Optimization of Power Consumption in Wireless Sensor Networks

Surendra bilouhan, Prof.Roopam Gupta

Abstract—In this paper, we consider the problem of discovery of information in a densely deployed Wireless Sensor Network (WSN), where the initiator of search is unaware of the location of target information. We propose a protocol: Increasing Ray Search (IRS), an energy efficient and scalable search protocol. The priority of IRS is energy efficiency and sacrifices latency. The basic principle of this protocol is to route the search packet along a set of trajectories called rays that maximizes the likelihood of discovering the target information by consuming least amount of energy. The rays are organized such that if the search packet travels along all these rays, then the entire terrain area will be covered by its transmissions while minimizing the overlap of these transmissions. In this way, only a subset of total sensor nodes transmits the search packet to cover the entire terrain area while others listen. We believe that query resolution based on the principles of area coverage provides a new dimension for conquering the scale of WSN. We compare IRS with existing query resolution techniques for unknown target location such as Round Robin Search. We show by simulation that, performance improvement in total number of transmitted bytes, energy consumption, and latency with terrain size

Index Terms—Wireless sensor networks, energy efficiency, scalability, CSMA, Sensor Sim , SIR, Low-power optimization , transmission strategy.

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1. INTRODUCTION

A sensor network is a group of specialized transducers with a communications infrastructure intended to monitor and record conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels and vital body functions.

A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. The transducer generates electrical signals based on sensed physical effects and phenomena. The microcomputer processes and stores the sensor output. The transceiver, which can be hard-wired or wireless, receives commands from a central computer and transmits data to that computer. The power for each sensor node is derived from the electric utility or from a battery. This paper provides an analytical model for the study of energy consumption in multihop wireless embedded and sensor networks where nodes are extremely power constrained. Low-power optimization techniques developed for conventional ad hoc networks are not sufficient as they do not properly address particular features of embedded and sensor networks. It is not enough to reduce overall energy consumption, it is also important to maximize the lifetime of the entire network, that is, maintain full network connectivity for as long as possible. This paper considers different multihop scenarios to compute the energy per bit, efficiency and energy consumed by individual nodes and the network as a whole. The analysis uses a detailed model for the energy consumed by the radio at each node. Multihop topologies with equidistant and optimal node spacing are studied. Numerical computations illustrate the effects of packet routing, and explore the effects of coding and medium access control. These results show that always using a simple multihop message relay strategy is not always the best procedure.

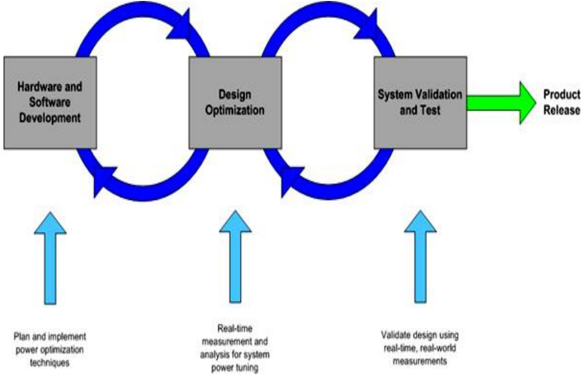

Fig1.Life cycle of sensor network

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2.BACKGROUND

Recent advances in sensor technology (in terms of size, power consumption, wireless communication and manufacturing costs) have enabled the prospect of deploying large quantities of sensor nodes to form Wireless Sensor Networks (WSN). These networks are created by distributing large quantities of usually small, inexpensive sensor nodes over a geographical region of interest with a view to collect data relating to one or more variables. These nodes are primarily equipped with the means to sense, process and communicate data to other nodes and ultimately to a remote user(s). WSN nodes can also have mobility capabilities which enable them to move around and roam the region of interest to harvest information. Figure 1 shows a typical sensor node hardware architecture. Sensor nodes may cooperate with their neighbors (within communication range) to form an ad-hoc Network. WSN topologies are generally dynamic and decentralized. Figure 2 gives a general overview of a WSN.

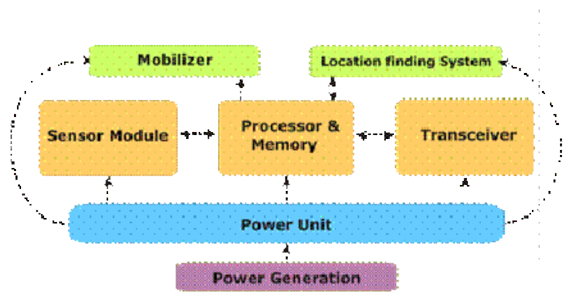

Fig2.Execution phase of sensor signal

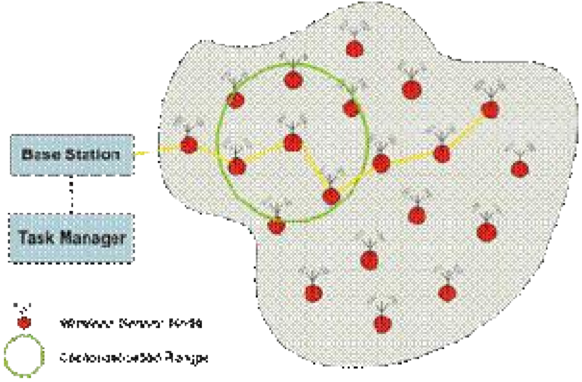

Fig3.wireless area consist of various sensor nodes.

BACKGROUND AND RELATED WORK

Understanding the performance and behavior of sensor networks requires simulation tools that can scale to very large numbers of nodes. Traditional network simulation environments, such as ns2 [6], are effective for understanding the behavior of network protocols, but generally do not capture the operation of endpoint nodes in detail. Also, while ns2 provides implementations of the 802.11 MAC/PHY layers, many sensor networks employ nonstandard wireless protocols that are not implemented in ns2. A number of instruction-level simulators for sensor network nodes have been developed, including At emu [11] and Simulavr [20]. These systems provide a very detailed trace of node execution, although only At emu provides a simulation of multiple nodes in a networked environment. The overhead required to simulate sensor nodes at the instruction level considerably limits scalability. Other sensor network simulationenvironments include PROWLER [21], TOSSF [19] (based on SWAN [14]), Sensor Sim [17], and SENS [23]. Each of these systems provides differing levels of scalability and realism, depending on the goals for the simulation environment. In some cases, the goal is to work at a very abstract level, while in others, the goal is to accurately simulate the behavior of sensor nodes. Few of these simulation environments have considered power consumption. Sensor- Sim [17] and SENS [23] incorporate simple power usage and battery models, but they do not appear to have been validated against actual hardware and real applications [18]. Also, SensorSim does not appear to be publically available.

Several power simulation tools have also been developed for energy profiling in the embedded systems community.

Performance Metrics Used

•**Number of transmitted bytes**: Average number of bytes transmitted by all the nodes in the network for finding the target information. As the message formats are not uniform across protocols, we measured the number of bytes transmitted instead of the number of messages transmitted.

•**Number of transmitted and received bytes:**Average number of transmitted and received bytes by all the nodes in the network for finding the target information.

•**Energy consumed:** The total energy consumed by all the nodes in the network for finding the target information.

•**Latency:** Time taken to find the target information, i.e., the time difference between, the time at which the search is initiated by the sink node by transmitting the search packet, and the time at which the search packet is received by the target node.

•**Probability of finding the target information**:Probability of finding the target information is a measure of the success probability of the search protocols. It is also a measure of non determinism of the search protocols.

4.Method of Reducing Power Consumption(WSN)

A method for reducing power consumption in a wireless sensor network is provided. An optimized path destined for a sink node is set using a common channel in which first and second nodes use a CSMA scheme. A first channel is set and transmission/reception slots for packet transmission/reception arc allocated in the first channel. A packet is transmitted to the second node through a first transmission slot using a TDMA scheme. When a packet is not received from the second node through a first reception slot within a first set amount of time, the first reception slot is allowed to transition to an inactive state. The first node is one of the sink node, at least one parent node, and at least one child node of the parent node, and the second node is one of child nodes of the first node.

3.Sampling energy consumption in wireless sensor networks

Knowing available energy in each part of a wireless sensor networks (WSN) is undoubtedly essential information. A simple approach to achieve this would be for sensor nodes to periodically report to the sink node on their available energy. This approach is expensive however in terms of energy consumption. In this work we apply several sampling techniques for obtaining such information in WSNs. The results show our samples are representative and the energy map may be satisfactorily built using information from a single subgroup of nodes hence leading to important energy savings

Software components embedded in wireless sensors are generally elaborated taking into account the limited available resources. Operating systems dedicated to the Wireless Sensor Networks (WSN) were thus developed. However, this design method can induce major problems if resource management policies associated to each software component are very different or opposite. The aim is to develop a global method in order to manage the energy consumption of the WSN.

The first goal of this post-doc is to develop an energetic model of wireless sensor in order to virtually test various policies of management. If some generic models exist at the level of the energy consumption of the communication medium, models dedicated to the energy consumption of the memory and the processor are not or poorly addressed in the literature. Some complete models already exist but are only dedicated to a specific hardware architecture of wireless sensor. It highlights the need of a model that can be applied to various wireless sensors. This model will be used in a WSN platform jointly developed by the Cemagref and the LIMOS laboratory of Clermont-Ferrand.

The second objective is to establish optimal action policies for a given sensor. Thus, a wireless sensor can be seen as a system that we would try to optimize the use of its resources such as energy, memory and computing power. The application of the viability theory to the energy management problem will be also studied during this year. The viability theory consists in maintaining a system in a space of constraints (for example, to maintain a frequency of sending between a minimal value and a maximum value). To do that, a control is defined on which one can act and, which allows us to maintain this system into a space of constraints. Thus the management of a wireless sensor can be done thanks to the use of control techniques such as viability. Some recommendations or policies applicable to a wireless sensor would be defined in order to achieve a lifetime long enough while performing assigned tasks. Some simulations will be done before an implementation into a real system. Finally, this work will be extended to the case of the whole WSN at the end of the post-doc.Salary: nearly 2000 euros per month.

An Energy-Efficient Routing Method of Wireless Sensor Networks

In wireless sensor networks(WSNs), as sensor nodes are characterized by having specific requirements such as limited energy availability, low memory and reduced processing power, energy efficiency is a key issue in designing the network routing. In the existing clustering-based routing protocols for the WSNs, the cluster-heads are usually selected randomly and do a lot of work, which may cause unbalanced energy consumption and thus short network lifetime. Based on this approach, the paper proposes a method that a cluster-head distributes energy load evenly among its members based on their energy usage by chain. With the chain, in a cluster, different cycle. The new method balances the nodes’ power depletion. Simulation results show that it has better power management performance and can prolong the lifetime of the network.

4.OPTIMIZATION OF ENERGY CONSUMPTION IN WIRELESS SENSOR NETWORKS

Multiple antenna systems are capable of providing high data rate transmissions in a fading environment without the need of increasing the signal bandwidth. This suggests the question whether they can be used to reduce the energy consumption inwireless networks. Before addressing this problem, we must first understand the problem of minimizing transmit powerssubject to some SIR requirements. In fact, note that for a fixed transmit time *TA*, a fixed number of antennas N and fixed beam formers U(k),V(k) at each transmitter-receiver pair, the problem of energy minimization subject to the SIR requirements is equivalent to minimizing transmit powers subject to the same SIR requirements.

5.CONCLUSIONS

In wireless networks, a widely studied approach is to minimize transmit powers subject to some QoS constraints. However, minimizing the transmit powers is not equivalent to minimizing the energy consumption. In this paper we addressed the problem of minimizing the overall energy consumption in wireless networks including the energy consumption for hardware. Therefore, we first pointed out some basic properties of the optimal power allocation. In order to give some insights, we then discussed the general energy minimization problem that depends on system parameters as the number of antennas N, on the transmission strategy represented by beam formers and number of parallel data streams and on transmit powers. Due to the fact that the general problem is quite complex we focused on a restricted problem. Considering the relation between transmission time and transmit power, we optimized both jointly to find an energy-optimal power-time tradeoff. More precisely, we proposed an algorithm that determines the energy-optimal number of data streams per link for a certain SIR requirement. To gain further insights into the energy minimization problem, it has to be considered for assumptions that may be more general or give another perspective on the problem. Further, note that the notion of energy minimization is not restricted to sensor networks. Thus, in future work the optimization problemmay also include other aims and constraints.

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