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A Cellular Data Placement model for Wireless Sensor Network based on Distributed Clustering Approach

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Abstract: **All the nodes in the WSN communicate their data to their respective destinations. But it requires a lot of energy to send that particular data. So due to long distance of the source and destination a lot of energy is required by the nodes to send the data. After some time all the energy of the node will be depleted and it cannot send data. Therefore to increase longevity and support scalability, nodes are often grouped into disjoint and mostly non-overlapping clusters. By using the clustering method, the nodes in the clusters do not have to send data directly to the destination instead they send data locally to the cluster head. The cluster head aggregates the data of all the nodes and performs data transfer on behalf of each and every node in the cluster. Thereby saving considerable amount of energy of the various nodes. In this paper, we propose a distributed clustering approach for our proposed real time data placement model for WSNs.**

***Keywords*--** **WSN, Cluster Heads (CH), Energy Efficiency, Centralized Clustering, ARS, Central Control Clustering Algorithm(CCCA).**

1. INTRODUCTION

A wireless sensor network is composed of hundreds sensor nodes which use wireless links to perform distributed sensing tasks. Each sensor node includes a sensing module, a computing module, memory and a wireless communication module with a very limited communication range. Wireless sensor network has received intensive research attentions due to its enormous application potential in battlefield surveillance, environmental monitoring, biomedical observation and other fields.

Sensor networks are especially useful in development of catastrophic or emergency applications where human participation may be too dangerous. In such applications sensor nodes are expected to operate autonomously in unattended environments and potentially in large numbers. Also sensors are expected to be deployed randomly in the area of interest by uncontrolled means, e.g. dropped by a helicopter. Given the vast area to be covered, the short lifespan of the battery-operated sensors low energy consumption is important in order in order to prolong the life time of the network [1].

In order to reduce the energy consumption, the clustering is a standard approach [2, 3]. In this approach, sensor nodes are divided into clusters, and for each cluster, one representative node, which is called cluster head (CH), aggregates all the data within the cluster and sends it instead of each individual sensor node sending its information. It results significant reduction in energy consumption of other member nodes of the cluster. Moreover clustering also helps in achieving efficient and scalable control as well as distribution of control over the network.

The operation of cluster based sensor network is divided into rounds. Each round has two phases, the clustering phase and the data transmission phase. Rounds are repeated to monitor events continuously.

2. BACKGROUND

The position of the node and were it has to send the data is quite important, because the node can make local as well as global data transfer. Therefore position of the source and destination is important. As according to the destination, we can just make an estimate of the energy required by the node to send the data [1].

In paper [2] a suite of algorithms for self-organization of wireless sensor networks, in which there is a scalable large number of mainly static nodes with highly constrained energy resources is proposed.

Paper [3] used strategy for saving energy and long live battery life for the sensor nodes. But whenever the load increased in the network, the low power WSN was not capable of handling.

Paper [4] looked at communication protocols, which can have significant impact on the overall energy dissipation of these networks. Based on that the conventional protocols of direct transmission, minimum-transmission-energy, multihop routing, and static clustering may not be optimal for sensor networks,.

In Paper [5] a novel distributed clustering approach for long-lived ad-hoc sensor networks was used. The proposed approach does not make and assumptions about the presence of infrastructure or about node capabilities, other than the availability of multiple power levels in sensor nodes.

In Paper [6] an efficient subdivision of a sensor network into uniform, mostly non-overlapping clusters of physically close nodes is an important building block in the design of efficient upper layer network functions such as routing, broadcast, data aggregation, and query processing.

As per the above referred papers and from the backround study we come to the conclusion that clustering has numerous advantages in saving the energy. Therefore

we conclude that dividing the nodes into clusters and forming many clusters of the sensor nodes results in better energy efficiency in the WSN and also the reliable delivery of the data by the ARS to other networks.

Hence we propose clustering is a good approach for saving the energy and reliable data delivery in WSN.

3. RESEARCH METHODOLOGY

The proposed work is discussed in Section 3.1 and 3.2 are as follows.

3.1 Architecture

The proposed architectural framework will be used as shown in fig 1 [1]. The framework is used for data placement strategy which is real time, reliable and distributed.

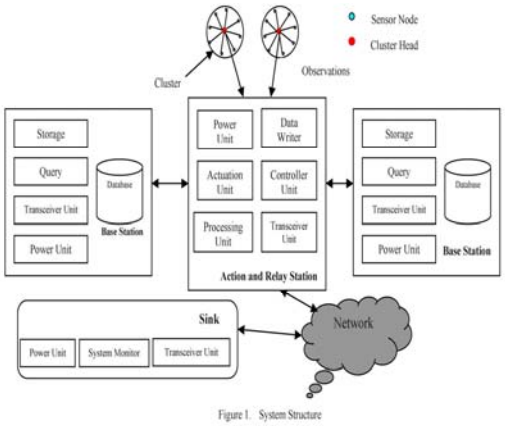

Fig . 1 System Architecture

The basic components of the system and there functions which will be used in our design are listed below:

1. *Sensor Nodes*

Sensors nodes are low-cost, low-power devices with limited sensing, computation and wireless communication capabilities. They can sense events in a circular coverage area with radius rs. To save energy some sensors can be in sleeping state but they can be activated when it is necessary.

2. *Cluster Structure*

The cluster structure is composed of many sensor nodes and among them a cluster head is formed. The different sensor nodes transfer their data to their respective CH. Only the cluster-heads (CH) need to communicate far distances to their respective action and relay station ARS.

3. *Cell Structure*

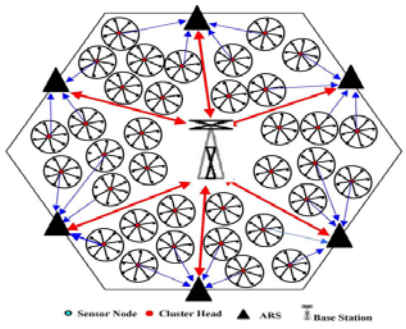

Figure 2. Various components of a cell

A cell will be comprised of number of clusters. Within every cell there will be many different clusters and there different cluster heads (CH). A minimum overlap between the clusters is possible and if there it will be only for energy efficiency.

4. *Base Station*

One of our concerns can be to stop or control the loss of data while moving from one network to the other. Therefore the base stations are used to store the data, here the data is distributed over the base stations.

5. *Action and Relay Station*

The ARS are resource rich nodes equipped with better processing capabilities, higher transmission powers and longer battery life. The ARS nodes are placed on the bordering areas of cells and are responsible for data dissemination in a time efficient manner.

6. *Sink*

The sinks supervises and synchronizes the working of various components of the proposed model and depending upon feedback it sets the value of various parameters like retention period so that the network can work efficiently.

3.2 Clustering in the Proposed Architecture

In the proposed architecture the group of sensor nodes forms a cluster. To prevent draining of battery of single sensor the cluster-head position is also randomly rotated among them. For cluster formation in the proposed architecture centralized clustering method is used. The architecture for clustering is shown in figure 2[1].

The Clustering is performed in the proposed architecture for the energy conservation of nodes. To fulfill our task we propose an algorithm called the CCCA i.e. Central Control Clustering Algorithm. The algorithm is discussed in the next section.

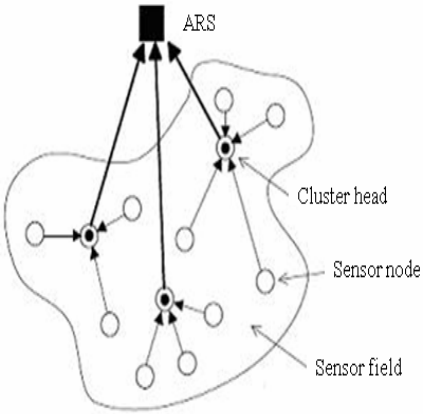

Figure 3: Cluster based sensor network

4. THE CENTRAL CONTROL CLUSTERING ALGORITHM

Now we look at our Central Control Clustering Algorithm(CCCA) which we have proposed for our Architecture. The CCCA works as follows:-

Step 1: The nodes are arranged into clusters depending on their sensing and initially a node is made a CH.

Step 2: An energy threshold is set for the CH by the ARS.

Step 3: All the nodes in the cluster transfer data locally to the CH.

Step 4: The CH forwards it to the CH of another cluster.

Step 5: The process of step 4 and 5 repeats till energy of CH is above the threshold. The threshold is the second highest energy node.

Step 6: Now a new CH is to be decided and here all the nodes forward there energy values to the ARS.

Step 7: The most energy efficient node is selected by the ARS as a CH

Step 8: Process is again repeated from step 3.

In our algorithm we can see that ARS plays an important role as many of the work is done by the ARS itself. The ARS collects and compares all of the energies received from the different nodes and selects the node with the highest energy as the cluster head. Therfore the ARS is also an important entity in the System Architecture.

5. MODEL OF ARS

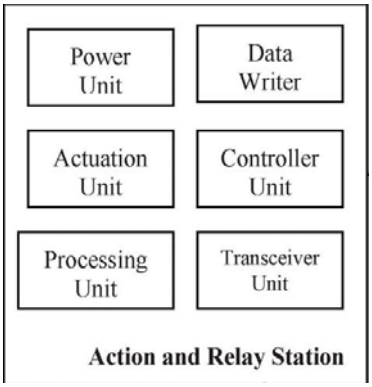

Fig 4: Structure of the ARS

The ARS i.e. Action and Relay Station is the main and the most important entity in our System Architecture. The ARS is responsible for the selection of the cluster head(CH) from among the nodes. It also maintains the list of the CH's of the different clusters present in the network.

There are six basic components of the ARS which are as follows:-

1. *Power Unit*: The **Power unit** manages the power of the ARS node and also manages the energy levels of the sensor nodes .
2. *Data Writer Unit*: The **Data writer unit** of the ARS copies the data of the sensor nodes to the base stations.
3. *Actuation Unit*: In the **Actuation unit,** to actuate is to put into motion, an actuation forwards the appropriate data in the network. Therefore we can say that the Actuation unit forwards data to appropriate network.
4. *Controller Unit*: The **Controller unit** manages the connection with the base station and the information of which BS are connected to it.
5. *Processing Unit*: The **Processing unit** is responsible for any query by the network and also sends the data to the Sink node.
6. *Transciever Unit*: The **Transciever unit** handles the transmission and receiving the data from the ARS to the base stations and vice-versa.

6. SIMULATION AND RESULTS

To show the results and the correctness of our proposed model we have used the Network Simulator NS2. Using this simulator we have performed the various tests on our model applying our algorithm and without the algorithm. The comparision of both the results have been carried to see the effectiveness of our proposed model. In the simulation we are taking 30 sensor nodes which are randomly placed in a region of 300 x 300 topography. To make things simple we are only making 3 clusters each comprising of 10 nodes.

We are taking the simulation results based on three parameters i.e. Dealy, Energy and Throughput.

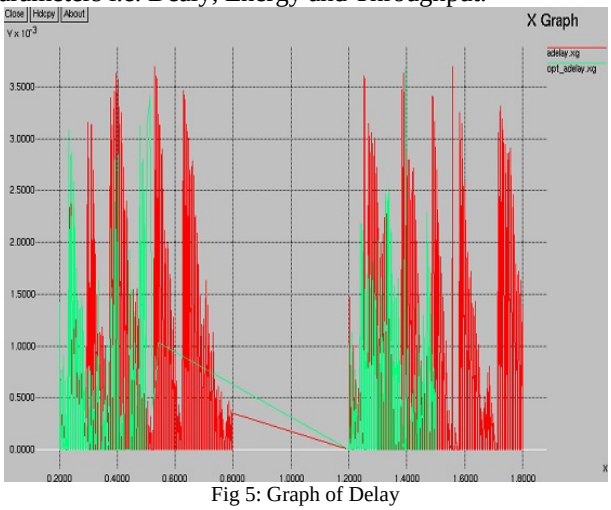

Fig 5: Graph of Delay

The graph for delay clearly fig 5 shows that the delay is higher in case of the normal execution i.e without clustering(red lines). Whereas it is comparatively low in case where we our implementing our algorithm(green lines).

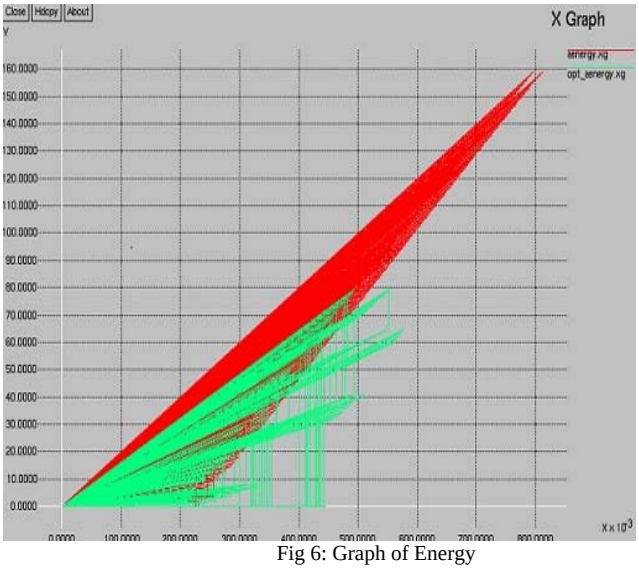

Fig 6: Graph of Energy

Also we can see in the graph of energy in fig 6 that the usage of energy when the algorithm is applied is quite less(green lines) as compared to the when the normal procedure is followed(red lines)

7. CONCLUSION

In this paper, we will propose a clustering method that will improve the performance issues of sensor nodes and will also contribute to minimize the energy consumption required during the data transmission phase. Cellular architecture for storage management has been proposed using centralized clustering. The proposed model will not only offer real time sensing and monitoring but also provides real time dynamic decision making based on the sensed data. The formation of cluster also helps the sensor nodes to easily send their data to the Cluster Heads and saving energy.

A new system architecture is proposed in this based on cellular architectural framework to provide features like timeliness guarantee, fault-tolerance, data integrity, data-centric and distributed storage, besides enhanced energy efficiency. In the proposed model, the sensor nodes which are deployed at their positions senses there data and sends it to their respective CH's. The CH's then forwards the data to where it is intended to go. Our proposed model is thought of as an application which will act as a base in the area of crisis management where energy is a big factor to deal with.

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