IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834, p- ISSN: 2278-8735.
PP 48-53
www.iosrjournals.org

Path Selection Using Rendezvous Point Method To Increase The Life Time In Wireless Sensor Networks

Sara Baby[1], Malini Soman[2]
[1]*Electronics and Communication Dep,SNGCE Kadayiruppu,India*
[2]*Electronics and Communication Dep,SNGCE Kadayiruppu,India*

Abstract *:The sink mobility along a constrained path can improve the energy efficient in Wireless Sensor Networks. To address this challenge a proposed method is to form a hybrid moving pattern in which a mobile sink node only visits rendezvous points (RPs),as opposed to all nodes. Sensor nodes that are not RPs forward their sensed data via multi-hopping to the nearest RP node. Fundamental problem becomes computing a tour that visits all the RPs within a given delay bound. Identifying the optimal tour , however is an NP hard problem .To address this problem Weighted Rendezvous Planning(WRP) method is proposed whereby each sensor node is assigned a weight corresponding to its hop distance from the tour and the number of data packets that it forwards to the closest RP.WRP enables a mobile sink to retrieve all sensed data within a given deadline while conserving the energy expenditure of sensor nodes. More specifically, WRP reduces energy consumption and also increases the network lifetime as compared with existing methods.*

Keywords - Data *collection,Mobile_Sink,Scheduling, Wireless Sensor Networks (WSNs).*

I. INTRODUCTION

WSN have emerged as a new information-gathering paradigm in wide-range of application such as medical treatment, outer-space exploration, battlefield surveillance etc. Each senor node has the capability to collect and process the data, and to forward any sensed data back to one or more mobile sink nodes via their wireless transceiver in a multi-hop manner. It is equipped with a battery, but which may be difficult or impractical to replace, given the number of sensor nodes and deployed environment .These constraints have led to intensive research efforts on designing energy-efficient protocols [5].In multi-hop communication nodes that are near a sink tend to become congested as they are responsible for forwarding data from nodes that are farther away. Thus, the closer a sensor node is to a sink, the faster its battery runs out, whereas those farther away may maintain more than 90% of their initial energy. This leads to non-uniform depletion of energy, which results in network partition due to the formation of energy holes. As the result ,the sink becomes disconnected from other nodes, thereby impairing the wireless sensor networks. Hence balancing the energy consumption of sensor nodes to prevent energy holes is a critical issue in wireless sensor networks.

The travelling path of a mobile sink depends on the real-time requirement of a data produced by nodes. For example, in hard real-time applications such as fire-detection system, environmental data need to be collected by a mobile sink quickly. In WSNs with a mobile sink is a fundamental problem to determine how the mobile sink goes about collecting sensed data. One approach is to visit each sensor node to receive sensed data directly [6].This is essentially the well-known Travelling Salesman Problem(TSP)[7],where the goal is to find the shortest tour that visits all sensor nodes .However, with an increasing number of nodes ,this problem becomes intractable and impractical as the resulting tour length is likely to violate the delay bound of applications. Researches have proposed the use of rendezvous points(RPs) to bound the tour length [8],[9].This means a subset of sensor nodes are designated as RPs and the other nodes are simply forward their data to RPs.AS a result the problem which is called rendezvous design ,becomes selecting the most suitable RPs that minimize energy consumption in multi-hop communications While meeting a given packet delivery time .A secondary problem here is to select the set of RPs that result in uniform energy expenditure among sensor nodes to maximize the network lifetime. In this paper ,we call this problem the delay aware energy efficient path(DEETP).we show that the DEETP is an NP hard problem and propose a heuristic method ,which is called weighted rendezvous planning (WRP),to determine the tour of a mobile sink node .In WRP ,the sensor nodes with more connections to other nodes and placed farther from the computed tour in terms of hop count are given a higher priority. Thus, this paper is summarized as follows:

- We define the problem of finding a set of RPs to be visited by a mobile sink. The objective is to minimize energy consumption by reducing multi-hop transmissions from sensor nodes to RPs. This also limits the number of RPs such that the resulting tour does not exceed the required deadline of data packets.

- We propose WRP, which is a heuristic method that finds a near-optimal traveling tour that minimizes the energy consumption of sensor nodes .WRP assigns a weight to sensor nodes based on the number of data packets that they forward and hop distance from the tour, and selects the sensor nodes with the highest weight.
- We mathematically prove that selecting the sensor node that forwards the highest number of data packets and have the longest hop distance from the tour reduces the network energy consumption ,as compared with other nodes. Moreover, we show that, in contrast to direct, rendezvous design methods, WRP is guaranteed to find a tour if the latter exists.

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

II. EXISTING SYSTEM

Existing methods on using a mobile sink in WSNs can be grouped into two categories:

1) *DIRECT METHOD*

Here the mobile sink visits each sensor node and collects data via a single hop. Initial studies used a mobile sink that visits sensor nodes randomly and transport collected data back to a fixed sink node. An example is the use of animals as mobile sink nodes to assist in data collection from sensor nodes scattered on a large farm [10]. To reduce the latency of visiting each sensor node randomly, researches have proposed TSP based data collection methods. In essence, the problem is reduced to finding the shortest traveling path that visits each sensor node[6].For example, TSP with neighborhood [11] involves finding the shortest traveling tour for a mobile sink node that passes through the communication range of all sensor nodes.

2) *RENDEZVOUS DESIGN*

Here the mobile sink only visits nodes designated as RPs .The main goal of protocols in category 1 is to minimize data collection delays, whereas those in category 2 aim to find a subset of RPs that minimize energy consumption while adhering to the delay bound provided by an application[12]. The problem with collecting data directly from sensor nodes is that it becomes impractical when there are large number of sensor nodes. Visiting each sensor node increases the mobile sink's traveling path length and results in sensor nodes experiencing buffer overflow due to data collection delays. To address this problem, researches have proposed a rendezvous based model, in which a mobile sink only visits a subset of sensor nodes called RPs. The sensor node outside the mobile sink path send their data via multi-hop communications to these RPs. A tour is then computed for the set of RPs, as shown in Fig.1. Studies [8],[9],[13]deploying this approach can be classified according to the mobile sink trajectory, i.e., whether it moves along a fixed path or its path unconstrained by any external factors. In [13],a WSN with a mobile sink node only visits nodes designated as RPs and collect data from RPs. Moreover, RPs perform data aggregation. As a result, the problem which is called rendezvous design, becomes selecting the most suitable RPs that minimize energy consumption in multi-hop communications while meeting a given packet delivery bound. A secondary problem here is to select the set of RPs that result in uniform energy expenditure among sensor nodes to maximize network lifetime.

In this paper, we call this problem the delay aware energy efficient path(DEETP).We show that the DEETP is an NP hard problem and propose a heuristic method, which is called Weighted Rendezvous Planning(WRP) , to determine the tour of a mobile sink node.

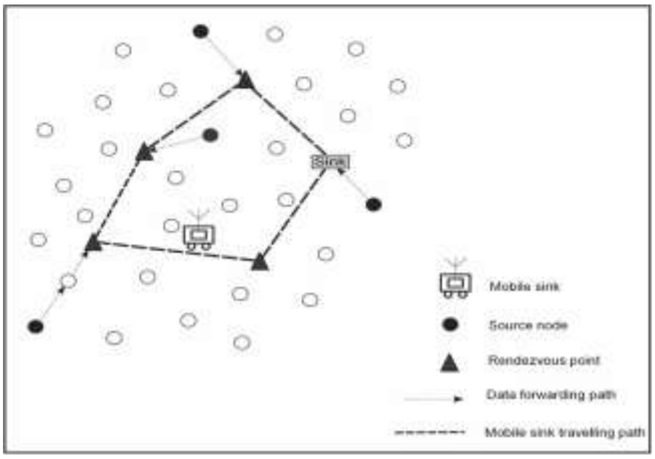

Fig.1. Hybrid movement pattern for a mobile sink node. Source nodes generate and send sensed data to the nearest RP.

III. Proposed Methodology

Weighted Rendezvous Planning(WRP) preferentially designates sensor nodes with the highest weight as a RP. The weighted of a sensor node is calculated by multiplying the number of packets that it forwards by its hop distance to the closest RP on the tour. Thus, the weighted of sensor node i is calculate

$$W_i = \text{NFD}(i) \times \text{H}(i,\text{M}) \qquad (1)$$

Based on Eq .1,sensor nodes that are one hop away from an RP and have one data packet buffer get the minimum weight. Hence, the sensor nodes that are farther away from the selected RPs or have more than one packet in their buffer have a higher priority of being recruited as an RP. Here the energy consumption is proportional to the hop count between source and destination nodes and the number of forwarded data packets.

Hence ,visiting the highest weighted node will reduce the number of multi-hop transmissions and thereby minimizes the energy consumption. In addition, as dense areas give rise to congestion points due to the higher number of nodes, energy holes are more likely to occur in these areas. Hence, a mobile sink that preferentially visits these areas will prevent energy holes from forming in a WSN. We model a WSN as G(V,E),where V is the set of homogeneous sensor nodes, and E is the set of edges between nodes in V. If sensor node i sends b bits to node j, its energy consumption is,

$$E_{TX}(i,j) = b\,(\alpha_1 + \alpha_2 \times d^{\gamma}_{i,j}) \qquad (2)$$

where $d_{i,j}$ is the physical distance between sensor node *i and j*, and α_1 is the energy consumption factor indicating the power per bit incurred by the transmitting circuit. The expression $\alpha_2 d^{\gamma}_{i,j}$ indicates the energy consumption of the amplifier per bit, where α_2 is the energy consumption factor of the amplifier circuit. Here ,γ is the path-loss exponent, which usually ranges between 2 and 4,depending on the environment. Moreover, the power consumption incurred by node i to receive b bits from node j is ,

$$E_{RX}(i,j) = b \times \beta \qquad (3)$$

where β is a factor that represents the energy consumption per bit of the receiving circuit.

Maximum Tour Length

The mobile sink node moves with a constant speed v. Hence, the maximum length of the traveled path l is,

$$l_{max} = \text{D} \times v \qquad (4)$$

A mobile sink node starts its movement from a node $m_0 \in$ V and before time D returns to its starting point. Each sensor node sends its generated data packets to the closest RP through multi-hop transmissions. We define a function called H(i ,M) that returns the closest RP in terms of hop count to the sensor node i , where M is the set of RPs and $h_{i,j}$ is the hop distance between nodes i and j .For each RP m_i ,our algorithm constructs a data forwarding tree Tm_i comprising the closest sensor nodes to said RP. The number of data packets NFD(i) that sensor node i forwards to the closest RP m_i in each time interval D is equal to its own generated data packet plus the number of its children in the data forwarding tree Tm_i.Specifically,its represented in Eq.5,

$$\text{NFD}(i) = \text{C}(i,Tm_j) + 1 \qquad (5)$$

where C(i,Tm_j) is a function that returns the number of children that node i has in the data forwarding tree rooted at its corresponding RP m_j . If the tour length is less than the required length l_{max} , the selected node remains as an RP. Otherwise ,it is removed from the tour. After a sensor node is added as an RP, WRP removes those RPs from the tour that no longer receives any data packets from sensor nodes. This is because adding a sensor node to the tour may reduce the number of data packets directed to these RPs. Consequently, this step affords WRP more opportunities to add other nodes into the tour. Note that the variable removed is used to guarantee that an RP will be deleted from the tour only once. If a removed RP is added to the tour for the second time, because its corresponding variable removed is true, it will not be removed from the tour when the required tour length for a mobile sink is bigger than the time to visit all sensor nodes. Fig.2.shows an example of how WRP finds a traveling tour for a mobile sink. The maximum tour length is l_{max} = 90 m. WRP starts from the sink node and adds it to the tour *M* is sink.

As Fig. 2(a) shows, the first iteration, WRP adds node 10 to the tour because it has the highest weight, yielding *M* = [Sink,10].

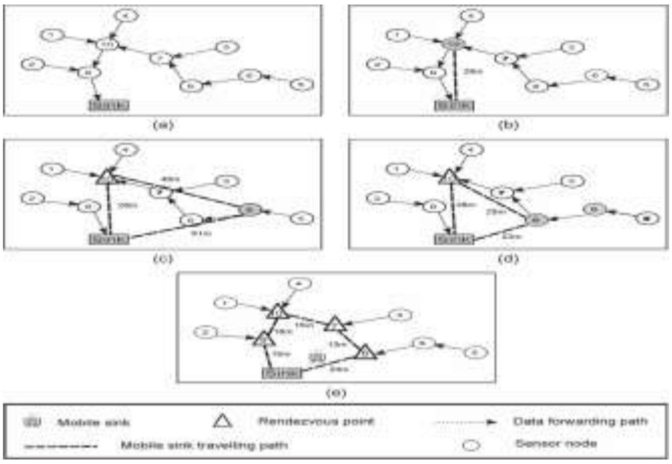

Fig. 2.Example of WRP operating in a WSN with ten nodes.

As Fig 2(b) shows ,the tour length of *M* is smaller than the required tour length (56 < 90),meaning node 10 stays in the final tour. In the second iteration, WRP recalculates the weight of sensor nodes because node 10 is now part of the tour. In this iteration, WRP selects node 6 as the next RP, which has the highest weight. As Fig. 2(c) shows ,the tour length of *M* =[Sink,10,6] is larger than the required tour length(119 > 90).Consequently ,WRP removes node 6 from the tour *M* =[Sink,10].In the third iteration, the weight of the sensor node will not change because node 6 is not selected as an RP but it says marked and will not be selected .WRP selects node 8 because it has the highest weight and is not marked[see Fig. 2(d)]. The TSP function returns 76m for *M* = [Sink,10,8],which is less than 90m.Therefore,node 8 is added to the tour. The process continues ,yielding a final tour of *M* = [Sink,8 ,7,10,9] with a tour length [See Fig.2(e)].

As shown in Fig.2, the final tour computed by WRP always includes sensor nodes that have more data packets to forward than other nodes as RPs. This ensures uniform energy consumption and mitigates the energy-hole problem. This is the key advantage of WRP over Direct, Rendezvous Design methods. The time complexity of our algorithms is dependent on how many times WRP calls the TSP solver to calculate a tour that visits all RPs. After a node is selected as an RP, WRP again unmarks other sensor nodes and restarts the search process. We like to point out that WRP always finds a tour when there is at least one possible tour in the network. This is because WRP checks the possibility of adding all sensor nodes to the tour.

IV. EVALUATION

We compare WRP against three existing methods that have the same objective as ours, Direct and Rendezvous Design methods .We consider a connected WSN where nodes are paced uniformly on a sensor field of size 400 × 400 m^2 .We note that interconnecting disconnected sensor nodes using a mobile node is a well known and separate problem. Having said that, we remark that WRP can be also made to interconnect disconnected nodes if the required delivery time for data packets is greater than the shortest traveling tour to visit all sensor nodes. The reason that we have assumed uniform sensor-node distribution is because energy holes are more likely to form when nodes are distributed uniformly[14].Experimental results in[15] demonstrated that, if sensor nodes are distributed uniformly up to 90% of residual energy is unused when the first sensor node dies. In addition, we adopt uniform distribution to ensure fair comparison with Direct and Rendezvous Design methods. Moreover, there are a maximum of 200 sensor nodes, which is reasonable for most applications.

Here we construct the network and done the experimental results using 50 nodes. To measure network lifetime ,we assume that all sensor nodes have a fully charged battery with 100 J of energy. We set the mobile sink speed(*v*) to 20m/s. We further assume that it visits each RP. Here the maximum allowed packet delay (*D*) is 18 seconds for 50 nodes. So the maximum tour length is 360m for 50 nodes. Based on the above parameters the experimental results are done. Fig.4and Fig.3.,shows WRP achieves high energy efficiency and better distribution of energy consumption between the sensor nodes compare than the previous methods. Finally the mobile sink path is efficiently selected in the proposed methodology when compare to the existing methods.

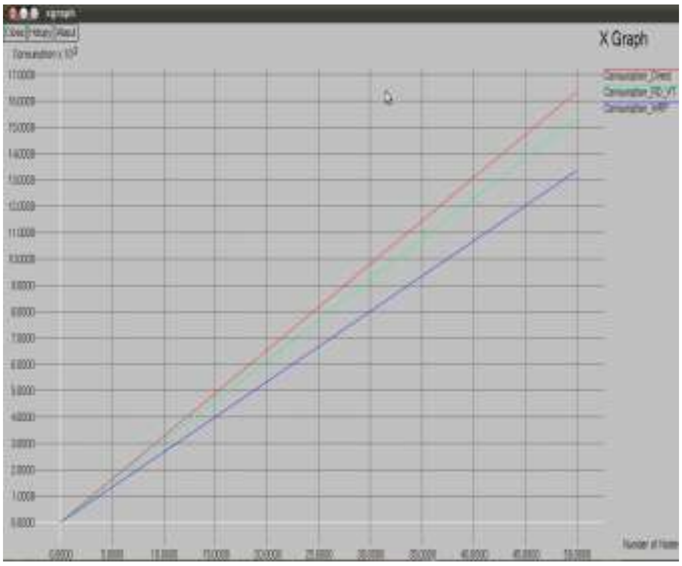

Fig.3. Network energy consumption for WRP, Direct and Rendezvous Design methods.

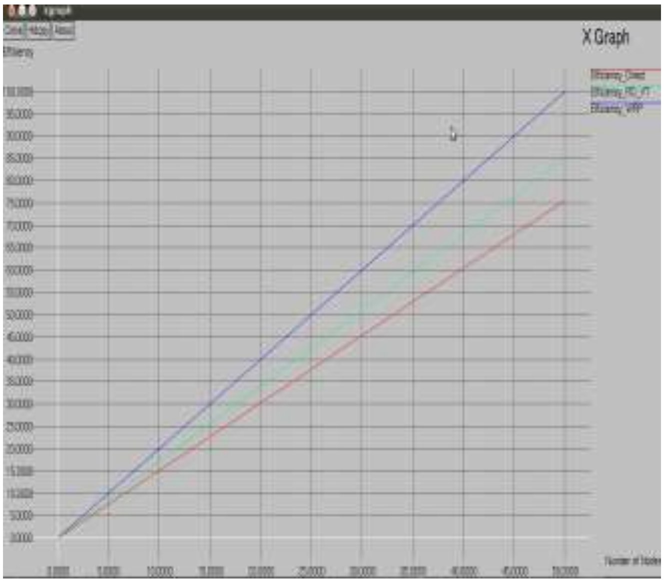

Fig 4.Energy efficiency for WRP, Direct and Rendezvous design methods.

V. CONCLUSION

Weighted Rendezvous Planning (WRP) enables a mobile sink to retrieve all sensed data within a given deadline while conserving the energy expenditure of sensor nodes. WRP selects the set of RPs such that the energy expenditure of sensor nodes is minimized and uniform to prevent the formation of energy holes while ensuring sensed data are collected on time. Our results ,which are obtained via computer simulation ,indicate that properties and effectiveness of WRP against the Direct method and Rendezvous Design methods. Moreover, WRP has 14% better performance than Rendezvous Design method and 24% better performance than Direct method .Our results show that WRP achieves high energy efficiency and better distribution of energy consumption between the sensor nodes compare than the previous methods .We plan to enhance our approach to improving the performance to reducing the energy consumption and also to reduce the number of RP node counts. It will increases the network lifetime by selecting efficient RPs

REFERENCES

[1] I.F.Akyildiz,W.Su,Y.Sankarasubramaniam,andE.Cayirci,"Wireless sensor networks:Asurvey,"*Comput.Netw*,vol.38,no.4,pp.393-422,Mar.2002.

[2] I.Bekmezci and F.Alagz, " Energy efficient ,delay sensitive,fault tolerant wireless sensor network for military monitoring,"*Int. J.Distrib.Sens.Netw*,vol.5,no.6, pp. 729-747,2009.

[3] A.Mainwaring,D.Culler,J.Polastre,R.Szewezyk,andJ.Anderson,"Wireless sensor networks for habitat monitoring," in *Proc.1st ACM Int. Workshop Wireless Sens.Netw.Appl.*,NewYork,NY, USA,Sep.2002,pp.88-97.

[4] J.Zhang,W.Li,Z.Yin,S.Liu,and X.Guo, "Forest fire detection system based on wireless sensor network,"in *Proc.4th IEEE Conf.Ind.Eectron.Appl.,Xi'an,China,May 2009,*pp.502-523.

[5] I.Akyildiz,W.Su,Y.Sankarasubramaniam,andE.Cayiric,"Asurvey on sensor networks,"*IEEE Commun.Mag.*,vol.40,no. 8,pp.102-114,Aug.2002.

[6] M.Ma and Y.Yang, "Data gathering in wireless sensor networks with mobile collectors," in *Proc.IEEE Int.Symp.Parallel Distrib.Process.*, Miami,FL,USA,Apr.2008,pp.1-9.

[7] S.Arora,"Polynomial time approximation schemes for euclidiean traveling salesman and other geometric problems," *J.ACM* , vol.45,no. 5,pp.753-782,Sep.1998.

[8] G.Xing,T. Wang,Z.Xie,and W.Jia,"Rendezvous planning in wireless sensor networks with mobile elements,"*IEEE Trans.Mobile Comput.*,vol.7,no.12,pp.1430-1443,Dec.2008.

[9] K.Almi'ani,A.Viglas,andL.Libman,"Energy-efficient data gathering with tour length-constrained mobile elements in wireless sensor networks," in *Proc. 35th IEEE Conf.LCN*,Denver,CO,USA,Oct.2010,pp.582-589.

[10] R.C.Shah,S.Roy,S.Jain and W.Brunette,"Data mules:Modeling and analysis of a three-tier architecture for sparse sensor networks ," *Ad Hoc Netw*,vol. 1,no.2/3,pp.215-233,Sep.2003.

[11] S.Nesamony,M.Vairamuthu,and M.Orlowska," On optimal route of a calibrating mobile sink in a wireless sensornetwork,"*inProc.4thInt.Conf.Netw.Sens.Syst.*,Braunschweig,Germany,Jun.2007,pp.61-64.

[12] X.Li.A.Nayak, and I.Stojmennovic,*Sink Mobility in Wireless sensor Networks.*Hoboken,NJ,USA:Wiley,2010,pp.153-184.

[13] G.Xing,T.Wang,W.Jia, and M.Li,"Rendezvous design algorithms for wireless sensor networks with a mobile base station,"in *Proc.9th ACM Int.Symp.Mobile ad hoc Netw.Comput.*,Hong Kong, China,May 2008,pp.231-240.

[14] X.Wu,G.Chen,and S.Das,"Avoiding energy holes in wireless sensor networks with nonuniform node distribution,"*IEEE Trans.Parallel Distrib.Syst.*,vol. 19,no.5,pp.710-720,May 2008.

[15] J.Lian, K.Naik, and G.B. Agnew, "Data capacity improvement of wireless sensor networks using non-uniform sensor distribution,"*Int. J.Distrib.Sens.Netw.*,vol. 2,no. 2,pp.121-145,Apr-Jun.2006.