An Efficient Data Gathering Mechanism using M_Collectors

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Abstract—Here, we present a new concept of M_Collectors instead of static collectors. M_Collectors provides the mobility in the network. Main objective of mobile data-gathering scheme is to improve the scalability and solves intrinsic problems of large-scale homogeneous networks. This new concept under the mobility provides data gathering tour periodically from the static data sink, polls each sensor in single-hop communications, and finally transports the data to the data sink. We mainly focus on the problem of minimizing the length of each data-gathering tour and refer to this as the single-hop data-gathering problem. Our single-hop mobile data gathering scheme can improve the scalability and balance the energy consumption among sensors. It can be used in both connected and disconnected networks. Mainly focus on the problem of minimizing the length of each data-gathering tour and refer to this as Single-Hop Data Gathering Problem (SHDGP). Our single-hop mobile data-gathering scheme can improve the scalability and balance the energy consumption among sensors. Here we proposed a data gathering tour, by using minimum spanning tree covering algorithm to find the path through which the M_Collector can move. Data gathering With multiple m_collector algorithm is also using for time management and also delay can be minimized using this multiple collectors. Many limitation of static collectors including energy consumption can be minimized by using mobility concept. Mobile collector may be mounted upon acity buses that repeatedly follow a predefined trajectory with a periodic schedule. The use of such existing infrastructure removes the unrealistic requirement for using dedicated mobile Controllable platforms to carry Mobile collector. Comparison between single and multiple collectors has given in the graph as a part of result. It gives an idea that when the number of nodes increases then the throughput of single and multiple collectors have same increment. When the number of nodes is less then the throughput also varies. By proposing the rendezvous node concept we can find the tour length is little greater for the single collector than multiple collector.

Keywords—M_Collector; Static Collectors; Static Data Sink; Single-Hop; Spanning Tree.

Abbreviations—Mobile Collector (M_Collector); Single Hop Data Gathering Problem (SHDGP); Wireless Sensor Networks (WSN).

I. INTRODUCTION

Due to the recent development of technologies in wireless communication, and in wireless sensor networks, many new information gathering mechanisms have developed in applications such as medical treatment, outer-space exploration. Without using a preconfigured infrastructure large number of sensors are deployed in the sensing field [Bai et al., 2012]. At first these sensor nodes must able to discover s their neighbor nodes and form the network by themselves. Most of the energy of the sensors is consumed on two major tasks: sensing the field and uploading data to the data sink. Energy consumption on sensing is stable because it does not depend on the topology, it only depends on the sampling rate [Guo et al., 2011]. In homogeneous network sensors are arranged in a flat topology, sensors close to the data collector consume more energy than sensor that are far away from the data collector [Liang et al., 2013]. So many sensors want to relay packets from the sensors. If any of the sensor fails then sensor can’t reach the data to the collector, then whole network will be disconnected [Shah & S. Roy, 2003]. In those areas mobile collector is perfectly suitable application. A mobile collector serves as a mobile data transporter that moves through every subnetworks. The moving path of the mobile data collector acts as virtual links between separated sub networks.
To provide a scalable data gathering scheme for large scale sensor networks, we utilize mobile data collectors to gather data from sensors. The mobile data collectors start a tour from the data sink traverses the network, collects sensing data from near by nodes while moving, and then returns and uploads data to the data sink [Amis et al., 2000]. The mobile data collector moves close to sensor nodes and if the moving path is well planned the network lifetime can be increased [Wang et al., 2005].

II. RELATED WORKS

Here we are discussing about some related work on the data gathering mechanism in WSNs.

In flat topology, data routing can cost energy expenditure so introduce a hierarchy to the network. A two layered hybrid networks are more scalable and energy efficient than homogeneous sensor networks [Luo & Hubaux, 2005]. In those networks sensor nodes are organized in to clusters and form as lower layer. At higher layer, cluster heads collect sensing data and move to the data sink. A cluster head acts as data aggregation point for collecting sensing data from sensors and also as a controller or scheduler to make various routing and scheduling decisions [Somasundara et al., 2004]. In homogeneous network where all nodes have identical capability, so some nodes are selected to serve as cluster heads. Cluster head consume more energy than other nodes, and it may fail faster than other nodes. So sensor nodes can become cluster heads rotationally.

Mobility of the sensor networks has been studied [Chessa & Santirash, 2002; Somasundara et al., 2004]. Those studies described about radio tagged zebras and whales were used as mobile nodes to collect sensing data in a wild environment. These animal based nodes randomly wander in the sensing field and exchange sensing data only when they move close to each other. But the mobility of the random moving animal is hard to predict and control. Thus maximum packet delay can not be guaranteed.

A number of mobile observers called data mules pick up data directly from the sensors when they are close in range, buffer the data and drop off the data to the wired access points [Shah & Roy, 2003]. The mobile observers traverse the sensing field along straight lines and gather data from sensors. But data mules may not be always able to move along straight lines, for example obstacles or boundaries may block the moving paths of data mules.

III. PRELIMINARIES

We consider the data gathering problem in which the M_collector can visit the transmission range of every static sensor, such that sensing data can be collected by a single hop communication without relay.

3.1. Polling Points

While moving, an m-collector can poll near by sensors one by one to gather data. Upon receiving a polling, message, a sensor simply uploads the data to the M_collector directly without relay. We define the positions where the M_collector polls sensors as polling points [Chessa & Santirash, 2002]. When an m_collector moves to a polling point, it polls nearby sensors within the same transmission power as sensors, such that sensors that receive the polling message can upload packets to the M_collector in one hop [Guo et al., 2011]. After data gathering from sensors around the polling point, the M_collector moves directly to next polling point in the tour.

\[ P = \{ p_1, p_2, \ldots, p_t \} \]

\[ DS \]

DS be the data sink.

Moving tour of the m_collector can be represented by \[ DS \rightarrow P_1 \rightarrow P_2 \rightarrow \ldots \rightarrow P_t \rightarrow DS \]. So, before an M_Collector starts a data gathering tour, it needs to determine the positions of all polling points and which sensors it can poll at each polling point.

IV. DATA GATHERING WITH SINGLE AND MULTIPLE COLLECTORS

4.1. Single-Hop Data Gathering

Here, we consider the problem of finding the shortest moving tour of an M_Collector that visits the transmission range of each sensor. The positions of sensors are either the polling points in the data gathering tour or within the one hop range of polling points. In the case of travelling salesman problem M_Collector must visit the location of every sensors one by one to gather data. The goal of TSP is to find the minimum distance tour that visits every points in the plane exactly once.

4.2. Heuristic Algorithm for the Single-Hop Data Gathering Problem

The basic idea behind our proposed Spanning Tree Covering algorithm is to choose a subset of points from the candidate polling point set. The algorithm tries to cover minimum average cost at each uncovered neighbor set of sensors with the minimum average cost at each stage.

Let \( P_{curr} \) contains all polling points, \( L \) be the set of remaining uncovered sensors at each stage of the algorithm. Let \( nb(l) \) denote neighboring set of \( L \). Let \( cost \{ nb(l) \} \) be the cost of an uncovered neighboring set.

Let \( $= cost\{nb(l)/nb(l)+U]\} \) denote the average cost to cover all uncovered sensors in \( nb(l) \).choose the \( nb(l) \) with $ minimum value.
4.3. Data Gathering with Multiple M_Collectors

The entire network can be divided into sub-networks. In each sub-network, an M_collector is responsible for gathering data from local subarea in the network [Wang et al., 2005]. From each M_Collector the data moves to the M_collector that visit the data sink.

Let L_max be the upperbound of any subtour, which guarantees the data to be collected before sensors run out of storage [Konstantopoulos et al., 2012]. Let t(v) denote the subtree of T. Let parent(v) be the parent of vertex v. Let weight {v} represent the sum of link cost in the subtree t{v}.

Data Gathering Algorithm with Multiple M_Collectors

Find the polling point set p
Find the spanning covering tree T on all polling points in p.
For each vertex v in T, calculate the weight value Weight(v)
While T≠empty
Find the deepest leaf vertex u in T
Let the root of the subtree t, Root(t)=u
While Weight(parent(Root(t)))≤L_max/2
Root(t)=parent(Root(t))
Endwhile
Add all child vertices of root(t) and edges connecting them into t and remove t from T
Update weight value of each remaining vertex in T
Endwhile

Spanning Tree Covering Algorithm

Create an empty set Pcurr
Create a set Ucurr, contain all sensors
Create a set L containing all candidate polling points
While Ucurr≠empty
Find a polling point l belongs to L, which minimizes $\text{cost}(nb(l))/(nb(l)+Ucurr)$
Cover sensors in nb(l)
Add the corresponding polling points of nb(l) in Pcurr
Remove the corresponding polling point of nb(l) from L.
Remove sensors in nb(l) from Ucurr
Endwhile
Find an approximate shortest tour on polling points in Pcurr.

5.1. Clustering

The large-scale deployment of WSNs and the need for data aggregation necessitate efficient organization of the network topology for the purpose of balancing the load and prolonging the network lifetime [Zhao & Yang, 2012]. Clustering has proven to be an effective approach for organizing the network in the above context [Amis et al., 2000]. Besides achieving energy efficiency, clustering also reduces channel contention and packet collisions, resulting in improved network throughput under high load. Our clustering algorithm borrows ideas from the algorithm of Chen et al., to build a cluster structure of unequal clusters. The clustering algorithm in constructs a multisized cluster structure, where the size of each cluster decreases as the distance of its cluster head from the base station increases.

Figure 1: Data forwarding paths in MobiCluster

Figure 2: Unequal Cluster Formation in MobiCluster
During an initialization phase, the MC moves along its fixed trajectory broadcasting periodically a BEACON signal to all SNs at a fixed power level. All nodes near the MC trajectory receive the BEACON message and thus they know that the clusters in their region will be small sized [Konstantopoulos et al., 2012]. Then, these nodes flood the BEACON message to the rest of the network.

VI. CONCLUSION AND FUTURE WORK

We have proposed a mobile data gathering scheme for large scale sensor networks. We introduced a mobile data collector which works like a mobile station in the network. An M_collector starts the data gathering tour periodically from the static data sink, polls the sensors and gather the data from sensors and finally uploads data to the data sink [Luo & Hubaux, 2005]. Our mobile data gathering scheme improves the scalability and solves the problems related to homogeneous networks. By introducing M_collector, data gathering becomes more flexible and adaptable to the unexpected changes of the network topology. We introduced multiple M_Collectors by allowing each of them moves through a shorter subtour than the entire tour. Our proposed scheme reduces the moving length, and it can prolong the network lifetime compared with the static data collector. This work gives a great impact in the field of data gathering in WSN by reducing the energy consumption of each sensors and there by increase the network lifetime.
REFERENCES


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