Wireless Sensor Network Using ARM Processors: A Review in Hardware Perspective

Manivannan Doraipandian, School of Computing, SASTRA University, Tamilnadu, India
Periasamy Neelamegam, School of Electrical and Electronics, SASTRA University, Tamilnadu, India

ABSTRACT
The hardware design of Wireless Sensor Networks (WSN) is the crux of its effective deployment. Nowadays these networks are used in microscopic, secure and high-end embedded products. WSN’s potentiality in terms of efficient data sensing and distributed data processing has led to its usage in applications for measurement and tracking. WSN comprises of small number of embedded devices known as sensor nodes, gateways and base stations. Sensor nodes consist of sensors, processors and transceivers. The property of embedded sensor devices, also called motes, is to determine the strength of WSN. Thus processor selection for the motes plays a critical role in determining a WSN’s competency. In this article, the absolute and obvious hardware characteristics of available and proposed sensor nodes are discussed. The objective of this work was to increase the efficiency and provision of sensor nodes by evaluating their processing and transceiver units. During this work, a sensor node was developed with ARM processor and XBee series 2 Unit. LPC 2148, LPC 2378 ARM processors were posed as processing unit and XBee series 2 acted as communication unit. Results of this experimental setup were recorded. Also a comparative study of the various available sensor nodes and proposed sensor nodes was done extensively.

Keywords: ARM, LPC 2148, LPC 2378, WSN, XBee2 and Motes

INTRODUCTION
A Wireless Sensor Network (WSN), a spatially distributed network, consists of tiny devices called “sensor nodes” also referred to as “Motes”. A Wireless network’s success is attributed to its monumental advancement in processor power, communication and usage of low power embedded computing devices. Sensor nodes (Ann Holms et al., 2006) are used to monitor environmental conditions like temperature, pressure, humidity, sound, vibration, position etc. The focal characteristics of sensor nodes are energy efficiency, low power consumption, small size, multi hop communication, adaptability over a network, self-configure mode etc. In real time, sensor nodes are more constrained in terms of computational energy and storage resources. Factors such as accuracy, reliability, physical parameters and real time constraints are the important restraints for the design of sensor node and network.

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Sensor nodes are equipped with four broad units namely sensing, processing, communication and power management (Holms et al., 2006). Each and every node has the ability to perform data gathering (Tharini et al., 2010), sensing, processing and communication. The sensing unit perceives the environment, the processing unit computes the limited permutations of the sensed data, and the communication unit executes exchange of processed information among neighbor nodes. Sensing unit integrates data from different types of sensors like thermal sensors, magnetic sensors, vibration sensors, chemical sensors, bio sensors and light sensors. The parameters measured by the sensors are fed into the processing unit which is the core of a sensor node.

In the processing unit, selection of processor/controller is the key, as it controls WSN’s development in spheres of cost, flexibility, scalability, ease of programming and low power consumption (Gholamzadeh et al., 2008). This central unit executes different tasks and controls the functionality of other components. The required services from the same are pre-programmed and installed into the processor. The energy utilization rate of the processor varies depending upon the nodes. The performance variation of the processor is identified from evaluating factors like speed, data rate, memory and peripherals supported by it. ATMEGA 128L, MSP 430 controllers are used popularly in motes (Healy et al., 2008). The computations are performed in the processing unit and the acquired result is transmitted to the base station through the communication unit.

In communication unit, a common transceiver acts as an exchange unit to facilitate transmission and reception of information amongst the nodes and base station. Radio frequency (RF) is mainly used for node-to-node communication since it does not require any line of sight (LOS). The four states in the communication systems are transmit, receive, idle (Ready to receive) and sleep (a function to switch off hardware thereby saving energy). These states are used to enhance the overall performance.

A sensor node is identified for WSN based on the parameters like computation rate, processing speed, storage, communication range (Healy et al., 2008). Relay node is an intermediate node assisting communication with the adjacent node. Actor node resolves actions depending upon the environment. It facilitates remote and automated interaction. Actor (Akyildiz et al., 2004) and Relay nodes are resource-rich devices. They are furnished with good processing capabilities, higher transmission powers and greater battery life. Sensor nodes (Tapia et al., 2009) are clustered along with a gateway; relay and actor nodes (Zhang et al., 2010) within its communication range and thus establishes the WSN. Cluster is nothing but a collection of sensor nodes in that particular sensor field. A typical WSN comprises of many clusters.

In some applications, sensor nodes are categorized into special purpose node, generic purpose node, low bandwidth node, high bandwidth node or gateway node based on its operational environment and scope (Benbasat et al., 2005). On board processing, computation rate and communication range differs from node to node in the network. Particularly for certain dedicated applications the sensor nodes are in accordance with their utility factors and services. For example, smart nodes are used for special purpose devices and intelligent nodes are exploited for generic functions. A high end smart node along with high bandwidth gateway nodes (Edmund et al., 2005) is availed for interconnectivity functions. Sensor node’s deployment may be fixed or random and is usually in an open environment for tracing physical and environmental changes. It transmits the information to a centralized server called gateway.

The computational rate and interaction latency of sensor nodes within the physical environment differs from node to node (Zoran et al., 2008). In real time applications, they perform different tasks like neighbor node discovery, smart sensing, data storage and processing, data aggregation (Tharini et al., 2010), target tracking, control and monitoring, node localization, synchronization and efficient routing between nodes and base station (Benbasat et al., 2005). For these functionalities, the required processing power by the sensor nodes is very high.
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