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Pre-Implementation on Data Gathering Using Trajectory Selection and Loophole Detection in Wireless Sensor Network

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ABSTRACT

Data collection from several sources is one of the most common uses in wireless sensor networks. However, owing to the sensor node's limited battery life, energy conservation is a major concern in WSN data collecting. As a result, the notion of the mobile node is presented to lower the energy utilization of sensor nodes. Sensor nodes are immobile in this approach, whereas sink nodes are mobile, collecting data from the static sensor node process and sending it to the base station. The motion sequence of the sink should be determined for better sink mobility so that the sink can follow the path and collect data more effectively and in less time. SinkTrail and SinkTrails, two energy-efficient proactive data reporting protocols are used to select the shortest path for sink mobility.

1. INTRODUCTION

The network as a data collection concept has been widely deployed with wireless sensor networks. Numerous sensor nodes can be put in a WSN to gather information from the supplied network [1]. WSN has been utilized in many sectors such as surveillance applications and forest fire detection. The data is then collected from the network and processed. However, it is impossible to recharge the power source once the node has been placed in the network. This means that the sensor nodes cannot be recharged. Because the sensor nodes' battery life is restricted, energy conservation is a key consideration while constructing the WSN.

When both the sensor nodes and the sink nodes remain static, the sensor nodes must expend more energy to transport the energy to the sink nodes. Investigators have used the notion of sink movability to lower the energy usage of sensor nodes [2]. Sinks are free to travel about the network, gathering data from sensor nodes and processing it.

As a result, sensor nodes do not have to waste energy transferring data to sink nodes. When the idea of a mobile sink is presented, the sink can be a robot, automobile, or animal that is outfitted with communication systems that are delivered into the network and communicate efficiently with the sensor nodes, resulting in a transmitting data channel that is optimized and the energy utilization is reduced.

Sink mobility saves power while also posing new obstacles in remote sensing applications. The route should be maintained by the sink when it is permitted to travel in the network so that it can operate more effectively.

For the sink to move through the network more effectively, a route must be identified on which the sink can move quickly and acquire data. On-demand routing, distance vector routing, geographical routing, and more techniques have been proposed to identify the best path. When geographical routing is utilized, the downside is that it implies that all nodes' geographical locations are specified.

To improve network effectiveness, several studies focused on arranging a mobile sink's movement trajectory in advance. However, in many cases, the specified trajectory isn't appropriate. As a result, without pre-defining the direction, we allowed the moveable sink to broadcast its location data throughout the network on a regular basis. SinkTrail is a proactive data reporting protocol that is used in sensor networks where the sink moves continually through the network at a low speed and collects data [3]. At a particular distance after the same time of interval sink nodes broadcast the control massage at a much lower frequency than is ordinarily required in existing data gathering protocol. The position where the message is broadcast is called a "footprint" [4]. This footprint is considered a virtual landmark. Using this virtual landmark sensor node can easily identify its hop count distance from the landmark. This hop counts distances combined represent the sensor node's coordinate in the logical coordinate space constructed by the mobile sink. By using the destination coordinates and its own coordinates, each sensor node selects the next hop with the optimized distance. Thus, the protocol finds the optimized path without the use of GPS or any predefined landmark. This protocol reduces the complexity of the routing algorithm as well as increases the battery lifetime of the sensor nodes [5].

2. Related Work

The goal of wired networks is to increase end-to-end throughput while minimizing latency. However, the fundamental challenge with wireless communication, particularly in a wireless sensor network, is energy utilization and low battery life. As a result, energy optimization is receiving an increased emphasis in wireless sensor networks currently. The data collection system is classified into two groups based on the mobility characteristic of the mobile nodes.

A. Uncontrollable Mobility

The mobile collector in Uncontrollable Mobility moves at random [6]. To ease communication among static sensors and convey data with random mobility, Shah et al. [7] proposed using a particular sort of mobile node as a forwarding agent. Jea et al. [8] do not enable users' nodes to choose a direct route to obtain network information. Batalin et al. [9] suggested the NIMs system, in which mobile collectors can only move along static cables between trees and are recharged at any moment during their journey. These techniques are noted for their excellent stability and reliability, as well as their ease of maintenance. They are, therefore, often inflexible and unable to adjust to sensor dispersion and environmental consequences.

B. Controlled Mobility

Multi-hop wireless relay relays inadequate relay routing data between sensor nodes. Load balancing, schedule patterns, and data duplication are all combined with effective relay routing. England et al. [15] suggested algorithms for constructing a robust spanning-tree topology for data gathering in order to minimize data loss and energy requirements.

C. Hierarchical Infrastructure

WSN is divided into clusters in hierarchical architecture, with one cluster head assigned to each cluster and responsible for data transfer from one sink to the other. However, the cluster head utilizes additional power than the other sensor nodes in a hierarchical system. Because each sensor node may become a cluster head, it must be capable of handling both inbound and outbound traffic. It raises the network's expenditure. Because sensors transmit information often, this could increase overhead.

D. Mobile Data Gathering

When the static hierarchical network is used many problems occur during data gathering. To overcome this problem mobile data gathering scheme has been proposed. In this scheme, mobile collectors are used which connect the static sensors.

Controlled mobility is the second category in which the mobile collectors move anywhere in the network freely and their trajectory will be a plan to move efficiently in the network. To increase the battery life of the sensor nodes, Ma and Yang [10] proposed tour planning algorithms for achieving a short data gathering tour and uploading all the data within a single hop. While these approaches minimize the energy consumption by completely avoiding multi-hop relays, they may result in long data gathering latency, especially in a large-scale sensor network.

A data gathering scheme is proposed by Zhao et al. [11] that jointly considers the full utilization of concurrent data uploading and tour

Shah et al. [16], proposed the mobile collectors, called data mules, which gather the data from nearby sensors store it, and later process it. Although it reduces the energy consumption of the sensor nodes, its moving trajectory is not controllable and packet delay is not predictable.

In [17], and energy-efficient object tracking scheme is proposed in which the number of tracking sensors is minimized through trajectory prediction. Here the mobile agents stay in contact with sensor nodes continuously which are nearer to the object which we have to track.

As the mobility of the randomly moving object is not predictable and not controllable, maximum packet delays are not guaranteed. Thus, for the sensor nodes deployed in the urban areas, buses or trains act as mobile base stations. Now the moving path and time are predictable.

Though the mobile data gathering scheme reduces the energy consumption in wireless sensor networks, data gathering latency increases. The scheme mainly focused on minimizing the moving trajectory but did not consider the data uploading time. These observations suggest designing a scheme that minimizes the total data gathering time which includes the moving time of the data collectors as well as the data uploading time of the sensor network. Thus, the joint approach of mobility and space-division multiple access (SDMA) techniques is proposed in [18].

E. Mobility and Space-division Multiple Access (SDMA) Technique

In this technique, mobile collectors act as mobile base station and polls each sensor while traversing its transmission range. Each sensor node directly sends information towards mobile collectors without any relay so that the lifetime of sensors can be prolonged. SDMA technique is also applied to data gathering by equipping the mobile collector with two antennas. With SDMA, two distinct compatible sensors may successfully make concurrent data uploading to the mobile collectors.

When the concept of sink mobility is introduced, it also introduced new challenges. Many approaches and protocols are suggested by the researchers to reduce the control overhead in the network introduced by sink mobility.

3. Routing Protocols

A. TTDD Protocol

The TTDD protocol, proposed in [19], constructed a two-tier data dissemination structure in advance to enable fast data forwarding. Control messages are flooded to wake up nodes in the delivery zone.

B. DRMOS (Dynamic Routing protocol for Mobile Sink)

Park et al. [20] proposed DRMOS that saves energy by dividing sensors into “wake-up” zones. DRMOS consists of a set of protocols that includes various algorithms which handle the mobile sinks by reusing the routing tree. Fodor and Vida’s lowered communication overheads by proposing a restricted flooding method; routes are updated only when topology changes. Luo and Hubaux proposed that a mobile sink should move following a circle trail in deployed sensor field to maximize data gathering efficiency.

C. Grid Location Service

Grid Location Service proposed in [22], is a scalable location service that is designed for mobile phones with the use of GPS. It is a decentralized approach to distributing the data in the network. Periodically all nodes publish the Location-to-ID in the network. GLS chooses the node on the basis of a predefined grid hierarchy. This hierarchy is used to find the closest location severs. But these services are not appropriate by means of a lifetime of sensor nodes.

D. The Landmark Routing

The landmark routing is similar to GLS routing. Location service gives the node ids to the coordinates. These coordinates, or landmark addresses, are a set of node identifiers of designated landmarks closest to the node. Each node publishes its landmark address information to a location server by hashing its own ID and using the result as the landmark address for the location server.

E. Mobile Element Scheduling (MES) algorithm

Mobile Element Scheduling (MES) algorithms [14] are used to control mobile sink mobility and advanced planning of the mobile sink’s moving path. Although the MES methods effectively reduce data transmission costs, they require a mobile sink to cover every node in the sensor field, which makes it hard to accommodate on a large scale and introduces high latency in data gathering.

F. SinkTrail Protocol

SinkTrail [1] is more adaptable than MES algorithms because it automatically adjusts to altering field settings while retaining low communication overheads. SinkTrail identifies data transmission channels in a greedy manner using sink location forecasting. To improve data reporting, Kelly et al. used the sequential Monte Carlo technique to forecast sink sites. SinkTrail uses a different prediction method that is far less sophisticated. The sinkTrail protocol uses a greedy algorithm to collect data using logical positions instead of geographical coordinates. Fonseca and colleagues proposed a vector form of virtual coordinates in which each element indicates the number of hops from the landmark node. SinkTrail employs this technology to locate the mobile sink's most recent location as a virtual landmark.

When the SinkTrail protocol is employed, mobile nodes enable users to travel around the area at a slower pace while still listening for data reporting packets. The sink comes to a halt in some locations for a shorter amount of time and broadcasts its location to the network. The sensor nodes now recognized this location or footprint as a virtual identifier. The locations are known as "Trail Points," and the massages are known as "Trail Massages”.

Conclusion

In this paper various aspects of data gatherings schemes such as uncontrolled mobility, controlled mobility, efficient relay routing, and hierarchical infrastructure are discussed, furthermore, the routing protocols such as TTDD protocol, DRMOS, Grid Location Service, the landmark Routing, Mobile element scheduling (MES) algorithm, SinkTrail protocol are listed. Various design approaches and protocols reduce the energy consumption and increase the battery life of the sensor nodes. As well as the various routing protocols optimize the route for moving sink nodes to gather the data in minimum time.

Conflict Of Interest

The authors declare that they have no conflict of interest.

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