Volume 6, Issue 3, March 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

# Energy Efficiency Data Gathering Using Shortest Tranjectory in Wireless Sensor Network

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***Abstract-A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors tomonitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. Energy consumption and limited battery life is the main issue in wireless communication especially in wireless sensor network. Therefore recently energy efficiency is getting more attention in wireless sensor network. To improve the battery life of sensor nodes we allow the sink to move in sensor network. For better sink mobility, the movement pattern of the sink should be decided, so that sink can follow the path and gather the data more efficiently also in less time. SinkTrail and SinkTrails, two energy efficient proactive data reporting protocols are used to select the shortest path for sink mobility.***

***Keywords: Sinks, SinkTrail, SinkTrails, Data gathering, and Senor Nodes.***

## I. INTRODUCTION

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes.

Engineers have created WSN applications for areas including health care, utilities, and remote monitoring. In health care, wireless devices make less invasive patient monitoring and health care possible. For utilities such as the electricity grid, streetlights, and water municipals, wireless sensors offer a lower-cost method for collecting system health data to reduce energy usage and better manage resources [1]. Remote monitoring covers a wide range of applications where wireless systems can complement wired systems by reducing wiring costs and allowing new types of measurement applications. Remote monitoring applications include:

- Environmental monitoring of air, water, and soil
- Structural monitoring for buildings and bridges
- Industrial machine monitoring
- Process monitoring
- Asset tracking

Wireless sensor networks consist of individual nodes that are able to interact with the environment by sensing or controlling physical parameters. These nodes have to collaborate to fulfill their tasks. The nodes are interlinked together and by using wireless links each node is able to communicate and collaborate with each other.

The sensor field constitutes sensor nodes. Typically, a sensor node can perform tasks like computation of data, storage of data, communication of data and sensing/actuation of data. A basic sensor node typically comprises of five main components and they are namely controller, memory, sensors and actuators, communication device and power supply. A controller is to process all the relevant data, capable of executing arbitrary code. Memory is used to store programs and intermediate data. Sensors and actuators are the actual interface to the physical world. These devices observe or control physical parameters of the environment. The communication device sends and receives information over a wireless channel. And finally, the power supply is necessary to provide energy. In wireless sensor networks, power consumption efficiency is one of the most important design considerations. Therefore, these intertwined components have to operate and balance the trade-offs between as small energy consumption as possible and also the need to fulfill their tasks. If the sensor nodes and sink both are static then more energy is required by the sensor nodes to convey the energy towards the sink nodes. Thus to reduce the power consumption of sensor nodes researchers includes the concept of sink movability [2]. Sinks are allowed to move in the network and gather the information from the sensor node and process over it.

Thus, Sensor nodes does not require to expense energy to transfer the data toward sink nodes. When the concept of mobile sink is introducing, the sink can be a robot, vehicle or animals which are equipped with radio devices are used which are send into the network and directly communicate with the sensor nodes which results in optimized data transmission path and reduces the energy consumption.

Sink mobility reduces the energy consumption; it introduces new challenges in sensor network applications. When the sink is allowed to move in the network, path should be followed by the sink so that it can work more effectively.

 

For the better movement of the sink in the network, route must be find, on which sink can move efficiently and gather the data in minimum time. Several algorithms has been suggested to find the optimized route such as on-demand routing, distance vector routing, geographical routing etc. when geographical routing is used the disadvantage in that is, it assumes that the geographical location of all the nodes are known.

Many researchers focuses on planning a mobile sink's moving trajectory in advance to optimize the network performance. But in many applications predefined trajectory is not applicable. So without predefining the trajectory we allow the moveable sink to frequently announce the location information throughout the network. SinkTrail, a proactive data reporting protocol is used in sensor network where the sink moves continuously in the network, in relatively low speed and gather the data [3]. At particular distance after same time of interval sink nodes broadcast the control massage in much lower frequency than it ordinarily required in existing data gathering protocol. The position where the message is broadcast is called as "footprints"[4]. This footprint is considered as virtual landmark. Using this virtual landmark sensor node can easily identify its hop count distance from the landmark. These hop count 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 nodes selects the next hop with the optimized distance. Thus the protocol finds the optimized path without use of GPS or any predefined landmark. This protocol reduces the complexity of the routing algorithm as well as increases the battery life time of the sensor nodes [5].

## II. RELATED WORK

Wired network focus on maximizing the end to end throughput and minimizing the delay. But energy consumption and limited battery life is the main issue in wireless communication especially in wireless sensor network. Therefore recently energy efficiency is getting more attention in wireless sensor network. Based on the mobility pattern of the mobile nodes data gathering scheme is divided into two categories.

### *A. Uncontrollable Mobility*

In Uncontrollable Mobility, the mobile collector moves randomly [6]. In[7] proposed to use a special type of mobile nodes as forwarding agents is used to facilitate connectivity among static sensors and transport data with random mobility. In [8] mobile nodes are not allowed to select straight route to gather the information in the network. Batalin et al. [9] set proposed a system NIMs, where mobile collectors can only move along fixed cables between trees and ensure that they can be recharged any time during the movement. A known feature of these approaches is high stability and reliability, and the system maintenance is simple. However, they typically lack the agility and cannot be adaptive to the sensor distribution and environmental dynamics.

### *B. Controlled mobility*

Controlled mobility is the second category in which the mobile collectors moves anywhere in the network freely and its trajectory will be plan to move efficiently in the network. To increase the battery life of the sensor nodes, tour planning algorithms is used for achieving a short data gathering tour and to upload all the data within a single hop[10]. 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.

Data gathering scheme is proposed in [11], that jointly considers the full utilization of concurrent data uploading and tour length minimization. In the scheme, multiple sensors can simultaneously upload data packets to the mobile collector in a single hop, which efficiently shortens data uploading time.

Efficient data gathering becoming a more important in recent years, for which many schemes are proposed by researchers. These schemes are categorized in three parts, efficient relay routing [12], hierarchical infrastructure [13], and mobile data gathering [14].

### *C. Comparison of data gathering schemes*

In polling based approach mobility of sink is controllable where the path of motion is not decided. In single-hop data gathering (SHDG) [15], a mobile collector stops at some selected sensor nodes to collect data such that single hop data uploading from each sensor to the mobile collector can be guaranteed. In controlled mobile element scheme (CME) [16], a mobile collector traverses the predefined track and collects data from the sensors nearby with multihop relays.

| | **Polling Based Approach** | **Single Hop Data Gathering** | **Controlled Element Data Gathering Scheme** |
|---|---|---|---|
| **Pattern of motion** | Can move anywhere, Controllable | Can move anywhere, Controllable | Path is decided, uncontrollable |
| **Locations for data gathering** | Movable sink stops at selected sensor | Movable sink stops at subset of sensor nodes | Pausing locations are not predefined |

 

| | | | |
|---|---|---|---|
| | nodes and gather data | and gather the data in single hop | |
| **Moving path** | Starts from sink visit each node at least once | Starts from the sink cover all the locations in transmission range | Moves on predefined path |

***D. Hierarchical Infrastructure***

In hierarchical infrastructure WSN is grouped into clusters, where in each cluster one cluster head is choose which is responsible for the data transfer from on one sink to another. But in hierarchical infrastructure cluster head consumes more energy than other sensor nodes. Since each sensor node possibly become cluster head each node should be powerful for incoming and outgoing traffic. It increases the overall cost of the network. It may increase overhead due to frequent information exchange among sensors.

***E. Mobile Data Gathering***

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

The mobile collectors, called data mules, are proposed in [16], which gather the data from nearby sensors store its and latter 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], an energy-efficient object tracking scheme is proposed in which the number of tracking sensors is minimized through trajectory prediction. Here the mobile agents are stay in contact of 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 delay are not garneted. Thus for the sensor nodes deployed in the urban areas, buses or trains act as mobile base stations. Now the moving path and time is predictable.

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

***F. 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 nodes 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.

## III. PROPOSED WORK

***A. SinkTrail Protocol***

Consider a large scale, uniformly distributed sensor network deployed in an outdoor area where the nodes in the network communicate with each other using radio links. All nodes in sensor network is connected with each other. We assume that when the process data collection starts sensor nodes will wake up means they are in awake state.

To gather the data from the network mobile sinks are used which are periodically send in network. As energy supply of mobile sinks can be replaced or recharged easily, they are assumed to have unlimited power[19].

When mobile sink enters in the network it terminates only when enough data is gathered or there is no data to gather. The SinkTrail protocol is proposed for sensor nodes to proactively report their data back to one of the mobile sinks.

In SinkTrail Protocol during the data gathering sink moves in the given network in low speed and concentrate on the reporting data packet. Mobile sink stops at some places for short duration of time, broadcast the message to whole network and starts moving forward. The points where the sink stops are called as trail points and the broadcast message are called as trail messages. There is no any predefined pattern is followed by this trail points. Trail messages generated by the sink contain the sequence number and the hop count of sink. The time intervals between two Trail points are known as “move”.

*Algorithm for mobile sink strategy*

1. Initialization
2. Msgseq←0

 

3. msghop←0
4. step size parameter K
5. moving strategies
6. while not get enough data do
7. go to next trail point
8. msgseq←msgseq+1
9. stops at some point and broadcast message
10. same time listen for data packet
11. end while
12. stop

In sinkTrail protocol predefined landmarks are not used in place of predefined landmarks logical coordinates are used. To represent the logical coordinate sink references are used. Each nodes maintain the trail reference and used during the data forwarding.

Two phases are used in SinkTrail Protocol. Logical coordinate space construction is the first phase. In this phase according to mobile sink's trail messages sensor nodes update their trail references.

Destination Identification is the second phase of SinkTrail.

Instead of scheduling a mobile sink's movement, it allows a mobile sink to spontaneously stop at convenient locations according to current field situations or desired moving paths[20]. These trail points in SinkTrail, are footprints of a mobile sink, and they provide valuable information for tracing the current location of a mobile sink.

### *B. Impact of number of mobile sink in network*

In sensor network number of mobile sinks affects the overall system performance. When multiple mobile sinks are used in network, several logical coordinate spaces are constructed concurrently and data packets are forwarded to the destination reference using the shortest path in any coordinate space. As the number of mobile sinks increases it reduces the average route length and also reduces the total energy consumption. But more mobile sinks also introduce heavier burdens for trail message broadcasting and routing information maintenance. Even worse, multiple number of mobile sinks in a network aggravate control traffic congestion and communication delays, which will in turn result in higher packet loss and retransmission rate.

## IV. CONCLUSION

In this paper various aspect of data gatherings schemes such as uncontrolled mobility, controlled mobility, efficient relay routing, hierarchical infrastructure are discussed, furthermore brief concept of SinkTail protocol is described for energy efficient data gathering where impact of multiple sink in network is described . SinkTrail uses logical coordinates to decide distances, and establishes data reporting path by greedily selecting the shortest path to the destination reference.

It also consist desired features of geographical routing without requiring GPS devices or extra landmarks installed.

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