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Performance Evaluation of Fuzzy C Mean and Simulated Annealing based Clustering in WSN

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Abstract—*Cluster based routing technique is most popular routing technique in Wireless Sensor Networks (WSNs). Due to varying need of WSN applications, efficient energy utilization in routing protocols is still a potential area of research. In this research work, focus is made on the optimization of clustering and to balance the load over the routes so that energy can be used effectively. The proposed work tried to overcome the problem of random distribution of clusters in LEACH. In this study, the optimization of clusters is made by using Fuzzy C Mean Clustering that gives uniformity in the cluster due to central tendency so that a uniform density can be seen in the participating clusters. To further distribute the load of transmitting data through a planned routing scheme Simulated Annealing is used. The performance of proposed work is evaluated on MATLAB by comparing it with some existing protocols.*

1. INTRODUCTION

Wireless sensor network represents the group of sensor network where the size of network can vary from a few to thousands. WSN consist of a large number of sensor nodes deployed densely in sensor field, these sensors are small programmable devices with low power, low cost, multifunctional features and have self-organizing, processing, storage and communication capabilities. Sensor nodes are self-organizing in nature to make an appropriate structure of the network, to perform a particular task collaboratively. These groups of sensors sense the physical environment and transmit this information to sink for further estimation with wireless communication. Many sensors are connected to the controllers and processing stations directly, these sensors in a large number communicate, transmit and collects the sensed data wirelessly to a central processing node called the base station or sink.

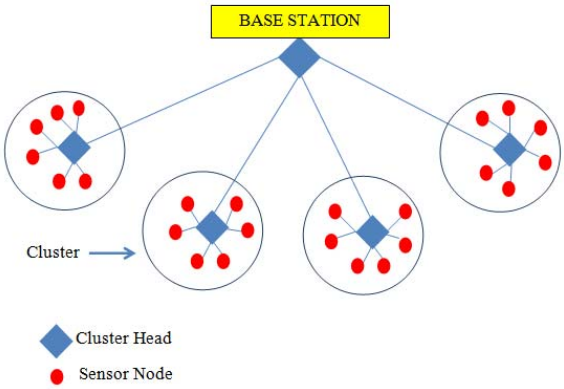

Figure 1: Architecture of wireless sensor network

ROUTING IN WSN

Routing is a process of searching a path between the source node and the final processing node (Sink or Base Station) for the transmission of data. Monitoring or tracking is the main objective of the wireless sensor network. According to the involvement pattern of sensors, routing protocols in WSN can be classified in to three methods which are given below:

DIRECT COMMUNICATION

In this method, all the nodes are directly connected to the base station and transmit their data directly to the base station. In this mechanism there are no intermediate nodes for the propagation of data. If this communication scheme is applied over a large area, the nodes drain their energy very quickly because they send their data directly.

CLUSTERING

In the clustering concept of this communication approach the cluster is made from a group of sensor nodes. Sensor nodes elect their cluster according to their signal strength, initial or remaining energy and distance from the cluster head. For

clustering the network field is divided into several clusters with the condition that each cluster has one cluster head. The cluster heads have the privilege to communicate with the base station directly.

2. RELATED WORK

W. Heinzelman *et al., (2000)* proposes LEACH (Low-Energy Adaptive Clustering Hierarchy) is a very first routing scheme which is based on cluster formation. It is a hierarchical routing protocol. Milt-hop communication scheme is used to provide communication between the sensing nodes. In this protocol, the selection of CHs is based upon probability. Therefore CHs distribution is not uniform. This leads to uneven distribution of CHs in the wireless network. As LEACH uses dynamic clustering scheme so it consumes more energy in cluster formation after every round. The basic operation of LEACH is divided in two levels. The first level includes, the setup phase, which is selection of cluster-head and formation of clusters. The second level includes data gathering, aggregation, and transmitting to the base station. The duration of the first level is assumed to be relatively shorter than the second level in order to minimize the protocol overhead.

Rab Nawaz, *et al.* (2009), emphasized on to efficiently energy usage of sensors and to increase the network lifetime. To do so a new hybrid technique of LEACH and LEACH-C has been proposed, which outperforms the conventional LEACH in terms of minimizing the overall energy consumption. In the proposed approach, two states have been declared the setup phase and the steady phase. In setup phase, temporary cluster head is chosen by the Base Station and the cluster head will maintain the record of the energy of the nodes in the cluster. And then, the node with the highest energy will become the cluster head and the lowest energy node will become the temporary cluster head for every round.

Deepak. S. Sakkari and T. G. Basavaraju (2012), The coverage problem has been discussed extensively in this paper; mainly the coverage associated with connectivity and span of network lifetime has been focused here. Constructing a well connected, properly encapsulated and power effective sensor network is impactful for real time applications, which is attributable to the limited resources of sensing nodes. This thorough study throws light on the latest research analysis and their related approaches for coverage of wireless sensor networks.

Prabhdeep Singh, *et al.* (2013), Wireless sensor networks comprises of low cost miniature sensor nodes that have a restricted transmission range and its processing, capabilities of storing and limited energy resources. These networks gather the piece of information from sensing nodes and transfer it to base station for further process. To perform routing in wireless sensing network with the limitation of power, energy and its storage capabilities is a main problem. Routing schemes are used for producing and maintenance of the routing in networks of sensors. The most significant consideration under designing policies for WSN is the power constraint of sensing nodes because of limited power. Cluster based routing scheme is capable to optimally maintain the power usage of sensing nodes by including them for multi-hop communication in a particular cluster. This paper presents a review on some power efficient clustering protocols such as LEACH, HEEP, PEGASIS TEEN in wireless sensor networks.

E.Prabashini and D.Sivakumar (2016), emphasize on the Energy of sensors which is a restricted resource in the wireless sensing networks. Clustering is an impactful way to improve the system progress of wireless sensing networks. We suggest an energy efficiency cluster based routing scheme in wireless sensor networks. In this scheme, we get knowledge in information transmission for cluster based wireless sensing networks, where the cluster formed are based on some appropriate arguments such as remaining energy of the sensing node, remaining buffer limit, and distance to sink. The Cluster head collects the piece of information and aggregated after finding an optimal path then send to sink.

Kamaldeep Kaur and Navjot (2016), authorizes a paper that explains a mixed approach of Genetic Algorithm (GA) and Fuzzy C-means clustering is suggested that provides good accuracy and elevates the rate of intrusion detection. This method provides a better accuracy to detection if compared to K-means and Fuzzy C Mean Clustering. With this proposed method intrusion detection rate is developed noticeably. This paper proposes genetic algorithm and fuzzy c-means clustering way to generate to detect intrusions. The goal of intrusion detection is to monitor network activities automatically, detect malicious attacks and to establish a proper architecture of the computer network security. We have used fuzzy data mining techniques to extract patterns that represent normal behaviour for intrusion detection.

3. PROPSED METHODLOLGY

The principle issue in WSN is its constrained energy assets as remote sensors are battery worked. Clustered based target coverage in WSN drags out the system lifetime. There are numerous bunching conventions that have been investigated in most recent couple of decades. In this paper we proposed a hybrid procedure by consolidating Fuzzy C Means grouping and Simulated Annealing (SA) for upgrading the system lifetime issue in WSN. Bunching is done on sensor hubs and target coverage for CH to base station for information transmission is settled as a compelling methodology for energy effectiveness in WSN. The no of CH is picked in view of no of alive hubs in the system rather than total no of hubs. To detect the target coverage between CH to BS the remote sensors are conveyed haphazardly. The proposed system in view of Simulated Annealing is best answer for advance target coverage on the network whose hubs are conveyed haphazardly. Simulated Annealing gives advanced target coverage to information transmission amongst CH and BS.

NETWORK MODEL

The proposed technique network model has 100 sensors nodes in wireless sensor network which are deployed in MXM (100X100) m area randomly. The sensor nodes are equipped with GPS or location aware system and they assumed to be fixed. The energy consumption is determined by the energy model which is same as LEACH protocol. The base station is assumed to be stationary or immobile in the centre of the network field. The sensor nodes at regular time interval sense the environment and send the information to their corresponding cluster head, whereas cluster head processes the data and relays it to base station. Similarly base station has all the responsibilities of receiving and processing data from cluster head, and then base station will present the overview of sensing field to the end user. The proposed method uses a network model that has certain characteristics that is mentioned below:

1. All the sensors nodes have limited energy and deployed randomly in an area.
2. All the sensor nodes have equal processing capabilities for wireless communication processing and transmitting the data.

FUZZY C-MEANS (FCM)

Fuzzy c-means (FCM) is a technique for clustering which enables a piece of information to get a place with at least two clusters. This technique (created by Dunn in 1973 and enhanced by Bezdek in 1981) is regularly utilized for clustering. This calculation works by allotting membership to each information that directly corresponding towards each cluster centre based on farness between the centre of the cluster and the information point. Progressively the close the information is to the centre of cluster the more is its membership towards the particular cluster centre. Clearly, summation of membership of each information point should be clearly equal to one. Fuzzy logic principles can be applied to cluster multidimensional information, doling out each point a participation in each cluster centre from 0 to 100 percent. This can be compared to conventional hard-threshold clustering where each point is doled out a crisp, exact mark.

The Optimal no. of clusters can be determined by calculating the derivative

$$copt = \frac{\sqrt{N}}{\sqrt{2\pi}} \sqrt{\frac{Efs}{Emp}} \frac{M}{\mathrm{d}^2\ \mathrm{toBS}} \quad (1)$$

Where,

C_{opt} is the no. of optimal clusters to be formed.

M is the network diameter

N is the total no of nodes deployed.

Once the number of cluster needed to be formed are calculated the base Station will gather the information of location of all the nodes deployed. On the basis of locations BS decides the centre of clusters using formula

$$cj = \frac{\sum_{i=1}^{N} x_i . u_{ij}^m}{\sum_{i=1}^{N} u_{ij}^m} \quad (2)$$

Where, j is the no of cluster

i is the no of nodes

m is the fuzzifier, here m=2

All the sensor nodes then calculate the degree of belongingness in all the clusters that are formed using the membership function

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{d_{ij}}{d_{kj}}\right)^{\frac{2}{m-1}}} \quad (3)$$

The higher value of membership coefficient (u_{ij}) of a node means that node has a strong participation in a given cluster. The membership function Matrix will have columns that will represent the no. of clusters and the row will represent the degree of belongingness of a sensor node in different clusters. The sum of all the values of degree of belongingness of a sensor in different cluster will be equal to 1.The purpose of the cluster formation in this protocol is to minimize the following objective function:

$$J_m = \sum_{i=1}^{c} \sum_{j=1}^{N} u_{ij}^m \, d_{ij}^2 \quad (4)$$

Hence on the basis of belongingness clusters are formed.

ANNEALING SIMULATED

Annealing is a procedure in metallurgy where metals are gradually cooled to influence them to achieve a condition of low vitality where they are exceptionally solid. Simulated annealing is practically equivalent to a strategy for enhancement. It is normally portrayed as far as thermodynamics is concerned. The irregular development relates to high temperature; at low temperature, there is little arbitrariness. Simulated annealing is where the temperature is decreased gradually, beginning from an irregular pursuit at high temperature in the end getting to be unadulterated voracious drop as its approach becomes near to zero temperature. The haphazardness should tend to bounce out of nearby minima and discover areas that have a low heuristic esteem; ravenous plunge will prompt neighbourhood minima. At high temperatures, compounding steps are more probable than at bring down temperatures

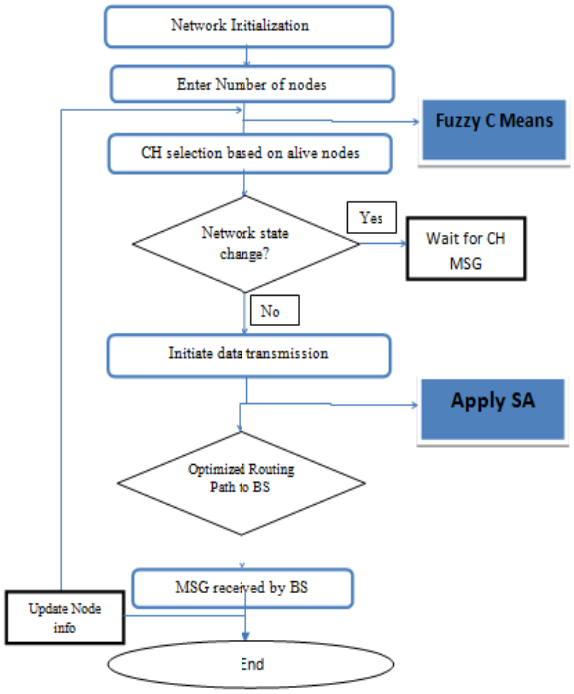

Figure 2: Proposed Architecture

4. RESULT ANALYSIS

Result analysis is based on parameters like Alive nodes, Dead nodes, Stability period and packets received by base station.

Figure 3 shows the experimental result is for alive nodes. In this figure x-axis represents total rounds of simulation and y-axis represents number of alive nodes. Here the proposed work compared with the existing traditional K-LEACH and EAMMH protocol in terms of alive node. The simulation is performed for 7000 rounds and we can clearly see that the network lifetime of K-leach is the highest as compared to our proposed work and EAMMH. K-LEACH has network lifetime of about 6400 rounds, our proposed work has around 5500 and EAMMH has around 2800 rounds. But if we see the graph pattern then our proposed work has performed more efficiently in intermediate states.

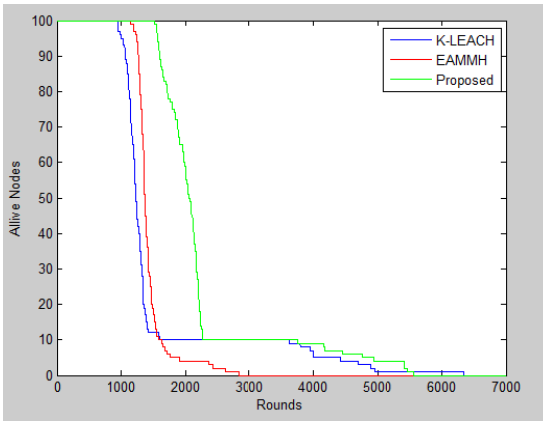

Figure 3: Alive nodes

From figure 4, we can clearly see that in our proposed work the rate of nodes getting dead is slower as compared to K-LEACH and EAMMH. The First node die time (FDT) of proposed work is around 1500 rounds whereas that of K-LEACH is around 900 and of EAMMH is around 1200.

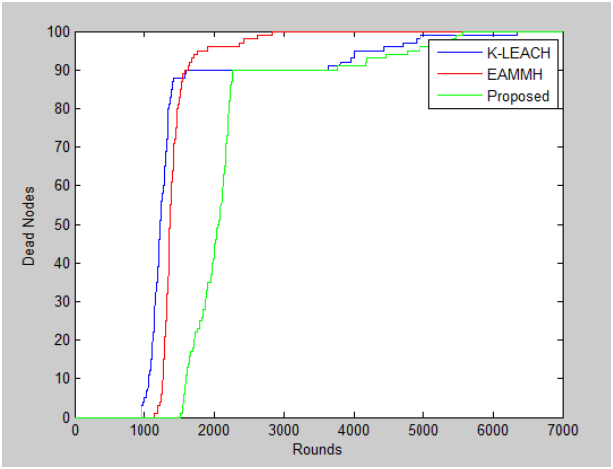

Figure 4: Dead nodes

Referring to figure 5, we can clearly see that the packets received by BS are actually maximum in our proposed technique if compared to other protocols. That clearly signifies that we have less packet drops and really good target coverage ability.

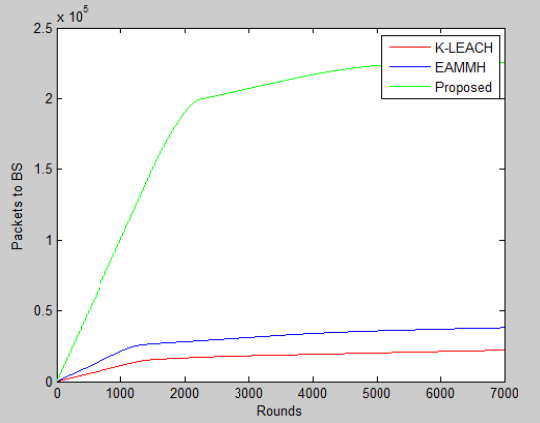

Figure 5: Packets to Base Station

5. CONCLUSION

A deeper understanding of the impact of Fuzzy C mean clustering and simulated annealing based load distribution over the routes between source and sink has been done by performing several simulations in the comprehensive study. The obtained results clearly depicts that the performance of our proposed work is enhanced by exploiting the soft clustering concept of Fuzzy C mean clustering. The simulation results helped me to present the comparative study of the proposed work with the already existing protocols. Apart from the simulation, experiment results also helped me to determine which variables affected the performance of the hierarchical network.

The main issue with the proposed work is it takes a lot of time for processing that actually makes the system performance slow. Hence, we can conclude that this method is actually good in terms of packets received to BS but it may take a lot of processing time.

REFRENCES

[1] Heinzelman, W.R., Chandrakasan, A. and Balakrishnan, H. "Energy efficient communication protocol for wireless micro sensor networks".*In Proceedings*HICSS '00 Proceedings of the 33rd Hawaii International Conference on System Sciences,IEEE Computer Society Washington, DC, USAJanuary 04 - 07, 2000, Page 8020

[2] Nawaz, R., Bilal, K.and Afzal, M. An Improved EnergyEfficient Cluster Based Routing Protocolfor Wireless Sensor Networks.Symposium on*Computersand Communications,* ISCC, 2009. IEEE, August 18, 2009, ISSN:1530-1346.

[3] Sakkari, D. S. and Basavaraju, T. G. "Extensive Study on Coverage and Network Lifetime Issues in Wireless Sensor Networks".*International Journal of Computer Applications*.(0975 – 8887). 2012, 52(8), pp. 39–46.

[4] Prabashini, E. and Sivakumar, D. Energy Efficient Cluster based Routing in Wireless Sensor Networks. *International Journal of Computer Science and Network Security.* 16 (3), March 2016, pp.125-128

[5] Kaur, K. and Kaur, N.A Hybrid Approach of Fuzzy C-mean Clustering and Genetic Algorithm (GA) to Improve Intrusion Detection Rate. *International Journal of Science and Research* (IJSR) 2015. pp. 8-10.