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Adaptive Path Design for Mobile Sink in Wireless Sensor Networks

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***Abstract*– The wireless sensor network with mobile sink attracted the world's attention because of its great applications in various fields. The wireless sensor network consists of a group of small, self-energy nodes that sense the natural parameters change and transmit this data to sink node. Because the sensors have limited energy reserves and are difficult to recharge, Interest in energy conservation has emerged. due to the nature of the different applications of these networks, we can have important data that cannot be postponed, so this problem also appeared. many researchers and developers have attempted to reduce sensor energy consumption and prolong network lifetime or increasing network throughput. In this paper we suggested an algorithm for mobile sink path, the achievement of this algorithm will improve the network throughput, reduce the end to end delay and prolong the network life time by decreasing the energy consuming in the nodes, in addition to gather the important data in minimum delay. The simulation has done, and the result has been compared with other studies.**

***Index Terms*– WSN, Sensor, Mobile Sink, Path Delay, Simulation and Parameters**

I. INTRODUCTION

WIRELESS sensor networks have entered various aspects of life, as they contribute to the industrial and agricultural sectors. To increase the percentage of receiving packets, it was suggested that the sink node to be mobile, which increases the percentage of packet reception, the network lifetime, and so forth. Several studies have made many suggestions to improve the path of the Sink node and made it sink sometimes and dynamically at other times. Recently, studies have emerged that combined the two methods to improve network performance.

We can know the important parameters in the wireless sensor network according to the application need. In general, throughput, delay and network lifetime are among the most important parameters. In our research we focused on these tree parameters with the possibility of dealing with the existence of important data in this network.

Our paper is organized as follows: in section II we discuss related works on mobile sink with or without important data, and in case of predetermined path and dynamic path. In section III we describe the problem clearly and we declare the network aspects. In section IV we introduced our algorithm to deal with important data and achieve our network goals. In section V we put the results of simulation and compare it with other studies.

II. RELATED WORKS

Most studies on collecting data in WSN was about collecting normal data, some of this studies introduced way to collect data by gathering information between some nodes to reach the mobile sink [1], [2], [3].

In research [4] which is improved on study [5] was introduced to integrate two ways of collecting data, first way was about collecting periodic data [6,7], second way was about collecting emergent data [8].

This study [4] succeeded in collecting periodic and emergent data by changing mobile sink's path, but it will consume much energy from node's batteries, because when mobile sink change it's path each node in skipped grid will wake up not only it's cluster head but also nodes and cluster heads in next grids which maybe will be busy and have some data to catch.

On other hand, maybe there will be important data in more than one grid of network in same time, this case was not addressed in this study. Another research [9] was set to improve lifetime of network and dealing with important data. In research [10] it studies WSN with mobile sink to get high throughput with sink predetermined path.

In our paper, we will introduce an algorithm to get less value of these three parameters end to end delay, packet loose, energy consumption (more life time), and deal with the case that there are important data in the network.

III. PROBLEM DESCRIPTION AND NETWORK MODEL

A) Problem description

This research focuses on collecting data, especially the important ones, with the least possible time without losing any packages of normal importance before and after the completion of the collection of important data.

B) Network model

The network is made up of N sensor nodes (N: variable number according to the simulation scenario). These nodes are randomly distributed over a square shape, this network (square shape) is divided into smaller squares, in each small square there is a Cluster Head which is the highest energy node. We assumed the following:

1- The sensor nodes are static, and it all have the same initial energy, communication range and the fixed power to transmit and receive data.
2- The mobile sink is no limited power, and it moves toward cluster heads one by one in predetermined trajectory.
3- Mobile sink has fixed speed V_s.

Advanced path algorithm description:

In the normal case, that is, when there is no important data, the sink node moves according to a predetermined fixed path. it will visit all the small squares and collects data and will not move towards the next square until the end of receiving data from the current square nods.

The network is divided into squares, as mentioned earlier, in each square There is a Cluster Head. The moving mobile sink divides the Cluster Heads into two groups A and B. Fig. 1 shows the network and its division.

As long as Cluster Heads are divided into two groups, this means that the network as a whole is divided into two groups (in the case of this network in Fig. 1).

1) Group A : 1,2,4.

2) Group B : 3,5,6.

Mobile sink will visit the network Squares in group A first then the nodes in squares in group B and collects data from node that has sensed data in one hope communication.

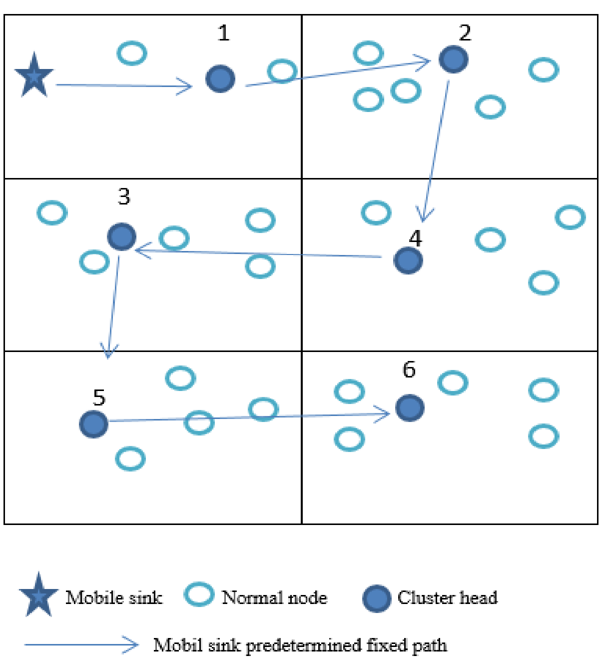

Fig. 1: The network division and sink node path

In the case that there are important data in the network from one square in the network, the Cluster Head will send a request message to the Mobile Sink, and here we distinguish two cases:

1)- mobile sink is not collecting data by the time it received a request message → it will move toward the square that the cluster head sent the request message in.

2)- mobile sink is collecting data by the time it received the request message → it will interrupt the data gathering process and move toward the square that the cluster head sent the request message from. After mobile sink finish gathering important data it will move toward the last position it was in.

Fig. 2 and Fig. 3 show the modified mobile sink path.

Here, mobile sink move from square 1 to square 2, in this square it received requested message from cluster 5, so it will interrupt the gathering data process and move toward the square 5 to gather important data, after finishing this gathering it will go back to square 2.

Note: we have a special case, if two cluster heads have sent two request messages in the same time → mobile sink will compare the numbers of clusters with the present cluster number i.e., the number of the present square. Mobile sink will move toward cluster whose number in the same group mobile sink in, or closer to the present square number.

Here, mobile sink in cluster 2 when it had received two request message from cluster head 4 and cluster head 5, mobile sink has already two groups A and B, cluster 4 is in the same group with the present position of mobile sink, so it will move to cluster 4 first, then it will move toward cluster 5 and after mobile sink will finish data gathering it will go back to cluster 2 if it did not finish gathering normal data and will move according to predetermined path. Steps of our proposed algorithm are shown in Fig. 4.

It shows the steps of the proposed algorithm in the form of a flowchart, it clarifies the mechanism of work when one or more requests was send important data are received and moving the sink node towards the nearest node and then the other node (in case of two requests) finally going towards the node where the sink node was, before gathering the important data, and continue receiving the regular data.

IV. SIMULATION AND RESULTS

A) Simulation environment

We have simulated the algorithm on N.S-2.35 (Network simulator 2.35), this simulator was downloaded on Linux-mint 18 on virtual machine on windows 7.

We assumed the sink node will complete a round of data gathering, when it will return to the first square of network again.

In each round cluster Heads will be re-elected and cluster head will be the node has highest level energy in each square, so important data cannot be loosed. The simulation parameters are shown in the Table I.

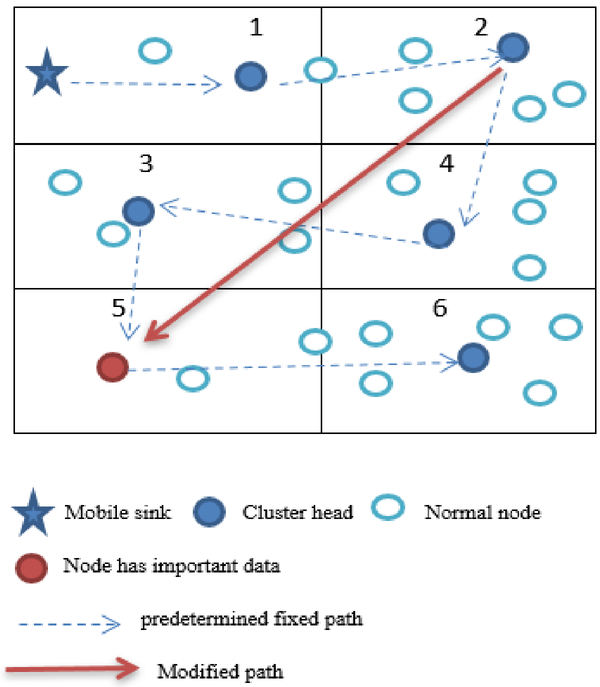

Fig. 2: Mobil sink predetermined and modified path

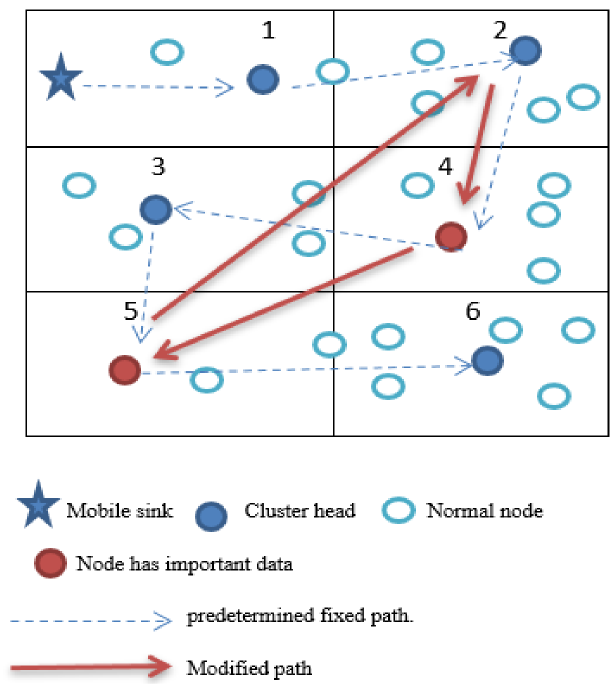

Fig. 3: Mobil sink predetermined and modified path

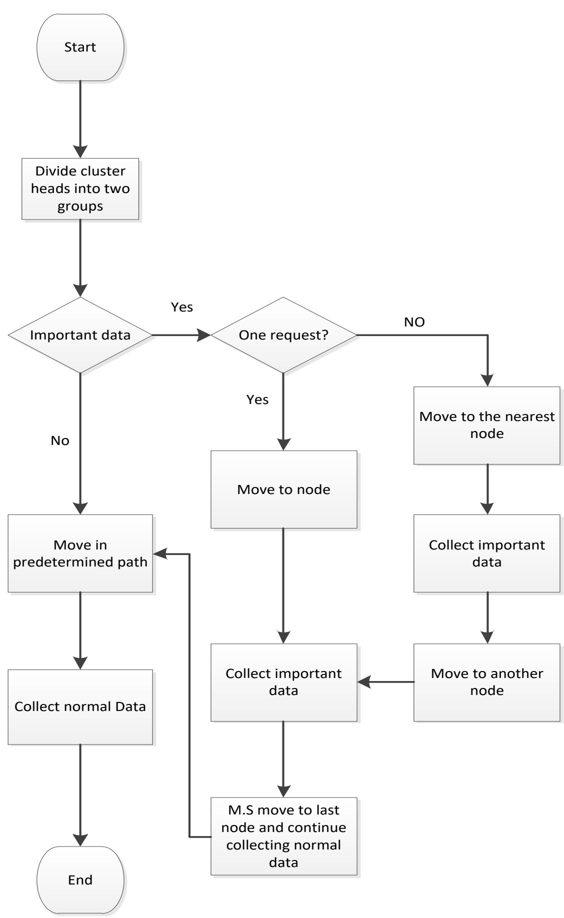

Fig. 4: Steps of proposed algorithm

Table I: Simulation parameters

Size of area	100x100 m^2
Number of nodes	30
Number of sink nodes	1
Communication protocol	IEEE802.15.4
Simulation time	100 s
Mobile sink speed	10 m/s
Node initial energy	1j
Node communication radius	25 m
Nodes distribution	Random

We chose these parameters for easy comparison with the results of previous researches. We assumed that the network will be divided into smaller squares, each square side length is "S" ➡ to make sure each two nodes will communicate in each square, Considering that node communication radius is R,

$$S^2 + S^2 \leq R^2$$

$$2S^2 \leq R^2 \Rightarrow S \leq \frac{R}{\sqrt{2}}$$

We take two result parameters which are end to end delay and packet loss rate, we compared the results with the results of study [4] and original path planning.

B) Results

We have got three parameters simulation results, we compare our algorithm results with the algorithm results in study [4], and random moving of mobile sink.

Throughput: throughput is the ratio of successful data packets reception; Fig. 5 shows the throughput comparison between three algorithm we mention before.

Simulation results show that our proposed algorithm did better results than the other two algorithms due to the facts that are In study [4], the sensor node will awaken nodes close to it and send request messages to the nodes in the grid where the sink node is located, and in our proposed algorithm the transmission between the sensing node and mobile sink is one hope and there is no third party, and there is fair consuming of energy, so sensing data cannot be loosed.

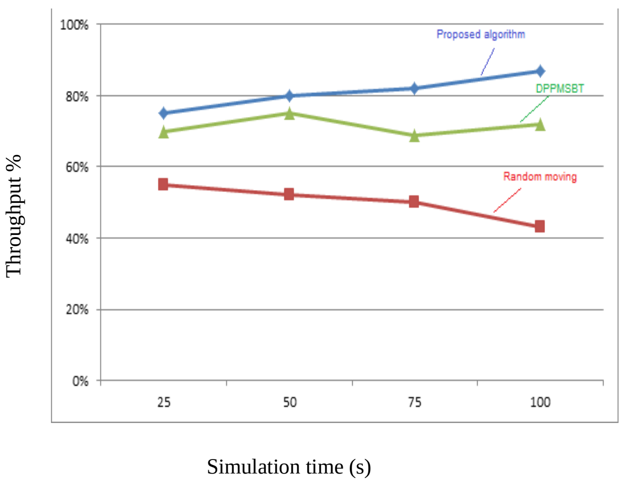

Fig. 5: The throughput of three algorithms

End to end delay: it refers to the time difference between expected arriving and actual arriving of packets. Fig. 6 shows an average end to end delay of network with tree methods.

Our proposed algorithm achieved the lowest value of delay due to many reasons some of them are: transmission data will be in one hop communication and there is no need to transmit data through long path (more nodes in path = more retransmission packets).

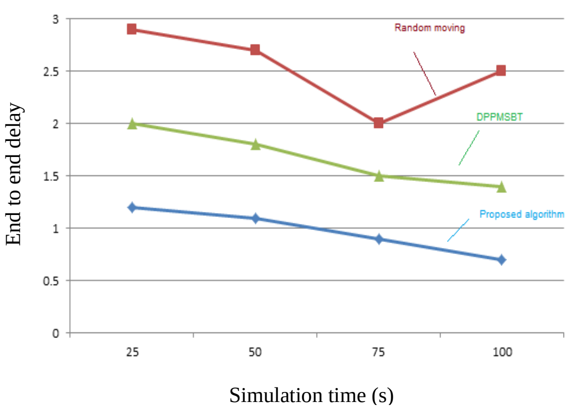

Fig. 6: end to end delay of three algorithms

Residual energy: If the remaining energy in the network nodes is greater at the end of the simulation, this means that the energy consumption is done fairly and gives an idea that the network life span will be longer.

Fig. 7 shows that when we applied our proposed algorithm there was more residual energy in the network by the ending of simulation.

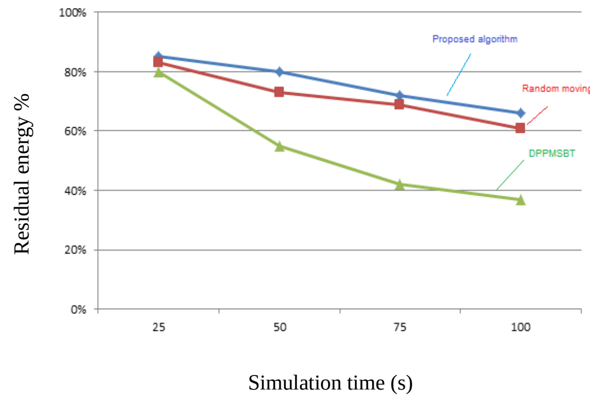

Fig. 7: Residual energy in the network

As we mentioned before, mobile sink will move in pre-determined trajectory in normal case, and will move to node that has important data and goes back to trajectory after it finish gathering important data, by this way there will be less energy consuming in the network, because there no need to more multi hope communication.

V. CONCLUSION

In this paper, we have introduced an algorithm to automatically modify the path of the Sink node while there are important data sensed from any sensor node in the network, without any loose of normal data. Our proposed algorithm gets better throughput ratio and save energy in sensor nodes, so it prolongs network lifetime, also collection data (normal and important) is in low end to end delay.

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