An Energy Efficient Clustering Scheme of Mobile Sink Node in Wireless Sensor Networks

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Abstract—The sensor network environment which is composed of a number of sensor nodes has been used for sink Node to monitor their surroundings at a fixed position. Now sensor nodes are extended to Ubiquitous applications, and sink node are giving mobility and seamless data transmission. This paper is accounting for dynamic clustering focusing on the sink node. After choosing cluster headers, which share base station and data transmission, dynamic clustering can transmit the data of the sink node. This paper defines the optimal hop counter and when a cluster is made, prolong life time of the network by reducing the whole network energy efficiency. One of the Experiments shows that clustering can be achieved within a single cluster by extending 6 hops at the maximum, and life time makes possible dynamic clustering when node remains more than 20% on average.

Keywords-Sensor Network, Dynamic Clustering, Cluster Header, Energy Efficiency, Hop Count, Dynamic Skyline Queries

I. INTRODUCTION

Recently increased interest in sensor network has led to a lot of active researches in the specific fields such as fire recognition in the forest, weather prediction, the military, and home network. Sensor nodes must achieve its own target by transmitting the collected data to BS accurately and rapidly. The general sensor nodes, however, have disadvantages that they should use the limited energy and memory resources. The longevity and function are the keys to this kind of imperfect environment. That is, the point in the sensor network environments will be how long the network is connected and how accurate the collected data is within the connected network.

Sink nodes provide wireless sensor network environment with mobility. Therefore, they are the most important in Location Tracking skill of the dynamic object in the sensor network environment. Location tracking skill of the dynamic object spends the least energy, detecting the location tracks of the sensor nodes. Also, keeping the highest missing rate, it can reduce the excessive energy waste of a specific sensor Node and extend the life cycle of the whole wireless sensor network as fully as possible. Studies on Location Tracking skill of the dynamic object can be divided into the following:

The first method is one which marks the location of an object approximately with the node location by using the single node which is near an object. Next, many nodes which are near an object make up of dynamic clustering. The last one is to predict the subsequent location and monitor it by using the mobility track and the existing nodes. In spite of these researches, the biggest problem with the existing wireless sensor network environment is that it lessens the life time of the network caused by the unnecessary power exhaustion of each sensor node at the time to solve the battery-dependant Low-power.

Therefore, it is urgent that we should build dynamic clustering to make the power exhaustion of each sensor node to a minimum and keep clustering in order that we can prolong the life time of the network. In terms of mobile sensor Node, message-efficient algorithm should be improved because the energy-efficient clustering suitable for the mobile sensor nodes. So this paper suggests an energy-efficient clustering suitable for a mobile sensor Node.

This paper has five chapters: In chapter 2, a related study will be conducted such as wireless sensor network and Hierarchy routing protocol based on clustering. Chapter 3 is a kind of suggestion, in which I will discuss dynamic predictable clustering. Next, the suggestion will be experimented on the basis of NS-2 in chapter 4. Lastly, chapter 5 will present a conclusion and further study.

II. RELATED WORK

A. Wireless Sensor Network

A mobile network where the normal nodes send and receive signals through the stations that are responsible for certain regions is the most typical among the communications models based on the clustering of network nodes. In case of dynamic clustering, sensor networks consist of strong cluster header nodes and weak ones. The strongest sensor nodes detecting objects become cluster headers, and form clustering with the surrounding sensor nodes. These sensor nodes send the data to the sensor nodes, which are cluster headers. Then cluster nodes transmit the data again to base stations. In order not to lose track of the objects, all cluster header nodes must keep an eye on all the sensor nodes. It is difficult to keep track of objects in the place where the sensor nodes are not evenly distributed, because only sensor nodes can be cluster header nodes.
One clustering is done, heads do not rotate and if the objects move at a very slow pace, certain cluster headers will waste too much energy. Consequently, the energy exhaustion between cluster header nodes will be uneven [8][9][10][11].

Clustering has a lot of advantages compared to routing protocol. It is a method by which the similar data received from the adjacent regions will be sent to cluster headers by forming local clustering, and the cluster headers deal with the data. This method makes possible the energy-efficient routing over the existing routing protocol. Besides, clustering can prevent non-efficient inquiry flooding because the requested inquires can be made by cluster headers.

When sensor nodes communicate with flood cluster headers either directly or flooding, each sensor node spends a lot of energy. In light of mobile sensor nodes, a large amount of energy exhaustion means non-efficient communications. Hence, while dynamic clustering makes longer the life time of mobile sensor network, we need an efficient routing protocol from cluster headers.

III. DYNAMIC CLUSTERING ALGORITHM

A. Dynamic Prediction Clustering Algorithm

DPCA (Dynamic Prediction Clustering Algorithm) takes sensor node mobility of the sensor network environment into consideration. In this paper DPCA refers to a method to predict where the sensor nodes proceed, and make clusters in advance. This method can reduce the power exhaustion of the sensor nodes due to a frequent message exchange that occurs among sensor nodes. DPCA operates on the basis of hierarchical clustering.

Table 1 shows the main environmental factors of this proposed algorithm.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Energy Size</td>
</tr>
<tr>
<td>$C_{CH}^N$</td>
<td>Hop Count from Cluster header to Based Station</td>
</tr>
<tr>
<td>R</td>
<td>Communication range of Sensor node</td>
</tr>
<tr>
<td>$p \lambda$</td>
<td>Density of cluster header</td>
</tr>
<tr>
<td>$(1 - p)$</td>
<td>Density of Not cluster header node</td>
</tr>
<tr>
<td>CH$_n$</td>
<td>Count of cluster header</td>
</tr>
</tbody>
</table>

$S_i$ is a random variable that represents the distance between base stations from sensors numbering $n ((x^i, y^i), i=1,2,3,.....n)$. It is assumed that base station is located in the middle of sensor fields, the sensor field is a $a \times a$ square. For a hierarchical clustering, we calculate the average total hop count in accordance with distribution density of the whole sensor nodes after the average hop count of the sensor nodes is calculated. Formula 1 shows the calculated hop counts from all cluster headers to base stations.

We calculate the average energy consumption of the sensor nodes in DPCA as the following Formula 2: here p means the probability of cluster headers, $p \lambda$ density, (1-p) the density of non-cluster headers, and SQ location value for dynamic clustering, respectively.

$$E\{C_{CH}^{Tot}|N = n\} = \frac{\int_{\triangle} \sum_{d}^{} \lambda \cdot d\lambda}{R}$$  \hspace{1cm} (1)

$$E\{C_{CH}^{Tot}|N = n\} = \frac{np \cdot (1-p) \cdot SQ}{2R}$$  \hspace{1cm} (2)

With Formula 2 we can solve the clustering problem through the existing identical size, and form clustering in accordance with the density of sensor nodes. Here how density can be achieved is a key matter. Next, on the basis of the average energy consumption of the sensor nodes, we can derive the average energy consumption rate (E[C$_{AVG}$]) like Formula 4.

IV. EXPERIMENTATION AND RESULT

Chapter 4 deals with the evaluation from simulations in the NS2 environment for DCPA. Table 2 shows the parameters to perform the simulations in the NS-2 environment.
TABLE II. The Parameters of Experiment

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Node Count</td>
</tr>
<tr>
<td>a</td>
<td>Radius of network</td>
</tr>
<tr>
<td>M</td>
<td>Network measure</td>
</tr>
<tr>
<td>BS</td>
<td>Base Station (100,100)m</td>
</tr>
<tr>
<td>IE</td>
<td>Initial Electric</td>
</tr>
<tr>
<td>CPᵦ</td>
<td>Probability of Cluster header</td>
</tr>
<tr>
<td>R</td>
<td>Communication area</td>
</tr>
<tr>
<td>SB₁E</td>
<td>Average Energy consumption of sensor node</td>
</tr>
<tr>
<td>SNCₑEA</td>
<td>Average Energy consumption of Cluster header</td>
</tr>
<tr>
<td>DₑEA</td>
<td>Average Energy consumption of Cluster header when it is data transmit</td>
</tr>
</tbody>
</table>

The scenario for the experiment is like this: we divide the grid-pattern topology, which is measured 100×100, into 100, 500, and 1,000 nodes, respectively. In the three cases, 2J values, the initial energy of each sensor, have been given equally, and the density of the sensor nodes changed to 5m within communications range. Then we measure and compare the energy consumption rates from 1 count to 4 counts. These repetitive tests based on this scenario led to the following results.

This paper has suggested DPCA for the energy-efficient dynamic clustering for the mobile nodes. Taking the mobility of such nodes into account, DPCA forms clusters in search of the informed courses with the knowledge on destinations. After clustering, DPCA selects cluster headers considering the remaining energy. Finally, DPCA seeks the dynamic clustering, going over the selected cluster headers and the mobility of those nodes.

If the mobile sensor nodes cannot cooperate with communications due to the energy depletion in dynamic clustering, it sometimes occurs that clustering and communications are disconnected, and network doesn't work. Such disconnected nodes are called dead node. Up to now we experimented from one count to the period when dead nodes happened from simulations. Because the dead nodes affect the life time of network, and further the network's clustering.

[Figure 1] indicates the status of dead nodes by nodes. As a result, we found out that the more the nodes are, the more the dead nodes increase. In other words, there will be an increase in nodes which cannot participate in communications. This leads to disconnection in communications. Consequently, it might be difficult to form clustering. In light of the average energy consumption rates of each sensor nodes, we noticed that the frequency of the dead nodes are relatively secure until 3rd count, but the dead nodes begin to occur from the fourth count.

In case of the fourth count, the average energy consumption rates accounted for 20%, that of cluster headers 28.1%, that of cluster headers in data transmission 28.9%, respectively. Also, 80% of the mobile nodes had the remaining energy and took part in network communications, making possible dynamic clustering. However, the situation has changed from the sixth count. The occurrence rate of the dead nodes increased sharply. This accounts for 57% of the whole dead nodes and have difficulty in network communications. Specifically, we had communications disconnection in 58.2% of the 500 nodes and 82.1% of the 1,000 nodes, respectively.

[Figure 2] shows the average energy consumption rates of the mobile nodes. DPCA makes clustering possible by the sixth count at the most. Still, as the number of nodes at the sixth count increased, there was very high energy consumption. As a result, to build a safe network, clustering by the fifth count at the maximum is a method to prolong the whole network.
V. CONCLUSIONS

In the sensor network that features mobility, it is not efficient to make clustering in the same way as the existing sensor network does. The main feature in the operation of the sensor network is to extend the life time of the network longer than before, and make communications durable. Because the existing one wastes too much unnecessary energy for clustering.

The purpose of this paper is to set the maximum counts from the cluster headers until boundary nodes in order to select the optimal clustering among the different clustering techniques, in the mobile sensor network environment for reduction in energy.

The increase in counts means the increase in energy consumption of each node. The suggested DPCA, however, makes clusters from the cluster headers until the 6th count at the maximum within a single clustering, and, as a result, communications are achieved. For the dynamic clustering we saw that clustering is available from cluster headers to the maximum 6th count. Also, it was found that more than 80% of the whole network are dead nodes, and they affect the entire network.

REFERENCES