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Multiple Mobile Sink Path Selection Using Weighted Rendezvous Planning in Wireless Sensor Network

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Abstract— The energy efficiency is the main issue in wireless sensor networks (WSNs), due to the limited battery capacity of the sensor nodes. Due to data traffic, the battery of the nodes near the sink is exhaust faster than the other nodes. To reduce this problem mobile sinks are introduced. Across the network, it provides equal energy consumption and loads balanced data delivery. The Packet delays and energy consumption are used to market the position of the mobile sink in the network. To handle this problem this paper proposed a multiple mobile sink routing protocol also known as Ring Routing. Ring Routing is a hierarchical routing protocol based on a virtual ring structure which is designed to be easily accessible and easily reconfigurable. The main objective of this paper is path selection for WSN using the mobile sink protocol further the travelling Sales Man Problem (TSP) with weighted rendezvous planning (WRP) algorithm is used to reduce the energy consumption through data transfer. The performance of the TSPWRP is compared with well known Floyd to analyze time complexity. From the experimental result, it is shown that TSPWRP reduces the energy consumption than Floyd and it provides high network lifetime**.**

Keywords— Mobile sinks, distributed routing, data dissemination, energy efficiency, mobility, wireless sensor networks Mobile sinks, distributed routing, data dissemination, energy efficiency, mobility, wireless sensor networks.

1.INTRODUCTION

A WSN of spatially distributed autonomous sensor is used to monitor physical or environmental conditions such as temperature, sound, pressure etc and to cooperatively pass their data through the network to the main location. The more modern networks are bidirectional and also enabling control of sensor activity. The development of WSN is motivated by military applications like battlefield surveillance. Recently WSN is used in many industrial and consumer applications such as industrial process monitoring and control health monitoring and so on. Regarding real-time applications, energy efficiency is considered to be crucial issue because of battery capacity is limited in the sensor nodes. Due to the joint nature of traditional WSN packet forwarding approaches resulting in the concentration of data traffic towards the sinks, the surrounding area of the static sink are more likely to deplete their batteries before other node, leading to the energy hole problem, disruptions in the topology and reduction in the sensing coverage[1]. Moreover, this problem could lead to the isolation of the sinks, hindering the delivery of the sensor data traffic [2]. To overcome this problem the researchers were introduced the mobile sink. The Mobile sink is used to control the sink mobility and guide to give priority that the area with less residual energy [3][4]. This paper is proposed for Multiple Mobile sinks to manage the energy efficiency. The sensor nodes collect the information from the environment and communicate with each other through wireless transceivers. The data collected by these sensor nodes will be delivered to multiple sinks. Multiple sinks in TSPWRP is used to reduce the energy and time consuming. In this algorithm, the sensor node is assigned a weight corresponding to the size of data forward to the sink. The energy consumption and formation of energy holes are reduced by the hybrid moving pattern. The work available in the Literature proved that the hierarchical approach to finding the shortest path based on Floyd-Warshall's algorithm was efficient and provides better performance [5]. Hence in this work, the TSWRP is compared with Floyd-Warshall's algorithm.

2. LITERATURE REVIEW

The nodes nearer to the sink carry heavier traffic loads. Furthermore, they also tend to consume more energy as they are responsible for receiving and forwarding data from the whole network. It leads to a non-uniform energy consumption among nodes that is the energy hole Problem [6].To overcome this problem the researchers were introduced mobile sink, used to balance the load f the sink by shifting the hotspot around the sink and spreading the increased energy drainage around the sink which helps to achieve uniform energy consumption that extends the network lifetime [7]. Existing methods of using a mobile sink in WSN is Rendezvous Point (RP), where a mobile sink only visit nodes designated as RPs. The aim of RP is to find a subset of RPs that maximize energy consumption while adhering to the delay bound provided by an application [8].RP uses a Travelling Salesman Problem(TSP) solve to calculate the tour length[9].TSP is used to find the shortest tour that visits all sensor nodes. Floyd algorithm is used to execute short computational times with additional storage space consumption [10].

3.PROPOSED METHOD

The by step procedure of the proposed system is shown in Figure 1. It involves the nodes creation, system model generation, distance finding, hop count, data transmission, NFD calculation, weighted Rendezvous calculation, and Initial RP calculation.

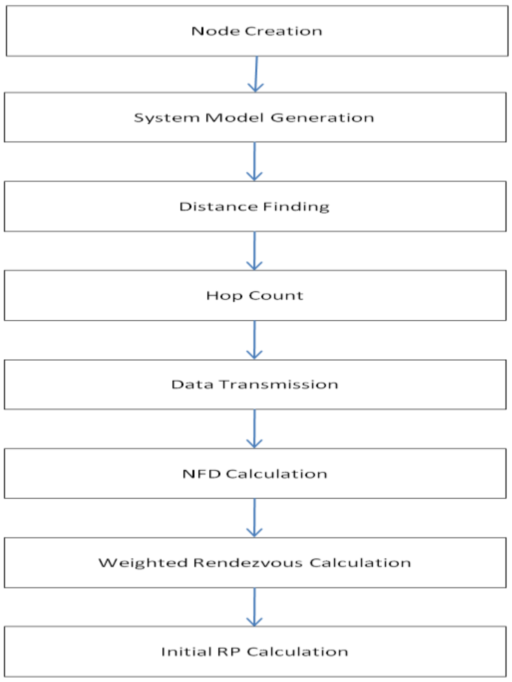

Figure 1. Overall Block Diagram of Proposed Methods

3.1 Node Creation

A WSN can be defined as a network of devices, denoted as nodes, which can sense the environment and communicate the information gathered from the monitored field.

3.2 System Model Generation:

3.2.1 Node Behaviors

Some of the modeling techniques are used to form the component based modeling to represent a sensor node. The WSN behavior is modeled by specifying the component's internal behavior, component to component interactions and the communication channel's characteristics.

3.2.2 Modeling Sensors and Hardware

To create a platform independent model some of the modeling techniques are surveyed. However, even in a platform independent model, there is a necessity to include some of the hardware details. One of the reasons for including the hardware details is that the software in the nodes of a WSN is tightly coupled to the hardware elements of the node. Therefore the binding of software and hardware components should be represented in the model.

3.2.3 Network Behavior

Modeling network behavior in a WSN is crucial because many important performance values are based on the network, like the trade-off between packet loss and power. Due to the fact that the node has limited power resources, it is common to use a power management algorithm that controls the wake-up state of a node from active to sleeping and vice versa.

3.2.4 Topology Modeling

The topology of WSN systems can be dynamic or static. The static topology represents the nodes in a fixed location while the dynamic topology represents the nodes while they are in a moving state.

3.2.5 Code Generation

Code generation is the process of generating source code from a model or another source code representation.

3.3 Distance Finding and Hop Count:

The node, which needs to learn their position, can find the shortest links connecting to at least three reference nodes through one hop or multi-hops. Based on these two assumptions, the nodes, by finding the shortest path to the reference nodes, can roughly estimate the distance to the reference nodes based on the hop count. To reach the data sink the multiple relay pack is used. The energy consumption on the path does not require network lifetime. To avoid this problem in multi-hop routing the proposed less hop count transmission is used.

3.4 Data Transmission:

Any node that receives the DATA packet performs the following actions. (i)If a receiver node receives the duplicate data, then it drops the data packet.

(ii)If the receiver node is a gateway node, then it forwards the data packet to the sink; otherwise, it forwards the DATA packet to its next node. (iii)It adds the sender and data sequence number to the list.

3.5 NFD Calculation:

Each sensor node produces one data packet with the length of it's in time interval.

3.6 Weighted Rendezvous Calculation:

The weight 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 weight of sensor node i is calculated as

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

The energy consumption is proportional to the hop count between source and destination nodes, and the number of forwarded data packets.
The highest weighted node will reduce the number of multi-hop transmissions and thereby minimizes the energy consumption.

WRP Algorithm:

1. WRP works. It takes as input G(V,E), and it outputs a set of RPs.
2. WRP first adds the fixed sink node as the first .Then; it adds the highest weighted sensor node.
3. After that, WRP calls TSP (·) to calculate the cost of the tour.
4. If the tour length is less than the required length the selected node remains as an RP.
5. Otherwise, it is removed from the tour.
6. 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

3.7 Initial RP Calculation:

If the energy level is low the mobile sink node will be dead. At this time choose the new mobile sink and process. This is the recycling process. Hence this work proposes multiple mobile sink.

4.SIMULATION ANALYSIS

4.1 Simulation Setup

To analyse the performance of the proposed system simulation experiments are implemented in Network Simulator (NS2). The parameters used in the simulation setup are listed in Table (1).

Table 1: Parameters used in Simulation Setup

No of Nodes	13
Target Size	[700,700] m x [700,700] m
Simulation Duration	30 seconds
Queue Limit	20 packets
Packet Size (Maximum)	512 Bytes
Packet Interval	0.1 seconds
Communication Range	30 m
Energy: Transmission	19mA
Energy: Reception	7mA
Energy: Idle	10_A
Energy: Sleep	1_A
Battery Capacity	1000 mJ
Mobile Sink Speed	50 km/h

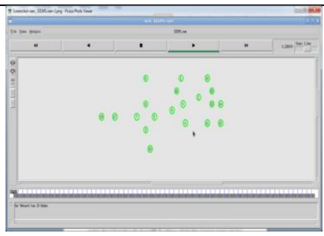

Figure 2

Figure 3

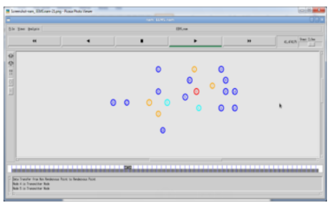

Figure 4

Figure [2][3][4] shows the node creation, NFD calculation and RP calculation respectively in the targeted field.

4.2 Performance Analysis

To analysis, the performance of TSPWRP and Floyd algorithm two important metrics are used. They are the Network lifetime and Average Energy Consumption.

Network Lifetime*:*

Network lifetime is represented by the number of rounds where each round begins with a set-up phase when the clusters are organized, followed by a steady-state phase when the data transfers to the base station. The network lifetime of the Floyd algorithm available in the literature [10] is compared with TSPWRP.

Table 2: Network Lifetime comparison of Floyd & TSWRP Algorithm

Sink Speed(km/h)	Floyd(min)	TSPWRP(min)
0	100	100
3	320	330
6	320	332
9	322	334
12	322	334

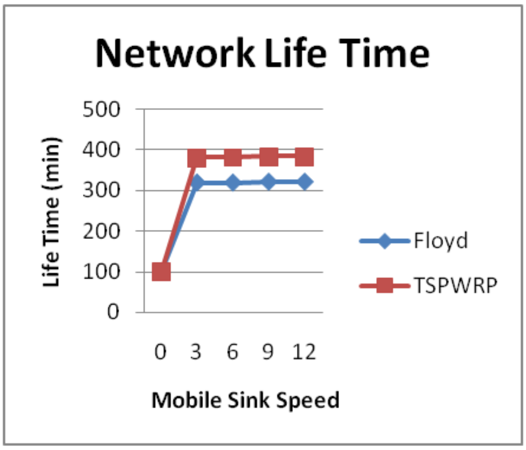

Figure 5 – Graphical representation - Network Lifetime comparison of Floyd & TSWRP Algorithm

From Table (2) and Figure (5) it is seen that if the sink speed increases the network lifetime also increases.

Energy Consumption

Energy consumption is the consumption of energy or power. Table 3 represents the energy consumption and figure 6 represents the same.

Table 3: Average Energy Consumption

Sink Speed(km)	Floyd(J)	TSPWRP(J)
0	470	420
3	395	330
6	410	330
9	440	335
12	470	333

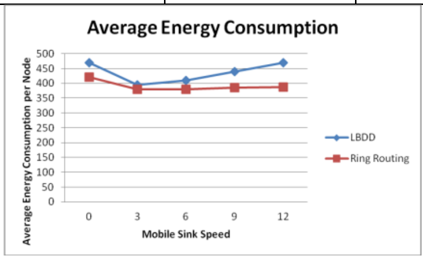

Figure 6- Graphical representation – Average Energy Consumption

From Table (2) and Figure (6) it is seen that if the sink speed increases the energy consumption decreases.

5.CONCLUSION

Many Researchers have demonstrated that the mobile sink is used to reduce the consumption of energy in nodes and to reduce the formation of energy holes in WSN. This paper uses multiple mobile sink and TSPWRP to reduce the consumption of energy and increase the network lifetime against Floyd algorithm. To extend the number of nodes, target area and packet size in the simulation setup and to test for efficiency of the WSN is the next step to be carried out.

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