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Data Collection Algorithm for Wireless Sensor Networks based on Mobile Sink

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Abstract: With the idea of increasing network lifespan, many data dissemination protocols and energy efficient algorithms are suggested by researchers for wireless sensor networks (WSNs). Due to more traffic load in sensor nodes which is near to the sink in sending the data, they rapidly decrease their energy, results in the problem like energy hole and network partition. Energy consumption, network lifespan, end to end delay can be improved by including mobility into sensor networks. In this paper, we are going to present Data Collection Algorithm based on mobility for wireless sensor network. Inspite of using one static sink, we used more than two movable sink in order to gather the sensed data to move in forward direction and return back to the same position in preset path. One mobile sink placed on diameter of circular area and other two mobile sink are fixed on arc lines and they move in preset path respectively. In order to gather the data from reference area, mobile sink stay temporarily at some fixed points. Additionally, our result is shown through extensive simulation method.

Keywords: wireless sensor networks, multiple mobile sinks, energy consumption, network lifespan.

I. INTRODUCTION

Wireless sensor networks (WSNs) is one of the developing research areas, it contains a lots of autonomous and distributed sensor nodes. These nodes are power-limited, small size, low-cost, and multifunctional devices with processing, sensing and wireless communication potentialities. Each sensor node has some work to measure and monitor the ambient circumstances and forward the collected data to a sink node in a direct transmission manner or multiple hop transmission manners. Nowadays, Wireless Sensor Network has wide range of applications, such as surveillance and military target tracking, biomedical health monitoring, smart home management, disaster warning system, greenhouse monitoring, wildlife animal protection etc. [1, 2].

Sensor nodes have limited battery power. This is one of the most significant confining factors for WSNs. Since sensor nodes are normally spread over special areas where human cannot get close to, it is very hard, it is not possible to recharge and replace the battery [3, 4]. So, in order to increase the network lifespan, it must be necessary to design and manage the energy resource of sensor networks carefully.

Sensor nodes which is close to sink, take a participation in forwarding the data to sink node for other sensor nodes. There is a result that they deplete their energy rapidly and lead to the hot spots problem because they dead soon [5, 6]. Introducing mobile sinks inspite of static sinks to expand network lifespan for Wireless sensor Networks has attracted increased attention in recent year [7]. Here the mobile strategies for Wireless sensor networks are to deploy mobile sink node(s), rather than mobile sensor nodes. Implementation of the deployment of mobile sink node is easier than the deployment of mobile sensor nodes. Since sink nodes are mobile so neighbor nodes of sink changes from time to time, energy expenditure among sensor nodes can be balanced and problem of hop spots due to static sink can be extenuated. Therefore, the network lifespan can be increased.

In this paper, to collect the sensed data from sensor nodes, three mobile sinks are used instead of one static sink. The mobile sinks will move in forward direction and return back to the same position along preset paths and in order to collect the data from reference area, mobile sink stay temporarily at some fixed point. Here, one mobile sink placed on diameter of circular area and other two mobile sink are fixed on arc lines and they move in preset path respectively. Whole network area is divided into two main parts: one part is the concentric circle of the area with radius r and second one is the rest part of the area. When the mobile sink stay temporarily at the center of the circular area, it receives the data from sensor nodes in the concentric circle of the area and when the mobile sink reaches to the other fixed points, it collects the sensed data from sensor nodes in the second part.

II. Related Work

The idea behind the utilization of mobile sink for wireless sensor network is proposed by the authors in [8]. The mobile sinks is known as "data MULEs" which move randomly around the network to collect the sensed data from sensor nodes, which are in their close range and drop off the aggregate data to the some access points. Communication with each other among MULEs is allowed to improve system performance. Consumption of the energy for the sensor node can be decreased largely because of short transmission range. However, sensor nodes don't have an idea about the exact time, when MULEs will come to the nodes range, since the movement of MULEs is not known means that cannot be predicted by sensor nodes.

Prolonging of Lifespan of the network was treated by the authors in [9] as presented MIN-MAX problem. In this reference, outing strategy and mobility of sink were also studied. The analytical solution of [9] gives the suggestion that movement of sink helps to optimize the lifetime of the network. The authors said about the wireless sensor network based on one mobile sink and one mobile relay individually and presented the simulation results that the network lifespan improvement over the static network which was upper bounded by a factor of four in [10].

In [11], authors proposed the novel method in order to admittance all sensor nodes in the targeted networks. This novel method based on the traveling salesman problem and set packing algorithm to improve fairness as well as efficiency of data collection.

In [12], the authors presented a novel data collection scheme known as Maximum Amount Shortest Path (MASP) used to solve the obstetrical delivery problem in large-scale Wireless sensor networks based on mobile sinks. This method reduces the energy consumption and improves the total amount of data packets.

III. System model

3.1 Basic Assumptions

- some basic assumptions as follows:
- Sensor nodes have unique ID.
- Sinks are mobile and Sensor nodes are stationary.
- Multi-hop routing protocol as shortest path routing protocol is used.
- Sinks are placed at certain points and sinks are mobile so it moves from one site to another freely.

3.2 Network Model

Assuming a number of sensor nodes are randomly

Deployed or spread to measure and monitor the surrounding environment. Figure 1 shows the network model where sink node can either move along the periphery or the diameter of the circle.

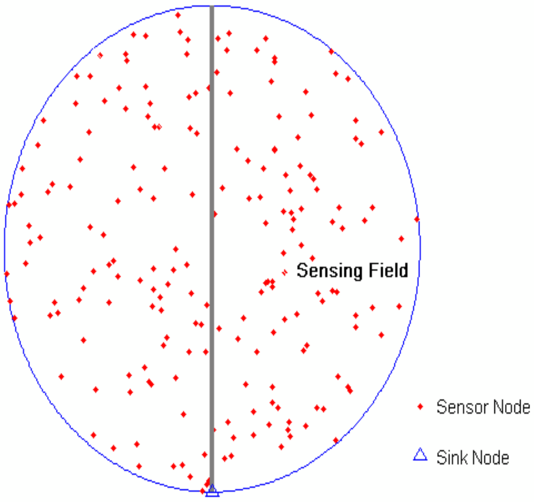

Figure 1. Network Model

3.3 Energy Model

In this paper, we have taken the first order radio model [2] which is used as the energy model. The multi-path fading channel (d^4 power loss) is used, If the distance between the receiver and the transmitter is larger than a threshold d_0; otherwise, the free space model (d^2 power loss) is used. The energy spent To transmit *β-bit* data form node *i* to node *j* over the distance *d* is given as:

$$E_{tx}(i,j)=\begin{cases}(\alpha_{tx}+\varepsilon_{fs}d^2)\beta, & d<d_0\\(\alpha_{tx}+\varepsilon_{mp}d^4)\beta, & d\geq d_0\end{cases} \quad (1)$$

Where α_{tx} and α_{rx} are the energy dissipated in transmitting and receiving the data bit respectively. ε_{fs} and ε_{mp} denotes the amplifier energy to maintain an acceptable signal to noise ratio.

The energy consumed in receiving the *β-bit* data is given by

$$E_{rx}(j)=\alpha_{rx}\beta \quad (2)$$

IV. Our Proposed Algorithm

In this part, we have planned to use three mobile sinks on behalf of one static sink to receive the sensed data form different areas of wireless sensor networks.

First of all, the whole network will be separated into two main parts, which is shown in Figure 2. The concentric circular area with radius r is represented by area A and the remaining part is represented by area B, Area B which is further divided into B1, B2…B8. Two mobile sinks will move along arc lines of the circular area and one mobile sinks will move along the diameter of the circle to collect the sensed data packets from sensor nodes.

Each sensor node contains two tables: route table and sink table. Route table records the information about the next hop of sensor node to reach a sink and the sink table records whether there is a sink node in its transmission range or not. If it is available in transmission range that is it is true then sink table will be marked with a flag NEIGHBOR_OF_SINK= TRUE; otherwise the flag is set to FALSE.

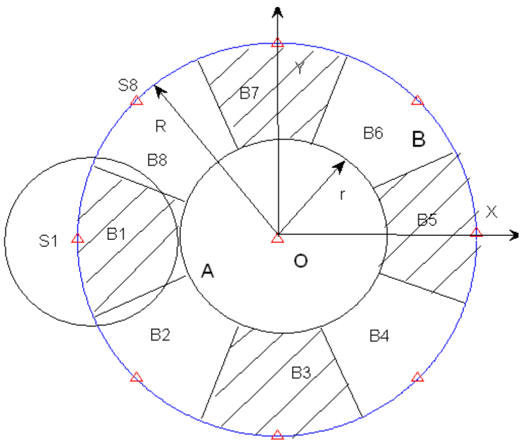

Figure 2. Network Partition

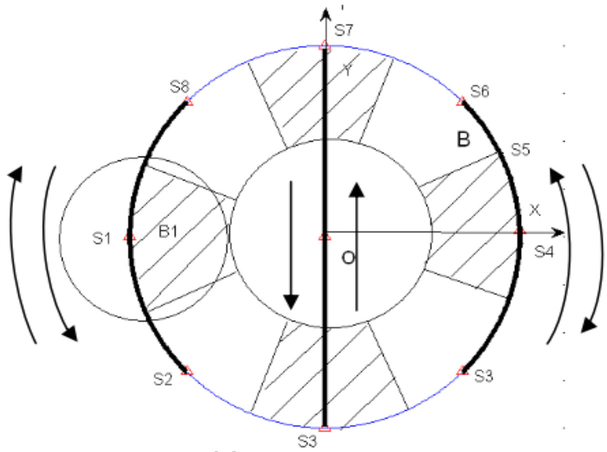

Figure 3. Mobility Trajectory

4.1 Mobility Trajectory

In our proposed algorithm, there are three predetermined movement route, which are presented by black thick lines in figure 3. Two predetermine paths are arc line of circle and third one is diameter of the circle. The mobile sink will move in forward direction and return back to the same position on these path and in order to gather the sensed data from reference area, mobile sink stay temporarily at some fixed point. Whenever mobile sink reaches to a sealed scheduled sojourn position, it broadcasts a message as hello to its neighbors. After receiving the message from the sink, sensor nodes will know about the location of the mobile sink means that mobile sink is available in their communication range. After this sensor nodes send their sensed data packet to the sink.

In figure 3, each predetermine path has three fixed points on which the mobile sink should stay temporarily at different points for same period of time. In this paper we have used three mobile sink which move along predetermine route such as along the diameter and along the arc of the circle. Cost of adding three mobile sink is acceptable and the transmission delay can be significant reduced.

V. PERFORMANCE EVALUATIONS

In this section, to evaluate the performance of our proposed algorithm we use MATLAB. Suppose that 100 sensor nodes are randomly spread over the circular field and the radius of circular field is 100 meters, initial energy of sensor nodes 0.5J.

To analyze the performance of the network, we have to plan to take a comparison of our proposed algorithm with two other different algorithms: the first one is by using three mobile sinks (Mobile Sink Routing (Jin Wang)), which divide the circle in three parts and move along the periphery of the network and using only one mobile sink (Random Sink Position Based Routing). In which the mobile sink moves along the periphery of the network. Both methods have almost same result, except the performance time. One mobile sink takes more time to collect the data from sensor nodes from reference area than the time taken by three mobile sinks. Therefore three mobile sink can save more time.

Comparison of above two algorithms in terms of network lifetime is shown in figure 4. In the given figure network lifetime is defined as the round. From the figure it is clear that the network lifetime using three mobile sink is better than the lifetime using one mobile sink. This figure also indicates that the sensor nodes die much faster in the algorithm using one mobile sink, as the round number increases.

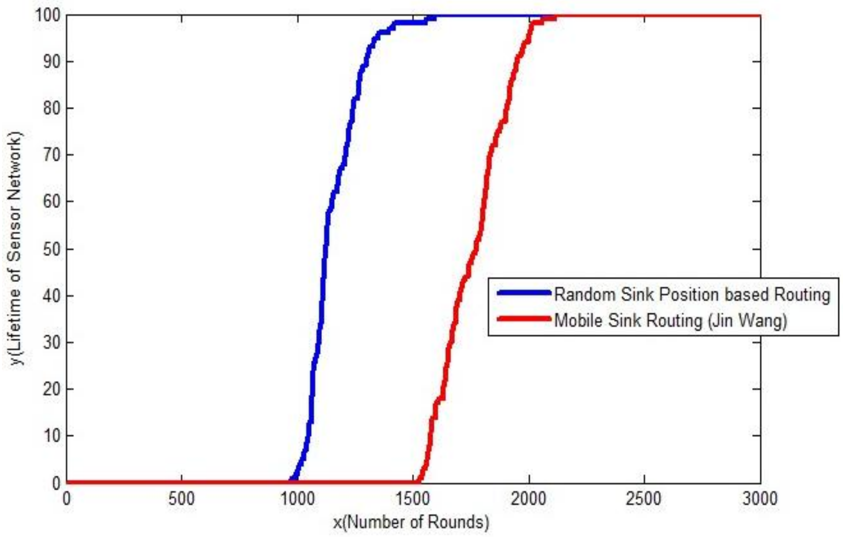

Figure 4: Lifetime Comparison

End to End Delay Comparison:

Latency is an important issue for wireless sensor networks. From Figure 5 we can see that end to end delay decreases when the number of round increases. As shown in the figure 5, the delay of using only one mobile sink is about 1.5 times of using our proposed algorithm. Means that our proposed algorithm gives much better performance in term of end to end delay.

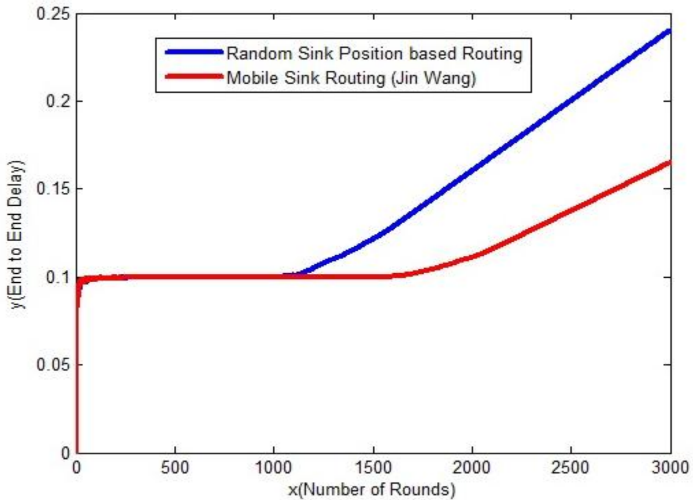

Figure 5: End to End Delay Comparison

VI. CONCLUSION FUTURE WORK

It is a better option or choice to deploy multiple mobile sinks to the WSNs to increase the network lifespan. In this paper, we presented our Data Collection Algorithm Based on Sink Mobility (DCAM) for WSNs, where the mobile sinks proceed along preset routes to collect the sensed data from sensor nodes. The performance of our proposed algorithm is demonstrated through simulation results.

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