

Using Sink Initiated Multicast Protocol for Reducing the Data Loss by the Mobile Sink in Wireless Sensor Network

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Abstract

In the wireless sensor networks the recent work has shown that sink mobility along a constrained path can improve the energy efficiency. But due to the path constraints, a mobile sink with constant speed has limited communication time to collect data from the sensor nodes deployed randomly. This has significant challenges in jointly improving the amount of data collected and reducing the energy consumption. To overcome this problem, the paper proposes a novel data collection scheme, called the Maximum amount shortest path (MASP). It increases network throughput and also conserves energy by optimizing the assignment of sensor nodes. MASP is formulated as an integer linear programming problem and then solved with the help of a genetic algorithm and also developing a practical distributed approximate algorithm to solve the MASP problem. A (Sink –Initiated Multicast protocol) SIMP protocol is used to reduce the data loss during the communication phase by mobile sink.

Keywords

Mobile Sinks, Shortest Path Tree, MASP, Data Collection, SIMP, Energy Efficiency

I. Introduction

The sink mobility has become an important research topic in Wireless Sensor Networks (WSNs). A wireless sensor network is a large-scale ad hoc multi hop network deployed in a region of interest for surveillance purpose [2, 4]. One of its fundamental tasks is to gather sensor readings from the sensory field at data sinks. Research has shown that sensors near a sink deplete their battery power faster than those far apart due to the heavy overhead of relaying messages. Non-uniform energy consumption causes degraded network performance and shortened network lifetime. We address the problem of energy-efficient data collection by mobile sink in delay-tolerant WSN. Wireless sensors are battery-powered sensing devices that are able to communicate through radio frequency. They are densely dropped at random in a large region of interest for object monitoring and target tracking. Once deployed, they self-configured into a connected wireless network and operate completely on their own. To minimize deployment budget, sensors are intentionally made low in cost, they have very limited resources such as energy, memory, computation and communication capabilities. In WSN, sensor readings are transmitted to one or more pre-defined data sinks for analysis and processing. The main sensor-to-sink communication pattern is multi-hop message relay, as most of sensors are out of the range of a sink. In this paper, aiming at the data delivery problem in large-scale wireless sensor networks with mobile sinks which move along fixed paths with constant speed, we propose an efficient data collection scheme that simultaneously improves the total amount of data and reduces the energy consumption [3].

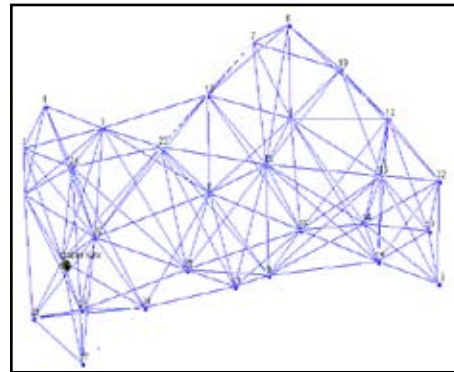


Fig. 1: An Example of Path-Constrains in Mobile WSNs

As shown in fig. 1, a mobile sink M installed on a transportation vehicle move along a fixed range L periodically when M arrives at the end point of its path once and returns back to the start point, then it has completed one round. Direct Communication Area (DCA) between range L1 and L2, and the Multihop Communication Area (MCA) for far-off sensor. Sensor nodes within the DCA, called sub sinks, can directly transmit data to the mobile sink due to their closer proximity of the range, L. On the other hand, sensors within the MCA, called members, must first relay data to the sub sinks which complete the final data transmission to the mobile sink. Sink or Target

II. Existing System

The problem of data collection in sensor networks is encountered in many scenarios such as monitoring physical environment. The objective is to collect data from sensors and deliver it to an access point in the infrastructures. The principal constraint is the energy budget of the sensors which is limited due to their size and cost. The Shortest Path Tree (SPT) method is proposed to choose sub sink and relay data from members. Each member chooses the closest sub sink in terms of hop distance as its destination and then sends its own data or forwards data from downstream nodes along shortest path trees [5- 6]. It is possible that some sub sinks with longer communication time own fewer members, implying that the mobile sink may collect less data than expected. In other words, the SPT method has low energy efficiency for data collection.

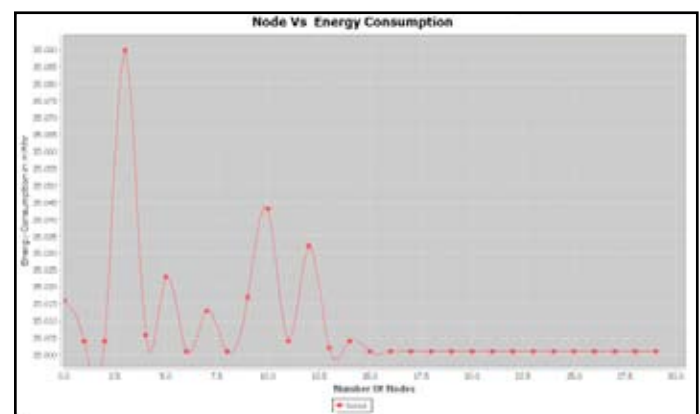


Fig. 2: A Graph Showing Node Vs Energy Consumption Model

III. Proposed System

SIMP (Sink –Initiated Multicast protocol) is used to collect the data without data loss based on communication time based and also without sub sink selection to collect the data directly through mobile sink.

A SIMP is using to reduce the data loss during the communication phase by mobile sink. While the mobile keep moving to collect data it collects data by broadcasting to sinks which are within its broadcast range. By using SIMP protocol, data loss and huge energy conservations are avoided.

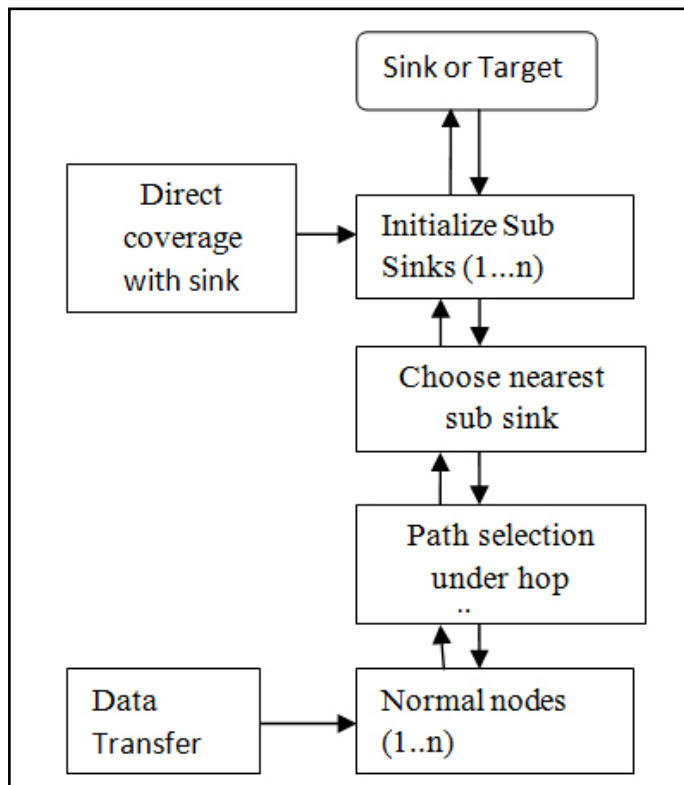


Fig. 3: Implementation of SIMP Architecture

Two Phase Communication Protocol

The two phase communication protocol is implemented in the following phases:

A. Data Discover Phase

In discover phase main task is to learn the topology information and assigning the members to their corresponding sub-sinks. the discover phase is done in three different rounds [2].

Round 1:

In round 1, the mobile sink transmits broadcast messages continuously. All nodes which are receiving the broadcast messages from the mobile sinks are automatically selected as sub sinks. Then the sub sinks start building the shortest path trees (SPTs) rooted from themselves in entire network. Then each node obtains the shortest hop information from themselves to all sub-sinks and the related hop information is send to the corresponding sub-sink. Mobile sink records the time when each node enters and leaves the communication range this is an important task in round 1.

Round 2:

In round 2, shortest hop information collected in round 1 is send to the mobile sink by the sub-sinks when the mobile sink passes by. The mobile sink calculates the communication time of the

each sub-sink according to the overlap time partition.

Round 3:

In this round, the mobile sink transverse the trajectory again to broadcast the results to members' assignment to the monitored area. The broadcast message consists of the list of the mapping relation between member and its destination sub-sink. Each node receiving the broadcast message will get sub sin as its destination. Then the node will delete its own item in the broadcast message and rebroadcast it. Finally, the optimized member assignment information will be disseminated to the entire network.

B. Data Collection Phase

In the data collection phase, all nodes in the monitored area start collecting data formally. The sensed data from members sends it to the destination sub-sink according to the routing table built in round 1 of the discovery phase sub-sinks pre-cache all data from their members and themselves before the mobile sink enters into their communication range. During the actual data collection, we adopt a handoff method to partition the overlapping time which is consistent with the one used in Round 2. In order to load balance the data originated from members, a round bin scheme [1] is used to transmit data at the sub-sinks. In this paper, the constraints on the network throughput are expressed by the number of members required by the Sub-sinks. However, the mobile sink may not collect the expected amount of data due to interference between transmission and reception on the sub-sinks. The communication resources (including time, bandwidth, etc.) between the sub-sinks and the mobile sink are more precious than those in a network where complete paths between the member nodes and the sub-sinks always exist. Based on this observation, we propose a Mobile Sink First (MSF) scheme to process the communication between the sub-sinks and the mobile sink in order to avoid the interference[4]. In the MSF scheme, the sub-sink will stop receiving the sensed information from its downstream nodes and make use of all time resource and bandwidth resource to transmit data to the mobile sink when it's current sub-sink's turn for transmission. In the meanwhile, the downstream nodes of current sub-sink need to buffer data from their child nodes. After the mobile sink moves away, the downstream nodes will start transmitting buffered data to the current sub sink.

B. Design of Zone-Partitioning in Wireless Sensor Networks

Each member always tries to choose the nearest sub-sink as its destination if the constraints about the MReqs are satisfied, which means all members seldom choose the sub-sink very far away when all nodes are deployed randomly and uniformly. Based on the above observations, we propose an algorithm to build Shortest Path Trees (SPTs) based on zone partitioning without relying on geographical information about the sensors and the sinks. Through zone partitioning, we can divide the whole monitored area into several zones. And then, the MASP scheme is executed separately to get the optimal assignment of the members to the sub-sinks in each zone.

C. Sink –Initiated Multicast Protocol(SIMP)

The total amount of data, Q_{total} , collected by the mobile sink in one round consists of the data collected from all sub-sinks as follow:

$$Q_{total} = \sum_{i=1}^{125} Q_i$$

Where, Q_i is the amount of data from sub-sink per round. In order to maximize the total amount of data in low density network, it must be guaranteed that no sub-sink owns more members than its MReqs value in Condition i.e. MReqs is the maximum and minimum requirement of members. Energy calculation is done in the MASP method depending on the amount of data transmitted and received by the nodes in one round.

IV. Simulation Results

In this section, we show and analyze the simulation results of network life time, energy consumption and total amount of data in network of our system.

- Total amount of data is the total amount of information collected by the mobile sink in one round.
- Total energy consumption is the total energy consumed by all sensor nodes in one round.
- Network life time is the number of movement rounds of the mobile sink from the beginning of the data collection phase to the first node energy exhaustion.

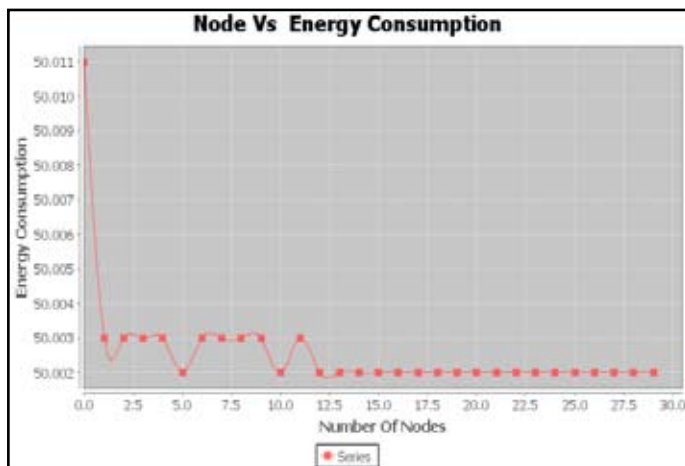


Fig. 4: Shows the Energy Consumption in the SIMP

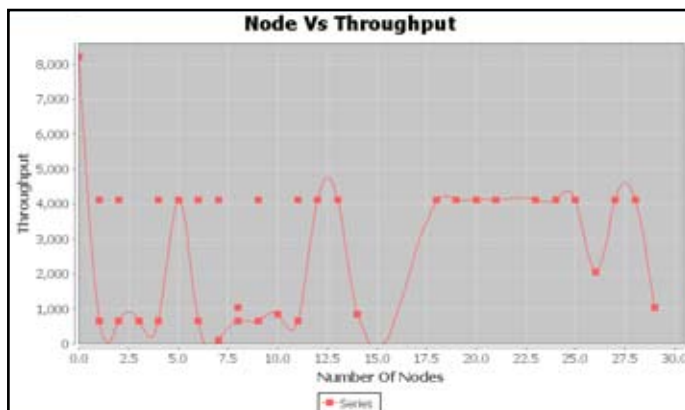


Fig. 5: Shows Comparison of Network Life Time in Two Methods

V. Conclusion

In this paper, we proposed an efficient data collection scheme called SIMP for wireless sensor networks with path constrained mobile sinks. In SIMP, the mapping between sensor nodes and sub-sinks is optimized to maximize the amount of data collected by mobile sinks and also balance the energy consumption. Simulation experiments under Glomosim shows that SIMP improves the energy Utilization efficiency and outperforms SPT method in

terms of total amount of data and the energy consumption. Hence, by using the Sink initiated multicast protocol for data collection in the mobile sink it is definitely reduces the energy consumption and also the data loss when compared to the MASP protocol.

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