IJIRMET ISSN (Online): 2456-0448
International Journal Of Innovative Research In Management, Engineering And Technology
Vol. 2, Issue 6, June 2017

An Efficient Mobile Sink Path Selection For Wireless Sensor Networks

[1] Saqib ul Sabha, [2] Dr Md Azharuddin
[1] [2]Department of Computer Science and Engineering, VIT University Vellore, Tamil Nadu-632014, India
[1]saqibulsabha@gmail.com, [2]md.azharuddin@vit.ac.in

Abstract: — ***Hotspot issue is one of the real obstruction in the long run working of the Wireless sensor networks. The uneven energy depletion can decline the lifetime of the wireless sensor network. The solution to this problem has emerged in the form of the Mobile sink. The mobile sink visits the sensor nodes and collects data from them. But this technique is suffering from some issues which affects its performance. The major issue is the path selection for the Mobile sink. In our work we propose an algorithm that will effectively get rid of these issues. Our algorithm is based on the Rendezvous point (RP) in which the mobile sink visits all RP's and collects data from them. The node with most number of neighbors is selected as Rendezvous point and after that the selected RP and its neighboring nodes are removed from our set of nodes. Same procedure is applied to select further RPs. The algorithm is simulated thoroughly and the results are compared with some existing algorithms using numerous performance metrics.***

Keywords: ***Wireless Sensor Networks; Hotspot; Mobile sink; Rendezvous points; nearest neighbor;***

I. INTRODUCTION

A sensor system is made out of an enormous number of sensor nodes, which are thickly installed either inside the occurrence or near it. The position of sensor nodes require not be built or pre-decided [1]. This permits arbitrary deployment in unreachable landscapes or catastrophe help operations. Sensor nodes are fitted with a processor which processes the data. Rather than sending the rough data to the hubs, sensor nodes utilize their processing capacities to locally do basic calculations and transmit just the required and partially processed information [2]. The sensor networks consists of nodes that are deployed in the required area. The nodes get data from the surroundings and then first process the data and then send the data to the sink [5, 6]. So, the SNs which are in the neighborhood of the sink node gets overburdened by receiving more data from the nodes. The problem with sensor nodes is their limited battery backup so these overburdened nodes die before the nodes which are less burdened with data forwarding. [17].This leads to the situation where the Sink does not receive data from some nodes. The problem is known as Hotspot problem [3, 4] which affects the regular working of the WSN. So to solve this problem, the researchers proposed the use of mobile sink which can be put over any mobile vehicle or any robot. This mobile sink visits all the nodes and collects data from them hence reduce the problem of hotspot by keeping the energy consumption in a balance [18, 19]. Now the problem that arises here is to determine which nodes need to be visited. It will be time consuming if the mobile sink visits all the nodes. A lot of research is going on to find the optimal sensor nodes which the mobile sink should visit [20, 21]. To solve the problem, Researchers came with an idea of Rendezvous points [25]. Here the mobile sink does not need to visit all the sensor nodes but it visits only the RPs and after collecting data moves to next RP and continues the cycle in the same manner. So it is a very difficult task to find an efficient path through these set of Rendezvous points to increase the lifetime of the network. [23, 27]. In this paper, we have devised an efficient way to select a set of RPs from all the SNs that are deployed in the network and afterwards design a path for the MS using (travelling salesperson problem) TSP over them. In order to compare the proposed algorithm, we used the existing algorithm without efficient path over the set of SNs. Then we simulate and compare our algorithm with the existing one over numerous performance metrics like End to end delay, Path energy consumption, Path selection and Packet loss.

II. RELATED WORK

A latest development in WSN is to make use of the sink movement for maintaining the energy reduction between the SNs. The researchers in [7] branded WSNs into immobile and mobile. In immobile sensor network [8], each sensor node is located at some stationary location in the sensor network and does sensing and data transmission till the battery expires. In mobile, the sink repositions itself if hot spots are created due to power constraint of some SNs [22]. Numerous research papers worked on sink relocation property. In [9, 10] the authors classified sinks mobility into random, predictable and controlled. In [26], sink movement is solved by finding the best location for a MS in the given area. In controlled sink mobility, the movement of the

MS is based on some of network conditions [24, 28]. To solve this problem, authors of [12] proposed protocols and algorithms which are based on the mobile sink. The authors of [11], proposed that MS can handle the network better than the static sink. The routing protocols of MS [13] can attain enhanced connectivity with relatively lesser effort than static sink. MS also helps in load balancing [14] since the sink travels from one location to another for data collection, the hotspots of the field also changes. So, the energy wastage nearby the sink is lessened, in this manner load balancing is gained. Another issue in WSN is to select the sufficient RPs as discussed in [15, 16]. The MS need to gather the data from the sensor nodes by walking through the shortest path. Authors in [6], proposed an energy efficient path for mobile sink using the empirical method known as WRP. In [7, 28] authors suggested a new method for improving the network lifetime through sink relocation. In our algorithm, we selected RPs using the nearest neighbor and then after selecting set of RPs we applied TSP to find the efficient path.

III. SYSTEM MODEL

We considered a reliable WSN which consist of lots of stationary SNs that are deployed in the required area. We consider the sink as movable with unconstrained power which travels through the SN and collects data. Whenever the mobile sink reaches within the communication range of the sensor nodes, it will start receiving data from them. Whenever the power supply of any node gets exhausted, we assume that the node is dead. Some of the Terminologies used in this Paper are described in the Table I.

Table I Terminologies used

Terminology	Description
WSN	Wireless Sensor Network
SN	Sensor Node
RP	Rendezvous Point
S	Set of Sensor Nodes
R	Communication Range of Sensor Nodes
Node Set	Set of Nodes
N	Total no of Sensor Nodes
K	Total no of RPs

IV. PROPOSED METHODOLOGY

In this paper, we have proposed a methodology in which we select a reduced set of SNs as RPs to generate a route for mobile sink. Firstly we deployed SNs in a network. Sensor nodes send data in single hop as well as multi hop. Each sensor node has a range. Let us assume that each sensor node has a range R. So one sensor node will be able to send and receive data from all nodes that come under its range in single hop. In our proposed algorithm we deploy set of nodes in a network. Each sensor node is capable of sending and receiving data from all those nodes which fall in its range. So a sensor node will send and receive data in single hop from its neighbors. Here neighbors are all those nodes will come in the range of a sensor node. In our proposed methodology, we will first apply nearest neighbor algorithm on all sensor nodes. Now we get the single hop neighbors of all the sensor nodes. Select the node which is having most number of neighbor nodes. We will select this node as our First Rendezvous point and will remove this node and all its neighbors from the set of nodes. Now repeat the process again and find the next RP. Continue this process till all the nodes are over. Once the set of nodes is exhausted, a set of RPs is ready. Now mobile sink will visit these selected RP's and will receive the data from them. In order to cover the set of RP's in smallest time, we need to find the efficient path for the mobile sink. To find the shortest and efficient path for the mobile sink, we made use of travelling sales person algorithm (TSP). The TSP algorithm is used to calculate the shortest path. In the system architecture as shown in the figure below. We started with creating a network of sensor nodes. Then we deployed the sensor nodes in the NS2. The simulations were done in the NS2. After the sensor nodes were deployed, we applied an algorithm to find the one hop neighbors of all the sensor nodes. After finding the neighboring nodes of all the sensor nodes, we choose those nodes which have highest sensor nodes. Now Select the first RP and remove these nodes from the Set of sensor nodes. Keep on repeating this procedure till no node is left. Now we got the set of Rendezvous nodes. Now sink will be scheduled to visit all the RPs to collect the data. The figure shows the system architecture and in part B of this section algorithm is shown.

System Architecture

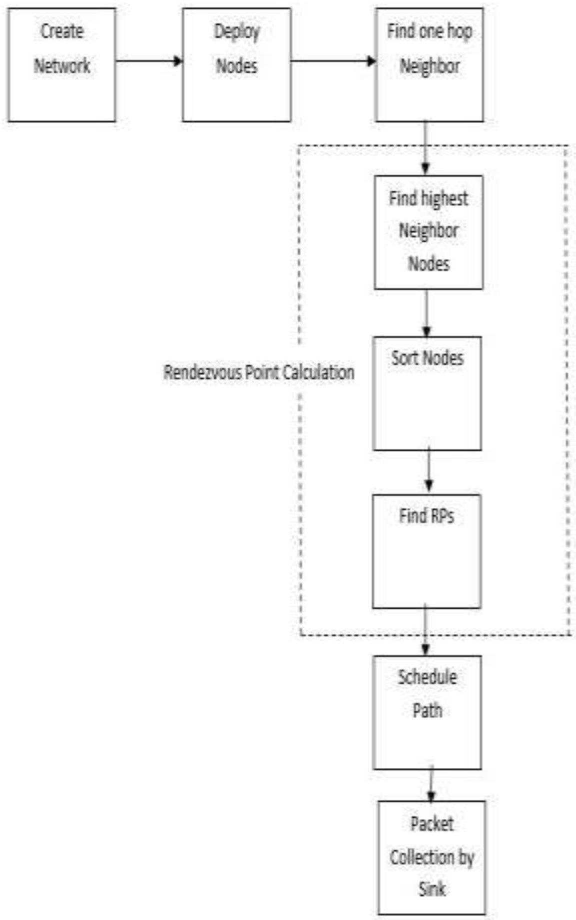

Fig 1: *System Architecture*

B.Algorithm

Input: Set of sensor nodes S= {SN1, SN2, ..., SNn} and R.
Output: Set of RPs = RP1, RP2,..., RPk

Step 1: Initialization RPs=θ, k=0, Node Set= S.

Step 2: While |Node Set| > θ

Step 3: Find one hop neighbor for all nodes

Step 4: Sort the nodes with highest number of sensor nodes

Step 5: Select Node with highest Neighbors as RP1.

Step 6: Select node RP1 and remove its neighbors from list and select next RP and repeat the process till no available nodes

Step 7: Call Travelling Sales Person (RPs) Path Formulation

Step 8: Each SN communicates with the nearest RP or a nearest SN communicating with an RP and move to next location

STEP 9: **STOP**

V. SIMULATION RESULTS

Simulation Setup

We performed simulations on the proposed algorithm using Network Simulator 2(NS2) on the system with Intel core i3 processor and speed of 1.90 GHz and 4 GB RAM. The operating system used is Ubuntu.

A. Path Selection

We deployed 120 sensor nodes. Each sensor node is having an initial energy of 2J. The mobile sink is having unlimited energy and can travels to all the Rendezvous points to collect the data from them. All the sensor nodes in the network sends data to its nearest RP. After RPs completes receiving data from the sensor nodes, we schedule the Mobile Sink to receive the data from RPs. The MS visits the RPs one after the other. The figure 2 below presents the path followed by the sink node.

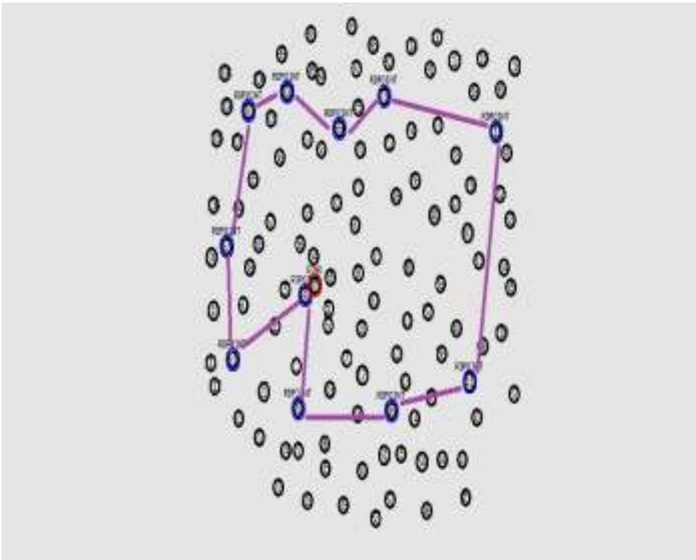

Fig 2: Path Selection for MS

B. End to End delay

End to End delay is the transmission time taken for a packet from source to destination. The above graph defines the delay in network. The experiment was running 60 seconds of time. The graph shows comparison of delay between existing algorithm and our proposed path scheduling algorithm. The graph clearly shows that our approach performs better as can be seen in the figure.

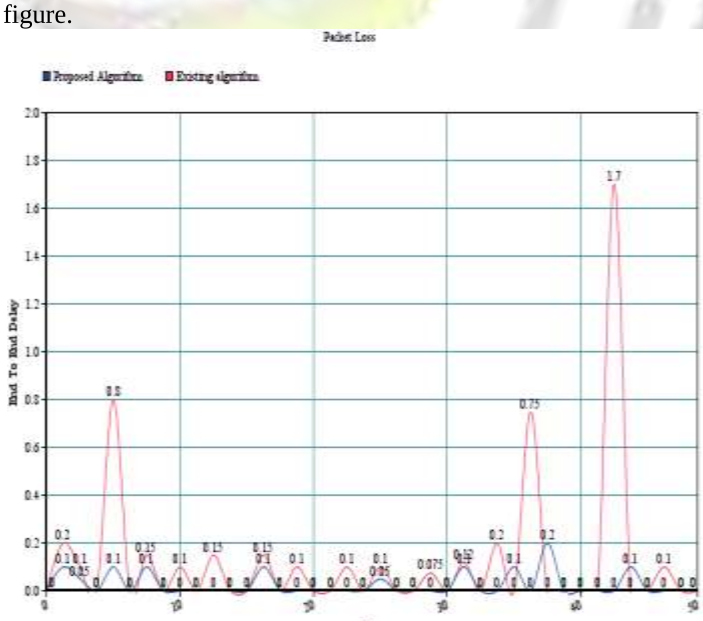

Fig 3: End To End Delay

ISSN (Online): 2456-0448
International Journal Of Innovative Research In Management, Engineering And Technology
Vol. 2, Issue 6, June 2017

C. Packet Loss

Packet Loss happens when network traffic does not reach the destination in a required time. The below graph defines the packet drop in the initialization phase. The experiment was running 60 seconds of time. The graph shows comparison of packet drop between before path scheduling and after our proposed path scheduling algorithm. It is clear that the packet loss percentage is much lesser in our proposed algorithm as can be seen in graph.

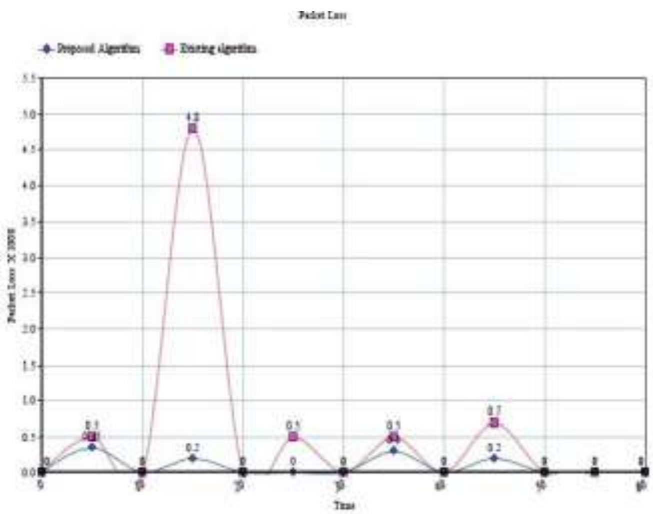

Fig 4: Packet Loss

D. Path Energy Consumption.

The simulation for path energy consumption was done and the results were plotted. Our proposed algorithm performs better that the existing algorithm. As we can clearly see in the figure the significant performance in our proposed algorithm.

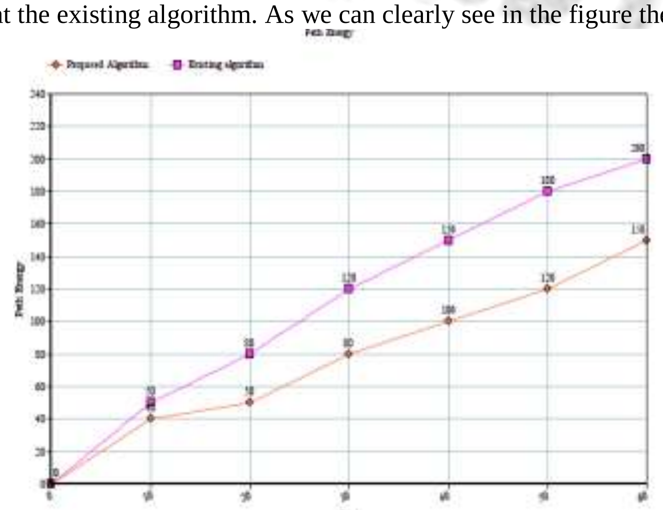

Fig 5: Path Energy Consumption

VI. CONCLUSION

In this Paper we have designed an efficient algorithm for path selection in sensor networks. Our algorithm is based on nearest neighbors in which we select those nodes as RP which have most number of neighbors so that they can efficiently receive data from neighboring nodes in single hop. Here we used the concept of Rendezvous points. We were able to efficiently restrict the hotspot issue. We showed that our proposed algorithm outclass the existing algorithm in terms of packet loss, Path energy consumption and End to End delay. Also the path was efficient and shortest as compared to other algorithms

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