ijournals International Journal of Software & Hardware Research in Engineering
ISSN No: 2347-4890 Volume 2 Issue 1/ January 2014

Evaluation of Communication Overhead and Energy Consumption in Wireless Sensor Network using Different Clustering Techniques

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Abstract **-** Wireless sensor network are formed by small sensor nodes communicating over wireless links without using a fixed network infrastructure. A WSN is a collection of three kinds of nodes: sensor node, relay node and sink node. Each node has a limited processing capability and energy sources and communication is performed via wireless medium. A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion or pollutants and to cooperatively pass their data through the network to a main location. Wireless Sensor Networks are design with energy constraint. Every attempt is being made to reduce the energy consumption of the wireless sensor node. Communication amongst nodes consumes the largest part of the energy. In order to reduce the energy consumption a clustering and node redundancy approach has been extensively used. This paper focuses on different clustering algorithms which are to be used to reduce communication overhead and energy consumption and increases network's lifetime.

Keywords **-** Wireless sensor network (WSN), Communication Overhead, Energy Consumption, Clustering, BBM, K-means algorithm, Fuzzy clustering algorithm.

I. Introduction

Wireless sensor networks are highly distributed networks of small, lightweight nodes and deployed in large numbers to monitor the environment parameters or system by the measurement of physical parameters such as temperature, pressure, or relative humidity. Each node of the network consists of three subsystems: the sensor subsystem which senses the environment, the processing subsystem which performs local computation on the sensed data, and the communication subsystem which is responsible for message exchange with neighbour sensor nodes. While individual sensors have limited sensing region, processing power, and energy, networking a large numbers of sensors gives rise to robust, reliable, and accurate sensor network covering a wider region.

Sensor networks consist of different types of sensors such as seismic, thermal, visual, and infrared, and they monitor a variety of ambient conditions. Sensor nodes can be used in military, health, chemical processing, and disaster relief scenarios. Among the main features of such network are that they do not have fixed station or any wire connection to exchange information and to manage the network. The nodes present in such networks work in cooperation with each other. To have this cooperation and coordination, there must be communication among which send information. In wireless sensor networks (WSN) data produced by
one or more sources usually have to be routed through several intermediate nodes to reach the destination. Problems arise when intermediate nodes fail to forward the incoming messages. 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. In WSN, since sensor is a small, lightweight, untethered, battery-powered device, it has limited energy. Therefore energy consumption is another critical issue in sensor network which affect the network's lifetime. To maximize the network's lifetime, clustering is an efficient technique which is to be used to achieve the specific performance requirements of large scale WSN. In clustering data is transmitted from normal node to CH (cluster head) and from CH to BS (base station). The selection of an optimum CH has an effective role in increasing a sensor network's lifetime.

II. Related Works

We introduce various clustering techniques which are to be used to reduce communication overhead and energy consumption and increase network's lifetime. In the present work, the comparative evaluation of communication overhead and energy consumption for the wireless sensor network based on clustering technique is carried out. . In Clustering approach, sensor nodes are divided into clusters. Each cluster has a coordinator,
referred to as a cluster head, and a number of member nodes. Clustering results in a two-tier hierarchy in which cluster heads (CHs) form the higher tier while member nodes form the lower tier. Figure 1 illustrates data flow in a clustered network.
The member nodes report their data to the respective CHs. The CHs aggregate the data and send them to the central base through other CHs. Because CHs often transmit data over longer distances, they lose more energy compared to member nodes. The network may be reclustered periodically in order to select energy-abundant nodes to serve as CHs, thus distributing the load uniformly on all the nodes. Besides achieving energy efficiency, clustering reduces channel contention and packet collisions, resulting in better network throughput under high load. 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. Cluster based operation consists of 3 rounds.

1. Cluster heads selection
2. Cluster formation
3. Transmission of data to the base station.

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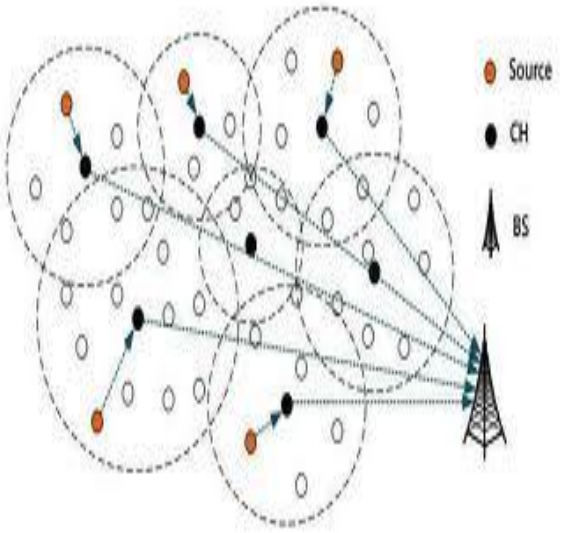

III. Clustering Algorithm

1. Hexagonal based clustering

The clustering technique is an efficient approach for reducing energy consumption in wireless sensor networks. To achieve these purposes, this paper presents a novel clustering algorithm based on virtual hexagon for prolonging lifetime of sensor networks. During the phase of cluster initialization, a sensed zone is divided into several virtual hexagons and the overlapping sensors of circular cluster can be avoided. Furthermore, we make some sub- circles in the formatted virtual hexagon based on the average distance between common sensors (non-cluster head sensors) and the cluster's centre. Depending on the weight value function, each sensor forms a cluster heads order list. The proposed clustering technique adopts a new method for cluster head election, which can avoid the frequent selection of cluster head. The BBM algorithm describe following:

Step1. During the phase of cluster initialization, a sensed zone is divided into several hexagons.

Step2. Furthermore, we make some sub-circles in the formatted hexagon based on the average distance between common sensors (non- cluster head sensors) and the cluster's centre.

Step3. Depending on the weight value function, each sensor forms a cluster heads order list.

2. 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. 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 or randomly.

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

Step3. Assign each node to the cluster that minimizes the variance between the node and the cluster center.

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

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

3. 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. 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 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].

IV. Simulation Results

Figure 1 shows the topology of access points in hexagonal distribution. Figure 2 shows the physical layout of nodes spread over a 1000 metre square area with 5 access points using K-means clustering. Figure32 shows the physical layout of nodes spread over a 1000 metre square area with 5 access points using Fuzzy clustering. Simulation was carried out in MATLAB software package [12]. 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

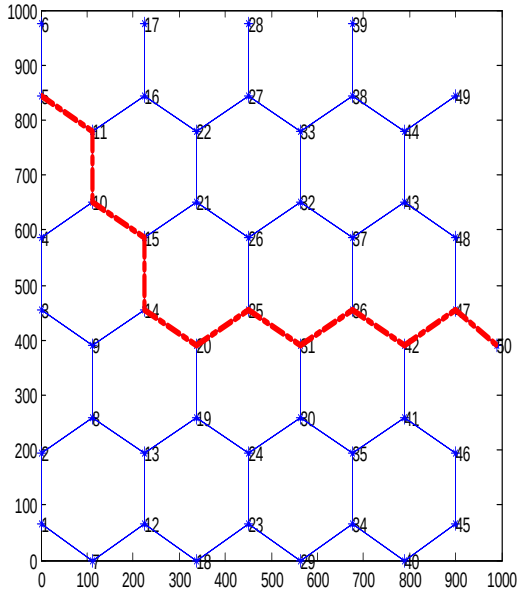

Fig.1. BBM hexagonal distribution of access points

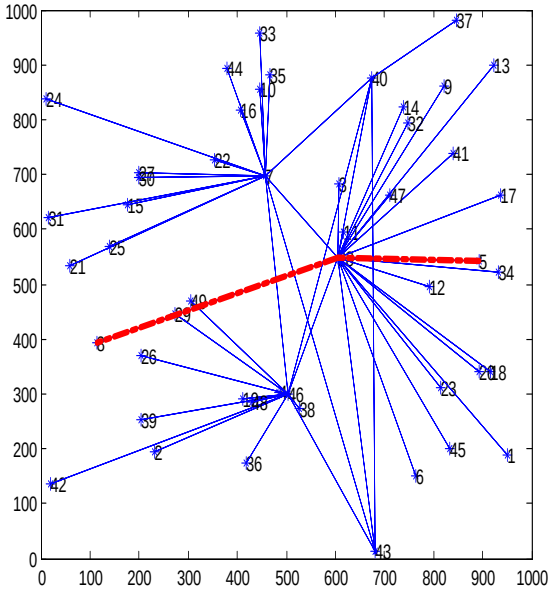

Fig.3. Fuzzy Cluster based approach

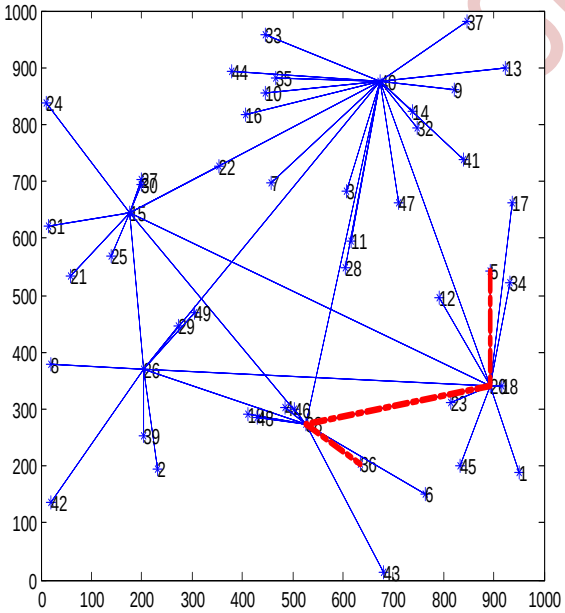

Fig.2. K-means Cluster based approach

As can be seen from figure 4 the communication overhead in fuzzy cluster based protocol is much less than the BBM based protocol and K-means cluster based protocol as the velocity of nodes increases. From figure 5 we observed that the reduction in energy consumption by fuzzy cluster based protocol is more than the two clustered protocol.

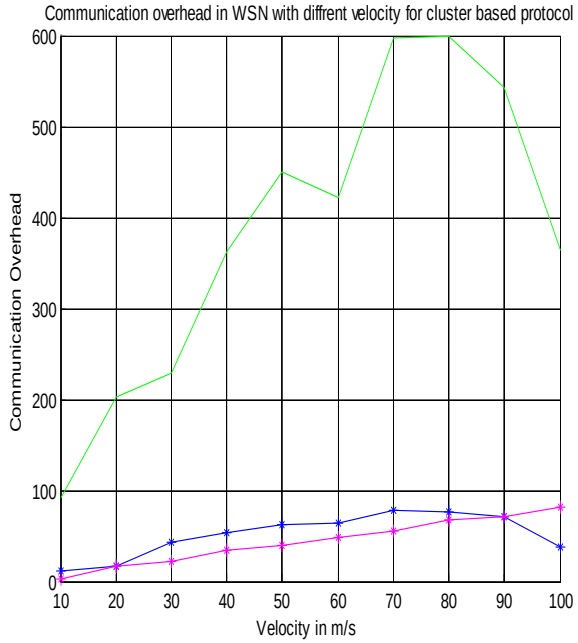

Fig.4.

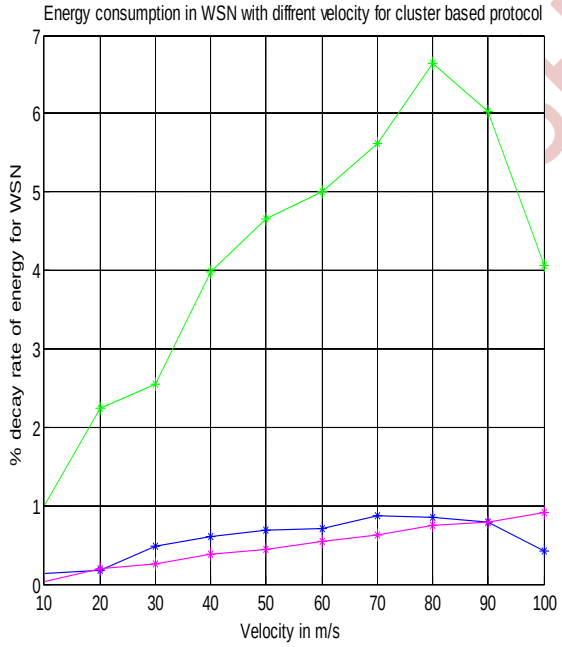

Fig.5.

V. CONCLUSION

As a result of these experiments, we evaluated the communication overhead and energy consumption in WSN using Hexagonal based clustering, 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 BBM and K-means algorithm.

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