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Data Aggregation In Wireless Sensor Networks Using Mobile Data Collector

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ABSTRACT: Wireless sensor networks (WSNs) have emerged as a new information-gathering paradigm in a wide range of applications, such as medical treatment, outer-space exploration, battlefield surveillance, emergency response, etc. Large-scale wireless sensor networks which introduce mobility into the network is an new data-gathering mechanism. A mobile data collector, called an M-collector, mobile robot or a vehicle equipped with a powerful transceiver and battery, working like a mobile base station and gathering data while moving through the field. Multiple M-collector are used for the data-gathering algorithm where multiple M-collectors traverse through several shorter subtours concurrently and sensing data collected from sensors are forwarded to the nearest M-collector to the data sink. It mainly focus on the problem of using Multiple M-collector the cost and energy. Energy consumption is reduced by using the backup device selection of node from each subgroup of sensors. Backup device aggregating the data from each sensors in a multi-hop communication with the help of single M-collector. Simulation results shows that the proposed data-gathering algorithm can greatly shorten the moving distance of the M-collector and energy. And also it can significantly prolong the network lifetime compared with a network with static data sink.

KEY WORDS: Data gathering, M-collector, Mobile data collector, Movement planning, mobility, spanning tree, salesman problem, Wireless Sensor Networks (WSN).

I. INTRODUCTION

Wireless sensor networks (WSNs) have emerged as a new information-gathering paradigm in a wide range of applications, such as medical treatment, outer-space exploration, battlefield surveillance, emergency response, etc. [1]-[2]. Propose a new data-gathering mechanism for large-scale wireless sensor networks by introducing mobility into the network. A mobile data collector, for convenience called an M-collector in this paper, could be a mobile robot or a vehicle equipped with a powerful transceiver and battery, working like a mobile base station and gathering data while moving through the field. An M-collector starts the data-gathering tour periodically from the static data sink, polls each sensor while traversing its transmission range, then directly collects data from the sensor in single-hop communications, and finally transports the data to the static sink. Since data packets are directly gathered without relays and collisions, the lifetime of sensors is expected to be prolonged. In this paper, 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 (SHDGP). We first formalize the SHDGP into a mixed-integer program and then present a heuristic tour-planning algorithm for the case where a single M-collector is employed. For the applications with strict distance time constraints, we consider utilizing multiple M-collectors and propose a data-gathering algorithm where multiple M-collectors traverse through several shorter subtours concurrently to satisfy the distance/time constraints. Our single-hop mobile datagathering scheme can improve the scalability and balance the energy consumption among sensors. It can be used in both connected and disconnected networks. Simulation results demonstrate that the proposed data-gathering algorithm can greatly shorten the moving distance of the collectors compared with the covering line approximation algorithm and is close to the optimal algorithm for small networks. In

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addition, the proposed data-gathering scheme can significantly prolong the network lifetime compared with a network with static data sink or a network in which the mobile collector can only move along straight lines.

II. BACKGROUND

2.1 Mobile data gathering mechanisms

Mobile data-gathering scheme improves the scalability and solves intrinsic problems of large-scale homogeneous networks. Sensor nodes are usually thrown into a large-scale sensing field without a preconfigured infrastructure. Before monitoring the environment, sensor nodes must be able to discover nearby nodes and organize themselves into a network. Most of the energy of a sensor is consumed on two major tasks: sensing the field and uploading data to the data sink.

Energy consumption on sensing is relatively stable because it only depends on the sampling rate and does not depend on the network topology or the location of sensors. On the other hand, the data-gathering scheme is the most important factor that determines network lifetime. Although applications of sensor networks may be quite diverse, most of them share a common feature. The data packets may need to be aggregated at some data sink. In a homogeneous network where sensors are organized into a flat topology, sensors close to the data collector consume much more energy than sensors at the margin of the network, since they need to relay many packets from sensors far away from the data collector.

After the sensors fails, other sensors cannot reach the data collector and the network becomes disconnected, although most of the nodes can still survive for a long period. Therefore, for a large-scale data-centric sensor network is inefficient to use a single static data sink to gather data from all sensors. In some applications, sensors are deployed to monitor separate areas. In each area, sensors are densely deployed and connected, whereas sensors that belong to different areas may be disconnected. Unlike fully connected networks, some sensors cannot forward data to the data sink via wireless links.

2.2 Mobile Data Collector

A mobile data collector serves as a mobile "data transporter" that moves through every community and links all separated subnetworks together. The moving path of the mobile data collector acts as virtual links between separated subnetworks. Sensing data are generally collected at a low rate and is not so delay sensitive that it can be accumulated into fixed length data packets and uploaded once in a while. To provide a scalable data-gathering scheme for large static sensor networks, utilize mobile data collectors to gather data from sensors.

A mobile data collector called M-Collector, or a mobile robot or a vehicle equipped with a powerful transceiver, battery, and large memory. A mobile data collector starts a tour from the data sink, traverses the network, collects sensing data from nearby nodes while moving, and then returns and uploads data to the data sink. If not all sensors are connected to the data sink, an M-collector needs to be sent out to discover the position of every sensor regardless of the data gathering scheme used. An M-collector starts the data-gathering tour periodically from the static data sink, polls each sensor while traversing its transmission range, then directly collects data from the sensor in single-hop communications, and finally transports the data to the static sink.

2.3 Single Hop Communication

Every sensor communicates directly with the base station or any device. It may require large transmit powers and may be infeasible in large geographical area. M-collector can be reached by any sensor within a single hop, no packet relay by sensors is needed. M-collector can visit the transmission range of every static sensor, such that sensing data can be

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collected by a single-hop communication without any relay. M-collector is moving, it can poll nearby sensors one by one to gather data. Upon receiving the polling message, a sensor simply uploads the data to the M-collector directly without relay.

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 the polling points. M-collectors move at a fixed speed and ignore the time for making turns and data transmission, such that can roughly estimate the time of a data-gathering tour by the tour length. Clearly, by moving through the shortest time such that the users will have the most up-to-date data is said to be the Single-Hop Data Gathering Problem (SHDGP).

2.3.1 Data gathering with Single M-Collector

Sensor are deployed in the area. Finding the shortest moving tour of an M-collector that visits the transmission range of each sensor. As shown in Figure 1, the positions of sensors are either the polling points in the data gathering tour or within the one hop range of the polling points. M-collectors move at a fixed speed and ignore the time for making turns and data transmission, such that roughly estimate the time of a data-gathering tour by the tour length by moving through the shortest tour, data can be collected in the shortest time such that the users will have the most up-to-date data refer to as the single-hop data gathering problem (SHDGP).

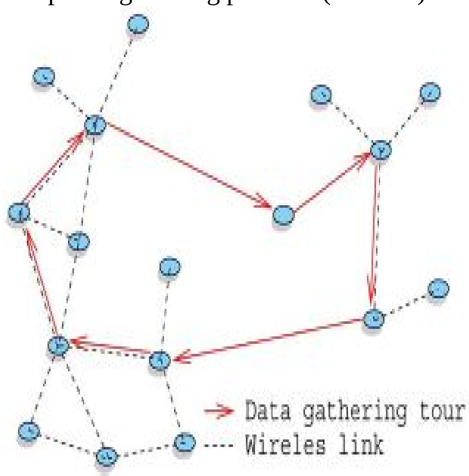

Figure 1: Single-Hop Data Gathering Problem

Traveling salesman problem (TSP) for points in the plane can be reduced to the SHDGP. The M-collector must visit the location of every sensor one by one to gather data. Since sensors are close enough to M-collectors while uploading data, transmission power can be minimized, and the lifetime can be maximized. The goal of the TSP for points in the plane is to find a minimum distance (cost) tour that visits every point in the plane exactly once, which is known to be NP-hard. The network reduces to a single-hop network, and like a base station in a WLAN, the M-collector can collect data directly from any sensor without moving.

2.3.2 Data gathering with Multiple M-Collector

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Single M-collector not be sufficient to visit the transmission ranges of all sensor in large-scale applications. To avoid unbalanced network lifetime, one-hop data gathering by utilizing multiple M-collector. M-collector can gather data remotely via wireless links without visiting the "home" of every sensor .Any two M-collector can exchange their data via wireless links meeting each other physically, which makes it possible for M-collector far away from the data sink to upload data the data sink through the relays of other M-collection than visit the data sink.

Data Gathering Algorithm with multiple M-collectors

```
set P
set T
while($T !=0)
{
u=$T;
weight {expr {Parent(Root(t))} <= {expr Lmax/2};
Parent(Root($t))=$Root($t);
end while;
}
```

In data gathering scheme with multiple M-collector , only one M-collector needs to visit the transmission range of the data sink. Built the spanning covering tree for data gathering with multiple M-collector. Decomposes the spanning covering tree into a set of subtrees and finding an approximate shortest tour on points of each subtrees. Sensing data collected from sensors are forwarded to the nearest M-collector to the data sink. Comparing to the single M-collector , it can prolong the network life time.

Spanning Tree Covering Algorithm

```
set Pc
set Uc
set L
while ($Uc != 0)
{
puts "$L"
set b = { cost{nb($l)} / nb($l).$Uc }
}end $L
```

III. PROPOSED SYSTEM

A possible solution to the problem is one hop data gathering scheme by utilizing Multiple M-collectors. For the applications with strict distance/ time constraints, Consider utilizing multiple M-collectors and propose a data-gathering algorithm where multiple M-collectors traverse through several shorter subtours concurrently to satisfy the distance/time constraints . M-collector can gather data remotely via wireless links without visiting the "home" of every sensor . Any two M-collector can exchange their data via wireless links meeting each other physically, which makes it possible for M-collector far away from the data sink to upload data to the data sink through the relays of other M-collection than visit the data sink.

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Data gathering scheme with multiple M-collector , only one M-collector needs to visit the transmission range of the data sink. Built the spanning covering tree for data gathering with multiple M-collector. Decomposes the spanning covering tree into a set of subtrees and finding an approximate shortest tour on points of each subtrees. Sensing data collected from sensors are forwarded to the nearest M-collector to the data sink. Comparing to the single M-collector , it can prolong the network life time. For each subtour , the rendezvous node is to be placed. It collects the data from nearby sensors in multihop communication. It is just like a backup device. Nearby sensors are directly transmit the data to base station. If it is not near with base station, it will transmit the data with the help of M-Collectors.

3.1 Backup Device Selection

Each subtour place, the rendezvous node to be placed. It collects the data from all sensors. It is just like a backup device. Nearby sensors are directly transmit the data to base station. If it is not near with base station, it will transmit the data with the help of M-Collectors. For prevention, there are too many algorithms are available.

Backup Device Node Selection Algorithm

```
int nb = 0;
int vtfirst=0,vtlast=0;
int ti=5.5;
int s1;
vtfirst=t1;
vtlast=vtfirst;
int nb=1,nbr=1;
while(ti!=0)
{
if(ti>0)
{
Record ti,si;
char nb = 0;
nb = nb+(ti-[ti-1]/[T1])
nbr = nbr+1;
vtlast=ti;
ti=0;
}
}
v.val=a1.Eresidualpower/Emax+a2.nb+a3.sum(seq[i,1,nb,si]/nb)
Transmit(v.node_($i),v.val,vtfirst,vtlast)
```

IV. IMPLEMENTATION

Utilizing single M-collectors and proposing a backup device selection a algorithm, where the M-collectors gathering the data from backup device which collects the data from nearby sensors to satisfy the distance/time constraints. Single-hop data gathering efficiently collects the data from all the sensors individually. If any one of the sensor fail due to energy, it can't affect any other sensors. M-collector can gather data remotely via wireless links without visiting the "home" of every sensor.

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The backup device based solutions are presented for fixed MS trajectories. The introduced technique assumes full aggregation. The whole algorithm is performed centrally at the BS. A number of other backup device-based solutions that assume variable MS trajectory . The work determine the MS trajectory in such way that certain optimization criteria (e.g., minimum energy consumption for transferring the data to backup device node (BDNs)) are met while obeying certain constraints (e.g., the MS trajectory length should be lower than a certain threshold). A common characteristic of the technique described above is that the routing structures that carry data from SNs to BDNs are built once and are used without any modification for the whole lifetime of the WSN. Most of the works are centralized that try to minimize an energy related cost function without paying proper attention to the selection of nodes that will serve as BDNs. BDNs receive the data from the sensor nodes of the network. Specifically, it take into account the contact time of a BDN can send the buffered data to the M-collector and M-collector forwared the gathered data to the MS.

A heavily loaded BDN that is in contact with the M-collector for only a short time may not manage to transfer all buffered data and this gradually may lead to buffer overflow or very long delivery delays. All SNs that send their data to the BDNs cannot send their data to MS any longer. A local or even a global rebuilding of the routing structures may be required in order to bypass dead BDNs.

4.1 Clustering

The large-scale deployment of WSNs data aggregation necessitate efficient organization of the network topology for the purpose of balancing the load and prolonging the network lifetime. Clustering has proven to be an effective approach for organizing the network . Besides achieving energy efficiency, clustering also reduces channel contention and packet collisions, resulting in improved network throughput under high load. Clustering algorithm is to build clusters of two different sizes depending on the distance of the CHs from the MS's trajectory. Specifically, SNs located near the MS trajectory are grouped in small sized clusters while SNs located farther away are grouped in clusters of larger size.

During an initialization phase, the MS moves along its fixed trajectory broadcasting periodically a BEACON signal to all SNs at a fixed power level. All nodes near the MS trajectory receive the BEACON message and thus they know that the clusters in their region will be small sized. Then, these nodes flood the BEACON message to the rest of the network.

4.2 BDNs selection

BDNs guarantee connectivity of sensor islands with MS. Their selection largely determines network lifetime. BDNs lie within the range of traveling sinks and the location depends on the position of the CH and the sensor field with respect to the sinks trajectory. Suitable BDNs are those that remain within the MS's range for relatively long time, in relatively short distance from the sink's trajectory and have sufficient energy supplies. In practical deployments, the number of designated BDNs introduces an interesting trade-off. A large number of BDNs implies that the latter will compete for the wireless channel contention as soon as the mobile robot appears in range, thereby resulting in low data throughput and frequent outages.

A small number of BDNs implies that each BDN is associated with a large group of sensors. Hence, BDNs will be heavily used during data relays, their energy will be consumed fast and they will be likely to experience buffer overflows.

4.3 Data Forwarding to Data Sink

To regulate the number of BDNs and prevent either their rapid energy depletion or potential data losses, a simple selection model whereby a set of cluster members (in vicinity to the MS's trajectory) from each cluster is enrolled as

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BDNs. BDN's role may be switched among cluster members when the energy level of a node currently serving as BDN drops below a pre specified threshold. After the selection of BDN, which aggregates the data from sensors and forwarded to M-collector. Finally M-collector transmit the collected data to sink.

V. CONCLUSION AND FUTURE ENHANCEMENT

WSN have emerged as a mobile data-gathering scheme for large-scale sensor networks. A mobile data collector, called an M-collector, which works like a mobile base station in the network. An M-collector starts the data-gathering tour periodically from the static data sink, traverses the entire sensor network, polls sensors and gathers the data from sensors one by one, and finally returns and uploads data to the data sink. For some applications in large- scale networks data-gathering tour with multiple M-collectors by letting each of them move through a shorter subtour than the entire tour . Energy consumption of using multiple M-collector is reduced by using the backup device selection of node from each subgroup of sensors in a multi - hop communication. Proposed data-gathering scheme can greatly reduce the moving length compared with the covering line algorithm and is close to the optimal algorithm in small networks . In addition, it can prolong the network lifetime significantly compared with the scheme that has only a static data collector. Backup device node is selected from the each group of sensor , which should have more memory and energy. There may be a chance of failure in backup device due to less energy and battery. For selecting the another senor node to be a backup device will be the further work.

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