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A Geographical Data Aggregation for Underwater Wireless Sensor Networks

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Abstract. Recently, underwater wireless sensor network is one of the popular research topics to scientist. There are many novel methodologies to reach the goal of the effectiveness network performance such as cluster-based structure, in-network data aggregation, etc. In this paper, we assume the network is clustered by a specific clustering scheme. Then, we suggest a new geographical-data-aggregation method for that clustered networks to enhance the network performance. The main idea of the suggested method is: Instead of sending sensed data immediately to the cluster head, a cluster member must pass two criteria of data similarity and surrounding space before its data transferring. To prove the suggested data aggregation method improve the clustered-network performances, we evaluate the performances among clustered-network with ordinary data aggregation function, clustered-network with geographical-data-aggregation method.

Keywords: Network Clustering; Data Aggregation, Similarity Functions; Underwater Wireless Sensor Networks

1 Introduction

Underwater wireless sensor network (UWSN) is state-of-the-art approach to reach the goal of monitoring underwater environment for many of application such as oceanographic data collection, disaster prevention, undersea exploration [1, 2]. Clustering and data aggregation are the two famous techniques which is used for UWSN to reach the goal of high network performances such as high throughput, low end-to-end delay as well as minimizing energy consumption, increasing data accuracy. Clustering is a valuable approach to extend network lifetime by reducing data transmissions. Data aggregation is known as a vital technique for reducing redundant data transmissions and improving the overall network lifetime [4, 5]. Thus, the ideal of combining the two techniques promises to enhance the network performances.

In this paper, we suggest a new geographical-data-aggregation method for a clustered-network. The method focus on sending function of sensor nodes, especially cluster member nodes. Instead of sending sensed data immediately to the cluster head, a cluster member must pass the sending criteria. First, cluster member compares the similarity between old and new sensed data. Second, it checks distance to surrounding member nodes in order to decide transfer or not the sensed data to cluster head. Focus

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on data aggregation process; hence, we assume the network is already clustered by a specific clustering scheme, and all sensor nodes use a same similarity function (ie., Euclidean similarity) to compare set of sensed/collected data.

The remainder of the paper is structured as follows. Section 2 reviews some related research on network clustering, cluster-head selection methods, cluster communications, and data aggregation in cluster-based networks. Section 3 describes in detail the proposed clustering scheme. Section 4 shows simulation results. Finally, section 5 concludes our paper and highlights the future works.

2 Related Research

In paper [3], authors proposed a scheme that relies on grouping the adjacent vehicles into clusters. The clustering considers dividing the network into groups of nodes based on their geographic location and defines a mechanism by which the clusters are connected. There are three kinds of nodes such as cluster head, cluster connector, and ordinary node depends on the connectivity. Each kind of node has different functionality as well as connectivity. Cluster maintenance is based on the position and movement information received from each node.

In paper [4], the authors formulate the aggregator node selection as a top-k query problem, and applied Sort-Filter-Skyline (SFS) algorithm to solve it. The proposed method constructs the skyline of the sensor nodes that allows obtaining a set of sensor nodes that are potential candidates to become an aggregator node. For example, using proposed method, you can select the aggregator node considering various attributes (i.e. distance from the base station, power consumption, battery life, communication cost, etc.) that suits to the current state of the WSN. If the current state of the WSN requires sending the sensor data a short time, then the proposed method selects aggregator nodes that have the highest communication power.

3 A Proposed Geographical Data Aggregation Method

In this section, we overviews the clustering scheme which is used to cluster the network. Then, we briefly explain our geographical data aggregation method.

3.1 Clustering Process

This clustering scheme mainly uses the geographical data and network type in order to cluster the network. The network type is used to divide the area (where the network is deployed) into smaller one. Then, the clustering process is applied to each separate area. The geographical data specifies sensor nodes' position, and is utilized to measure the distance from a node to others. There are three kinds of nodes are used, such as cluster head candidate, cluster head, and cluster member. The cluster head candidates are chosen by residual energy, distance to others nodes, distance to area border, and node's identification (additional). A cluster head is selected from cluster head

candidates, and all cluster head candidates must become cluster head one time to eliminate the re-clustering process. The clusters are continuous maintained and only re-formed only if all cluster head candidates had done their role as a cluster head and a new group of cluster head candidates is decided. Figure 1 shows the basic process of clustering.

Fig. 1. Clustering Process

3.2 Data Aggregation Process

Data aggregation function of cluster head and cluster member are quite different.

A cluster head collects data from its member nodes within a constraint time which was set at the beginning of the data aggregation process. Every time a new data set is transferred to a cluster head, it checks the similarity to the old data set in order to accept or deny the receiving data.

A cluster member continuously senses data of the environment, and frequently reports the sensed data to its cluster head depend on the timer setting. However, in this method, we apply a similarity function to all nodes in order to eliminate the redundant data which is sensed in a short time. Hence, a member node must check the similarity between previous-data and the current-data. If the two data are similar, it will not send that current data and wait for the next sensing data. Also, it will not send data to cluster head if another close-member node has similar data but closer to the cluster head. The advantage of using geographic data is all sensor nodes know each other's position. Therefore, it is good ideal for eliminating the redundant data sent to cluster head as well as reducing the transmission power. The pseudo code below shows the behavior of a cluster member in data aggregation process.

```
Start sensing_timer;
Do
{
    If (previous_data == current_data)
        Ignore to send current_data;
    Else
    {
        If (d(currNode,neighNode) < Thd &&
                d(currNode,CH) > d(neighNode,CH))
            Ignore to send current-data;
        Else
            Send current_data;
    }
```

} until (sensing_timer expires)

4 Research Status

The performance of the proposed clustering scheme was run on Qualnet5 simulator. Dimension of the scenario is 5000 m × 5000 m. The scenario consists of 20 sensor nodes with 10 CBR (Constant Bit Rate) applications, is deployed randomly 200 m below the sea. In order to replicate a shallow underwater environment, channel frequency and propagation speed were set at 35 KHz and 1500 m/s, respectively. The energy consumption parameters were set according to the UWM100 LinkQuest Underwater Acoustic Modem [6]. Transmission power of sensor nodes are set equal 30 dBm, and time for each simulation run was 30 minutes.

5 Conclusions and Future Works

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