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Collaborative Filtering Based Aggregator Node Selection in Wireless Sensor Networks

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Abstract. In typical WSN, the sensor nodes have limited resources such as battery power, computing capability and memory. In order to achieve the equal usage of limited resources in the wireless sensor networks (WSNs), we must aggregate the sensor data before passing it to the base station. Careful selection of the aggregator nodes in the data aggregation process results in reducing large amounts of communication traffic in the WSN. In this paper, we propose a collaborative filtering based aggregator node selection method. The proposed method uses a recommendation function that calculates the attributes of sensor nodes, such as distance from the base station, power consumption, battery life and communication cost, and selects a set of leading aggregator nodes according to the recommendations made by neighboring sensor nodes.

Keywords: collaborative filtering, data aggregation, aggregator node selection.

1 Introduction

Wireless Sensor Networks (WSNs) are constructed of many tiny and low-cost sensor nodes randomly scattered over a large location. These sensor nodes are instrumented with sensing, processing and wireless communication capabilities. Each node is equipped with a wireless radio transceiver, a power source, small microcontroller, and multi-type sensors. These components allow a sensor node to sense the environment, communicate and exchange sensory data with other nodes in the area. WSNs can be used in many applications, such as military target tracking and surveillance, meteorological hazards, wildlife monitoring, and natural disaster relief.

In typical WSN, the sensor nodes have limited resources such as battery power, computing capability and memory. Communication is a dominant source of energy consumption in the WSNs [1]. Thus, the general approach is to jointly process the sensor data, generated by the different sensor nodes, while transmitting it to the base station. This process is called as a data aggregation process. Careful selection of the aggregator nodes in the data aggregation process results in reducing large amounts of communication traffic in the WSN [2]. However, network conditions change continuously due to sharing of resources, and computation load, as well as congestion on network nodes and links, which can make the selection process of these aggregator nodes difficult [3].

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2 Aggregator Node Selection in Wireless Sensor Networks

In [4], the authors presented the Tiny AGgregation (TAG) service for aggregation in low-power, distributed, wireless environments. TAG allows users to express simple, declarative queries and have them distributed and executed efficiently in networks of low-power, wireless sensors. This approach defines two attributes. First, it offers a simple, declarative interface for data collection and aggregation, inspired by selection and aggregation facilities in database query languages. Second, it intelligently distributes and executes aggregation queries in the sensor network in a time and power-efficient manner, and preserves the resource constraints and loss communication properties of wireless sensor networks.

In [5], Power-Efficient GAthering in Sensor Information Systems (PEGASIS) was presented, which significantly reduces energy cost to increase the life of the sensor network. The authors claim that proposed protocol is near optimal in terms of energy cost for this data gathering application in sensor networks. In PEGASIS, each data aggregation chain has a leader that is responsible to transmit aggregated data to the base station. In order to evenly distribute the energy expenditure in the network, sensor nodes take turns acting as the chain leader so that the average energy spent by each node per round is reduced. The chain forming can be achieved either in centralized manner by the base station or in a decentralized manner by using a greedy algorithm at each sensor node.

In [2], the authors investigated optimal aggregator node selection in WSNs. The selection process is formulated as a top-k query problem, which is solved by adapting a modified Soft-Filter-Skyline (SFS) algorithm. The main idea in this approach is to perform a skyline query on the sensor nodes in WSNs in order to extract among those sensor nodes that are potential candidates for the leading role, and those that cannot possibly become an aggregator node. Experiments show that our method outperforms existing approaches by up to several times in many cases.

3 Selection of Aggregator Node using Collaborative Filtering

Collaborative filtering is a technique used by recommender systems. We analyze the raw data regarding the nodes, and generate various recommendations using Collaborative Filtering technique. Similarity measure is the most important part of collaborative filtering algorithms. Choosing a proper similarity function can obviously improve the performance of such algorithms. In the literature, there are several functions to calculate the similarity between the users. Cosine similarity is the most

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widely used in collaborative filtering. The two users are thought as two vectors, while the similarity between two vectors is calculated by their cosine angle [2]:

$$cos\sim,\sim = \quad \sim\Sigma \;\; \Sigma \;\; 2\,\Sigma \;\; {=}1 \;\; {=}1 \;\; 2 \;\; {=}1 \qquad (1)$$

where is the score of the element *k* given by the user *i*.

4 Conclusion

In this paper, we have proposed a collaborative filtering based aggregator node selection method. The proposed method uses a recommendation function that calculates the attributes of sensor nodes, such as distance from the base station, power consumption, battery life and communication cost, and selects a set of leading aggregator nodes according to the recommendations made by neighboring sensor nodes.

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