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ENERGY OPTIMIZATION TECHNIQUES IN WIRELESS SENSOR NETWORKS

[1] A. Arul Prakash, [2] M. Prabhakaran
[1] Faculty, [2] ME - Scholar
[1] GALGOTIAS UNIVERSITY, [2] Mahabarathi Engineering College

ABSTRACT: There has been plenty of interest in building and deploying sensor networks. These networks are composed of a high number of very easy nodes wherever the majority of them ought to perform the function of a router also. Energy consumption of these nodes is important issue because the power provide of the node is provided by restricted batteries methodology, which limit the lifetime of the links additionally to whole networks. The energy treatment of network sensor node is serious issue for long lifespan of the network. Because the sensor nodes are being acting like routers as well, the choice of routing algorithm would be a key role within the energy consumption control. Wireless sensor network with the different energy levels nodes can prolong the lifetime of the network and also its reliability. We discuss the improvement to be made for future proposed energy efficient schemes.

Keywords: [Optimization, Routing, WSN, Applications]

1. INTRODUCTION

In today's world of computing, information gathering is a fast growing and challenging field in the different area such as inhospitable and low-maintenance areas where conventional approaches prove to be very costly. Sensors provide a low-priced and straightforward solution to these applications. These physical devices are small in size that is capable of gathering environment information like heat, light or motion of an object . Sensors are deploying in a simple model in the area of interest to monitor events and gather data about the surroundings. Networking of these unattended sensors is expected to have a major impact on the effectiveness of many military and civil applications, such as combat field observation, security and adversity management. Sensor motes in such systems are typically throwaway and expected to last until their energy drain. Therefore, for sensor networks power is a very inadequate resource and for the duration of a particular mission. It has to be managed wisely to extend the life of the sensor motes. The sensor networks pursue the model of a base station, where sensors relay streams of data to the base station either like periodically or based on actions. The control node/ base station may be statically allocated in the surrounding area of the sensor, or it may be mobile so that it can move around the field and collect data from the network. In either case, the base station cannot be reached strongly by all the sensor motes in the network. The motes /nodes that are located far away from the base station will consume more energy to transmit data than other nodes and therefore will die sooner.

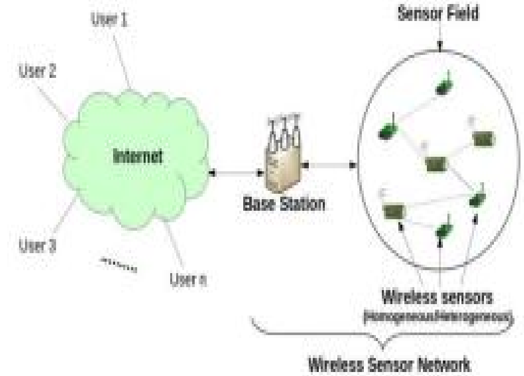

Figure 1: Wireless Sensor Network

The general design of WSN is shown in figure 1. The WSN consists of a sink node which is sometimes also referred to as base station. WSNs also consists of a large number of sensors that are distributed above a large geographical area. The are over which the sensor nodes are spread is also called sensor field. The sensors as well as the sink can be stationary or moving. The sink is usually also connected with internet or some other form of WAN. Users operate and monitor the entire WSN remotely using the sink node. All the operations of WSN consume energy. However the highest percentage of energy is consumed in transmitting messages from sensor node to sink node (long distance communication). Other operations like sensing of environment or processing of data etc. normally consumes way too less energy than transmitting of data. Energy conservation techniques in WSNs usually follow two techniques- either reduce the frequency of data communication from sensor nodes to sink nodes or reduce the frequency or amount of data sensed by sensor nodes.

2. TAXONOMY OF POWER OPTIMIZATION TECHNIQUES IN WSN'S

Power optimization techniques can be broadly classified into five distinct categories as shown in figure 2- radio transmission optimization, reducing data inside WSN, power optimized routing techniques, sensor nodes sleep/wake mechanisms and energy repletion techniques etc.

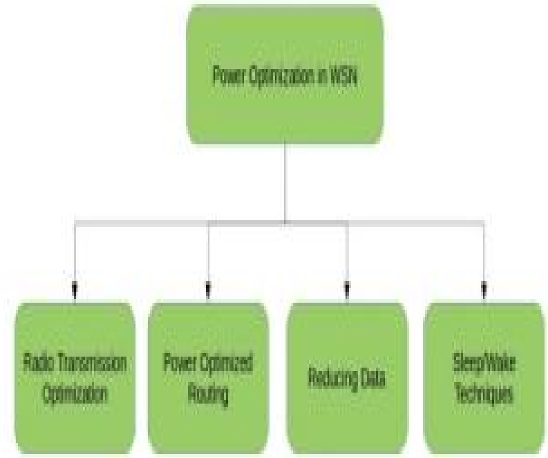

Figure 2: Architecture of WSN

Radio Transmission Optimization

This is the first category of power optimization technique which involves reducing the power consumed by radio component of a WSN. The radio sub component is responsible for transcieving (transmitting as well as receiving) the data to and from sink node. Radio optimization can be further sub categorized as : improving modulation, collaborative communication, optimizing transmission power, designing intelligent radios that can select the most appropriate radio channel etc.

Power Optimized Routing Technique

Routing in WSN is required in multihop WSN when the distance between sensor node and sink is so large that data cannot be transmitted directly between them. Routing also consumes a considerable amount of resources of a resource constrained sensor node. The nodes closer to sink are often burdened with additional task of routing data on behalf of the whole WSN to sink. This results in fast depletion of battery of nodes closer to sink. Power optimized routing can be achieved through clustering, multipath routing, routing using relay nodes or repeaters etc. In cluster based routing the WSN is divided into clusters or groups and each cluster is managed by a cluster head which is selected from one of the nodes inside the cluster. All the nodes belonging to a cluster first transmit their cluster head which in turn transmit it to sink node. Thus energy is conserved since majority of nodes only have to transmit data over a very short range. In multipath routing techniques, there is more than one path from sensor nodes to sink node on which data is transmitted. This not only reduces network congestion but also distributes workload of routing. The drainage of battery on the paths from sensor node to sink is also reduced as compared to single path routing. In relay based routing, enhanced capability nodes can be placed in crucial positions of WSN. They can help in data transmission, analysis and interpretation. Also the sink node can also be made mobile so that keeps on moving within the WSN and collects data from various parts. Thus no particular set of nodes will be overloaded with additional data transmission tasks and will result in longetivity of the WSN.

Reducing data inside WSN

Another popular technique of power optimization is reducing the amount of data generated, processed or transmitted in WSN. Data reduction inside WSN can be primarily achieved by two techniques- reducing the frequency of sample collection and limiting unnecessary sample collection. Apart from this, other computer techniques such as data compression and network coding can also be utilized to diminish the sensed data. Also there certain parameters that are highly correlated and one can be implied from the other. Thus, this correlation can also be exploited to lessen the quantity of data.

Sensor nodes sleep wake mechanisms

A sensor node always consumes energy whether it is working or it is idle. A node in idle state will not do anything yet consume the similar amount of energy as a working node. Thus the best solution to put the idle nodes in sleep mode and wake them up when there is a task for them. The sleep wake mechanisms utilize an important technique known as duty cycling. Various nodes in a WSN are not kept awake all the time. Rather they are alternatively put to sleep wake mode based on some predicated criteria. The nodes might be sleeping and can be awaken if the need arises or they can set their schedule such that they sleep for some time and then stay awake for sometime or a they can sleep for random duration of time before waking up.

3. COMPONENTS OF SENSOR NODES

Sensor nodes have hardware and software components. Hardware components include processors, radio-transceiver sensors, and power unit. The software's used for sensor nodes are TinyOs, Contiki, and Nano Rk. In this section, we discuss hardware components briefly.

A. Sensors- There are two types of Sensors nodes: digital sensors and analog sensors. Analog sensors gives data in continuous or in waveform. The data is further processed by the processing unit that converts it to human readable form.Digital sensors directly generate data in the discrete or digital form. Once the data is converted, it directly sends it to the processor for further processing.

B. Memory- Microprocessors use different types of memory for processing data. The memory and input/output devices are integrated on the same circuit. Random-access memory (RAM) stores data before sending it, while read-only memory (ROM) stores operating system of sensors nodes.

C. Processors- Microprocessors of sensor nodes are also known as small scale CPUs which is related about the CPU speed, voltage, and power consumption. Sensors operations run at low CPU speed. Most of the time, sensors remain in sleep mode. In sleep mode processor is involved in other activities like time synchronization and consumes small amount of the power.

D. Radio Transceiver- The transceiver receives and sends data to other sensor nodes. The radio frequency is used to connect sensors with other nodes. Data transmission process consume most of the energy in transceiver section. The transceiver has four operational modes such as sleep, idle, receive, and send. 1) Sleep Mode: In sleep mode, nodes turn off their communication devices or modules so that there are no more transmission and reception of data frames. In sleep mode, nodes can listen to data frames. This is listening stage of sleep mode. When nodes listen to the data frame, it turn in to the active mode; otherwise, it remains in sleep mode. 2) Active Mode: In active mode, data is transmitted normally. Nodes communication devices are in active state and can send or receive data. Typical architecture of sensor node. 3) Idle Mode: It is also one of the sleep modes. In this stage, sensor nodes are in low-power mode and remain in this mode for agreed amount of time. When sensor nodes go back to the awake or active mode from the idle mode, they again connect to the networks and start communication.

E. Power Unit- It is the most important part of the sensor node. Sensor node cannot perform any work without this unit. The lifetime of the sensor node is defines by the Power unit.

4. APPLICATIONS OF WSN

Sensor nodes gather and forward data for the particular application whenever some kind of physical change occurs, such as change in temperature, sound, and pressure. WSNs have many applications such as military, civil, and environmental applications. Some important applications are discussed below.

Area Monitoring

Sensor nodes are deployed in the area where some actions have to be monitored; for instance, the position of the enemy is monitored by sensor nodes, and the information is sent to the base station for further processing. Sensor nodes are also used to monitor vehicle movement.

Environmental Monitoring

WSNs have many applications in forests and oceans, and so forth. In forests, such networks are deployed for detecting fire. WSNs can detect when the fire is started and how it is spreading. Senor nodes also detect the movements of animals to analyses their habits. WSNs are also used to analyses plants and soil.

Industrial Monitoring

In industries, sensors monitor the process of making goods. For instance, in manufacturing a vehicle, sensors detect whether the process is going right. A response is produce if there is any manufacturing fault. Sensor nodes also monitor the grasping of objects by robots.

Medical and Healthcare Monitoring

Medical sensors are used to monitor the conditions of patients. Doctor scan monitor patient's conditions, blood pressure, sugar level, and so forth, review ECG and change drugs according to their conditions. Personal health-monitoring sensors have special applications. Smart phones are used to monitor health, and the response is generated if any health risk is detected. Medical sensors store health information and analyze the data obtained from many other sensors such as ECG, blood pressure, and blood sugar.

Traffic Control System

Sensor nodes monitor traffic flow and number plates of traveling vehicles and can locate their positions if needed. WSNs are used to monitor activities of drivers as well such as seat-belt monitoring.

Underwater Acoustic Sensor Networks

Underwater special sensors can monitor different applications of numerous oceanic phenomena; for instance, water pollution, underwater chemical reactions, and bioactivity. For such purposes, different types of 2D and 3D static sensors are used. 3D dynamic sensors are used to monitor autonomous underwater vehicles (AUVs).

CONCLUSION

In this paper discussed the taxonomy of power conservation schemes and then discussed, analyzed and compared few important ones in detail. One conclusion that we can draw from this study is that most of the modern day researches focus on only one specific technique rather than focusing on a a combination of two or more techniques to conserve power. Different techniques for reducing energy consumption in WSN are reviewed here. Energy hungry parameters in traditional methods have identified. By modifying these parameters required energy efficient performance can be achieved. Techniques modifying GPS duty cycle have promising future due to high accuracy and real time performance.

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