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Energy Evaluation of Sensor Protocol based on AI Techniques using CRAWDAD Data

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Abstract*: *Wireless sensor networks (WSNs) are one of popular communication networks that have garnered most prominent research attention due to their flexibility to sense physical environment parameters and converts into signal form. Battery power is limitation of WSN i.e. network will alive till battery is available. The network lifetime of WSN can be improved by use of energy-efficient cluster-based routing algorithms. In this paper, a key idea is attempting to improvise the LEACH protocol with the help of various clustering techniques and develop improved protocol such as LEACH-K, LEACH-FUZZYC, and LEACH-SOM. Simulation results show that LEACH-FUZZYC outperforms as compare to LEACH, LEACH-K and LEACH-SOM.

***Index Terms*: LEACH, clustering techniques, K-means, Neural Network, Fuzzy c-means.**

I. INTRODUCTION

Wireless sensor networks (WSNs) [1] are made up of networks of sensor nodes. When sensor nodes communicate one another via radio signals deployed in range from hundreds to thousands deployed at particular area than whole network is known as wireless sensor network. This type sensor network has many characteristic properties such sensing more than one parameter, processing and manipulation on parametric values etc. From these sensors a huge range of data is generate and collected from Base Station (BS) node. Due to less cost and easy to deploy sensor networks are most popular in present day. Starting from weather monitoring application to high end weapon designing application these sensor networks are used [1], [2], [3]. The main property which attracts to choose WSN is it can do work in any harsh environment without the intervention of human. So, it can be deploying in indoor as well as outdoor scenarios. The configuration requirement and its radio functionality and other processing capabilities are totally depending on the scenario or application it will be deployed. For example, in weather forecasting applications, mainly sensor nodes that should be deployed must be very strong i.e not brittle in nature. Equipment's are made up of best quality material so that it can resists outside environment. Another thing for weather forecasting is proper calibrated sensor must be installed and have self-configurational properties. Each sensor is equipped with battery. So, protocol in each node should be energy efficient. Hence, these are some main requirement for weather forecasting scenario. As Battery power in each scenario is major constraint. Therefore, we need to apply that type network which consumes less processing and computational cost in terms of battery power. LEACH protocol is most popular protocol which come under hierarchical protocol and do work on clusters basis. The whole sensor network divided into some specific number for clusters and based on some threshold value out all sensor node some sensor nodes elected as cluster heads. Other sensor nodes from clusters by selecting one cluster head node and transmit the monitored data. This process of election of cluster head, transmission of monitored data repeats round by round so that sensor node does not die rapidly. But still there is a strong possibility of improvement in present LEACH protocol, need more efficient protocol. So in this paper we have attempted to apply various artificial approaches on sensor network protocols [1],[2],[3]. In this paper section 2 is dedicated to LEACH Protocol, in section 3 we discuss briefly various artificial intelligence techniques and section 4 for implementation and section 5 represents experimental results and in the last section we conclude our work.

II. LEACH PROTOCOL

LEACH means Low-Energy Adaptive Clustering Hierarchy protocol [3], [4]. It is based on clustering the sensor nodes deployed in the application environment to collect the physical phenomena values into digital form. It works on simple criteria that out of all sensor nodes few sensor nodes are elected as cluster head node. Election of sensor node act as cluster head provides the extra functionality to CH node to collaborate the other neighboring sensor node for particular round. After dispersion of control message to all neighboring node, each node will send confirmation message that mean to be part of that CH node for that round. All collaborative sensor nodes to particular CH node is called non-CH nodes. After sensing the data rather than sending data to Base station which is done traditional protocols. Each non-CH node disseminate its data to CH node. CH node aggregates the data in steady phase of LEACH protocol[5]. After collecting whole data, it sends the data to Base Station. This process repeats round by round. CH head rotation is process which follows after every round in that process the sensor node once elected as CH node not able to become CH again. LEACH protocol maintain the list of sensor elected as CH node and non-CH nodes.

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For every round the election is done from non-CH nodes. It is also not a random process there are various parameters on basis of that election of CH node is possible from non-CH node list. These parameters are remaining energy of node, concentration of node, center of vicinity of node etc[8],[9].

The energy consumption of each CH node is totally depends on two concepts which are aggregation of data and data transmission to sink nodes. To compensated reduced energy of CH node, cluster head rotation operation is performed after every round completes.

III. CLUSTERING TECHNIQUES

A. K-means

K-means algorithm is categorized into unsupervised algorithm extensively used for clustering huge range of data. K-means is also help to solve complex mathematical problems [10]. It is generally selected for clustering the sensed data into defined number of clusters. This algorithm initially set 'k' number of centriods and therefore uses "euclidean distance" for computing the distance from the centroids to form various clusters. Best choice is to distribute centriods farthest from each other. The main aim of this algorithm is to minimize an *objective function*, in this case a squared error function[8].

The objective function is computed by:

$$J = \sum_{j=1}^{k} \sum_{i=0}^{n} ||m_i^{(j)} - n_j||^2 \qquad (2)$$

B. Fuzzy C Means

Fuzzy C Means Clustering approach is one of the most popular clustering approach in artificial intelligence field. In this approach, input data is clustered based on some categorical strategy. This is totally depending on the application we need to apply this approach. The member-ship value is denoted to some specific range of categories of parameter to perform clustering. Specifically, sensor dataset contains different value at different time. For example, if sensor monitors temperature parameter than if membership value should be denoted than the range temperature value is define itself by Fuzzy c means approach. The clusters can be properly distinguished as due to membership value lie between 0 to 1 [10]. The objective function which computes the clusters is as follows:

$$J = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^{m} \; ||x_i - c_j||^2 \;, \quad 1 \le m < \infty \qquad (3)$$

C. SOM Neural Network

Self-Organizing Maps (SOM) neural network [9], [11], [12] is fall under the category of unsupervised learning techniques and used to optimize complex problems. In this technique it suggests that there is no existence of teacher. SOM neural network is mainly used to categorize the data based on some parameters. The Dataset is split into two parts: training set and test set. Training set data is near about 80 % and test set data 20 %. The training set data is embedded into SOM neural network. It learning and adjust the weight vector according the input data. Than we classify the analysis based on the test data. The performance is checked later. How well perform the model? In most of the cases SOM neural network is perform well when large dataset is embedded during the training phase. Finally, the categorized data can be visualized into different clusters[10],[11],[12]. Clustering is main motive achieved in better way.

IV. IMPLEMENTATION

The LEACH protocol is discussed in section 2. LEACH protocol has been described using various clustering techniques which have been discussed in section 3. The LEACH flow-chat shows details regarding various steps include in the process of execution. As shown in fig.1. Starting from initial parameters set-up leads to lifetime close step. Process of selection of cluster heads falls under cluster setup phase under which few sensor nodes selected as cluster heads. Next step is data aggregation at cluster heads from connected sensor nodes to their corresponding cluster heads. After this phase, one by one clustering techniques have induced in this protocol and record the network lifetime.

V. EXPERIMENTAL RESULTS

Simulation implementation is done using MATLAB (2013a). As in section IV has discussed how actual LEACH protocol implemented with three clustering techniques. Now, in this section represents experimental results and analysis. Fig.2 shows the CRAWDAD dataset that has been taken for experiment. CRAWDAD is community resource for archiving wireless data at Dartmouth. This dataset is available online. With the use of temperature parameter from this dataset LEACH protocol is processed. Three clustering algorithms are implemented one by one over LEACH protocol such as LEACH-K (K-means), LEACH-FUZZYC (Fuzzy c-means), and LEACH-SOM (SOM neural network). Fig3. Shows K-means clustering result i.e 2 clusters are created one is red in color and another is blue in color. Circle-crossed mark shows centroids of K-means clusters. Fig. 4a shows data in random view. Fig 4b shows clustered data into 4 clusters represented in different colors with help of Fuzzy c-means clustering. Fig.5 shows membership function graphs for each cluster. Fig. 6 and Fig. 7 show results by SOM neural network. It is weight position representation of SOM neural network. Fig. 8 shows comparative analysis for energy parameter for four routing protocols such as LEACH, LEACH-K, LEACH-FUZZYC, and LEACH-SOM.

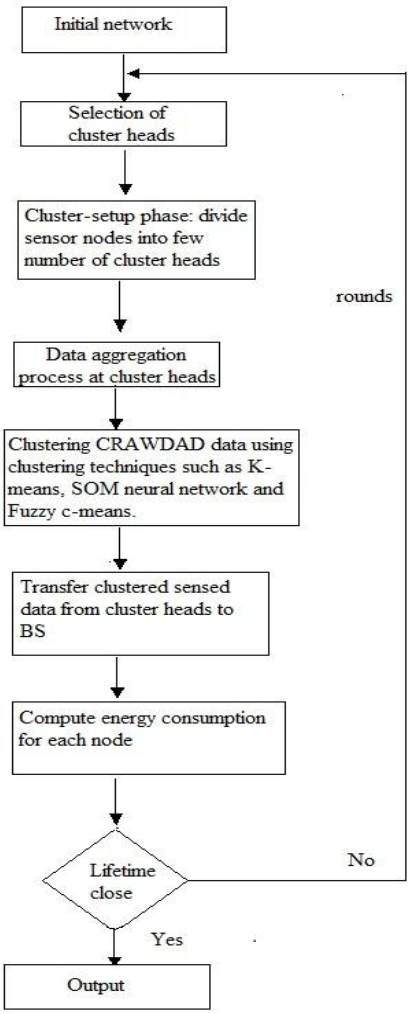

Fig. 1 Flow-chat of Clustering based LEACH protocol

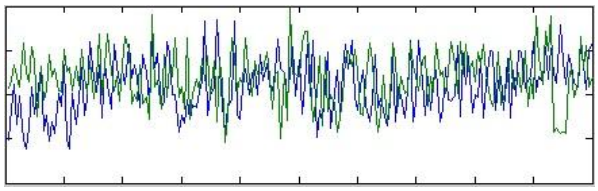

Fig. 2. CRAWDAD temporal sensor dataset

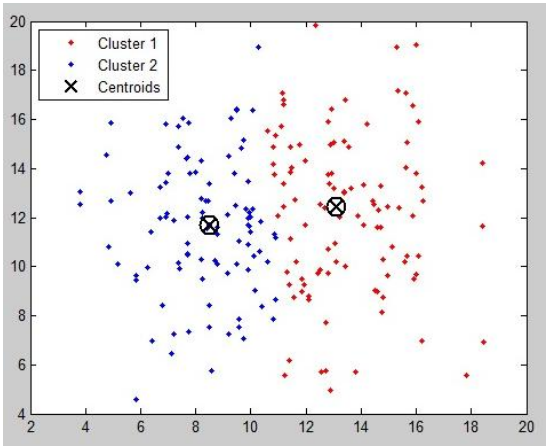

Fig. 3. Kmeans clustering on sensor data

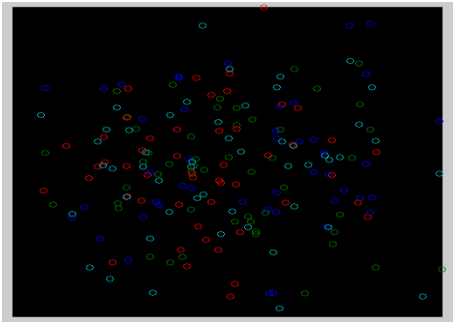

Fig. 4a. Fuzzy C-means clustering before clustering

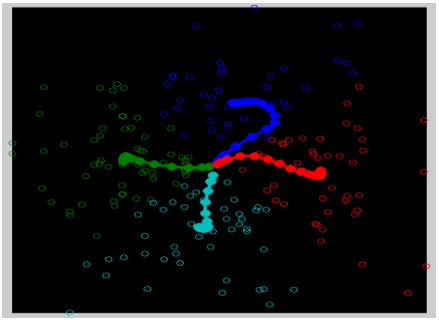

Fig. 4b. Fuzzy C-means clustering into 4 clusters

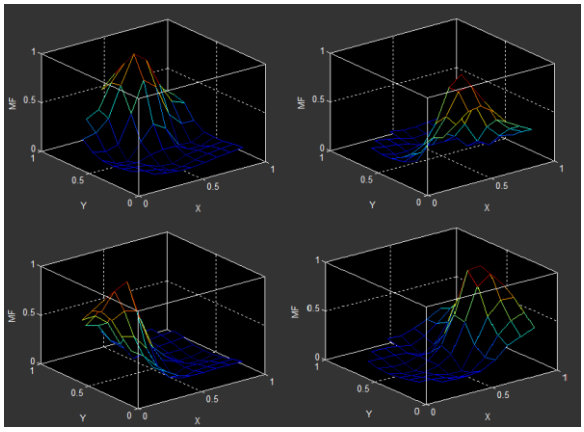

Fig. 5. Membership Functions for four different clusters

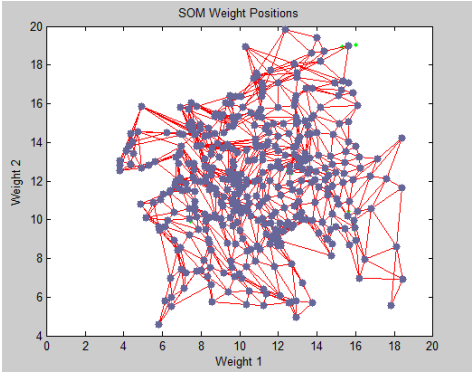

Fig. 6. Weight positions for sensor dataset based on SOM neural network

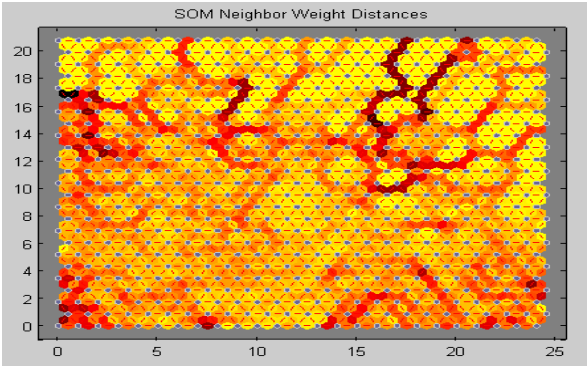

Fig. 7. SOM Neighbor weight distances

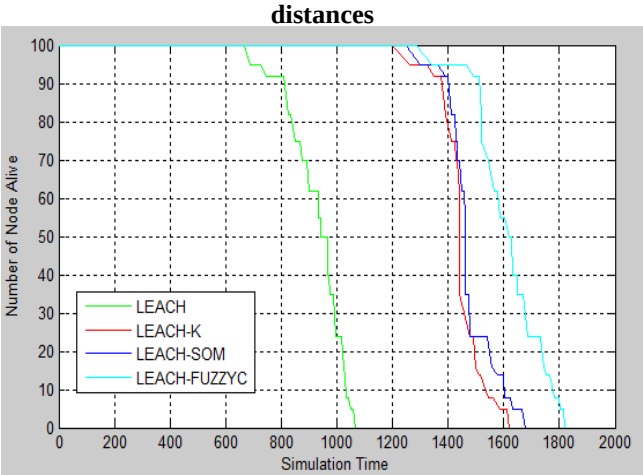

Fig. 8. Comparative analysis of network lifetime

VI. CONCLUSION

The improved energy system is main aim in wireless sensor network. To get this system, main requirement to overcome major constraints like battery life, packet delivery delay, latency etc. In this paper, various clustering techniques like K-means, Fuzzy c-means and SOM neural network has been implemented on LEACH protocol after data aggregation process completed at cluster head nodes. This helps to reduce huge amount of data into greater extent. As experimental values shows various results with various clustering techniques. Fig.8 represents the network lifetime of 4 protocols. It shows that LEACH-FUZZYC protocol performs best out of other protocols.

REFERENCES

1. Akyildiz I.F.,Su W. ,Sankarasubramaniam Y., Cayirci E., *Wireless sensor networks: a survey*, Computer Networks, vol. 382, pp. 393–422 (2002).
2. Heinzelman W. R., Chandrakasan A., Balakrishnan H., *Energy-Efficient Communication Protocol forWireless Microsensor Networks*, Proceeding of IEEE International Conference System Science, Hawaii, pp. 1 -10 (2000).
3. Heinzelman W. R., Chandrakasan A.,Balakrishnan H., *An Application-Specific Protocol Architecture for Wireless Microsensor Networks*, IEEE Transaction Wireless Communication, vol.1, pp. 660-670, (2002).
4. Oh H., Chae K., *An Energy-Efficient Sensor Routing with low latency, scalability in Wireless Sensor Networks*, International Conference on Multimedia and Ubiquitous Engineering, pp. 147-152 (2007).
5. Mittal M., Kumar K., *Network Lifetime Enhancement of Homogeneous Sensor Network Using ART1 Neural Network*, Sixth International Conference on Computational Intelligence and Communication Networks, pp. 472-475 (2014).
6. Laurene Fausett, *Fundamentals of Neural networks: Architecture, Algorithm and Applications*, Pearson Education (1994).
7. Mittal M., Kumar K., *Delay Prediction in Wireless Sensor Network Routing Using ART1 Neural Network*, IEEE, African Journal of Computing & ICT Vol 8. No. 3, pp. 175-180 (2015).
8. Enami N., Moghadam R. A., *Energy Based Clustering Self Organizing Map Protocol For extending Wireless Sensor Networks lifetime and coverage*, Canadian Journal on Multimedia and Wireless Networks, vol.1, pp. 42-54 (2010).
9. Mittal M., Kumar K., *Data Clustering In Wireless Sensor Network Implemented On Self Organization Feature Map (SOFM) Neural Network*, published in IEEE international conference on Computing Communication and Automation(ICCCA) (2016).
10. Mittal M., Kumar K., *Quality of Services Provisioning in Wireless Sensor Networks using Artificial Neural Network: A Survey*, International Journal of Computer Application (IJCA), pp. 28-40 (2015).
11. Mittal M., Bhadoria R. S., *Aspect of ESB with Wireless Sensor Network*, Exploring Enterprise Service Bus in the Service-Oriented Architecture Paradigm", igi-global publications, pp. 319 (2017).
12. Mohannad A. Alswailim, Hossam S. Hassanein, Mohammad Zulkernine, "CRAWDAD dataset queensu/crowd_temperature, 2015.(http://crawdad.org/queensu/crowd_temperature/20151120/temperature)

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