Rendezvous Planning of Data Collection in Wireless Sensor Networks

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Abstract — In today's world people interact with the network and collects data from network with the help of handheld devices. Here we propose a novel approach for the mobile users to collect data network wide. Most of the traditional Wireless Sensor Network (WSN) architectures consist of static nodes which are densely deployed over a sensing area. The route structure of data collection is updated every time when the movement of the mobile user changes. By considering this approach we perform limited modification to update the route structure while the route performance is bounded and controlled compared to the optimal performance in the Wireless Sensor Network. In this we need to update the route structure of data collection whenever there is mobile movement. The proposed protocol to update route structure is easy to implement. The protocol uses three approaches as: Initialization of data collection tree, Updation of data collection tree, Routing of data. Our analysis generated the above mentioned protocol is use to shows that the proposed approach is scalable in maintenance overheads, performs efficiently in the routing and provides continuous data delivery during the movement of the user. Finally we examine the efficiency of our protocol by varying the settings of networks which provides the efficient way of data collection using wireless sensor network.

Keywords - Wireless Sensor Network, data collection, mobile user, data routing, data collection

I. INTRODUCTION

Recent advances in Wireless Sensor Network technologies provide people the ability to better understand the physical world. With the data collected from the entire network, the sensor network supports a variety of applications, including security surveillance [1], [2], [3], localization [4], information enquiry, and transmission [5], [6], [7], [8], etc. In this paper we consider the rendezvous planning approach for data collection by mobile users in Wireless Sensor Networks. In this the handheld devices equipped by mobile users communicate with the different sensor nodes present in wireless sensor network and instantly access the network from the nearby sensors. This interaction of sensor network explores interaction with human beings and provides people the facility to collect data and expands the capability of wireless sensor network.

The Rendezvous planning of data collection approach considered in this paper is essentially differs from traditional data collection problems in static settings. In a static sensor network, an optimal data collection tree is fixed and suffices to efficiently deliver data to the static sink[10],[11],[12],[13],[14],[15]. Now for collecting data in the rendezvous manner in the presence of user mobility, the data collection tree at one point is normally not enough when mobile user moves. To efficiently deliver data network wide to the mobile user, the data collection tree needs to be constructed and updated every time when the mobile user moves.

II. SYSTEM DESIGN

The Proposed protocol used for collection of data in the Rendezvous manner to update route structure is easy to implement. The Proposed protocol uses three approaches as:

1) Intialization of data collection tree
2) Updation of data collection tree
3) Routing of Data

1. Initialization of Data Collection Tree

We consider the entire wireless sensor network as a graph G ={V,E}. where the vertex set V represents the static sensors and the edge set E represents the communicational links. Without loss of generality, the initial virtual sink is denoted as u€V, through which the mobile user accesses the network-wide data at the beginning. There have been many research studies proposed for constructing a global data collection tree for a given sink node [10], [11], [13], [14], [15]. Similar to these existing schemes, Data Collection Tree Initialization in our protocol is realized by the floding control in an iterative manner, like[10]. More precisely, an optimal routing tree can be formed as follows: The sink node launches the routing tree construction by broadcasting a control message and the initial value of the communication cost1 to the sink node at each sensor side is set to be infinity. In general, by exchanging information, sensor i configures Hi to be the neighbor with the minimum cost to the sink compared with all other neighbors, where Hi is the child node of sensor i in the routing tree, i.e., sensor i only transmits or relays packets to sensor Hi. Once Hi is updated, sensor i will inform its neighbors and the neighbors can update their own configurations accordingly.

2. Updation of Data Collection Tree

The mobile user keeps moving around and the virtual sink that connects the user to the sensor network changes accordingly. When the mobile user moves away from the original virtual sink u and designate a new virtual sink v, a new data collection tree at virtual sink v must be constructed, namely T v. A natural solution is to reconstruct T v with the same process of building T u, i.e., Data Collection Tree Initialization can be relaunched to form T v.

3. Routing of Data

After Data Collection Tree Updating completes, a new routing structure is built. If sensor i has data to send or helps other sensors to relay data, it simply transmits data to the neighbor indicated by Hi. Data are guaranteed to be delivered toward the mobile user observed from some research work done on this approach.

III. IMPLEMENTATION

The typical application we have envisioned is the Forest Surveillance. In The GreenHorbs Project[9], these three approaches are successfully implemented using 300 sensor nodes. The application collects the Rendezvous data from the forest such as Temperature, Humidity, Concentration of CO_2 and all the other information from the forest.For the implementation of this project the system uses mainly the following sensors and their function which is specified in table as :

Table: Sensor in a GreenOrbs Node :

SENSOR	FUNCTION
SENSIRION	SHT11 TEMPERATURE
HAMAMATSU S1087	ILLUMINANCE
mcu-internal voltage SENSOR.	MCU-INTERNAL VOLTAGE
GE TELAIRE 6004	content of carbon DIOXIDE

GreenOrbs aims at all-year-round ecological surveillance in the forest, collecting various sensory data, such as temperature, humidity, illumination, and content of carbon dioxide. The collected information can be utilized to support various forestry applications.In this First, we propose an additive approach that updates the data collection tree. In particular, through a limited modification of existing data collection tree in the network, a new collection tree ca be constructed in a lightweight manner in terms of time efficiency and overheads. Moreover, the proposed approach is easy to implement and the resulting routing performance on the new collection tree is bounded and controlled with regard to the optimal value. Second, the proposed approach in this work supports delivering continuous data streams even with routing transitions. When the mobile user moves within the sensor network, the data collection tree keeps updated to stream the unreceived data toward the mobile user. Such a property ensures a low data collection delay, providing a real-time data acquisition for the mobile user. Third, we implemented and need to test the system in a 49 Telos Mote testbed. The experiment results validate the feasibility and applicability of the proposed approach in practice.

IV. EXPERIMENTAL EVALUATION

In previous sections, we elaborate the design principles and important properties of our ubiquitous data collection approach. In this section, we validate the feasibility and applicability of the proposed protocol in practice. We implement our protocol on TelosB motes and use a 49-node testbed to examine its performance, Forty nine nodes are organized as a 7 _ 7 grid. Due to the experimental space limitation, the power of each Telosb mote is set to be the minimum level and the communication range is about 10 centimeters. The average degree of each sensor node is around six. Starting from the left-top conner, sensors are placed following the left-to-right and top-to-bottom order based on their IDs. The software on the experimental sensor nodes is developed based on TinyOS 2.1.The Data Collector module and the Configurator module provide the received flooding packet and the system parameter respectively. Note that a virtual received flooding packet will be offered to the sink node at the initial stage of Data Collection Tree Updating. Based on the input information, the Analyzer module figures out whether the updating needs to be performed or not. If the answer is positive, the Flooding Control module conducts several necessary local information updatings and prepares the flooding message for the Routing Tree Construction module. The Logger module is in charge of data access (read and write) to the measurement serial flash. The Statistics Analyzer module merges and encapsulates the data from sensors, network, and flash, based on the preconfigured message formats. We conduct two trails of experiments. During the experiment, the mobile user enters the sensor network

V. RELATED WORK

As a basic operation, the data collection in WSNs has been extensively studied. A surge of works study the data gathering but with static settings. In addition, according to how does each packet transmitted, the data collection can be further divided into two categories: with aggregation or without aggregation. In the former category, in-network aggregating data results in a reduction in the amount of bits transmitted, and hence, saves energy. Typical examples include [15], [21]. Michael et al. [15] propose the first such protocol. In [21], authors study the construction of a data gathering tree to maximize the network lifetime. In the latter category, Rangwal et al. [14] propose to collect data through a tree structure with fair rate control. [12] proposes to form an information potential-based routing structure. In[11], Challen et al. present IDEA, a sensor network service enabling effective network-wide data collection framework. Even WSNs are capable to support large volume data accessing, while recent works [16], [17] indicate that existing data collection schemes under the static setting incur a poor performance if they are used in the network with mobile users directly. The problem will become even worse if the transmission loss and interference are serious in the network [23]. In the network context with mobile users, most existing works explore how to plan the moving trajectory for the mobile user or sink to achieve an efficient data collection. [18] exploits reactive mobility to improve the target detection performance. Mobile sensors collaborate with static sensors and move reactively in [18]. Tan et al. [19] further jointly optimizes data routing paths and the data collection tour. In [23], the authors investigate the approach that makes use of a mobile sink for balancing the traffic load and in turn improving network lifetime. SinkTrail is proposed in [21] as a proactive data reporting protocol, and the SHDGP problem is studied in [21]. Moreover, on the application level, Gao et al. [17] propose to adopt HST tree to distributed manage resources in WSNs and [18] introduces a method to collect event data using mobile sinks. On the other hand, some recent works do not assume the fixed trajectory of mobile users or sinks. In [20], authors propose to use data traffic to probe the future position of the mobile user. The mobile user probing process does not introduce extra communication costs; nevertheless, [20] is not tailored for the optimization of routing tree transitions. In [16], authors propose to use mobility graphs to predict the future data collection position of the mobile user. Leeet al. [17] utilize linear programming to optimize the prediction accuracy. Those works mainly focus on predicting the movement of mobile users to improve routing efficiency. So far as we know, however, no works for directly optimizing the rendezvous planning of data collection process of mobile users have been proposed.

VI. CONCLUSION

In this work, we study the Rendezvous planning approach of data collection for mobile users in wireless sensor networks. Essentially different from existing works, we utilize the spatial correlation to efficiently build and update the data collection tree in the system. Whenever the mobile user moves and changes the virtual sink to access the sensor network, a new data collection tree can be efficiently formed by locally modifying the previously constructed data collection tree. With such an approach, the routing performance is bounded and controlled compared to the optimal performance while the overhead in updating the routing structure is significantly reduced. Such a property ensures low data collection delay, providing real-time data acquisition for the mobile user. In addition, our proposed protocol is compatible to existing mobility prediction mechanisms and easy to implement. We tested the proposed protocol in a 49-node testbed and test its feasibility and applicability in practice. We further conduct extensive simulations, which prove the efficiency and scalability of our approach.

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