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PERFORMANCE COMPARISON OF FCM AND K-MEAN CLUSTERING TECHNIQUE FOR WIRELESS SENSOR NETWORK IN TERMS OF COMMUNICATION OVERHEAD

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Abstract:

Wireless Sensor Networks are consists of several sensors which are connected through a gateway using wireless communication. These smart sensors are directly interacting with environmental condition such as temperature, pressure, humidity, vibration etc. and communicate these over the wireless network. Communication overhead is increase when any sensor node is fail. The protocol will follow multiple path to destination node. So energy consumption is more. Multiple paths are increased when sink node is mobile. In this paper we introduce cluster technique for making cluster in network to reduce communication overhead due to less connection with sink and make the network hierarchical. We use two technique k-mean and fuzzy c-mean algorithm for making cluster .k-mean is useful for stationary sink node and fuzzy c-mean is useful for mobile sink node due to fuzziness of nodes in cluster. In this paper we compare both algorithms.

Key Words: - FCM, Kmean, Clustering, overhead, wireless Sensor Nertwork.

1. Introduction

Wireless Sensor Networks have emerged as an important new area in wireless technology. In the near future, the wireless sensor networks are expected to consist of thousands of inexpensive nodes, each having sensing capability with limited computational and communication power [1] , [2] which enable us to deploy a large-scale sensor network.

A wireless network consisting of tiny devices which monitor physical or en-vironmental conditions such as temperature, pressure, motion or pollutants etc. at different areas. Such sensor networks are expected to be widely deployed in a vast variety of environments for commercial, civil, and military applications such as surveillance, vehicle tracking, climate and habitat monitoring, intelligence, medical, and acoustic data gathering. The key limitations of wireless sensor net-works are the storage, power and processing. These limitations and the specific architecture of sensor nodes call for energy efficient and secure communication protocols. The feasibility of these inexpensive sensor networks is accelerated by the advances in MEMS (Micro Electro mechanical Systems) technology, combined with low power, low cost digital signal processors (DSPs) and radio frequency (RF) circuits [3], [4].They consists of a radio transceiver, microcontroller, power supply, and the actual sensor. The sensing circuitry measures ambient condition related to the environment surrounding the sensor and transforms them into an electric signal. Processing such a signal reveals some properties about objects lo-cated and/or events happening in the vicinity of the sensor. The sensor sends such collected data, usually via radio transmitter, to a command center (sink) either 2 directly or through a data concentration center (a gateway).

Wireless Sensor Networks are challenging network as resources are limited and different topologies are possible.

The proper optimization of communication overheads in WSN is an important issue which requires significant amount of effort on the part of designer. Large efforts are being made to optimize or minimize the communications overheads. Wireless sensor networks are dynamic in nature so resource optimization is very important. Establishing a secure communication link in a wireless sensor network is a challenging task due to little resource.

2. Communication Overhead in WSN

In Wireless sensor Network (WSN) data are transmitted from source to destination with multiple route. It follows multiple intermediate node. Problem occurred when intermediate nodes fail. And it doesn't support to forward incoming messege to other node. To make reliable system topology provide multiple path from source to destination node and sending same data from source to destination node through multiple route. due to this technique traffic increased therefore more energy consumed than previous path. The different network protocol like query based routing, Negotiation based routing, quality of service based routing, multiple path based routing etc decides the overhead in WSN. In [3] authors have carried out a comparative evaluation of communication overhead due to sink mobility with speed variations, the effect of update time variation, the effect of number of nodes

used in the WSN. It has been demonstrated by authors that the communication overheads increase significantly when sink mobility is high. The communication overheads can be reduced by increasing update time.

In the past few years, intensive research that addresses the potential of collaboration among sensors in data gathering and processing, and coordination and management of the sensing activity was conducted. In most applications, sensor nodes are constrained in energy supply and communication bandwidth. Thus, innovative techniques to eliminate energy inefficiencies that shorten the lifetime of the network and efficient many routing, power management, and data dissemination protocols have been specifically designed for WSNs, where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture.

3. Clustering in WSN

The major advantage of WSN is the ability to deploy it in an ad-hoc manner, as organizing these nodes into groups pre-deployment is not feasible. For this reason, a lot of research has been conducted into ways of creating these organizational structures (or clusters). A clustering scheme divides the sensor nodes in a WSN into different virtual groups, according to some set of rules. In a cluster structure, sensor nodes may be assigned a different status or function, such as cluster head or cluster member

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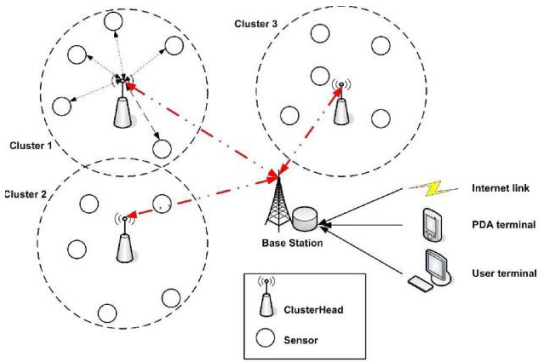

Fig.1: Cluster in WSN

We can see in the Figure 1, the architecture of a generic WSN, and examine how clustering is an essential part of the organizational structure.

Sensor Nodes: Sensor nodes are the building blocks of a WSN. They can play multiple roles in aWSN, such as simple sensing, data processing, data storage and routing.

Clusters: Clusters are the organizational unit of WSNs. The dense nature of WSNs requires them to be broken down into clusters to simplify tasks such as routing.

Cluster heads: Cluster head is the organizational leader of a cluster. It organizes the activities in a cluster. The activities include data-aggregation, diffusion, organiz-
ing the communication schedule of the cluster, etc.

Base Station: The base station is often located far from the network. It provides the communication link between the WSN and the end-user.

End User: The data obtained from sensor network can be used for a wide-range of applications. A particular application can make use of the network data over the internet, using a PDA, or even a personal computer. In a queried sensor network, queries are generated by the end user.

4. Clustering Algorithm

Many algorithms have been proposed for routing in WSN. Clustering algorithms have gained opularity in this field. Clustering algorithms can be classified as:

- .Distributed algorithm,
- Centralized algorithm
- .Hybrid algorithm

In distributed clustering techniques, any node can choose itself as a CH or join an already formed cluster on its own initiative, independent of other nodes. Distributed clustering techniques are further classified into four sub types based on the cluster formation criteria and parameters used for CH election as identity based, neighbourhood information based, probabilistic and iterative. In centralized methods [6], the BS requires global information of the network to control the network. CHs are elected by the base station. Hybrid schemes are composed of centralized and distributed approaches. In a hybrid environment, distributed approaches are used for coordination between CHs, and centralized schemes are followed for CHs to build individual clusters.

5. K-Means Clustering

K-means is the simplest algorithms that solve the clustering problem. The efficient cluster head selection method using K-means algorithm to maximize the energy efficiency of WSN. It is based on the concept of finding the cluster head minimizing the sum of Euclidean distances between the cluster head and member nodes. 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:

Algorithmic steps for K-Means clustering:
1) Set K – To choose a number of desired clusters, K.

2) Initialization – To choose k starting points which are used as initial estimates of the cluster centroids. They are taken as the initial starting values.

3) Classification – To examine each point in the dataset and assign it to the cluster whose centroid is nearest to it.

4) Centroid calculation – When each point in the data set is assigned to a cluster, it is needed to recalculate the new k centroids.

5) Convergence criteria – The steps of (iii) and (iv) require to be repeated until no point changes its cluster assignment or until the centroids no longer move.

6.FCM 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. 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:

Algorithmic steps for FCM clustering:

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

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].

7. Simulation and Result

Figure 2 shows the physical layout of node spread over a 1000 meter square area with 5 cluster using k-mean clustering. Figure 3 shows the topology of 5 access point using FCM clustering. Simulation is carried out in MATLAB software package.

Simulation parameters for velocity vs. Communication overhead are taken as follows.
- No. of nodes: 50
- Sink: single
- Update time: 10 sec
- Velocity: 10 m/s

Simulation parameters for % decay rate of energy vs. velocity are taken as follows.
- No. of nodes: 50
- Sink: single
- Update time: 10 sec
- Velocity of node 10 m/s

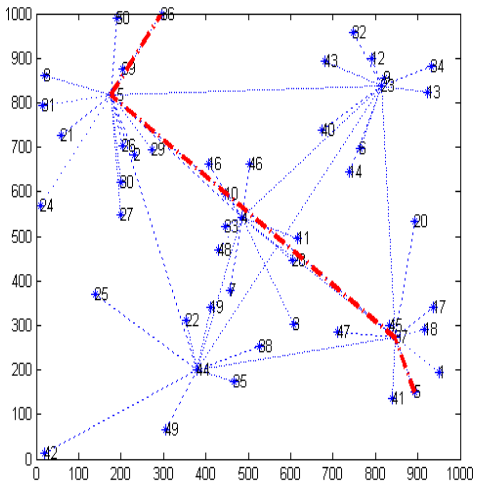

Figure 2: K-mean cluster based approach

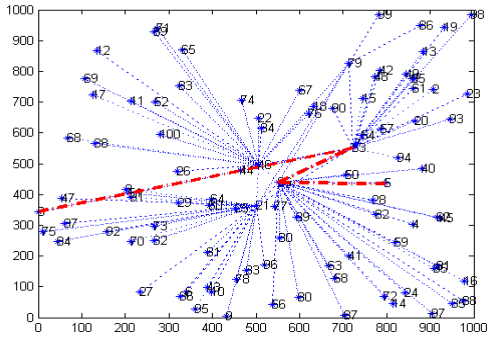

Figure 3: FCM based Cluster approach

As can be seen from figure 4 the communication overhead in FCM cluster based protocol is much less than the K-mean based protocol. as the velocity of

nodes increases. In K-mean protocol overhead increases almost linearly with nodes velocity. It can also be observed from figure 5 that overhead in FCM cluster based protocol is not much dependent upon update time. These simulation results indicates that FCM cluster based protocol outperforms the BBM based protocol.

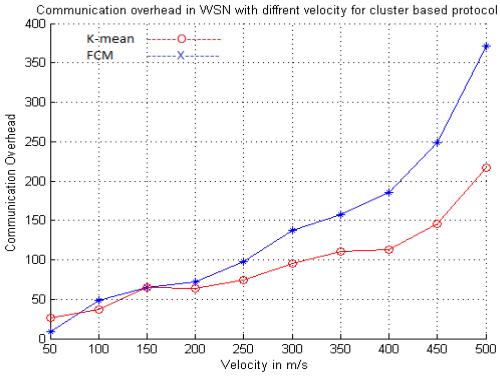

Figure 4: communication overhead in WSN with different velocity for FCM and K-mean.

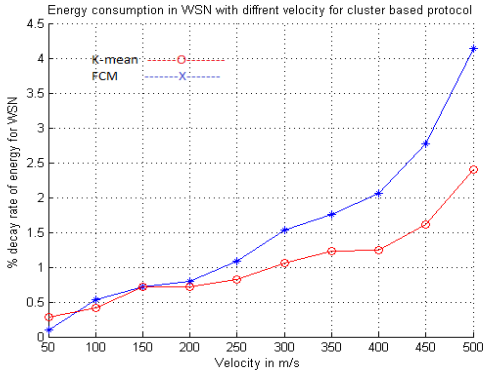

Figure 5: Energy consumption in WSN with different velocity for K-mean And FCM.

8. Conclusion

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

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