

Improved Data Collection in Wireless Sensor Networks

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Abstract— In the wireless sensor networks the energy of the nodes present in the network is limited. Due to the low manufacturing costs of sensor nodes, they can be deployed in large numbers and having more challenges in topology, routing and data management protocols. Challenges are complicated by severe energy constraints and the inherently unreliable nature of wireless communications. Main objective is to increase the tolerance level and decrease the complexity of the wireless sensor networks. We discuss about fast data collection process with reduced interference and increased the lifetime of the network. We use a heterogeneous configured network (nodes with different coverage range and energy levels), depending on the conditions relay nodes are get selected randomly and data is collected and sends to the mobile sink node.

Index Terms— Mobile Sink, Range based location, Coverage range, Relay nodes formation, and Beacon Communication range.

1. Introduction

Wireless Sensor Networks have been used for many applications such as military, home, industries etc. This paper proposes a mechanism that allows identifying the relay node and transfers data to the mobile sink. The mobile sink is used for data collection whenever any event of interest occurs. It travels in a selected way with dynamic speed. During its travel, it broadcasts its location information to all relay nodes within the sensor field. A relay node can compute the location of sensor nodes and gathers the information from the sensor node and transfers the gathered information to the mobile sink.

2. Related Work

Recent research work has proved the applicability of mobile elements (submarines, cars, mobile robots, etc.) for the retrieval of sensor data from the nodes. In the past, many works have been proposed using the mobility of the sink for collecting the data. The sink mobility had classified into mobile base station, data collector and the Rendezvous based taking into account the movement pattern of mobile sinks and in this manner the data get collected [3]. The benefits of using heterogeneous sensor networks, containing devices with different capabilities, have been presented recently in literature. In [10], it is proved that properly deployed heterogeneity can triple the average delivery rate and provide an increase in the network lifetime. In [1], the time scheduling on a single frequency channel with the aim of minimizing the number of time slots to complete a converge-cast. Then combine scheduling with transmission power control to mitigate the effects of interference and shows when power control helps in reducing the schedule length under a single frequency. In [4] comparing the energy usage of multi-hop and single-hop transmissions in small-scale sensor networks experiencing high path loss and shown that in single-hop transmission the nodes present far away from the sink perform much worse compared to the multi-hop case.

However, the closest nodes from the sink become hotspots when the multi-hop transmission is used, because of relaying all other nodes traffic.

Therefore they propose to use some nodes for just relaying the other nodes traffic without any sensing and the other technique is cooperation. In [2] proposed a novel data collection method called as maximum amount shortest path, which increases the network throughput as well as conserves energy by optimizing the assignment of sensor nodes. Maximum amount shortest path is formulated as an integer linear programming problem solved with the help of genetic algorithm. A two-tier communication protocol based on the zone partition is designed to implement the maximum amount shortest path scheme. They developed a practically distributed approximate algorithm to solve the maximum amount shortest path problem. In mobile data collector, many mobile data collectors are used to collect the sensed data from fixed sensors. According to sink mobility pattern, we can classify it into random, predictable and controlled mobility. In [9] random mobility, mobile data collectors move in a random path inside the sensor field and implement the technique for collecting data from fixed sensors. But random mobility does not guarantee the collection of data from all sensors nodes and need a high delay for the data delivery.

In predictable mobility, the mobile data collector moves in a predefined or a fixed path for improving the network performance. In this case, all the sensor nodes should know the movement of data collectors in order to predict the forwarding time, helping to improve overall network performance. In controlled mobility, the mobility of data collectors is controlled. In [5] comparison with a multi-hop network it transfers to a centralized sink node. A mobile sink moves through the network deployed region and collects the data from static sensors over a single hop radio link when approaching within the radio range of the sensor node or with limited hop transfers if the sensor nodes are located far away. This avoids a long-hop relaying technology and reduces the energy consumption

at sensor nodes near the base station prolonging the network lifetime. In [6] proposed, density-based proactive techniques that do not impose any restrictions on mobility of the sink. Their approach combines a probabilistic flooding and storing scheme for collecting the data.

In [8] it explores recent data dissemination protocols using mobile sinks and analyzes the mobility impact on energy consumption and network lifetime. In [7] proposed an approach in which mobile sinks can change their location when the energy of sensor nodes near to mobile sinks is depleted. The new location of mobile sink follows the path with the maximum energy of sensors for improving network lifetime.

3. Proposed Work

In the proposed protocol, Mobile Sinks are mounted upon the aircraft circulating within fixed environments on fixed trajectories and periodic schedule. Namely, mobile sinks are not controllable and their routes do not adapt upon specific WSN deployments. But our assumption is that mobile sinks are placed in the aircraft. Some number of nodes is enrolled as Relay Nodes. Those relay nodes get the beacon message from the mobile sink and transfer the data to the mobile sink whose data are collected from the sensor nodes as shown in fig1. There is a presence of three conditions in using the relay nodes

1. If a small number of relay nodes used which results in their rapid energy depletion
2. If a large number of relay nodes used which results in reduced data throughput.
3. The most common assumption in sensor network literature is that nodes, which are closer than a certain transmission range R can always communicate with the mobile sink node directly.

There are two types of data collection they are aggregated data and the raw data collection. In the aggregated collection data are sent to the local sink or relay node and then those data's are get transmitted to the sink node. In the raw data collection method data are directly transferred to the main sink node without transferring to the local sink node by this the node energy can be consumed.

By using a shortest path algorithm the node, which is far away from relay node gets communicated. The nodes present very near to sink node get communicated directly. The relay node is changed at particular time intervals with some conditions (the sensor node which contains energy) and thus the lifetime of the network is increased. Range of sensor node is greater than 0. Range of relay node should be lesser than the range of sensor node. By using the sink mobility the data is collected very fast by reducing the time delay between the inter relay node communication. There is also a presence of loop free routing, which reduces the congestion in the network.

Proposed Algorithm:

Relay Node to Mobile Sink Communication

1. Initialize beacon count value $bc=0$, $t_{first}, t_{last}=0$
2. Wait until beacon message is received
3. If beacon bc is received
4. Enter the time t_i to the relay node
5. Note the $t_{first}=t_1$ and $t_{last}=t_2$ and $bc=1$ and
6. Start the connection timer ct
7. When the connection timer not expired, relay node R_n transmitting data to the mobile sink

And

8. Wait until the connection timer becomes $ct=0$ Else
9. Reset the beacon counter $bc=0$ and wait for the new beacon message

Sensor Nodes to Relay Node Communication

Begin

10. Node with high coverage area c_{rt} battery power b_p and high coverage range c_{rt} is selected as relay node
11. Calculate the distance between all the nodes with respect to relay nodes position

12. Route the data from sensor node to the relay node via the calculated shortest path Using the dijkstra Euclidian method
 13. Calculate the energy dissipation as $\text{Energy dissipation} = \text{transmission power} + \text{data flow rate}$
 14. $E_i = \text{residual energy} - \text{energy dissipated}$
 15. If $E_i = 40$ then that node acts as a sensor node Else
 16. Elect the new node as relay node with the same conditions as mentioned in step 11
- End

End

3.1 Phase 1: Relay Node Formation

All the sensor nodes are deployed in a randomly manner on the basis of heterogeneous configured network in the given geographic area. All the nodes identify its neighbor node by using the Euclidian distance. Relay Nodes guarantee connectivity of sensor groups with the mobile sink. The selection of relay node largely determines network lifetime. Relay nodes lie within the range of moving sink and also about the sensor node groups. There is a presence of two conditions in using the relay nodes .If a small number of relay nodes used which results in their rapid energy depletion. If a large number of relay nodes used which results in reduced data throughput.

3.2 Phase 2: Data Collection

Relay nodes are selected based on two parameters coverage range and the battery power bp. Based on the relay node position distance between the sensor node get calculated. Then the data are transmitted through the routed path. If the energy of relay node get lowered there is a presence of re-election to find another relay node is identified and data get transferred to the sink node.

Note that all the relay nodes present in the geographic area are not communicated with the sink node at same time. Only the node, which receives the beacon message from the mobile sink gets communicated. All the data are collected from the sensor node by means of shortest path and then data is transmitted to the mobile sink. If the mobile sink wants to move from that place it sends another beacon message that it moving from the place. Then the relay node stops sending the data to the sink node.

4. Implementation & Simulation

4.1 Simulation Settings

We use a region of 10 sensor nodes scattered randomly. Java wireless toolkit is used to implement the simulation. Here we introduce the relay nodes, which are having higher energy level and higher coverage range comparing with other sensor nodes, so there is a presence of heterogeneous configured network.

Specifically, we have the following settings:

Let 15% to 20% of the nodes are relay nodes, which consist of higher energy and coverage range. We separated the sensor nodes deployed region into four main regions, from those regions relay node is elected and by obtaining the shortest path other sensor node transmit those data to the relay node dynamically and from the relay node data get transmitted to static sink.

At first we did our work with a static sink communication. In that we calculated the energy consumption in 10 to 300 seconds with 150 node in the region. At time 20 the overall energy is 89% and reduces to 48% at the end of simulation. Figure 2 shows the energy consumption graph. This shows that the overall energy consumption is low and network lifetime is increased

We configured with mobile sink and compare the result by varying the speed of mobile sink into 2m/s to 10m/s and measure the average delay, packet delivery ratio and varying energy in respect to speed. Figure 3 shows the packet delivery ratio and Figure 4 shows the average delay with respect to speed of mobile sink, which receive packets.

We consider the sink node mobility to analyze the energy consumption. We varied the speed levels of the sink node and plotted a graph based on the speed energy level get decreased. But when comparing to static sink the energy of mobile sink is increased by 15%. Next we consider the same sink node mobility and analyzed the packet delivery ratio with respect to time were static sink has the average delivery of 87.5% were as mobile sink has 95.5% of delivery. Then average delay has been reduced gradually with the increase in speed of sink node.

5. Conclusion

This paper introduced mobile sink to retrieve information from the restricted and rural parts of wireless sensor networks. Mobile sink mainly aims to maximize the data throughput and balancing the energy present among the sensor nodes. Energy balancing is

achieved by using the relay nodes (based on energy another relay node is identified), which lies in the range of passing mobile sink, which is used to catch and deliver the sensory data delivered from source nodes. Data throughput is increased, by regulating the number of relay nodes, for allowing sufficient time, by sending the beacon messages, which prevents from data losses. When the node senses the data it obtains the shortest path and transmits data to relay node. Thus proposed algorithms can maintain balanced energy consumption among nodes in a sensor network and thus prolong the network lifetime and reduces the interference.

6. References

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Used Symbols Explanation

| | |
|-----|------------------|
| bc | Beacon Count |
| Rn | Relay Node |
| Ct | Connection Time |
| bp | Battery Power |
| Ei | Available Energy |
| crt | Coverage Range |