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Optimization Strategy in Wireless Sensor Networks for Network lifetime based on Data Gathering Algorithm

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ABSTRACT: This article introduces a new data gathering mechanism for large scale wireless sensor networks by introducing mobility into the network. Most of the traditional WSN architectures consist of static nodes which are densely deployed over a sensing area. In proposed method a M-collector (mobile data collector) starts the data gathering tour periodically from the static data sink, pools each sensor while traversing its transmission range, then directly collects data from the sensor in single hop communications and finally transport data to the static sink. This paper 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). We propose a data gathering algorithm where multiple M-collectors traverse through several shorter sub tours concurrently to satisfy the distance/time constraints. Simulation results demonstrate that the proposed data gathering algorithm can greatly shortens the moving distance of the collectors and significantly prolong the network lifetime.

KEYWORDS: WSN, Data Gathering Algorithm, Network Lifetime, Static Collector, Dynamic Collector.

I.INTRODUCTION

A wireless sensor network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy. Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN. The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes. Sensor nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Energy conservation and harvesting increase lifetime of the network. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes.

Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible. This address the lifetime problem in wireless sensor networks. Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the life time until the first battery expires is an important consideration. Designing energy aware algorithms increase the lifetime of sensor nodes. In some applications the network size is larger required scalable architectures. Energy conservation in wireless sensor networks has been the primary objective, but however, this constrain is not the only consideration for efficient working of wireless sensor networks. There are other objectives like scalable architecture, routing and latency. In most of the applications of wireless sensor networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station becomes an important issue. It is important to guarantee that information can be successfully received to the base station the first time instead of being retransmitted.. In wireless sensor network data

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gathering and routing are challenging tasks due to their dynamic and unique properties. Many routing protocols are developed, but among those protocols cluster based routing protocols are energy efficient, scalable and prolong the network lifetime .In the event detection environment nodes are idle most of the time and active at the time when the event occur. Sensor nodes periodically send the gather information to the base station. Routing is an important issue in data gathering sensor network, while on the other hand sleep-wake synchronization is the key issues for event detection sensor networks.

Typically, in multi-hop data communication scenario, the sensors closed to the sink are the first to run out energy. This is due to fact that these sensors are required to forward all other nodes data. Once these nodes are disconnected, the operational lifetime of the networks ends, since the entire network become unable to communicate with the sink. This raise reducing the energy consumption as a major challenge.

To address this problem, many proposals [1][2][3] in the literature, have investigated the use of the Mobile Elements (MEs). A Mobile Element serves as a data carrier and travel the entire network to collect the data of each sensor via single-hop communication. By using Mobile Elements, we can avoid the energy consumption due to multi-hop communication. However, the speed of the mobile element is typically low [4][5], and therefore reducing the data gathering latency is important to ensure the efficiency of such approach. In this paper, we assume that are given more than one mobile element and the objective is to design minimum number of required tours to cover the network. Such that each sensor node is either on the tour or one hop away from the tour, and the length of the tour to be bounded by predetermined value L. We term this problem as the Length-constrained Tours Minimization. To address the presented problems we present heuristic-based solution, which uses cluster-based mechanism to build it solutions.

In the literature, several proposals [6][7] have investigated the use mobile sink(or mobile elements) to increase the lifetime of the network. By varying the data gathering path, the residual energy in the nodes becomes more evenly balanced throughout the network, leading to a higher network lifetime. Zhao et al. [8], [9] investigated the problem of maximizing the overall network utility. Accordingly, they proposed two algorithmic-based solutions, where the mobile element visits each gathering point for a period of time and gather the data from nearby sensors via multi-hop communications. They considered the cases where the sojourn time is fixed as well as variable. Guney et al. [10] formulated finding the optimal sink trajectory and the data flow routs problem as mixed integer programming formulations. Accordingly, they presented several heuristic to address the presented problem. The problem presented in this work share some similarities with the problem proposed by Xu et al.[11]. In their problem, the objective is to plan the mobile element tour to visit set of nodes in the network named gathering points. The upper-bound of the obtained tour must be also bounded by pre-determined time-deadline. In addition, they also restrict the depth of the routing trees.

II. RELATED WORK

1) Distributed Clustering in Ad-hoc Sensor networks: A Hybrid, Energy-Efficient Approach---> Ossaiiia Younis and Sonia Fahmy
   -- In this paper, author proposed a new energy-efficient approach for clustering nodes in ad hoc sensor networks. Based on Hybrid Energy-Efficient Distributed clustering, that periodically selects cluster heads according to a hybrid of their residual energy and secondary parameter, such as nude proximity to its neighbors or node degree.
   Pros and Cons:
   --This approach can be applied to the design of several types of sensor network protocols that require energy efficiency, scalability, prolonged network lifetime, and load balancing.
   --Only provided a protocol for building a single cluster layer.
2) Maximizing Networking Lifetime in Wireless Sensor Networks with Regular Topologies--->HuiTian, Hong Shen and Matthew Roughan
   --In this paper, author first present how to place SNs by use of a minimal number to maximize the coverage area when the communication radius of the SN is not less than the sensing radius, which results in the application of regular topology to WSNs deployment.
   Pros and cons:
   -- Mobile node rotation can extend WSN topology lifetime by more than eight times on average is significantly better than existing alternatives.
   --It considers WSNs that are mostly static with a small number of mobile relays not practically declared for Dynamic WSNs.

3) Modeling a Three-Tier Architecture for Sparse Sensor Networks--- (R. Shah, S. Roy, S. Jain, and W. Brunette) --- (Sept. 2003)

--This paper deals with mobile data gathering, which employs one or more mobile collectors that are robots or vehicles equipped with powerful transceivers and batteries

Pros and cons:

--The performance metrics observed are the data success rate (the fraction of generated data that matches the access points) and the required buffer capacities and the sensors and the MULEs.

--An important issue that is not addressed in this paper i.e. latency.

4) Integrated Coverage and Connectivity Configuration for Energy Conservation in Sensor Networks€”>Guoliang Xing, Xiaorui Wang, Yuanfang Zhang, Chenyang Lu, Robert Pless, And Christopher Gill

--In this paper author presented the design and analysis of novel protocols that can dynamically configure a network to achieve guaranteed degrees of coverage and connectivity. This work differs from existing connectivity or coverage maintenance protocols in several key ways.

Pros and cons:

--Capability of our protocols to provide guaranteed coverage and connectivity configurations through both geometric analysis and extensive simulations.

--It is not extending solution to handle more sophisticated coverage models and connectivity configuration and develop adaptive coverage reconfiguration for energy-efficient distributed detection and tracking techniques.

5) Call and Response: Experiments in Sampling the Environment---> M. Rahimi, Y. Yu

--In this paper author have developed an embedded networked sensor architecture that merges sensing and articulation with adaptive algorithms that are responsive to both variability in environmental phenomena discovered by the mobile sensors and to discrete events discovered by static sensors.

Pros and cons:

--They also showed relationship among sampling methods, event arrival rate, and sampling performance are presented.

-- Sensing diversity does not introduced which is used to enhance Fidelity Driven Sampling.

6) Data Storage Placement in Sensor Networks--> M. Rahimi, Y. Yu

--In this paper author introduces storage nodes to store the data collected from the sensors in their proximities. The storage nodes alleviate the heavy load of transmitting all the data to a central place for archiving and reduce the communication cost induced by the network query.

Pros and cons:

-- Stochastic analysis for random deployment and conduct simulation evaluation for both deterministic and random placements of storage nodes are also presented.

--Optimization of query reply in a sensor network was not considered in this presentation.

7) Data Pre-Forwarding for Opportunistic Data Collection in Wireless Sensor Networks-->Xiuchao Wu, Kenneth N. Brown

--In this paper author proposed a distributed DPF mechanism is proposed to exploit the spatial locality of human mobility in the context of opportunistic data collection. The communication protocol is first carefully designed so that sensor nodes could rendezvous and communicate with their neighbors and mobile nodes energy efficiently.

Pros and cons:

-- It also deals data pre-forwarding to improve the performance of opportunistic data collection.

--Another potential area consideration is left i.e.is to handle contact probing and data pre-forwarding together with the consideration of joint optimization.

8) Mobile Relay Configuration in Data-intensive Wireless Sensor Networks-->Fatme El-Moukaddem, Eric Torng, Guoliang Xing

--In this paper author proposed using low-cost disposable mobile relays to reduce the energy consumption of data-intensive WSNs. Our framework consists of three main algorithms. The first algorithm computes an optimal routing tree assuming no nodes can move. The second algorithm improves the topology of the routing tree by greedily adding new nodes exploiting mobility of the newly added nodes. The third algorithm improves the routing tree by relocating its nodes without changing its topology.

Pros and cons:

--A holistic approach to minimize the total energy consumed by both mobility of relays and wireless transmissions.

--These simulations show it substantially reduces the energy consumption by up to 45%

9) Novel Strategy for Data Dissemination to Mobile Sink Groups in Wireless Sensor Networks-->Soochang Park, Euisin Lee, Min-Sook Jin, and Sang-Ha Kim

--In this paper author proposed a novel strategy for data dissemination decoupled with any member sink of a mobile sink group. In order to independently deal with a mobile sink group, the strategy is composed of three mechanisms: representative location update, distributed data collection, and per-group foot-print chaining.

Pros and cons:

-- It improves performance and energy efficiency.

--Only one member sink updates location in C-SGM (Cluster-based Sink Group Management).

10) Ubiquitous Data Collection for Mobile Users in Wireless Sensor Networks--> Soochang Park, Euisin Lee, Min-Sook Jin, and Sang-Ha Kim

--In this paper analyzed that the proposed approach is scalable in maintenance overheads, performs efficiently in the routing performance, and provides continuous data delivery during the user movement.

Pros and cons:

--The proposed protocol is easy to implement.

--The routing transitions during the movement of the mobile user are not optimized.

III. SYSTEM ANALYSIS

In existing, a network which has only a static data collector, or a network in which the mobile collector can only move along straight lines. In previous method data packets are forwarded to the data sink via multi hop relays among sensors. However, due to the inherent nature of multi hop routing, packets have to experience multiple relays before reaching the data sink. Selecting cluster heads dynamically also results in high overhead due to the frequent information exchange among sensor nodes. The main drawbacks of existing methods are Energy consumption is high and High data gathering delay.

We propose new data-gathering mechanisms for large-scale sensor networks when single or multiple M-collectors are used. In our data-gathering scheme with multiple M-collectors, only one M-collector needs to visit the transmission range of the data sink. The entire network can be divided into sub networks. In each sub network, an M-collector is responsible for gathering data from local sensors in the subarea. Once in a while, the M-collector forwards the sensing data to one of the other nearby M-collectors, when two M-collectors move close enough. Finally, data can be forwarded to the M-collector that will visit the data sink via relays of other M-collectors. All data are forwarded to M-collector 1 from other M-collectors, and then, M-collector 1 carries and uploads data to the data sink. The main advantages of the proposed work are reduced data gathering delay and Low energy consumption in WSN.

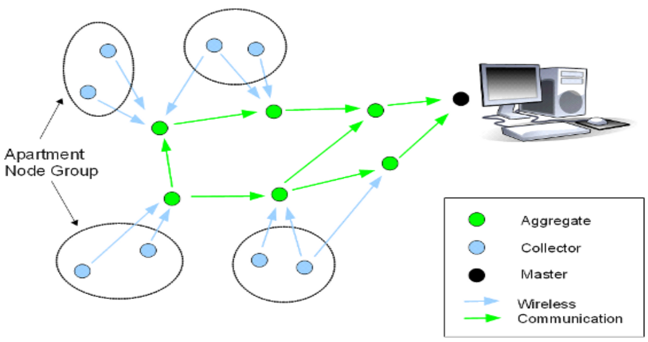

Fig. 1: Collecting Data from Nodes to Master device by using Mobile Collectors

IV. ALGORITHM DESCRIPTION

The proposed data-gathering scheme includes multiple mobile collectors (i.e. Two Mobile collector here we used) and emergency data forwarding through hop to hop communication that we implemented can significantly prolong the network lifetime as well as the proper aggregation of data with less delay compared with a network with static data sink or a network in which the mobile collector c- n only move along straight lines.

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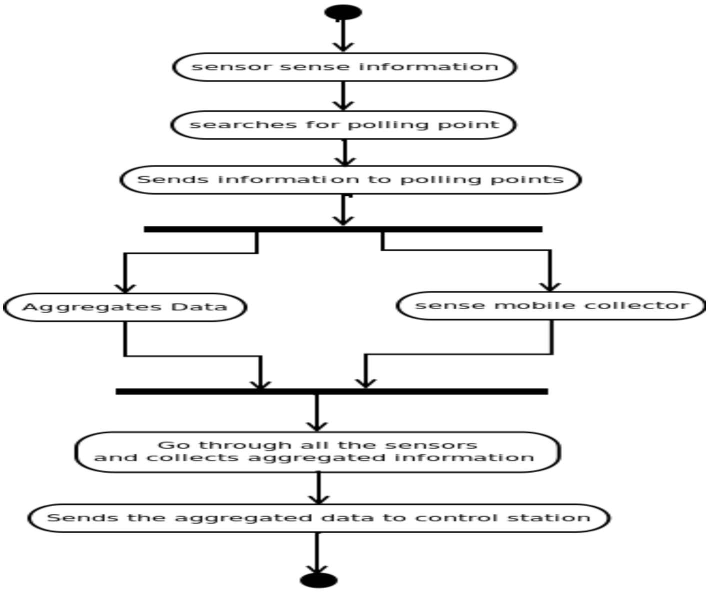

Fig. 2 Activity Diagram of M-Collector

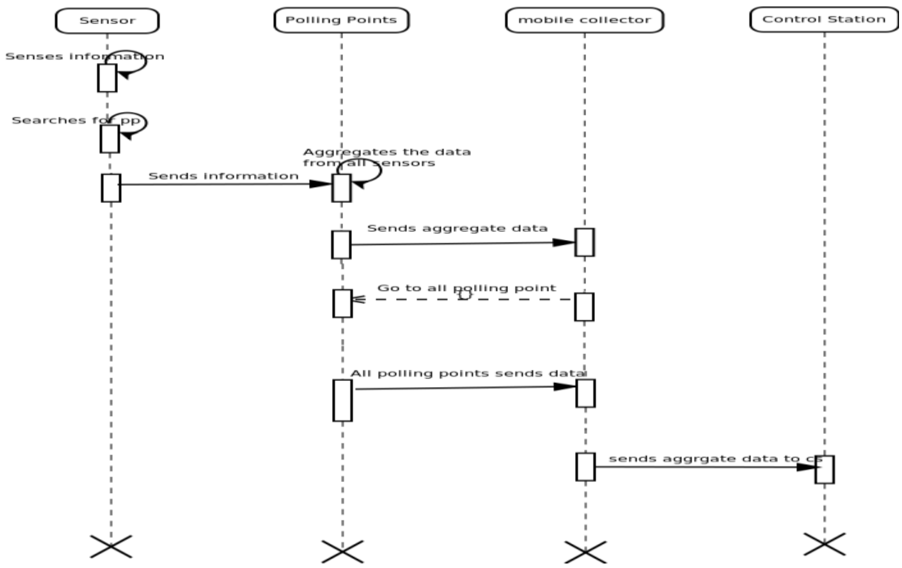

Fig. 3 Sequence diagram

The activity and sequence diagrams of M-Collector as shown in Fig. 2 and 3.

A. Existing Algorithm

- Single hop data gathering
  1. Mobile collector go anywhere but controllable
  2. Rendizous point collects the data from sensors in single-hop
  3. MC can collect the data from sensor, when MC within the transmission range
- Controlled mobile element scheme
  1. Un controlled fixed moving system

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2. Traveled through parallel track (from/to data sink)
3. Multi-hop relay without bound.

B. Proposed Algorithm

- Polling based approach (shortest path based)
  1. MC can move anywhere but controllable
  2. Multiple MC uses to collect data from rendizous point
  3. Rendizous points collect the information from sensors
  4. MC collects the information from PP's.
  5. MC share data to data sink
  6. Then data sink to user

V. RESULT AND DISCUSSION

During the last decade there were a lot of studies and works produced pertaining to the application, protocols, network types, network elements, and traffic models. Most of these studies and works have been based on the use of simulators. Network simulator ns-2 has been the most used network simulator for these studies. Most mobile ad-hoc research groups employ the ns-2 to implement and validate various algorithms, since it provides a kind of integration environment. The virtual environment provided by simulation makes it a highly beneficial approach for an assortment of favorite characteristics, such as network modeling depending on specified criteria and analyzing its performance under different scenarios.

We begin with an analysis of the network lifetime for a setup involving a large number of sensor nodes (50 to 100 nodes) distributed densely and non-uniformly in a square area of 100 $\times$ 100 as shown in Fig. 4 to evaluate the tradeoff between node residual energy and data correlation for building near-optimal but maximum network lifetime hierarchical aggregation architecture.

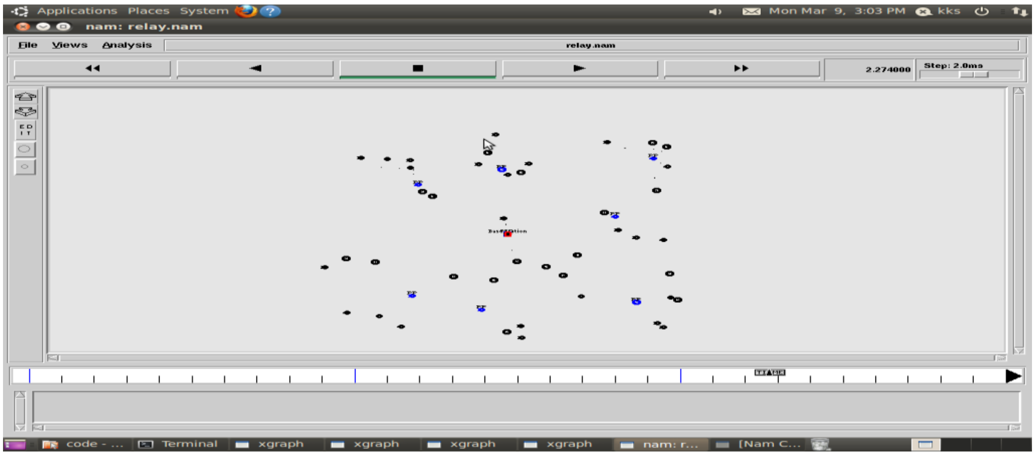

Fig. 4 Random deployment of sensors in wireless sensor networks

Fig. 5 represents the M-collector collects the data from the different nodes and sends it to base station effectively. Therefore saving the time to send the data to base station.

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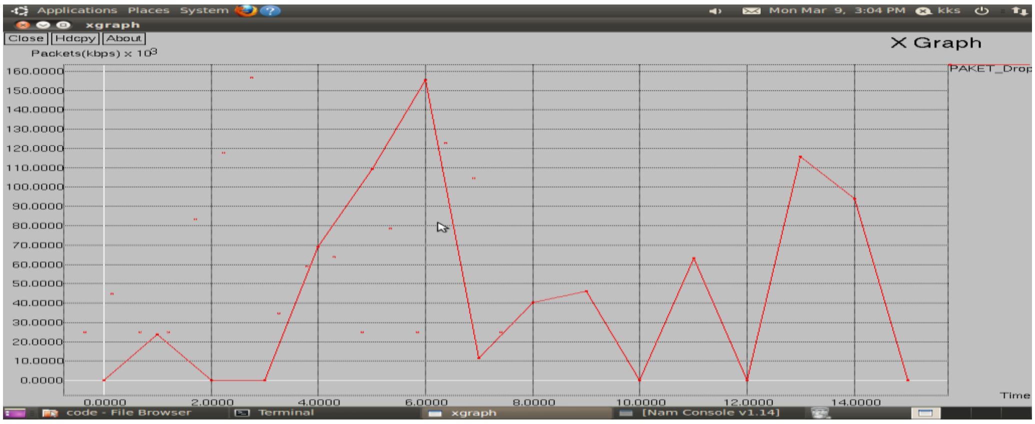

Fig. 5 Simulation result for packet transmission from sensor node to base station

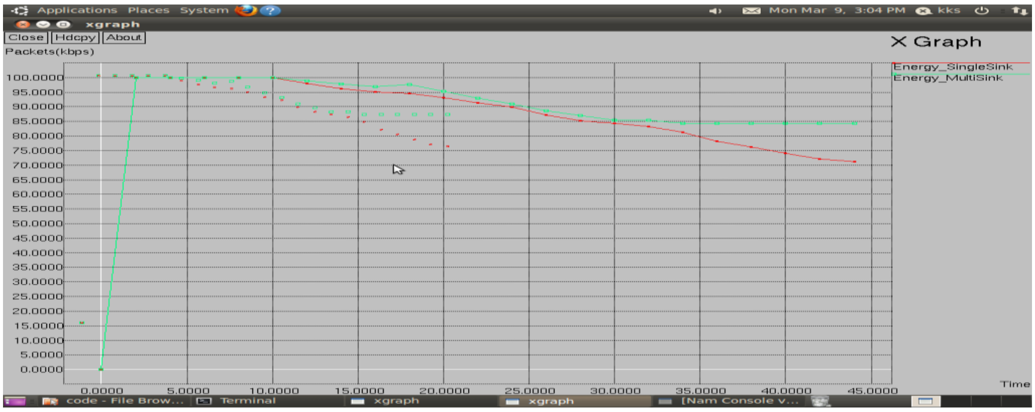

Fig. 6 Energy consumption for single sink and multi sink transmission packets

In our work we compare the energy consumption and life time for single sink and multi sink M-collectors. The comparison of energy consumption between single and multi sink cases as shown in Fig. 6. From the simulation result we can say that the multi sink M-collector gives lower power consumption than single sink and also have very more life time and less delay for gathering the data to base station. The throughput comparison between existing single sink and proposed multi sink M-collectors as shown in Fig. 7.

Fig. 7 Throughput comparison between existing and proposed methods

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VI.CONCLUSION

In this paper, we propose a new data-gathering mechanism for large-scale wireless sensor networks by introducing mobility into the network along with emergency signal generation. 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. In this we use two M-collector to collect data from rendezvous points to reduce the delay and consumption of energy. We first formalize the Multiple M-collector into a mixed-integer program and then present a Spanning tree algorithm for the case where a Multiple 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. 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 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 c- n only move along straight lines.

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