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Review of lifetime optimization techniques in Wireless Sensor Networks

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Abstract: *In the recent years, the technology of wireless sensor networks has gained a lot of importance. Wireless sensor networks are a special case of ad-hoc wireless networks. A wireless sensor network is a collection of sensor nodes that communicate through wireless links to work together to carry out functions. The sensor nodes' basic function is to monitor the physical and environmental changes in terms of pressure, humidity, temperature etc. (referred as sensing). Sensor nodes have processing, communication and sensing capabilities. WSNs are used in number of diverse scenarios including area monitoring, health care monitoring, air pollution monitoring, natural disaster prevention, industrial health monitoring, calamity prevention etc. Sensor nodes have small batteries with limited power. Large number of sensor nodes in WSN makes it impractical to replace sensor node batteries. Thus the life time of sensor nodes is an important attribute of a wireless sensor network. The life time of a sensor network is the time spent from the deployment to the instant when the network is considered non-functional. This paper presents a survey of different techniques to optimize the lifetime of the sensors in WSN. We have tried to find out problems that exist with lifetime optimization and have tried to present solutions for the same.*

Keywords: *Wireless sensor networks, lifetime optimization, energy efficient protocols*.

1. Introduction

The emerging field of wireless sensor networks combines sensing, computation, and communication into a single tiny device. Through advanced mesh networking protocols, these devices form a sea of connectivity that extends the reach of cyberspace out into the physical world. As water flows to fill every room of a submerged ship, the mesh networking connectivity will seek out and exploit any possible communication path by hopping data from node to node in search of its destination[1]. While the capabilities of any single device are minimal, the composition of hundreds of devices offers radical new technological possibilities.

Wireless sensor networks (WSNs) have been receiving significant attention due to their potential applications in environmental monitoring and surveillance domains. In WSNs, unbalanced energy consumption is an intrinsic problem and this can considerably decrease network lifetime [2].

The power of wireless sensor networks lies in the ability to deploy large numbers of tiny nodes that assemble and configure themselves. Usage scenarios for these devices range from real-time tracking, to monitoring of environmental conditions, to ubiquitous computing environments, to in situ monitoring of the health of structures or equipment [3]. While often referred to as wireless sensor networks, they can also control actuators that extend control from cyberspace into the physical world.

A wireless sensor network consists of the following – a sensing unit (senses changes in the environment), a processing unit (works on data – embedded in microcontroller), a transmission unit and a power supply [4]. The topology of WSNs can vary from either star to multi-hop wireless mesh networks. A node can be in three phases- active (receiving or sending data), idle and sleep (nodes shut down to save energy).The challenges faced by WSNs are – limited energy capacity, necessity to know locations of sensor nodes of WSNs, data aggregation, different application requirements which differ from network to network, scalability, fault tolerance, diverse node density requirements and necessity for self – configuration, avoidance of manual dependence, reliability and security threats. In wireless sensor networks, owing to the limitation of energy, memory, and computation, it is necessary to construct the networks under the constraints [5]. The on-off sensor that is either awake or asleep (on or off) is also effective to save the observation energy. The collaboration of censoring and sleeping plays a great role in saving more energy. Extending network lifetime and energy efficiency are important objectives and challenges in wireless sensor networks. In wireless sensor networks, node energy resources are so limited that how to reduce energy consumption and prolong network lifetime become the primary factor that should be taken into account for the design of wireless sensor network routing protocols.The coverage problem is also one of basic problem in wireless sensor networks; it can be dealt with the nodes' deployment. In Wireless Sensor Networks (WSNs), the coverage means how well a sensor network will monitor the total area of the region [6]. Node deployment is one of the important issues that need to be solved. The number of sensor nodes has direct impact on the cost of the Wireless Sensor Networks. So, keeping this in mind, the proper deployment of nodes can reduce the complexity of problems, energy consumption can be reduced and thus extends the lifetime of the Wireless Sensor Networks. Sensor networks specifications are highly dependent on the application defined for the network. WSNs use lithium batteries in general for the power supply. The utilization in power for different types of sensors like gas, pressure, temperature etc. is different [7].

It is seen that most of the previous approaches for chose alternate path directly when any node shout down that dropped performance and have relative higher complexity. As the mobile nodes operate on the limited power of battery therefore it becomes very necessary to develop techniques which can successfully maintaining lesser complexity. Recently researcher tries to develop a new approach which can successfully maintain the researched with lesser battery power in order to long survival of Sensor network.

2. Energy Issue in Wireless Sensor Network

Recently researcher mainly focuses on the distributed (and local) designing algorithms for these problems, where individual nodes perform their own algorithms for computing solutions to global problems. A distributed algorithm is one in which the nodes individually execute the same algorithm and make decisions accordingly without knowing the general network topology. However, in some distributed algorithms, it is permissible that the nodes can learn some overall information (for example, the number of sensors in the Network and / or the maximum level of the underlying curve). A stronger version of distributed algorithm is known as the local algorithm. Unofficially, a local algorithm, allows a node to communicate only with their neighbors, which are plus a constant jump away to make decisions during the execution of the algorithm

Broadcasting issues Diffusion is a process by which a message generated by a node of the network, is sent to all other nodes in the network. After a simple approach to flooding is inefficient. This is because many useless transmissions (or transmissions only) messages are generated and transmitted in the network, which in turn makes the nodes to quickly dissipate their precious energy. Therefore, we have to design energy efficient algorithms that can prevent or at least reduce the amount of redundant transmissions [8].

Clustering - Clustering is a well-studied topic in the community of sensor networks, where the goal is to divide the entire network in a number of groups (not necessarily disjoint) and select a node in the cluster head (CH) of each group. each Maybe CH is assumed to be active and do all the work of coordination, eg, detection, data collection and data transmission on behalf of the group to the base station, while the other cluster nodes can enter sleep mode. Based on grouping the problems is to minimize the number of CHs, provided of any node in the network or a CH group or at least directly connected to CH. That would leave more detectors in low energy reserve. This problem is also known as the minimum set of key problem. However, like all CHS (even minimal CHS) is busy all the time for detection, processing and transmission of such data, power running quickly, while other nodes (CHS) are not left with a lot of energy. this causes a significant power supply nodes and reduces disequilibrium web of life. One way to solve this situation is to find a family of disjoint sets of CHs and make iterative assets so that the energy consumption balanced between the nodes of the network.

Surveillance Target Monitoring (also called coverage) is an important and widely studied issue in sensor networks. In general, the main objective of the research in this area is the design of scheduling algorithms, such as the individual sensors in the network slots to indicate that during the time interval that is active during those days are slots allocated to sleep. Given a WSN that monitors certain objectives, it is sometimes possible to find a subset of sensors and encourage them to do the same activity monitoring. So instead of all active nodes for this purpose (which is obviously redundant) we possibly can choose a small subset that can guarantee the same supervision. This observation led researchers to design efficient algorithms so that at any time a small number of nodes are only active for controlling all the objectives in question [9].

Self Protect sensor networks We study an interesting problem which deals with the provision of the sensors with a level of protection by other sensors. Sensors for monitoring the target, it is often necessary to give a level of protection (additional sensors) so that the sensors can take certain actions when attacks are directed at them. A natural idea is to monitor sensors by neighbors as neighbors can inform the base station when other sensors are in danger (or not working due to a malfunction). We elaborate on this in what follows. Sometimes you may need to know if all the sensors in the network is healthy to do their homework [10]. From a faulty sensor, ie, a defective or compromised sensor cannot report to the base station of your condition, targets controlled by the faulty sensor become unprotected and the system has no way to read about it vulnerability. In this case, we have to find a subset of sensors whose function is to control other sensors, so when all sensors (including themselves) failure or malfunction sensors reported the situation to the base station. The base station and then take appropriate action, such as the deployment of additional nodes to replace those that do not operate continuously to provide protection to these objectives.

3. Related works

Hui Lin [8] developed a parallel algorithm for the solution of an integrated topology control and routing problem in Wireless Sensor Networks (WSNs). After presenting a mixed-integer linear optimization formulation for the problem, for its solution, they develop an effective parallel algorithm in a Master–Worker model that incorporates three parallelization strategies, namely low-level parallelism, domain decomposition, and multiple searches (both cooperative and independent) in a single Master–Worker framework. For improved algorithmic efficiency, they introduce three reduced sub problems and devise partial objective value cuts from these reduced models. They utilize both the reduced models, for which they suggest efficient approaches for their solution, and the associated cuts in their parallel algorithm. They observe[8] that the reduced models provide valuable information on the optimal design variables for the original model and they exploit this fact in their parallel algorithm. Their overall parallelization scheme utilizes exact optimization models and solutions as its components and allows cooperation among multiple worker processors via communication of partial solution and cut information. The depleting speeds of battery energy of sensor nodes will significantly affect the network lifetime of a WSN. Most researchers have aimed to design energy-aware routings to conserve the usage of the battery energy to prolong network lifetimes. A reloadable sink is another approach for prolonging network lifetime by avoiding staying at a certain location for too long which may harm the lifetime of nearby sensor nodes. This approach [9]can not only relieve the burden of the hot-spot, but can also integrate the energy-aware routing to enhance the performance of the prolonging network lifetime. In this paper, they have[9] proposed an energy-aware sink relocation method (EASR), which adopts the energy-aware routing MCP as the underlying routing method for message relaying. Theoretical analysis is given in this paper to demonstrate that EASR can prolong the network lifetime of a WSN. Sensor nodes are often deployed in remote area. It is inevitable to update their codes for introducing new functionality or fixing bugs after the deployment. Network reprogramming provides an ultimate solution to this problem through efficient dissemination that relies upon wireless broadcast. Yet, existing code dissemination protocols for reprogramming Wireless Sensor Network (WSN) become inefficient, in terms of power dissipation or delay, in unreliable broadcast environments. In this paper, we design an Adaptive Code Dissemination Protocol (ACDP) for reprogramming wireless sensor network. The proposed ACDP reduces communication cost without introducing intensive computation or complicated transmission control. More importantly, its load balancing feature is capable of extending the lifetime of the entire sensor network, as well as that of individual sensor. They [10] have proposed a network reprogramming protocol ACDP by using random linear coding for code dissemination. The memory overhead in ACDP cans fit the hardware resource of most modern sensor nodes. Moreover, the impact of different coding windows on the protocol reliability and traffic is analyzed. The optimum coding windows of different network sizes are studied and provided. ACDP can achieve better load balance and faster reprogramming. It guarantees reliability. It can reduce the number of transmitted packets, which directly affects network lifetime. In terms of overhead, it needs a slightly more memory and computational cost to get power saving for the whole network. Unbalanced energy consumption is an inherent problem in WSNs and this can significantly reduce network lifetime [11]. Judicious node deployment is one of the primary solutions for unbalanced energy consumption in WSNs. The objective of designing such a node deployment function is to achieve energy balance and enhancing network lifetime while maintaining coverage and connectivity. We have analyzed two node deployment strategies viz. Gaussian distribution based node deployment strategy [12] and Non-uniform node deployment strategy [13] From the analysis it is observed that both the deployment strategies do not ensure enhancement of network lifetime to its fullest extent as these are not energy balanced. To mitigate the problem, we have identified Archimedes' spiral, a geometric model using which we have proposed a node deployment scheme.

4. Conclusions

In this paper made a survey of the routing protocols and the energy conservation methods to try and conserve the battery energy of the sink node from depleting. The sensor nodes deplete their energy and consequently their lifetimes, mainly those near the sink as they consume more battery because they have to deliver their own and other nodes' data. With a mobile sink, the nodes around the sink always changes, thus balancing the energy consumption in the network and improving the network lifetime. Mobile sinks reduce end to end delay, increase success rate and decrease energy dissipation in wireless sensor networks. Here in the sink relocation mechanism, we have used the energy aware sink relocation (EASR) protocol for mobile sinks. It adapts the maximum capacity path (MCP) as the underlying routing method. Here residual energy of nodes is taken into account to adjust the transmission range of nodes and relocating methods for the sink.

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