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Clustering Techniques to Analyze Communication Overhead in Wireless Sensor Network

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ABSTRACT:
Wireless Sensor network is a tiny sensor device about a cubic size having sensors and small battery, which enables applications that connect the physical world with pervasive networks. These sensor devices do not only have the ability to communicate information across the sensor network, but also to cooperate in performing more complex tasks, like signal processing, data aggregation and compression in the network rather than out of the network. The major problem with wireless sensor network is their limited source of energy, the courage constraint and high traffic load. In this paper we introduce various clustering techniques which are to be used to reduce communication overhead and increase network's lifetime. In the present work, the comparative evaluation of communication overhead for the wireless sensor network based on clustering technique is carried out.

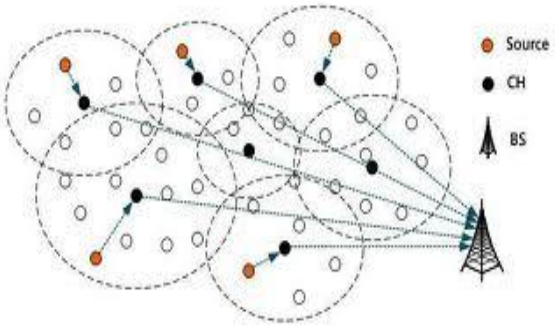
Keywords– Wireless sensor network (WSN), Clustering, K-means algorithm, Fuzzy clustering algorithm.

I. INTRODUCTION

Wireless Sensor Networking is a network of wireless sensor nodes deployed in an area. The wireless sensor network consists of the sensor nodes. The components of wireless sensor networks are sensing unit, processing unit and communication unit. The sensing unit senses the surroundings and acquires the data. The processing unit processes the acquired data and removes the redundancy. The communication unit acts as a transceiver, i.e. it receives the data and also transmits it. Wireless Sensor Networks (WSN) now-a-days is very popular for its specialty.WSN applications are having wide variety of domain. It include right from military application to farming application. The surveillance system for enemy or threat, the precision agriculture where farmer can control the temperature, humidity, etc. are the few examples of WSN applications. Health domain is having full of challenges with which the WSN can play important role in monitoring and disseminating the data to base station. Every application of WSN comprises of a set of sensor nodes and the base station called as sink. It is a sort of distributed system where all the nodes can work together to convey the data up to the sink. The entire node senses the data, depending on the application and sends it to the sink. The data may be reaching up to the destination in a single hop or through multi hop. In single hop, the data acquired by each node is transmitted to the base station directly. In multi hop, the data to be transmitted to the base station is through a number of nodes, i.e. the nodes transmit their data to the next node which is then transmitted to the next node, and finally to the base station.

II. CLUSTERING

In order to reduce the energy consumption a clustering and node redundancy approach has been extensively studied. In Clustering approach, sensor nodes are divided into clusters. Each cluster has a leader which is called cluster head (CH) aggregate all the data received by members of cluster and sends aggregated data to Base Station (BS). Clustering allows aggregation of data. It helps in removing the redundant data and combining the useful data. It limits the data transmission. The cluster system gives an impression of a small and very stable network. It also improves the network lifetime by reducing the network traffic.



III. CLUSTERING ALGORITHM

Clustering algorithms are designed to reach goals like a specific cluster structure and cluster-head distribution respectively. Also load-distribution among CHs, energy saving, high connectivity, and fault tolerance are often emphasized goals. Clustering provides re-source utilization and minimizes energy consumption in WSNs by reducing the number of sensor nodes that take part in long distance transmission. Cluster based operation consists of rounds. These involve cluster heads selection, cluster formation, and transmission of data to the base station. The operations are explained below.

1) Cluster Head Selection

In order for a node to become cluster head in a cluster the following assumptions were made.

- All the nodes have the same initial energy.
- There are *S* nodes in the sensor field.
- The number of clusters is *K*.

Based on the above assumptions, the average number of sensor nodes in each cluster is *M* where

$$M = S/K$$

After *M* rounds, each of the nodes must have been a cluster head (CH) once.

2) Cluster Formation

The next step in the clustering phase is cluster formation after CHs have been elected. Below gives the description of new cluster formation.

Step 1: The new cluster heads elected above broadcast advertisements (ADV) message to all non-cluster nodes in the network using Carrier Sense Multiple Access (CSMA) MAC Protocol.

Step 2: Each sensor node determines which clusters it will join, by choosing CH that requires minimum communication energy.

Step 3: Each non-cluster node uses CSMA to send message back to the CHs informing them about the cluster it wants to belong.

Step 4: After CHs have received messages from all nodes, Time Division Multiple Access (TDMA) scheduling table will be created and send it to all nodes. This message contains time allocated to each node to transmit to the CH within each cluster.

Step 5: Each sensor node uses TDMA allocated to it to transmit data to the CH with a single- hop transmission and switch off its transceiver whenever the distance be-tween the node and CH is more than one hop to conserve energy. To avoid a single node transmitting data multiple times in one round, we set a threshold value *G*. *G* is the total time of all nodes in the cluster forwarding their data to the CH in one round.

Step 6: CHs will issue new TDMA slots to all nodes in their clusters when allocated time for *G* has elapsed, for each node to know exact time it will transmit data to avoid data collision during transmission that can increase energy consumption.

Step 7: CH transceiver is always turn-on to receive data from each node in its cluster and prepare them for inter-clusters transmission. Inter-cluster transmission is of two types: single hop and multi-hop [23,24]. We adopted multi-hop transmission in order to save more energy during inter-cluster transmission.

3) Transmission of Data

After all data has been received, the CH performs data fusion function by removing redundant data and com-presses the data into a single packet. This packet is transmitted to the base station via multi hops transmission. After a certain period which is calculated in advance, the next round starts with the election of new CHs using our initial algorithm as described in 1 above and formation of new clusters as explained in 2.

3.1 K-means Clustering

K-means is one of the simplest algorithms that solve the well known clustering problem. The efficient cluster head selection method using K-means algorithm to maximize the energy efficiency of wireless sensor network. It is based on the concept of finding the cluster head minimizing the sum of Euclidean distances between the head and member nodes. The K-Means method is numerical, unsupervised, non-deterministic and iterative technique. It is used to partition an image into *K* clusters. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids,[5] one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early group age is done. At this point we need to re-calculate k new centroids as barycenters of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move anymore. K-Means clustering generates a specific number of disjoint, flat (non-hierarchical) clusters. It is well suited to generating global clusters. K-means clustering is responsible for reducing communication overhead, energy consumption in wireless sensor network and increases network's lifetime The basic K-mean algorithm describes following:

Step1.Choose the number K of clusters either manually, randomly or based on some heuristic.

Step2.Generate K clusters and determines the cluster's center.

Step3. Assign each pixel in the image to the cluster that minimizes the variance between the pixel and the cluster center

Step4.Re-compute cluster centers by averaging all of the pixels in the cluster.

Step5.Repeat steps 3 and 4 until some convergence criterion is met.

3.2 Fuzzy Clustering

In hard clustering, data is divided into distinct clusters, where each data element belongs to exactly one cluster. Fuzzy clustering methods, however, allow the objects to belong to several clusters simultaneously, with different degrees of membership. In many situations, fuzzy clustering is more natural than hard clustering. Objects on the boundaries between several classes are not forced to fully belong to one of the classes, but rather are assigned membership degrees between 0 and 1 indicating their partial membership. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters. One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) Algorithm. The algorithm of fuzzy c-means clustering is as follows:

Step1. Choose a number of clusters in a given image.

Step2. Assign randomly to each point coefficients for being in a cluster.

Step3**.** Repeat until convergence criterion is met.

Step4. Compute the center of each cluster.

Step5**.**For each point, compute its coefficients of being in the cluster [4-5].

IV. SIMULATION RESULT

Simulation was carried out in Matlab. As seen from Figure (1) communication overheads increases significantly when velocity of sinks nodes increases using K-means clustering algorithm.

Figure (2) shows using Fuzzy clustering algorithm communication overhead increases with velocity on sink node and drops at the end.

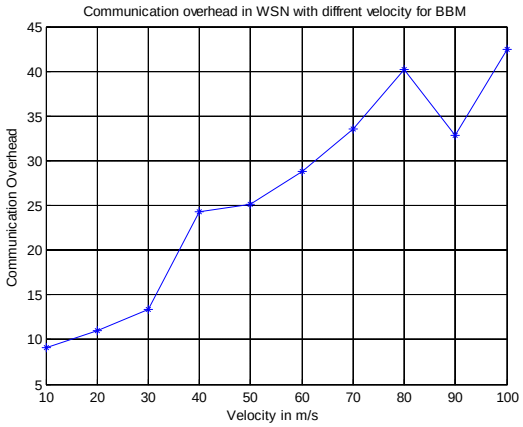


Figure (1)

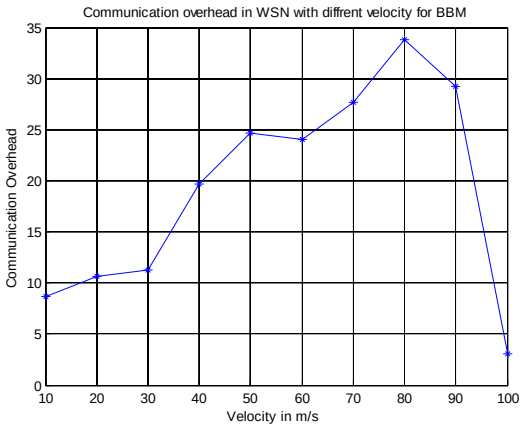


Figure (2)

V. CONCLUSION

As a result of these experiments, we evaluated the communication overhead in WSN using K-means clustering algorithm and Fuzzy clustering algorithm. We find that FCA is stable and energy efficient algorithm because it gives the low communication overhead as compare to K-means algorithm.

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