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ENERGY MINIMIZATION FOR ACTIVE WIRELESS SENSORS USING DATA DRIVEN APPROACH

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Abstract

The Energy minimization of wireless sensors is ongoing research with lot of efforts made by the researchers. The wireless sensor consists of a large number of active sensor nodes which are deployed over an area to perform local computations based on information gathered from the surroundings. The active sensor nodes are equipped with a battery, but it is almost very difficult to change or recharge batteries; therefore, we need to maintain the lifetime of the active sensor for a long time. Hence, maximizing the lifetime of the active sensors through minimizing the energy is an important challenge in wireless sensor nodes, so it is not an easy take to achieve, therefore we cannot be easily replaced or recharged due to their ad-hoc deployment in hazardous environment. The lot of attempts made by the researchers in the last one decade the many of the survey says the main techniques used for energy conservation in active sensor networks. This paper mainly discuss on a new approach called data driven is used to minimize the energy saving of active wireless sensor nodes. So the future researchers can able to take this input for further improvement for passive sensors.

Keywords: Wireless sensor network, Energy Consumption, Sleep-mode, Energy-Efficient Scheduling.

1. Introduction

Recent advances in micro-electro-mechanical systems, low power and highly integrated digital electronics have rununder the development of micro sensors. A wireless sensor network consists of sensor nodes deployed over a geographical area for monitoring physical phenomena like temperature, humidity, vibrations, seismic events, and so on. Typically, a sensor node is a tiny device that includes three basic components-a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, and also a wireless communication subsystem for data transmission. In addition, a power source supplies the energy needed by the device to perform the programmed tasks. The architecture of WSN discussed is Figure 1.As sensor nodes are primarily operated on a limited battery power, the major concern is to reduce overall energy consumption; this power source often consists of a battery with a limited energy budget. The development of wireless sensor network was originally motivated by military applications like battlefield surveillance. However, wireless sensor networks are now used in many civilian application areas including the environment and habitat monitoring due to various limitations arising from their inexpensive nature, limited size, weight and ad hoc method of deployment; each sensor has limited energy. Moreover, it could be inconvenient to recharge the battery, because nodes may be deployed in a hostile or impractical environment. At the network layer, the intention is to find ways for energy efficient route setup and reliable relaying of data from the sensor nodes to the sink, in order to maximize the lifetime of the network. The major differences between the wireless sensor network and the traditional wireless network sensors are very sensitive to energy consumption.

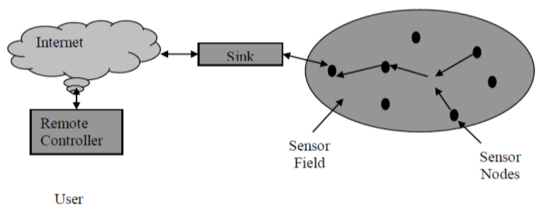

Figure 1. **Sensor Node Architecture.**

Moreover, the performance of the sensor network applications highly depends on the lifetime of the network. We adopt as a common lifetime definition the time; when the first sensor dies. The proposed sensor is widely utilized in the sensor network research field. An alternative lifetime definition that has been used is the time at which a certain percentage of total nodes run out of energy the sensors in a certain area exhibit similar behaviours to achieve energy balance. In other words, when one sensor dies, it can be expected the neighbours of this node will run out of energy very soon, since they will have to take over the responsibilities of that sensor and we expect the lifetime of several months to be several years. Thus, energy saving is crucial in designing life time wireless sensor networks.

2. Working of Active Wireless Sensor Nodes

The main components of a sensor node are a microcontroller, transceiver, external memory, power source and one or more sensors.

2.1. Active Wireless Sensor Node Controller

The Active Wireless Sensor Node controller performs tasks, processes data and controls the functionality of other components in the sensor node.While the most common controller is a microcontroller, other alternatives that can be used as a controller are a generalpurpose desktop microprocessor, digitalsignalprocessors, FPGAs and ASICs. A microcontroller is often used in manyembedded systems such as sensor nodes because of its low cost, flexibility to connect to other devices, ease of programming, and low power consumption. A general purpose microprocessor generally has a higher power consumption than a microcontroller, therefore it is often not considered a suitable choice for a sensor node [1].

Digital Signal Processors may be chosen for broadband wireless communication applications,but in Wireless Sensor Networks the wireless communication is often modest: i.e., simpler, easier to process modulation and the signal processing tasks of actual sensing of data is less complicated [2]. Therefore, the advantages of DSPs are not usually of much importance to wireless sensor nodes. FPGAs can be reprogrammed and reconfigured according to requirements, but this takes more time and energy than desired.

2.2. Active Wireless Sensor Node Transceiver

Sensor nodes often make use of ISM band, which gives free radio, spectrum allocation and global availability. The possible choices of wireless transmission media are radio frequency, optical communication (laser) and infrared. Lasers require less energy,but need line-of-sight for communication and are sensitive to atmospheric conditions. Infrared, like lasers, needs no antenna but it is limited in its broadcasting capacity. Radio frequency-based communication is the most relevant that fits most of the WSN applications [3].WSNs tend to use license-free communication frequencies:173,433,868, and 915 MHz;and 2.4 GHz. The functionality of both transmitter and receiver are combined into a single device known as a transceiver. Transceivers often lack unique identifiers. The operational states are transmitting,receive, idle, and sleep. Current generation transceivers have built-in state machines that perform some operations automatically.

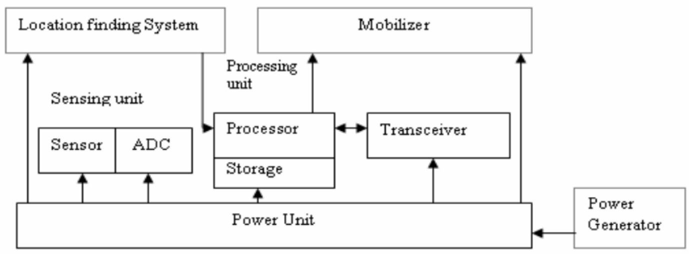

Figure 2.**Sensor Node Transceiver.**

Most transceivers operating in idle mode have a power consumption almost equal to the power consumed in receive mode. Thus, it is better to completely shut down the transceiver rather than leave it in the idle mode when it is not transmitting or receiving. A significant amount of power is consumed when switching from sleep mode to transmit mode in order to transmit a packet [4].

2.3. Active Wireless Sensor Node External memory

From an energy perspective, the most relevant kinds of memory are the on-chip memory of a microcontroller and Flash memory off-chip RAM is rarely, if ever, used. Flash memories are used due to their cost and storage capacity. Memory requirements are very much application dependent [5]. Two categories of memory based on the purpose of storage are: user memory used for storing application related or personal data, and program memory used for programming the device. Program memory also contains identification data of the device if present.

2.4. Active Wireless Sensor Node Power source

A wireless sensor node is a popular solution when it is difficult or impossible to run a mains supply to the sensor node. However, since the wireless sensor node is often placed in a hard-to-reach location, changing the battery regularly can be costly and inconvenient. An important aspect in the development of a wireless sensor node is ensuring that there is always adequate energy available to power the system. The sensor node consumes power for sensing, communicating and data processing. More energy is required for data communication than any other process. The energy cost of transmitting 1 Kb a distance of 100 metres (330 ft) is approximately the same as that used for the execution of 3 million instructions by a 100 million instructions per secondprocessor. Power is stored either in batteries or capacitors. Batteries, both rechargeable and non-rechargeable, are the main source of power supply for sensor nodes. They are also classified according to electrochemical material used for the electrodes such as Nicd(nickel-cadmium), NiZn(nickel-zinc), NiMH (nickel-metal hydride), and lithium-ion. Current sensors are able to renew their energy from solar sources, temperature differences, or vibration [6].Two power saving policies used are Dynamic Power Management and Dynamic Voltage Scaling. Dynamic Power Management conserves power by shutting down parts of the sensor node which are not currently used or active.A Dynamic Voltage Scaling scheme varies the power levels within the sensor node depending on the non-deterministic workload[7]. By varying the voltage along with the frequency, it is possible to obtain quadratic reduction in power consumption.

2.5. Active Wireless Sensor Node Sensors

Sensors are used by wireless sensor nodes to capture data from their environment. They are hardware devices that produce a measurable response to a change in a physical condition like temperature or pressure [8]. Sensors measure physical data of the parameter to be monitored and have specific characteristics such as accuracy, sensitivity etc. The continual analog signal produced by the sensors is digitized by an analog-to-digital converter and sent to controllers for further processing. Some sensors contain the necessary electronics to convert the raw signals into readings which can be retrieved via a digital link and many convert to units such as °C. Most sensor nodes are small in size, consume little energy, operate in high volumetric densities, be autonomous and operate unattended, and be adaptive to the environment. As wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts. Sensors are classified into three categories they are passive, omnidirectional sensors; passive, narrow-beam sensors; and active sensors. Passive sensors sense the data without actually manipulating the environment by active probing. They are self-powered that is, energy is needed only to amplify their analog signal. Active sensors actively probe the environment, for example, a sonar or radar sensor, and they require continuous energy from a power source. Narrow-beam sensors have a well-defined notion of direction of measurement, similar to a camera. Omnidirectional sensors have no notion of direction involved in their measurements. Most theoretical work on Wireless sensor networks assumes the use of passive, omnidirectional sensors. Each sensor node has a certain area of coverage for which it can reliably and accurately report the particular quantity that it is observing. Several sources of power consumption in sensors are signal sampling and conversion of physical signals to electrical ones, signal conditioning, and analog-to-digital conversion. Spatial density of sensor nodes in the field may be as high as 20 nodes per cubic meter.

3. Minimization of Energy on Active Sensor nodes using a New Data Driven Approach

The Data driven approaches is basically based on data reduction and energy-efficient data Acquisition. Data-driven approaches are planned to reduce the amount of sampled data by keeping the sensing accuracy within the acceptable level for application. Sampled data are generally having strong spatial and or temporal correlation, so there is no need to communicate the redundant information to the sink. Energy efficient data acquisition schemes are mainly aimed at reducing the energy spent by the sensing subsystem. It has two sub systems they are data reduction and energy efficient data acquisition, it is shown in the Figure 3.

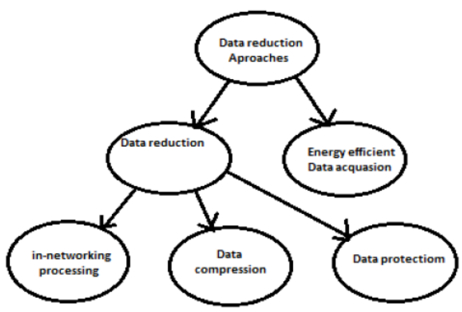

Figure 3. Data Driven Approaches.

3.1. Data reduction

In data reduction techniques, data prediction methods construct a model describing the sensed phenomenon, so that queries can be answered using the model instead of the actually sensed data. There are two instances of a model in the network, one residing at the sink and the other at source nodes. The model at the sink can be used to answer queries without requiring any communication, thus reducing the energy consumption. Sensor nodes just sample the data as usual and compare the actual data against the prediction. If the sensed value falls within an application-dependent tolerance, then the model is considered valid. The features of a specific data prediction technique depend on the way the model is built.

The second class of data prediction techniques is time series forecasting, where a set of chronological values obtained by periodical samplings are used to predict a future value in the same series. The main difference with respect to other statistical or probabilistic approaches is that time series analysis explicitly considers the internal structure of data. The first instance of the model is computed by sensor nodes using a set of sampled values. During this learning phase, nodes store the samples in a queue. When the queue is full they can get the model and send it to the sin.

The third category of data prediction techniques is Algorithmic Approach relies on a heuristic or a statetransition model describing the sensed phenomenon, In Energy Efficient Data Collection mechanisms;Each node associates an upper and a lower bound,whose difference represents the accuracy of readings, to the actual value of sensed data. These bound are sent to the sink, which stores them for each sensor in the network. While acquiring the information, the sensors check the samples against the bounds. If they fall outside the expected precision, the nodes send an update to the sink.This kind of interaction is called source-initiated update. On the other side, the sink receives queries from users with an associated requested accuracy. When the requested accuracy is lower than the actual accuracy provided by the value limits, the sink can act in response using the cached range. Otherwise the sink may request the real value and its new approximation to be used for following queries directly to sensor. This kind of interaction is called consumer-initiated request and revise. Finally, algorithmic techniques have to be considered case by case, because they tend to be more application particular.

3.2. Energy-efficient data acquisition

Energy consumption of energy subsystem not only may be applicable, but it can also be greater than the energy consumption of radio or even greater than the energy consumption of the rest of sensor node. In this case reducing communications may be not enough, but energy conservation methods have to actually decrease the number of acquirement.By reducing the data sampled by source nodes, they decrease the number of communications as well. Adaptive sampling can decrease the number of samples by exploiting spatio-temporal correlations between information.

The temporal analysis of sensed data.Precision can be traded off for energy efficiency by using the low-power sensor to get coarse-gained information about the sensing field. Then, when an event is detected or a region has to be observed with greater detail, the accurate power hungry sensors can be activated. For example, consider a target tracking application. Target can be discovered using low power sensor such as magnetometers or passive acoustic energy detectors. Such sensors can detect targets, but they can lead to fake positives. In addition, also when the detection is successful, they cannot be accurate enough to identify the type of type of target. In this case high resolution acoustic beam forming or image capturing sensor can help. Instead of keeping these power hungry sensors always on, the less accurate ones are used to detect possible targets. When a target is detected, the more accurate sensor is activated as long as the target has been completely characterized or tracked.

4. Conclusion

In this paper we have reviewed the main approaches to energy saving methods in Wireless Sensor Network using new data driven approach. These energy saving methods are basically used to increase the life time of sensor nodes in wireless sensor networks. We have also stressed the importance of design issues of Wireless Sensors Networks such as power consumption, hardware constraints, environment, and transmission media. There are still many issues to be resolved around energy management in order to increase the life time sensor nodes such as data aggregation, and information management. By solving these issues, we can further, reduce the energy consumption of sensor node in wireless sensor networks.

A methodical study of the relation between energy efficiency and system lifetime is an avenue of future research. Analytical results on the bounds of life span of sensor networks are another area worth exploring. The sensor data are usually highly interrelated and energy efficiency can be achieved by joint source coding and information compression. Although some research has been pursued in this direction, there is significant scope of future work.

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