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A Survey on Maximization the Lifetime of Wireless sensor network by minimizing Energy hole problem

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Abstract: In wireless sensor network (WSN), there is a problem of energy hole, which means nodes near the sink region will die sooner because these nodes send their own data to sink as well as forward data for other nodes. After energy hole comes, data cannot be transmitted to sink even though energy is still remained in outer region nodes which affects the lifetime of the networks. In this paper I briefly present the survey to overcome the problem of energy hole so that the lifetime of wireless sensor network will be improved.

Keywords: Wireless Sensor, lifetime, energy, Hole Problem

I. INTRODUCTION

Wireless Sensor Network (WSN) consist of small nodes with sensing, computation, and wireless communications capabilities [1]. A Wireless Sensor Network (WSN) contains hundreds or thousands of sensor nodes. These sensors have the ability to communicate either among each other or directly to an external base-station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Figure 1 shows the schematic diagram of sensor node components. Basically, each sensor node comprises sensing, processing, transmission, mobilizer, position Finding system, and power units (some of these components are optional like the mobilizer). The same Figure shows the communication architecture of a WSN. Sensor nodes are usually scattered in a sensor Field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources. Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s) [2]. A base station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data.

APPLICATION AREAS OF WIRELESS SENSOR NETWORK:

A general categorization of WSNs applications may include *military applications*, *environmental applications*, *health applications* and *other commercial applications [2]*.

Military Applications:

Dense deployment of disposable and low-cost sensor nodes makes WSNs concept beneficial for battle fields. Some military applications of WSNs are:

- Monitoring friendly forces, equipment and ammunition.
- Battlefield surveillance
- Exploration of opposing forces and terrain
- Targeting
- Battle damage assessment
- Nuclear, biological and chemical attack detection

Environmental Applications:

Although there are some other techniques to monitor environmental conditions, random distribution and self organization of WSNs make them suitable for environmental monitoring. Some applications include:

- Bio complexity mapping of environment
- Detection of natural disasters, such as fire, flood and earthquake detection
- Precision agriculture
- Habitat monitoring
- Pollution detection
- Planetary exploration

Health Applications:

Tiny sizes and light-weight structure of WSN nodes provides much functionality in health applications, including:

- Tele monitoring of human physiological data
- Tracking and monitoring doctors and patients
- Drug administration

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Other Commercial Applications:

In addition to all of above, there are many commercial applications of WSN including

- Home automation for smart home environments
- Interactive museums
- Environmental control in buildings
- Detecting and monitoring burglary/ thieving
- Vehicle tracking and detection
- Managing inventory control

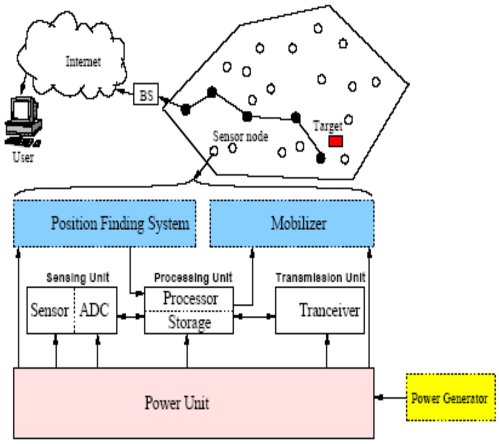

Figure 1: The components of a sensor node

LIFETIME OF WIRELESS SENSOR NETWORK

Wireless sensor networks consist of large number of sensor nodes randomly distributed in some regions. Basically nodes are driven by batteries and in many applications it is not easy to replace the batteries or sometimes not even recharge the batteries so each node has a limited energy supply. Lifetime is very important factor in WSN.Lifetime of a sensor network has different definitions: It may be defined as the time till the first node dies.Although the time until the first node fails is an important measure from the complete network coverage point of view, this performance metric alone cannot measure the lifetime performance behavior for all nodes in the network. Loss of a single node will only affect the coverage of one particular area and will not affect the monitoring capabilities of the remaining nodes in the network. Information collected at the remaining nodes can still be delivered successfully to the base-station. So lifetime may also be defined as the time till a proportion of nodes die. If the proportion of dead nodes exceeds a certain threshold, it may result in uncovered sub regions, and/or network partitioning. The location of the failure nodes is also of importance. If the proportions of nodes that have run out of battery are located in some critical part of the network, e.g., connecting the central sink and the rest of the network, it may result in early dysfunction of the entire network. Our discussion will be taken in the spirit of the second definition. Now we come to and important point related to lifetime which is energy hole problem. Sensor nodes sitting around the sink need to relay more traffic compared to other nodes in outer sub-regions, nodes in inner regions suffer much faster energy consumption rates and thus have much shorter expected lifetime. This phenomenon of uneven energy consumption rates is termed as energy hole problem, which may result early dysfunction of the entire network, even if the other parts of the network still have a lot of energy.

II. SURVEY ON MAXIMIZATION THE LIFETIME OF WIRELESS SENSOR NETWORK BY MINIMIZING ENERGY HOLE PROBLEM

Energy hole problem proved by Olariu and Stojmenovic [3]. They have done an experiment under the uniformly distributed network. They have divided the experiment area into concentric coronas from the sink. And Simulation results show that, when the first corona consumed all the energy, the energy expended by a sensor in the 10-th corona is only about 4.197%. It proved that an uneven energy consumption rate is unavoidable if all nodes are homogeneous and uniformly deployed in the network.

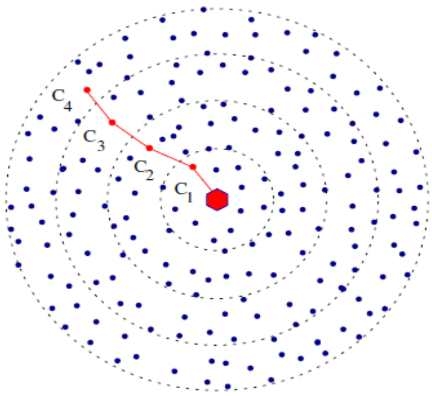

Figure 2: Concentric Coronas with homogenous distribution

Li and Mohapatra [4] investigate the problem of uneven energy consumption in a large class of many-to-one sensor networks. The authors describe the energy hole in a ring model (like corona model), and present the definitions of the per node traffic load and the per node energy consuming rate (ECR). Based on the observation that sensor nodes sitting around the sink need to relay more traffic compared to other nodes in outer sub-regions, their analysis verifies that nodes in inner rings suffer much faster energy consumption rates and thus have much shorter lifetime. The authors term this phenomenon of uneven energy consumption rates as the energy hole problem, which may result in serious consequences, e.g. early dysfunction of the entire network. Shiue [9] propose an algorithm to resolve energy hole problem, which uses mobile sensors to heal energy holes. However, the cost of these assistant approaches is a lot.

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Lian [10] argue that in static situations, for large-scale networks, after the lifetime of the sensor network is over, there is still a great amount of energy left unused, which can be up to 90% of total initial energy. Thus, the static models with uniformly distributed homogeneous sensors cannot effectively utilize their energy. The authors propose a non-uniform sensor distribution strategy. The density of sensor increases when their distance to the sink decreases. Their simulation results show that for networks with high density, the non-uniform sensor distribution strategy can increase the total data capacity by an order of magnitude. The authors present some approaches to the energy hole problem, including deployment assistance, traffic compression and aggregation.

Wu [11] propose a non-uniform node distribution strategy which can achieve a sub-balanced energy consumption of nodes. The authors state that if number of nodes from outer corona to inner corona increases by an exponent q. Then the total number of nodes in the network would be $N = NR \cdot qR-1$ (R represents the number of coronas, NR represents the node number in the out most corona). But it is not practically worked because the model assumes that each sensor node should generate data with same length at a unit time. The consequence is that: for the same size of areas, the area near the sink generates more data than the area away from the sink in the same time.

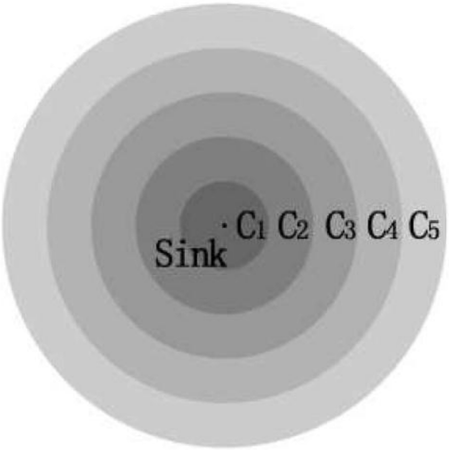

Fig. 3. A circular area consisting of five coronas.

From the viewpoint of the whole network, the nodes are distributed geometric. Therefore the density are related as follows

$\rho1 > \rho2 > \rho3 > \rho4 > \rho5$ (1)

In Fig. 3, a darker corona shows a higher node density.

For balancing the energy load among sensors in the network, Jarry [12] propose a mixed routing algorithm which allows each sensor node to either send a message to one of its immediate neighbors, or to send it directly to the base station, and the decision is based on a potential function depending on its remaining energy. However, when the network area radius is bigger than the sensor's maximal transmission range, the proposed algorithm cannot be applicable.There are also some fine grained node distribution methods of power aware routing under the corona model [14-15]. The coronas are narrower than that of [13], while the corona number is larger. Each node in one corona can communicate with the nodes form k nearest coronas. Song [14] propose an iterative method that for every corona of the network, they use greedy algorithm to adjust its transmission distance iteratively.

Yun [15] propose an arbitrary selection method that a node in one corona can transmit its data randomly to the neighbor k coronas. And the average energy depletion would be larger than optimal in this method because some node may choose large energy route by chance. Due to the narrowness of coronas, there may be better energy balancy. But the deployment of the node may be very difficult in fine grained node distribution.

III.CONCLUSION AND FUTURE WORK

In the paper, I study the later fruits of the network lifetime by overcoming the problem of energy hole . In view of the recent study many researchers have done, we find that the network lifetime is important for sensor network, especially the problem how to optimize the network lifetime is more complicated and important. In the sensor network, because of its own characteristic, so much work have been required to do so that the network lifetime can been improved. Until now although the research fruit we can use is so much, many researchers has contributed much, but still it is a challenge for researching the network lifetime. Therefore it is manfully for us to research the network lifetime, Of course it is very important to study the later fruit. The survey may not be especially completed, but I have tried our best to study the later and especially good research fruit.

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