Application Specific Threshold-Based Energy Estimation in Wireless Sensor Network

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Abstract: With the recent growth in the applications of wireless sensor network, the energy efficient utilization becomes a critical issue in sensor nodes. In this paper, we are analyzing various technical issues regarding energy efficiency and network lifetime of the sensor network. The working model of sensor network depends upon some specific applications, so we are proposing application specific threshold-based algorithm for energy estimation in wireless sensor network. Finally, we conclude with advantages, limitations and future enhancement of our proposed application specific algorithm.

Keywords: Big Data, Regression, MapReduce, Predictive Analytics.

I Introduction

A wireless sensor network (WSN) is a collection of tiny sensor devices not connected by wires, that can sense, process, and propagate environmental factors like temperature, humidity, pressure, and movements [1]. Every sensor device, referred to as a node, has four basic units: a processor, communication unit, memory and power supply. There are multiple vendors manufacturing different types of sensors and sensor subunits for assembly as sensors. Consequently, there are multiple implementation choices for the hardware and drivers used for communication and to manage the sensors. Some vendors provide an end-to-end solution including sensors, testbeds, drivers and application interface modules; these solutions often come at huge cost, are limited by minimal customization options and have only fixed protocol support [2, 3]. The critical factor in setting up an application of a WSN is to limit node energy as the nodes must be able to execute with limited battery power [4, 5]. Figure 1 presents an architectural view of wireless sensor network.

We need an extensible design of a wireless sensor node and a service panel to consolidate all the hardware/software options so that any desired application with the required WSN profile can easily be set up [6, 7]. The service panel should assist not only in setting up an implementation testbed, but also in managing the WSN activities, especially energy engineering, thereby ensuring extended lifetime of the nodes. Since the demise of a node causes a break in the coverage area, this should be monitored, predicted in advance and avoided [8]. Thus, we need preventative action to identify

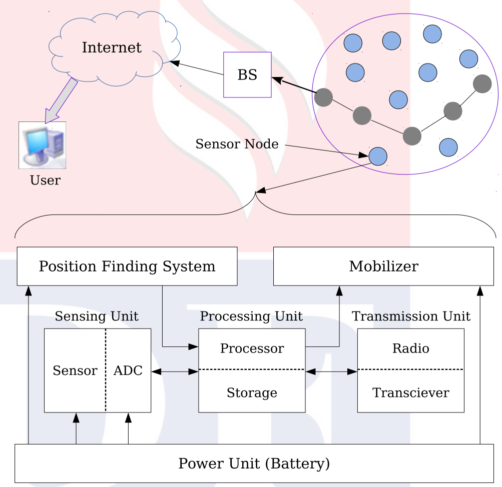

Figure 1: Architecture of Wireless Sensor Network

energy depletion in nodes and predict the loss of a node in the coverage enabling this to be addressed ahead of time as a self healing activity. In this paper, we discuss the energy management framework, which acts as an application specific protocol service panel to set up, functionally manage activities, and support the energy efficiency processes in a WSN.

II WSN Application Fields

The specific applications of wireless sensor network technology have been classified into four major categories: environmental monitoring, health care, security and additional applications as presented in Figure 2. The advantages of the technology can be clearly demonstrated through the WSN application classification even though, regardless of the application field, this technology has the capability to transform worldwide human life in all parts of society [9].

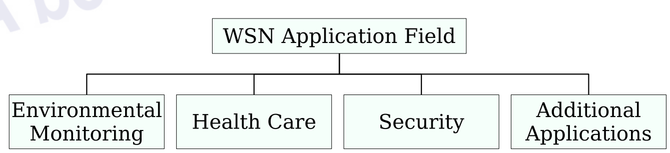

Figure 2: WSN Application Fields

III Challenging Issues in WSN

3.1 Sensor Node Design

Sensor implementations are created for various purposes such as wild fire detection, intruder detection, industry automation, intelligent traffic systems and precision agriculture, using temperature, motion, and humidity sensors. When considering setting up these implementations, the initial considerations revolve around the traditional quality of service (QOS) parameters, namely, baud rate, latency delays, channel utilization, collision avoidance schemes and shortest path routing protocols [10, 11]. However, the key fact to consider is that a sensor network is not just an extension of a traditional network; it exists with limited battery power supply in the nodes, which determines the lifetime of the network. It is difficult to charge remotely distributed nodes and enormous extra effort and cost is spent on energy engineering to reduce the power cost in the name of power budgeting [12].

3.2 Energy Aware Decisions

Based on the discussion above, it is necessary to consider power-aware hardware, drivers, applications, energy optimized protocols, aggregation schemes, scheduling mechanisms and time synchronization methods when designing an implementation. If multimedia data transmission is needed, the graphical ports should be enhanced [13]. Thereafter, there may be a need for multiple integrated sensors rather than a single sensor. In the case of a traffic sensor, temperature sensors for fog detection and movement sensors for understanding the traffic are incorporated. If there is a need for location awareness, geosensors must also be taken into account. Multiple protocol support and multiple communication unit support with configurable bandwidths constitute the next decisions. A single testbed supporting multiple purposes has many features that can lead to complexity in the future [14, 15].

3.3 Custom Hardware Design with Custom Software

In the current market, there are no ready-made hardware designs that support all these considerations. In most cases, either custom hardware is designed or standard devices are customized. Adopting the former option involves drivers and application design. In the latter case, it is almost impossible to customize the system, since in doing so, we invariably loose the technical support and guarantees of the vendor. Hardware and drivers are almost integrated with fewer choices [16].

Software applications are associated with the hardware and consolidate the programming abstraction of the selected application logic as the needs of the next level. Nevertheless, developing a framework for a configurable hardware neutral application is near impossible [17].

IV Related Work

Most simulator and implementation hardware vendors consider a WSN as an extension of a traditional network, with the exception that data and control communication is wireless. It is a fact that the limited power supply in a wireless network is hardly considered. The difficulty in remote charging and the risk of dead nodes and broken links for communication due to a lack of energy in the critical implementation are seldom considered during the design and deployment, nor in the selection of an application, that is, the algorithmic components of the WSN. Recently, researchers have begun incorporating and spending more effort on energy engineering in WSNs.

4.1 Energy Efficient Protocol Design

Low energy adaptive clustering hierarchy (LEACH) [18] protocol design creates distributed cluster heads and uses energy efficient techniques like rotating cluster heads and local processing to reduce global communication and compress data for minimal transmission frames. HEED (hybrid energy-efficient distributed clustering) [19] is the cluster based communication protocol. Data centric protocols (SPIN) are designed in such a way that the metadata are published as advertisement metadata (ADV) packets rather than publishing the actual data. Nodes that are interested in the advertised message send a request for the data (REQ) to the publisher node, which, in turn, sends the data only to those nodes having expressed interest, rather than to all the nodes. Bluetooth smart protocols are available as single and dual mode low energy versions, in which all communication is low energy and builds on the service-based architecture [20].

4.2 Energy Efficient Software Component Design

In existing energy-balanced data aggregation algorithms, there is a trade-off between delay and energy consumption. Thus, data can be prioritized and lower-priority data can be delayed to save energy. PEGASIS is an energy greedy chain-based aggregation algorithm where the energy consumption during the aggregation process is also considered in decision-making. In the case of data aggregation algorithms, the network of sensors is considered as images and data packets are transmitted based on behavioral analysis, receiver tolerance limits and predicted data rates, rather than using immediate aggregation or transmission. Location-aware approaches and suppression-based selection, aggregation and multi-path aggregation are some of the variations of the generic aggregation methods in the more recent protocols for energy efficiency improvement.

4.3 Energy Engineering in WSN

Energy engineering initiatives in WSNs can be broadly classified as energy auditing, energy optimization, energy harvesting and energy scavenging. The first step in energy engineering is to measure and monitor energy usage. An energy audit is an inspection, survey and analysis of energy flows for energy conservation in a process or system to reduce the amount of energy input into the system without negatively affecting the output(s). This has the effect of making the design and operation energy-aware, thereby reducing energy consumption. This is referred to as energy optimization. The energy reclaimed from the unused portion of energy that is dumped is referred to as energy scavenging. Energy harvesting is the systematic process by which energy is derived from the external sources captured and stored [21, 22].

V Proposed Model

We proposed an integrated energy management framework for WSNs development and application specific WSNs. An energy model is the collection of factors considered in a WSN system to measure energy. In traditional energy measurement methods, only the residual energy is considered; activity wise, unit wise and application component wise energy is not recorded. Therefore, we need a more accurate energy model for micro energy management. The energy model must be able to capture both activity level energy and operational level energy. It is depicted in Figure 3.

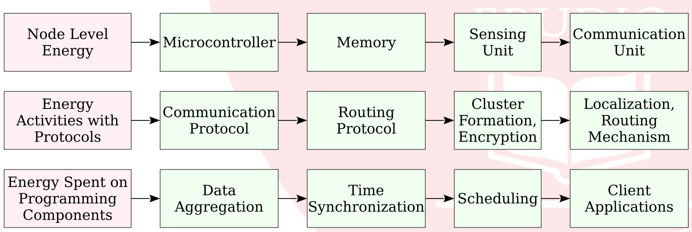

Figure 3: Proposed Framework

When energy optimization is considered proactively in the design of the application testbed and in the WSN itself, power cost can be reduced substantially with a minimum capital investment in optimization. However, validation of the investment in energy saving, the cost saved from the energy optimization, and the consistency of the QoS parameters before and after the energy saving must be performed.

VI Conclusion and Future Work

The paper presents an efficient platforms for the WSN which are available for establishing better end-to-end integration and voluminous sensing and processing. These inclusive platforms simplify the connectivity of devices in the WSN, protocol stacks, data processing and data reporting. Hard ware platforms serve this purpose and efficient data handling of data in a WSN with a platform invariably improves energy consumption and gives us an insight into the business intelligence of power budgeting.

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