discussed above i.e. based on the distance to the base station, average distance to other nodes in the same cluster and residual energy of the nodes. In the steady state phase nodes send their sensed data to corresponding CH during pre-allocated fixed time slot.

According to Basanta K Nayak using FLEECH protocol network lifetime will increase and efficiency of network will get increase. In a cluster radios of nodes are kept off until their allocated time slots reaches but radio of CH is always kept ON to receive data from all the node.

III. PROBLEM STATEMENT

The problem of node failure is the major problem in the wireless sensor network. The problem of node failure occurred due to loss of energy of a particular node. Cluster head failure is also one problem for energy consumption. If failure of cluster head is identified than there is no response for certain amount of time. Due to this energy of particular cluster will get reduce, so the network lifetime is less. How to select Cluster head is the main part for increasing efficiency of the wireless sensor network.

There are various approaches available for the cluster head selection. Still there are many problems in selection of a cluster head like how to find distance from the base station, hoe to find threshold value for choosing Cluster head, how to calculate remaining energy of the node. Based on all this one of the problem is threshold value selection process. If threshold value is randomly taken then there may be chances that node with the less energy

may get selected as a CH and which will die earlier in the network which will decrease the lifetime of a wireless sensor network.

IV. PROPOSED WORK

In the proposed work energy efficient clustering protocol is proposed to overcome the limitation of the existing work for selection of a cluster head.

There are many clustering algorithms available or energy efficient approach for wireless sensor network. In the wireless sensor network there are many application in which sensor nodes require to move and change their location. In the proposed work the selection of a threshold value is according to following equation [12]

$$T(n) = \left\{ \left(\frac{P}{1 - P * \left(r \bmod \left(\frac{1}{P} \right) \right)} \right) \frac{Eresidual}{Einitial} \right) * Koptimal, n \epsilon G \right\} \quad (2)$$

This threshold value is used for the CH selection mechanism.

Where K optimal is the optimal number of cluster head during the cluster formation which is calculated as follow [12].

$$K_{optimal} = \sqrt{\frac{N}{2\pi}} * \sqrt{\frac{Efs}{Eamp}} * \sqrt{\frac{M}{d^2 \ to \ BS}} \quad (3)$$

Where N is a number of node M is network area E_{fs} and E_{amp} are the amplification power loss and d is the distance between the selected cluster head and the base station.

Main proposed algorithm is as given below

- The algorithm is divided into number of rounds.
- For the first round the nodes with the highest energy for that particular cluster, are selected as CHs, and data transmission is performed.
- At the start of second round, the CH send the residual energy of other members and calculate threshold at that CH.
- All the CHs will do the same and inter cluster communication is performed to reach at BS by selecting optimal CH.
- That CH will calculate Network Energy Range from Maximum and minimum Energy and transmit back to their member nodes.
- Now every node have energy range and can calculate threshold value.
- Now if threshold value of a node>= Threshold value, then that particular node will be selected as CH for next round.
- The Optimal CH at each round will send the information to the base station and do not involve Base Station to select CH at each round, this will reduce the energy consumption at each round.

In this way proposed algorithm will work. The proposed algorithm is based on LEACH protocol that is used to improve performance of wireless sensor network. By considering the residual energy and threshold value the proposed algorithm guarantee to increase the lifetime of the wireless sensor network.

Main area for consider for improvement performance of the wireless sensor network are:

Reduce energy consumption:

There are many clustering algorithm use to improve the lifetime of the wireless sensor network. The decision to select cluster head is based on the residual energy and certain threshold value that can be formulated using fitness function that is depend on the various parameter like average distance between sensor nodes and base station, network area etc.

The energy dissipation models for the transmitter and the receiver equation is given below [3]:

$$E_{TX}(I,d) = \begin{cases} IE_{elec} + IE_{fs}d^2, & \text{if } d \le d0 \\ IE_{elec} + IE_{mp}d^4, & \text{if } d > d0 \end{cases} \quad (4)$$

$$E_{RX}(l) = lE_{elec} \quad (5)$$

Where E_{elec} is the energy required to transmit or receive one bit and l is the length of the message.

The energy and time consumption at Base station can be reduced if the entire threshold is calculated at the CHS itself.

Improved Lifetime of node:

The node that have higher energy and threshold value than its residual energy will be selected as a cluster head that will increase the lifetime of the individual cluster member. Next cluster head decision is based on the Cluster head rather than base station which will help to increase the lifetime of member node and increase the lifetime of the whole wireless sensor network.

V. ANALYSIS OF SIMULATION RESULT

Number of experiment have been carried out for the compare the FLEECH with the proposed protocol. The performance gain in the proposed work is shown in below figure. Results have been taken for the Energy consumptions, Network lifetime and data sent to BS. Following table shows the simulation parameters.

Table 1 Simulation Parameter

Simulation Used	NS-2.35
Number of Nodes	50
Dimension of Simulation Area	1000 * 1000
Routing protocol	LEACH
Simulation Time	20 Sec
Antenna Type	Omni Antenna
MAC Protocol	802.11
Queue	Drop Tail
Channel Type	Wireless Channel

Energy Consumption

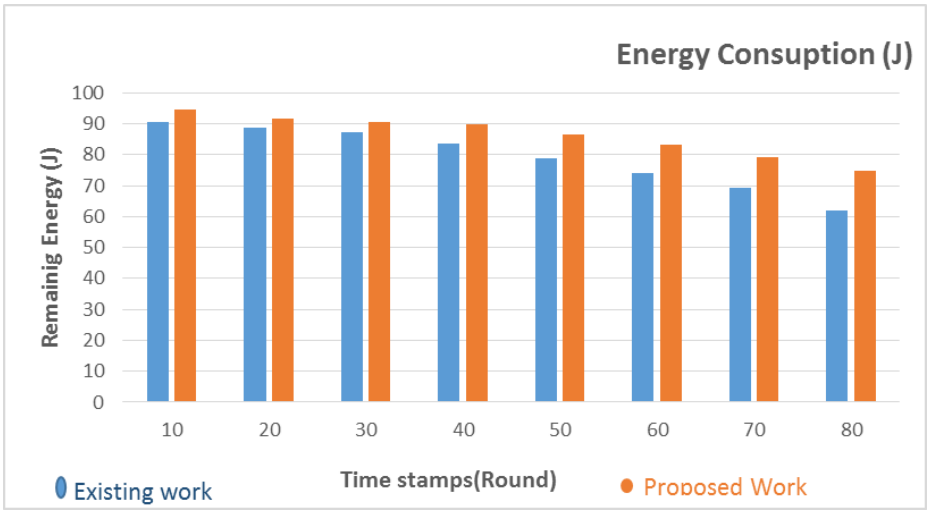

Fig: 1 Energy Consumption (time v/s Remaining Energy)

From fig. 1 we can conclude that our proposed protocol will work better than existing one. Proposed algorithm consume less energy compared to existing one.

Network Lifetime

Below fig. 2 shows the network lifetime of an existing and proposed work.

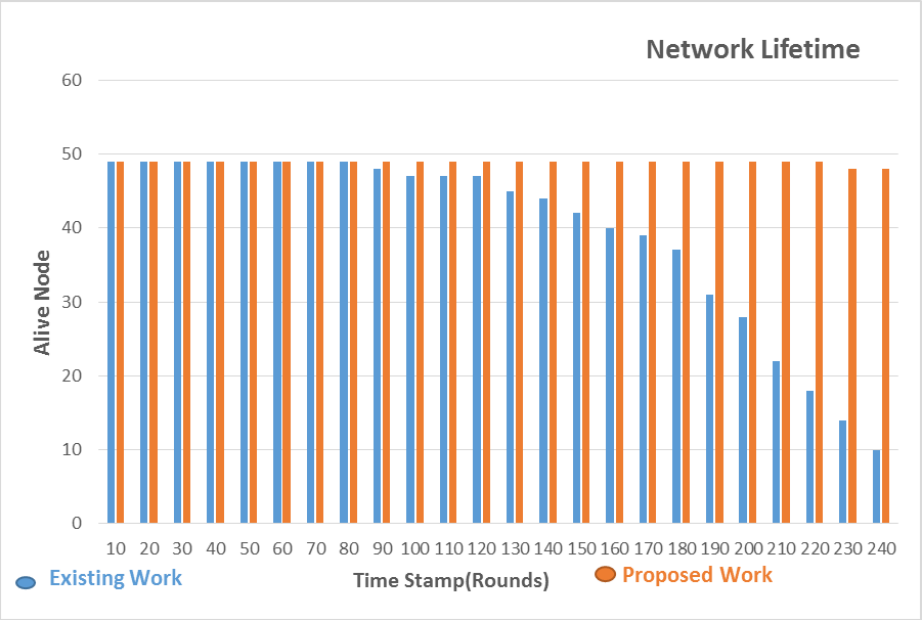

Fig: 2 Network Lifetime (Time v/s Alive Nodes)

As shown in fig 2 network lifetime will increase with the number of round increasing in the proposed work.

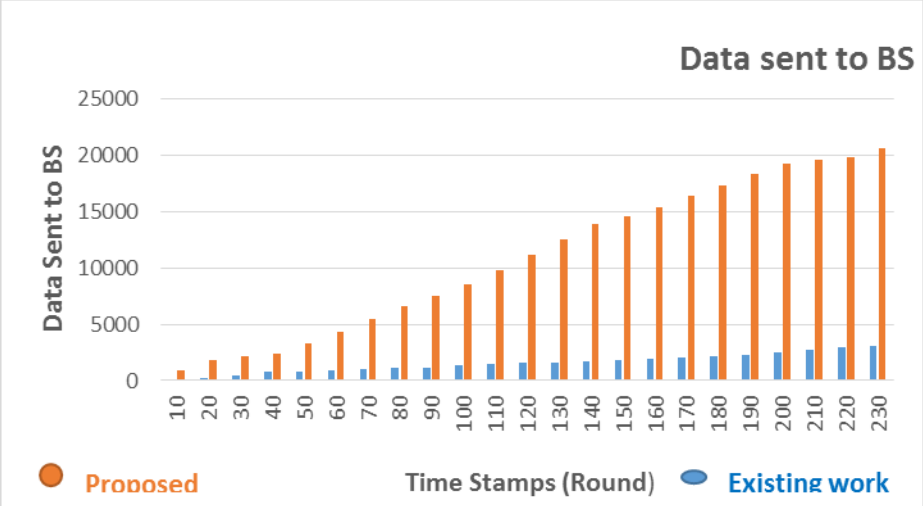

Fig: 1.3 Data sent to BS

As shown in fig 1.3 data packet sent to the BS will increase in the proposed work compare to existing work

VI. CONCLUSION

There are number of energy efficient techniques for wireless sensor networks that consists of mobile and fixed nodes that improve the cluster head selection method and improve lifetime of the wireless sensor network. In this work we have carried out the cluster head selection method to reduce the energy consumption of the wireless sensor network. Using the formulation lifetime of sensor network can be increase. By using appropriate threshold value proper cluster head will be selected, this will help to improve the lifetime of

the network. Proposed algorithm is perform better than the existing one in terms of energy consumption, network lifetime and data sent to BS.

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