ISSN:0975-9646

Dhivya.M et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (2) , 2015, 1015-1018

Sink Mobility for Data Collection in Wireless Sensor Network Life Cycle

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Abstract- A wireless sensor network is a great number of nodes which are micro sensors able to collect and to transmit data in an autonomous way. The wireless sensor networks (WSNs) used in various fields: environmental monitoring, health, protection of the borders, industry, military applications, natural safety, transport, disasters etc. In recent studies undertaken, the sensor nodes are regarded as stationary. This mobility relates to either a sensor node, or an actuator in the case of the networks of sensors/actuators, or the point of collection called Sink. We were interested in the mobility of the sink in the wireless sensor networks for monitoring applications with an aim of data collection in an intelligent and reliable way, and especially of ensuring the safety and the network lifetime. Controlled sink node mobility present a set of algorithms for deciding where and when to move a sink node to improve network lifetime. Moreover, a load-balanced topology construction algorithm is used as another component of our solution. We did extensive simulation experiments to evaluate the performance of the components of our mobility scheme and to compare our solution with static case and random movement strategy.

INTRODUCTION

The emergence of tiny sensor nodes as a result of advances in micro electromechanical systems has enabled wireless sensor networks (WSNs). A typical sensor node has generally an irreplaceable limited-capacity battery. Since replacing the batteries is very hard or impractical, the total energy should be efficiently used for the particular system. Several approaches are used to minimize the energy consumption and improve network lifeline in WSN like, minizing the number of messages travelling in the network and using only necessary set of nodes for sensing and communication

Recent technological advances in the field of the wireless communications allowed the development of low costs tiny systems micro-electro mechanics (MEMS), called sensors, able to detect measure and bring back physical data related to their environment for monitoring. WSNs aims to collect sensor readings from sensory fields at predefined sinks (without aggregating at intermediate nodes) for analysis and processing. Most routing solutions for WSNs use static sinks to collect data from the entire network. sink mobility has been exploited to reduce and balance energy expenditure among sensors. Sensors that are generating data are called sources. They transmit their data to one or more sinks for analysis and processing .Sink node collects the incoming data from sensor nodes and when data aggregation is not used, each sensor node transmits its own packet to the sink, and also relays the packets of its children. Since most of the time a tree topology rooted at the sink is used to collect data, all packets are delivered to the sink node via its first-hop neighbours. The main motivation behind sink mobility is to change these neighbouring nodes periodically by moving the sink to different locations. A node that was a neighbour of the sink in a round and therefore had a large packet load should have a smaller packet load in the next round. In this way, on the average all nodes would have a nearly equal cumulative packet load and remaining energy levels at an arbitrary time.

LITERATURE REVIEW

In this paper, we propose a set of algorithms for different aspects of the sink mobility problem in wireless sensor networks. We propose two sink-site determination algorithms. Additionally, we present an energy-efficient topology construction algorithm for improving the network lifetime. These issues have not been addressed together in most of the previous studies. Here only one mobile sink that moves through a straight line while data are collected from the sensor nodes. So it reduces the number of packet hops that has to travel in order to reach the sink. Each sensor node will start transmitting data to the mobile sink when an event matches the sink's interest. It uses acknowledgments to ensure packet successfully received, and a sensor node will transmit other packets only after it has received an acknowledgment message from the sink.

THE WIRELESS SENSORS NETWORKS (WSNS)

Wireless Sensor networks are categorized in to

- layered architecture
- cluster architecture and
- Sensor nodes with mobile sink node architecture.

To understand Wireless sensor network first understand basic architecture of sensor network that consist of Sink Node are data collector all sensor nodes send data to the sink node. Sensor nodes are source information, they may also forward message in network. Cluster head receives data send by sensor node.

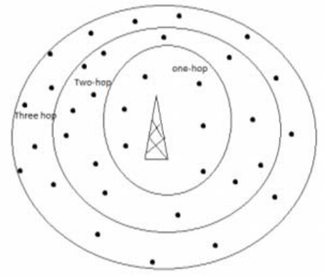

Figure 1. Layered Architecture of wireless sensor network

Sink sites are determined to answer the question of where to move the base station during network operation. Sink-site determination is mostly done by assigning a set of predefined points to the area Figure 2 shows the Cluster Architecture of wireless sensor network .

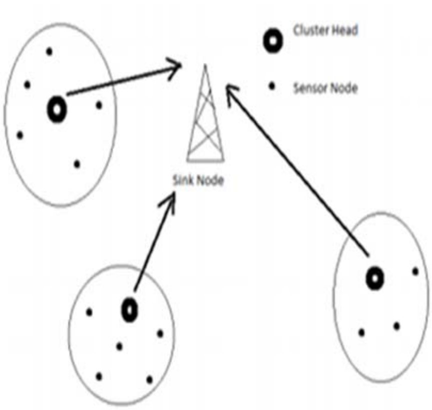

Figure.2 Cluster Architecture of wireless sensor network .

THE PROBLEM IN WSN

The main issue is the energy intake, which is affected by the communication between nodes. The transmission of one bit is equivalent 1000 instructions. When number of sensor increases, power emission also increases consequently it will consume energy and reduce its lifetime. Therefore moving the sink leads to the following problems:

- The problem of mobile element.
- The problem of data transfer
- The problem of timing
- The problem of radio range.

SINK MOBILITY IN WIRELESS SENSOR NETWORKS

The sink mobility is used to reduce and balance the consumption in energy. The mobility can be controllable or uncontrollable by two cases:1.This is attaching a sink node on a certain mobile entity which already exists in the deployment environment and is out of control of the network 2. This is achieved by adding a mobile into the network to carry the sink node.

1.SINK MOBILITY EXPERIMENTS

A sink should move towards data sources in order to shorten the way length and thus to reduce and balance the energy consumption. During the transfer, the sink can continue to receive data. It will bring the additional expenditure to the nodes in its visited sectors. The sink mobility facilitates the routing of the data, ensures connectivity and connectedness. The optimization of sink displacements makes it possible to save energy. Ensures a good cover of the zones to be supervised. It avoids the loss of information.

In this section, the movement patterns is introduced. As the first step of our overall scheme, we choose one of the sink-site determination algorithm either coordinate-based determination or neighbourhood-based determination algorithm. Coordinate based sink-site determines the possibilities to group the nodes using their coordinate values and Neighbourhood information of nodes can be used for determining candidate sink positions.

For the second step, the max-min approach, the visit-added max-min approach, or the random movement approach is chosen as a strategy when moving through migration points. In RM, when the sojourn time expires, the base station moves to the coordinate of a random sink site in the area. The static sink (STS) is used as a fourth approach. As its name implies, in this case, the sink does not move between points in the area but is placed at the center of the area, which is the point that maximizes the network lifetime. In all approaches, if one of the neighbours of the sink loses one or more levels of energy (out of 20 levels, 5% of its whole energy), then the sink decides to move to another point (its sojourn time expires).the sojourn time expires when the energy change of any node becomes greater than 1/L of its initial energy.

In the experiment, the minimum time the base station must stay at its current site. After this time expires, the sink controls whether one energy level change (among values) has occurred or not. If this is so, the sink decides to move; otherwise it remains where it is until the next decision time arrives. With a value, it is possible to observe the effect of the sink mobility trend in the network. For small values of , the sink becomes highly mobile, whereas for larger values of it tends to stay longer on a site, thus demonstrating a low mobility pattern. Figure 5 shows the results of different approaches under values between 50 and 250 simulation seconds. 400 nodes are randomly deployed to an area of m and value of 30 m. VMM performs better than all other approaches. Network lifetime values of VMM increase up to a point (for , in this case) and then start to decrease again. If sink changes its location too frequently this will cause higher topology construction cost. If it stays too long, then it will not utilize the benefits (even load distribution of sink's neighbour's) of mobility (lifetime will decrease). That is why we see first an increase following a decrease in the results.

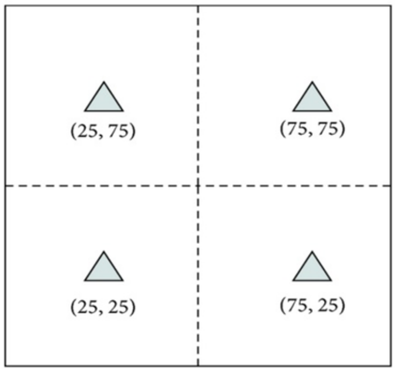

Figure.3 Different sink selection approaches.

static sink has the lowest latency (since it is placed in the center of the area which is optimal and stays there at the end of the network lifetime) and random movement follows it tends to move the sink to the center of the area mostly. VMM has lower latency than MM, and this can be seen as an achievement, since latency is decreasing while the network lifetime is increasing at the same time. RM has lower latency than VMM, since VMM uses more intelligent approach and higher network lifetime. However, when time goes to infinity, on the average, RM visits each site for equal number of times and this balances number of hop counts to the sink.

2.DIFFERENT NETWORK TOPOLOGY CONSTRUCTION MECHANISMS EXPERIMENTS

Two different topology construction algorithms are compared in terms of network lifetime and data latency. The first one uses a simple broadcast mechanism and the second uses the load-balanced approach .

Although the load-balanced algorithm achieves a nearly two times bigger network lifetime in some cases, it only has a 2.6% bigger average hop count value at most (this is intuitive because the load-balanced topology algorithm aims to distribute the load as uniformly as possible instead of using the shortest paths). That means the balanced tree topology construction approach significantly improves the network lifetime and causes only very low extra data latency overhead when doing that. After examining different parts of the scheme, it would be reasonable here to see the overall performance of the proposed algorithms together. In this experiment, we compare two different mobility schemes with different properties. The first one uses the coordinate-based sink-site determination algorithm, VMM, and the balanced tree-based construction algorithm for topology generation. The second method uses the grid-based sink-site determination algorithm, RM, and the simple broadcast mechanism for topology construction, the network lifetime difference between these two approaches increases when the number of nodes increases. The VMM approach performs up to 3.5 times better than the random movement case, even though RM is also a mobility scheme. This brings an important improvement to the network lifetime when using different components of the scheme together.

ENERGY DISSIPATION IN WIRELESS SENSORS NETWORKS

Indeed, the sensors consume their energy in two cases: when they communicate between them and when they process data locally. 1. To limit communication times is a solution to reduce the energy consumption. 2. The researchers identified four reasons of energy wasting: - First, the collision is the case where two nodes transmit data frame at the same time only to one recipient that generates a collision on the receiver. This collision implies a retransmission data frame and increases the energy consumption. - The second reason is passive listening (overhearing), where the nodes listen to the data frame which are not intended to them. Since the medium is a common environment, when a transmitter transmits its data frame, all the nodes which are around it are obliged to listen to this transmission. This passive listening is necessary to determine the moment when the medium of transmission is released in order to transmit the data frame. The wireless channel is a transmission medium disturbed and there are very often transmission errors. Then, the use of control package is an effective method to control the errors frames. However, when they do not contain any data and they consume, it is an energy wasting. - Lastly, the last reason is inactive listening. Indeed, it is time when a node listens to the medium to await a possible transmission towards him. When a node cannot know the moment when the others send the data frame to it, it must always start its transceiver. So if there is no transmission towards him, this node consumes energy for nothing. The sensor networks have a very low level of traffic. Either the sensors send the data periodically, or they send the data when there is an event. Most of the time, the nodes are in an inactive listening and this is a source of more important energy wasting. In a network model, the MAC layer decides on the operating process of the transceiver. Therefore, this layer must manage the transceiver to reduce the inactive listening time of the sensors in order to reduce the consumption energy and to prolong the lifetime of the sensors network.

CONCLUSION

Wireless sensor networks plays an important role in a variety of applications that require fast response such as battlefield and hostile environment surveillance, emergency preparedness, etc. However, most solutions are focused in static sensor nodes and sinks. Most techniques that employ mobiles sinks deal with the problem of collecting data in non-delay-sensitive scenarios. In this paper, we have considered the problem of deploying mobile data collectors in order to alleviate the high traffic load and resulting bottleneck in a sink's vicinity caused by static approaches and all this to minimize the energy consumption. In this paper we investigate the controlled sink mobility problem to improve lifetime of wireless sensor networks. We deal with different components of the sink mobility problem. First, we propose two efficient sink-site determination algorithms, using neighbourhood relationships and coordinates of nodes as inputs. we also determine sojourn times using a dynamic approach. We define it as the time that passes until the first node exhaust its energy. There are other definitions that can be used and tested, such as the time until the percentage of messages received drops below a threshold.

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