An Improvement of Energy Efficiency Clustering Protocol by using K-Means Algorithm

Divya Prasad[1], Venkata Padmavati Metta[2],

[1]*Research Scholar, Department of Computer Science and Engineering, BIT, Durg, Chhattisgarh, India*
[2]*Professor, Department of Computer Science and Engineering, BIT, Durg, Chhattisgarh, India*

---***---

Abstract – *A Wireless Sensor Network (WSN) is a network which includes large number of tiny sensor nodes responsible for establishing a communication link between other sensor nodes. A power battery is used in a wireless sensor network for performing different task. But during the transmission of data between sensor nodes and to the Base station, it consumes more power.*
Due to this major problem, it affects the life time of a sensor network. Clustering is an effective method which reduces the consumption power. A new approach is proposed which is combination of developed distributed energy efficiency clustering protocol (DDEEC) with K-means algorithm. This approach is based on enhancing the performance of DDEEC protocol with K-means which is given by EK-DDEEC protocol. The simulation result shows that EK-DDEEC protocol improves the life time of a network and consumes less power to other protocols.

Key Words**: Wireless Sensor Network (WSN), Clustering algorithm, Developed distributed energy efficiency clustering (DDEEC), K-means**

1. INTRODUCTION

A network which includes large number of sensor nodes that communicate with each other through wirelessly is known as Wireless Sensor Network (WSN). For performing communication, Wireless Sensor Network includes a processor unit for processing data, a memory for storage, a battery for power supply and a radio set for transmitting or receiving data. There are many applications where Wireless Sensor Network is used, such as in health monitoring, military surveillance, air pollution monitoring, forest fire detection monitoring, industrial monitoring, disaster monitoring, etc.
A Wireless Sensor Networks are mostly in those areas where there are a more chances of loss of connection between the nodes [11]. A centralized algorithm is a conventional method which uses knowledge for global connectivity of the whole network and if there is a loss of data or connectivity, the protocol will also affects. A distribution algorithm is used to place a node in a partial manner, thus can prevents the loss of data. The low power battery is the biggest limitation in Wireless Sensor Networks [10]. To solve this problem, we proposed a clustering technique which is enhancement of DDEEC protocol with K-means algorithm known as enhancement of developed distributed energy efficiency clustering protocol by k-means (EK-DDEEC). This proposed work improves the life time of a network, also provides stability and balanced structure in a network.
The remaining part of the paper is given as follows: Section 2 includes the review of related work, Section 3 includes the radio energy model of a sensor network, Section 4 includes the propose work model, Section 5 includes the simulation result of the proposed work, and Section 6 includes the conclusion.

2. RELATED WORK

Wireless Sensor Network includes two types of clustering: homogeneous clustering and heterogeneous clustering. The clustering are applied to the homogeneous network known as homogeneous clustering and the clustering are applied to the heterogeneous network known as heterogeneous clustering. In [1], it describes the LEACH, which is a cluster based routing increase the efficiency of the network by distributing the energy. In [2], it describes the HRP, which are self- organize capabilities for deploying large scale of network. In [3], it describes the voting-based clustering algorithm which is used for maximizing the life time of a network by adding two load balancing design. In [4], it describes a distributed energy-efficient clustering algorithm which prolongs the network life time. It is based on the ratio between residual energy of each node and the average energy of the network. In [5], it describes an energy efficient heterogeneous clustered scheme for wireless sensor networks based on weighted election probabilities of each node to become a cluster head according to the residual energy in each node. In [6], it describes a Developed Distributed Energy- Efficient Clustering scheme which is based on changing dynamically and with more efficiency the cluster head election probability. In [7], it describes an energy efficient cluster formation algorithm based on a multi-criterion optimization technique. This is implemented as a distributed protocol in which each node makes its decision based on local information. In [8], it describes a hybrid multi-hop routing algorithm using flat multi-hop routing algorithms which minimize the total power consumption of the entire network. In [9], it describes equalized cluster head election routing protocol which conserves energy by using balancing clustering. The routing protocol includes the Gaussian elimination algorithm, calculates the combinations of nodes that can be chosen as cluster heads in order to extend the network lifetime.

3. RADIO ENERGY MODEL

A wireless sensor network consist a large number of sensors for transmission and receiving of the data. This all are done with the help of radio device or transmission-receiving device. A radio energy model includes a transmitter for transmitting, an amplifier for amplifying transmit data and a receiver for receiving data. The model of the radio energy is given in figure 1.

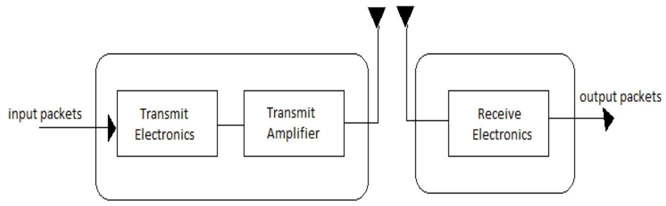

Fig-1: Radio Energy Model

Distance between the transmitter and receiver is given by distance d and this is used for calculating the free space (d^2) and the multipath fading (d^4) channels for the network. Power amplifier is used for setting down the power control loss by inverting it. A free space channel is selected, if distance d is less than threshold value d_0 and if distance d is greater than threshold value d_0, multipath fading channel is used. The transmit L-bit of data packet is given by

$$E_{Tx}(L,d) = \begin{cases} L.E_{ele} + L.E_{fst}.d^2 & if\, d < d_0 \\ L.E_{ele} + L.E_{am}.d^4 & if\ d \geq d_0 \end{cases} \quad (1)$$

Here, the energy of the electronic device E_{ele} is built on the factors i.e. digital coding, modulation and the spectrum of the signal transmit. $E_{fst}.d^2$ for free space and $E_{am}.d^4$ for multipath and the amplified energy is depends on the distance to the receiver and tolerable bit-error rate of the amplifier. The value of the threshold value distance d_0 is given by

$$d_0 = \sqrt{\frac{E_{fst}}{E_{am}}} \quad (2)$$

4. PROPOSED WORK MODEL

The proposed work model is title by enhancement of DDEEC protocol with K-means algorithm (EK-DDEEC). It includes same strategy like DDEEC protocol and the selection of the cluster heads by using K-means method.

In DDEEC, it includes initial and residual energy levels of the nodes which are usually elected for the cluster heads.
Every node needs the global knowledge of the network. To avoid this, DDEEC extends the standard value of the network lifetime and this is used for counting the reference energy which is used by all the nodes during every round. In this proposed work, we assume a wireless sensor network with N nodes, and all the nodes are placed uniformly within M × M square region.

Cluster hierarchy network are used to organize the network. The data is aggregated by the cluster head from nodes and the data is directly sent to the base station by cluster nodes. We assume that topology of the network is fixed and placed the base station at the center of the network. It includes two- level heterogeneous network, which includes two types of nodes i.e. a normal nodes '$(1-m_i)N$' and an advance nodes 'm_iN'. The initial energy of the normal node is given by E_0 and initial energy of the advance node is given by $E_0(1+a_i)$.
The calculation equation of the total amount of heterogeneous network initial energy is given by

$$E_{tot} = N(1-m_i).E_0 + m_i N.E_0(1+a_i) \quad (3)$$
$$= N.E_0(1+m_i.a_i)$$

The selection of cluster head is base on the residual energy of the network and the average energy of r^{th} round is given by

$$\overline{E}(t) = \frac{1}{N}E_{tot}.\left(1-\frac{r}{R_i}\right) \quad (4)$$

Where, R denotes the total rounds of network lifetime and R is given by

$$R_i = \frac{E_{tot}}{E_{round}} \quad (5)$$

and E_{round} is the total energy loss in the network during one round is given by

$$E_{round} = L\big(2N.E_{ele} + N.E_{da} + kE_{am}d_{To\ bs}^4 + NE_{fst}d_{To\ ch}^2\big) \quad (6)$$

Where, k denotes the number of clusters in a network, E_{da} denotes the cost of data aggregation in cluster head, $d_{To\ bs}$ denotes the average distance between the base station and the cluster head and $d_{To\ ch}$ denotes the average distance between cluster head and the cluster member.
We consider a network is equally distributed and the average distance between the cluster head and base station; and cluster member and cluster head is given by

$$d_{To\ ch} = \frac{M}{\sqrt{2k\pi}}, \qquad d_{To\ bs} = 0.765\frac{M}{2} \quad (7)$$

To balance the network we have change in the probability of cluster head and it is given by

$$p_n = \begin{cases} \frac{p_{opti}.E_i(r)}{(1+m_i.a_i).\overline{E}(r)} & for\ normal\ node \\ \frac{(1+a_i)p_{opti}.E_i(r)}{(1+m_i.a_i).\overline{E}(r)} & for\ advance\ node \\ c\frac{(1+a_i)p_{opti}.E_i(r)}{(1+m_i.a_i).\overline{E}(r)} & for\ adv\ and\ nml\ node \end{cases} \quad (8)$$

For increasing the performance of the DDEEC we have merge it with k-means algorithm.

K-means Algorithm-

The K-means clustering algorithm is the algorithm which is used for clustering approach. It obtains the cluster's centre point by minimizing the distance between the points assigned to that cluster and the virtual center. Then K-means algorithm is based on the Euclidian distances and cluster head selection.

The selection of cluster heads in K-means is given by the following steps-

- *Start Phase*: In this phase, all the clusters are divided into k non-empty subsets and computes base points as the centroids $C_j(i)j=1$ to k which are the index of centroids and i=1, where i denotes the number of the nearest nodes in the network. The remaining node determines its nearest CH according to the Euclidean distance.
- *Re-clustering*: In this phase, the centroid of each cluster is calculated. For finding the new cluster head (CH) in the cluster; the process is continuously occurred until the CH is not changed any more.
- *Election of cluster head:* After the clusters are created, an ID number is assigned to each node of a cluster according to the distance from the centroid, assigning smaller number to the closer one. The ID number of a node indicates the order to be chosen as the CH. Therefore, the ID number plays an important role in the selection of a node as CH.

  The connectivity of the network is retained by checking the residual energy of the CH every round. If this energy is smaller than the threshold, the node in the next order is selected as a new CH. The newly elected CH informs other nodes of the change of the CH.

5. SIMULATION RESULTS

The proposed approach has been implemented in MATLAB and the performance is evaluated by simulation, the lifetime of the network is measured in terms of rounds when the first sensor node dies. The base station is assumed in the center of the sensing region. All the parameters values including the first order radio model characteristic.

To compare the performance of the proposed approach with a two-level heterogeneous network is considered.

During performance of proposed protocol, we note that the network is subdivided into eight clusters that are correctly distributed over the sensing area. There is no intersection between the different clusters.

In the simulation results Figure-2, Figure-3 and Figure-4 gives the curves of the number of alive nodes, packets to base station and the number of dead nodes per round for each scenario.

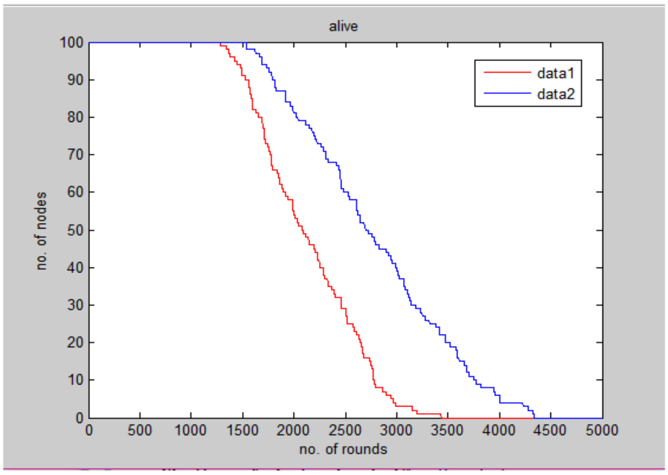

Fig-2: Alive nodes

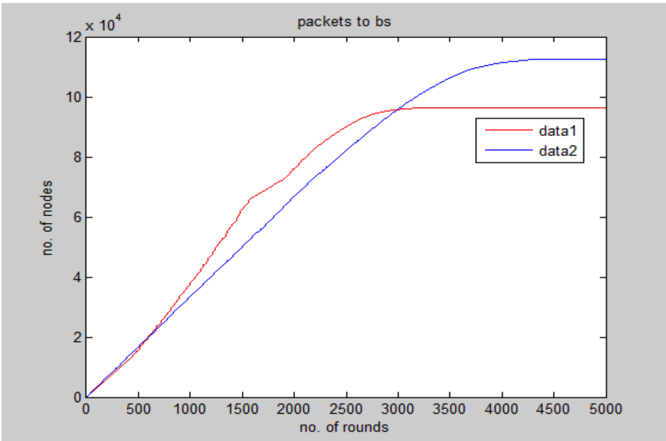

Fig-3: Packets to base station

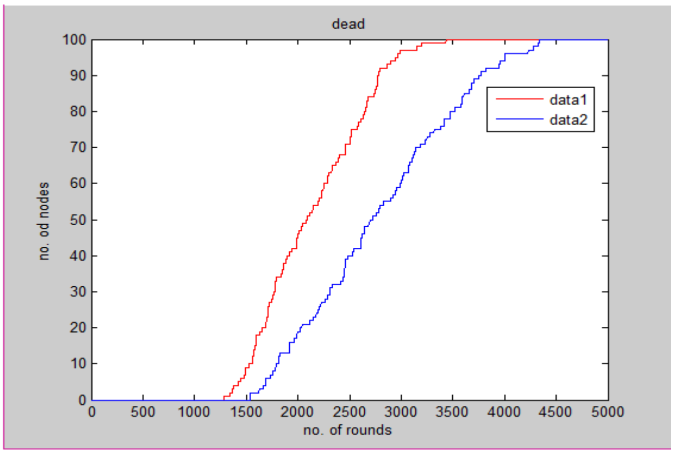

Fig-4: Dead nodes

Where, data 1 shows the curve of DDEEC protocol and the data 2 shows the curve of EK-DDEEC protocol.
The comparison table for simulation result is shows as the following table:

Table -1: Simulation results

Simulation Result	DDEEC protocol (no. of rounds)	EK-DDEEC protocol (no. of rounds)
Alive Nodes	1285	1542
Dead Nodes	1296	1535
Packets to base station	3137	2437

6. CONCLUSION

In this paper, we have showed the energy limitation of the DDEEC protocol. The simulation results show that equal-distribution of space between nodes in a network by using K-means algorithm and during election process; the residual energy of each node improves the life-time of a network. This technique improves the network performances by less energy dissipation and extending the network lifetime more efficiently.

REFERENCES

[1] Wendi Rabiner Heinzelman, Anantha Chandrakasan, and Hari Balakrishnan, 2000. Energy-Efficient Communication Protocol forWireless Microsensor Networks, 0-7695-0493-0/00 2000 IEEE.
[2] Zahariah Manap, Borhanuddin Mohd Ali, Chee Kyun Ng, Nor Kamariah Noordin, Aduwati Sali, 2013. A Review on Hierarchical Routing Protocols for Wireless Sensor Networks, Wireless Pers Commun DOI 10.1007/s11277-013-1056-5, Springers.
[3] Min Qin and Roger Zimmermann, 2005. An Energy-Efficient Voting-Based Clustering Algorithm for Sensor Networks, 0-7695-2294-7/05 $20.00 © 2005 IEEE.
[4] Li Qing, Qingxin Zhu, Mingwen Wang, 2006. Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks, Computer Communication, 29 (2006) 2230–2237.
[5] Dilip Kumar, Trilok C. Aseri, R.B. Patel, 2009. Energy efficient heterogeneous clustered scheme for wireless sensor networks, Computer Communication, 32 (2009) 662–667.
[6] Brahim Elbhiri, Saadane Rachid, Driss Aboutajdine, 2010. Developed Distributed Energy-Efficient Clustering for heterogeneous wireless sensor networks, IEEE, 978-1-4244-5998-8/10/$26.00 2010IEEE.
[7] Nauman Aslam , William Phillips, William Robertson, Shyamala Sivakumar , 2011. A multi-criterion optimization technique for energy efficient cluster formation in wireless sensor networks, Information Fusion, 12 (2011) 202–212.
[8] Ahmed E.A.A. Abdulla, Hiroki Nishiyama, Nei Kato, 2012. Extending the lifetime of wireless sensor networks: A hybrid routing algorithm, Computer Communication, 35 (2012) 1056–1063.
[9] Stefanos A. Nikolidakis, Dionisis Kandris, Dimitrios D. Vergados and Christos Douligeris, 2013. Energy Efficient Routing in Wireless Sensor Networks Through Balanced Clustering, Open Access Algorithms , 2013, 6, 29-42.
[10] Debnath Bhattacharyya, Tai-hoon Kim and Subhajit Pal, 2010. A Comparative Study of Wireless Sensor Networks and Their Routing Protocols, Sensors Open Access, Sensors 2010, 10(12), 10506-10523; doi:10.3390/s101210506.
[11] Kemal Akkaya, Mohamed Younis, 2005. A survey on routing protocols for wireless sensor networks, Ad Hoc Networks , 3 (2005) 325–349.