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Review Paper

Wireless Sensor Networks, A Review: Factors to be considered in implementation

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Abstract

This paper provides a brief review about the IEEE standards for WSN, WSN Topologies, its components, basic architecture and factors affecting its implementations in the real world. Smart sensors are capable of sensing and producing useful results when used along with computers and other devices connected in a network. It is also possible to manage and monitor these devices remotely without much human intervention. Using this technology not only affects and improves performance of a system but it can also provide better decision abilities as well as better control. Much more technology advancement is taking place in newly emerging fields as data collection, application control, monitoring of systems, supply chain logistics etc. One of the purposes of the development of these networks is to reduce the direct involvement of man power and to automate systems reducing the risk of human error. Many wireless devices such as sensors, gauges and actuators can now be monitored easily in wireless mode. However a few factors need to be checked before the implementation of these nodes in the real world and careful analysis is required for its implementation.

Keywords: Wireless Sensor Network Implementation, Smart Sensors Technology, Automation by using Smart Sensor Networks, Sensor Network Topologies, Wireless Sensor Architecture, Factors affecting Wireless Sensors.

Introduction

Wireless sensor networks (WSNs) are fast growing, useful and reliable technology upon which we are depending for accuracy. This is also a low cost technology using less power and that too a wireless technology. WSNs are a group of spatially distributed sensing nodes (Figure-1) with low maintenance requirements, which can automatically monitor environmental parameters and cooperatively transfer the data through a gateway to a main database using wireless networking[1]. The protocol used in the wireless technology depends on the requirement of application[2]. Some of the standards currently available are in the 2.4 GHz. They are generally based on IEEE 802.15.4/IEEE 802.11 Wi-Fi standards. There are a many applications for WSN ranging from environmental monitoring to health care[3].

Wireless sensor networks (WSNs) have distributed autonomous sensor 'nodes'. These nodes work in coordination and send their data through a network to the main node called 'gateway' in the system[4]. The networks have different topologies; common examples include star and mesh topologies[5]. Medium access control (MAC) protocols must be established to allow communication over the network by multiple devices and routing algorithms must be developed to create reliable and energy efficient package delivery [6]. A few factors also need to be tested before implementations[9].

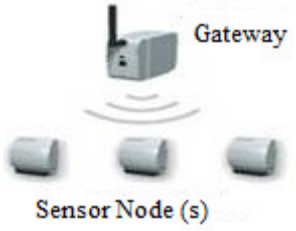

Figure-1
Gateway and Distributed Nodes in a WSN

WSN Components

A WSN network comprises various components as Radio with given frequencies, Battery for power supply, Microcontroller for processing, an Analog Circuit along with a Sensor Interface (Figure-2). Using data at higher rates and use of radio signals frequently in the radio by the nodes may also result in higher Power consumption.

The next consideration in the technology of WSN systems is its battery life. It is generally considered that a battery should have a three years life which is also a requirement. Therefore many of the WSN systems deployed now a days uses a a lower power consumption technology called Zigbee[7]. Due to the available IEEE 802.11 bandwidth and evolvement of technologies for improving battery life power management etc., Wi-Fi has

become an interesting technology. Apart from longer battery life, some other factors to be considered are as per the international standards are the weight and size of batters. As carbon Zinc and Alkaline batteries are of low cost and available widely they are the preferred choice.

WSN nodes periodical wake up and transmit data, and go back to sleep mode whenever transmission is not required. This improves battery life to a lot extend. Thus the processor wakes, powers up and returns to sleep mode quite efficiently. Efficient use of power while maintaining and increasing processor speed should also be a feature of microprocessors of WSNs. The above factors play a key role in the selection of a processor for a WSN.

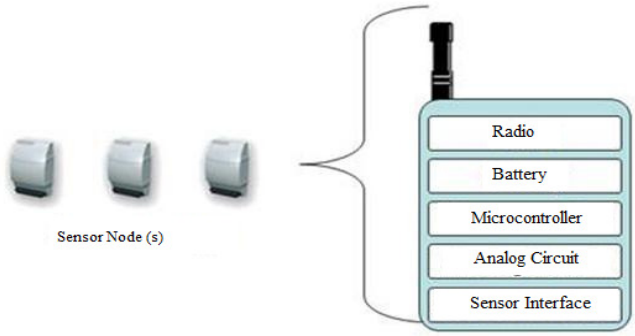

Figure-2
Components of Sensor Nodes in a WSN

WSN Network topologies

WSN nodes use topologies which can be broadly classified into three types. They are Star, Cluster Tree and Mesh (Figure-3).

Star Topology: In this type each node directly gets connected to a gateway.

Cluster Tree Topology: In this type each node connects to its higher node and then gets connected to the gateway. Routing of the data takes place from the lowest to the highest node and then ultimately passes through the gateway.

Mesh Topology: Nodes can be connected to multiple nodes forming a system and then pass data through the most reliable path which is available in the network. This link through this data passes is generally referred as a router.

Basic Architecture of a Smart Sensors

The components of Smart Sensor Nodes which form its architecture are shown in the Figure-4. The sensing unit is used for sensing the changes in the parameters and the digital signals get generated from the electrical signals by the circuit called signal conditioning. Analog to Digital conversion is performed and the output is provided as input to the processing units or programs in application. Transceivers are used for communication with base station and the task processing is done with the help of memory unit.

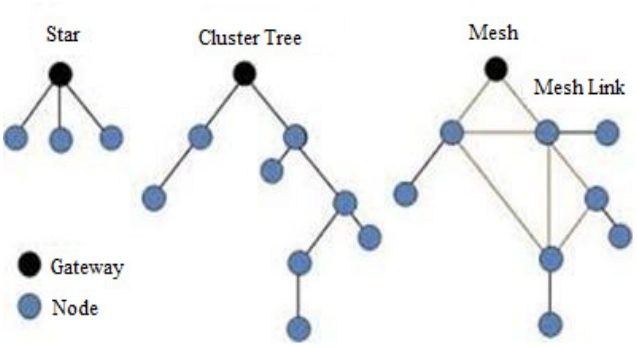

Figure-3
Network Topologies used in WSN

The sensor nodes comprise of various parts as Central Unit, Battery, Transceiver, Memory and a Communication Module. The Central unit is a type of Microprocessor used for managing the process, Batteries are used as a power source, Transceiver is used for interaction and collection of data, Memory for storing and processing of data and the Communication Module comprising of transceiver is used to forward and receive data to and from the central module.

Since WSNs are generally placed in remote areas, replacement and repairing of nodes is difficult. Thus energy efficiency plays a crucial role for longer network life. The various nodes cooperate and spread the task of data processing and finally send the processed information to sinks.

Keeping the above factors in view RFID chips are used as they have no batteries. To monitor different parameters such as noise levels at various places (Construction sites, Traffic Signals), lighting, humidity, movement of vehicles, makeup of soil, to check mechanical stress level etc., sensors may be used. These sensors may also be thermal, acoustic, magnetic, visual, seismic or radar. These sensors may identify themselves and can also diagnose for any errors.

Working of the sensor nodes may be broadly classified as per their targeted categories. The categories may be broadly divided: (i) To target a predefined object using line of sight for example in visual sensors. (Calculating speed of a moving vehicle) (ii) To target Space and Time Relationship as in Seismic sensors (Earth quake etc.) (iii) To seek propagation which is wave like as in Acoustic sensors.

Unlike address centric networks (IP based), these are data centric networks. Instead here the queries are directed to a sensor network cluster. This data is collected and aggregated in a local node meaning the aggregator node does the function of analyzing the data; summarize the findings and aggregation of the data which results in the reduction of communication bandwidth. This aggregation of data also increases the level of accuracy as the conclusion is drawn considering failure of nodes, data redundancy etc.

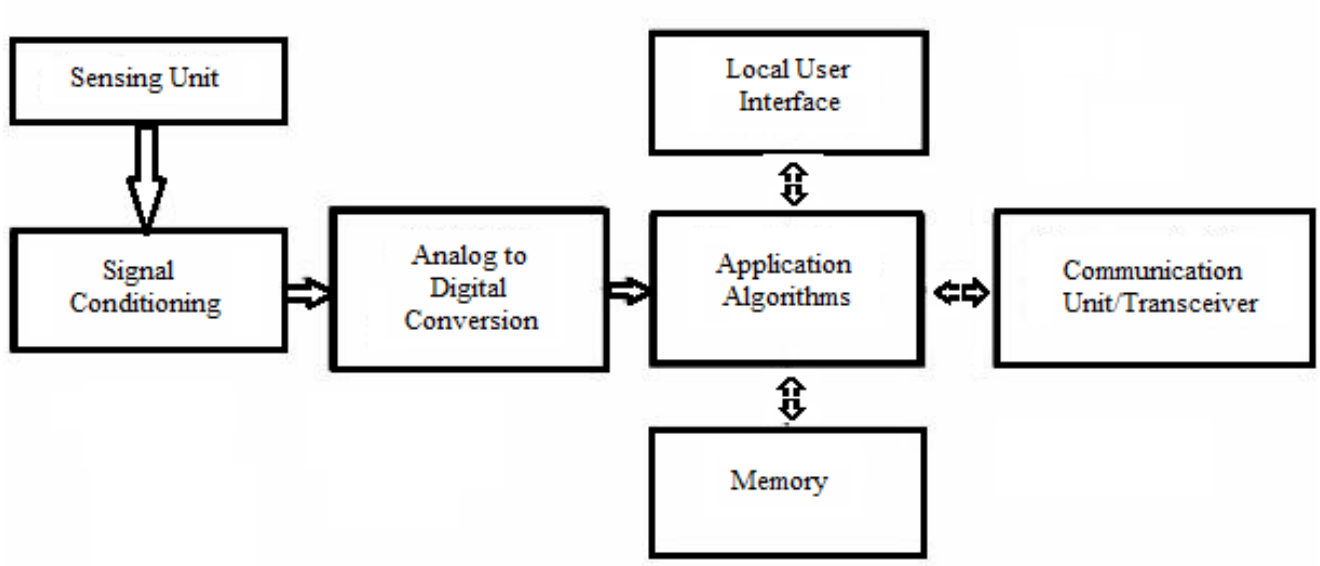

Figure-4
Components of Smart Sensor Node Architecture

Sensor nodes combine various tasks such as sensing, computing, controlling etc. Therefore while implementing the nodes in various types of networks (simple and complex) the cost and size of individual sensor node play a vital role. Purpose of the sensor networks also has an important role in determining its type. They can either support or prevent any rapid response during events and may recovery afterwards with after analysis of events.

The count of sensor nodes deployed (number of nodes used) can be a crucial factor affecting the results. Deployment of lesser number of nodes may not provide accuracy and too many nodes can result in wastage of resources in terms of cost, energy and maintenance. It is very necessary to analyze the approximate number of nodes to be deployed by thorough analysis. Duration of the deployment of nodes may also be a factor. Longer deployment may require higher quality, high power requirements and durability.

Basic Standards for Smart Sensor Networks

Though sensing is the main function of a sensor network, it has many other desirable functions such as reliability, self-identification, ease of installation etc. A few points such as Coordination with other sensor networks, Standard Control Protocols and Network Interfaces are also important.

IEEE-1451: In year 1993 IEEE and NIST (National Institute of Standards and Technology) worked on a standard for Smart Sensor. IEEE-1451 was thus developed. Development of new Smart Sensor networks and the interfaces with the devices to networks was much easier due to the use of above standards[7].

Figure-5 shows the basic components as TEDS, TII, STIM and NCAP. IEEE-1451 gave the formal concept of Smart Sensors[8]. A smart sensor provides extra functions apart from generating a better representation of sensed information.

Definition of TEDS for each transducer is a key elements of IEEE-1451. It can be implemented as a memory which is attached to the transducer and which contain information needed by the measurement instrument or a control system to interface with a transducer. TEDS can be implemented in two ways, first in which it can reside in the embedded memory i.e. Electrical Erasable Programmable Read Only Memory (EEPROM) in the transducer which may be connected to the control system or the system for measurement and the second is a virtual one which can exist as a data file which can be accessed by control system or measurement instrument.

Other factors to be Considered in Implementation

The conclusion on an experiment performed on ZigBee Technology can play a vital role for assessment of node range while using in the field[8]. In the experiment in a real greenhouse environment which was performed with growing plants they found that the impact of foliage of the cultivated crop affected the performance of the network significantly. The range of the sensing nodes as specified by the vendor was far higher than the results found while experimentation in the real time concluding that the network topology and density should be carefully analyzed before implementation. Nominal distance values provided by a WSN vendor should not be misconceived and in order to achieve a well-functioning deployment thorough experimentation may be necessary. Such factors may be affective in other fields also. Analysis may be required as and when necessary and the performance of devices may be considered after a thorough observation and conclusions in the field for correct throughput.

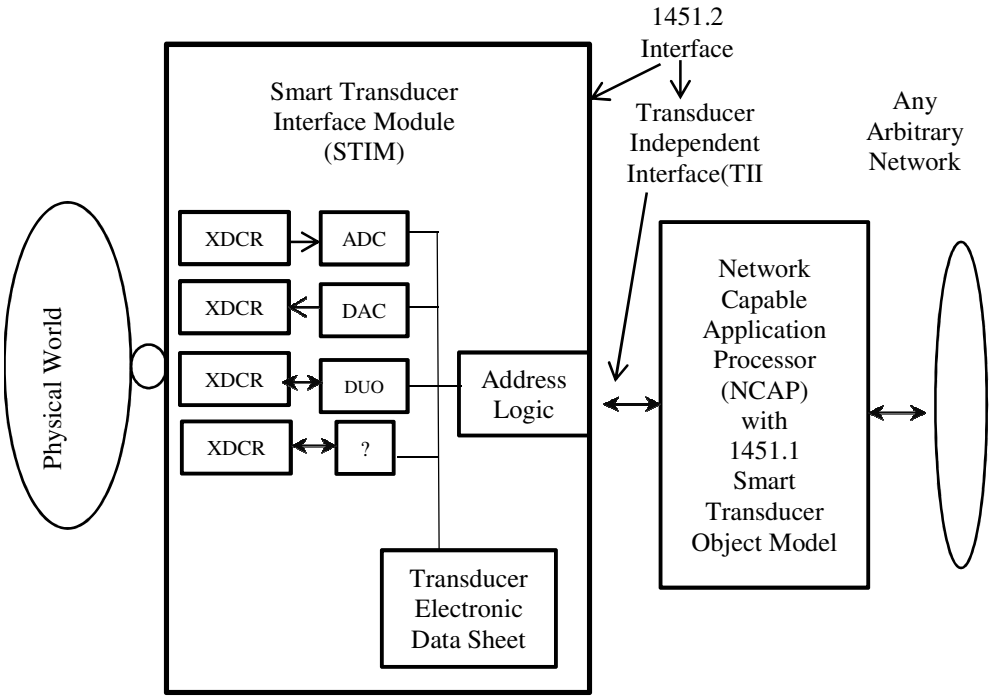

Figure-5
IEEE1451 Standard for Smart Sensor Node

Conclusion

Sensor Networks play a vital role in gathering and sensing information in remote locations as and when required. The field of Smart Sensor Technology offers a wide scope for research may be power related issues, efficient design, efficient operation etc. Since these technologies have a vast possibility in the future, a lot needs to be done in every aspect which may be application, technology or efficiency. It is also very important to do a thorough study before deployment for best results. Further work is necessary in the areas of battery life, media access control and security.

References

1. Akyildiz F. and Kasimoglu I. (2004). Wirless Sensor and Actor Networks: Research Challenges. *Ad Hoc Networks*, 2(4), 351-367.

2. Puccinelli D. and Haengii M. (2005). Wireless Sensor Networks: Applications and Challenges of Ubiquitous Sensing. *IEEE Circuits and Systems Magazine*, 5(3), 19-31.

3. Othman M. and Shazali K. (2012). Wireless Sensor Network Applications: A Study in Environment Monitoring System. *Procedia Engineering*, 41, 1204-1210.

4. Akyildix F. and Kasimoglu I.H. (2004). Wireless Sensors and Actor Networks: Research Challenges. *Ad Hoc Networks*, 2(4), 351-365

5. Buratti C., Conti A., Dardari D. and Verdone R. (2009). An Overview on Wireless Sensor Networks Technology and Evolution. *Sensors*, 9(9), 869-6896.

6. Demirkol C.E.F.A.I. (2006). MAC Protocols for Wireless Sensor Networks: A Survey. IEEE Communications Magazine, 115-121.

7. Lewis F.L. (2005). Wireless Sensor Networks, Advanced Controls, Sensors, and MEMS Group Automation and Robotics Research Institute. The University of Texas at Arlington

8. Manali Chaudhari and Srinu Dharavath (2014). Study of Smart Sensors and their Applications. *International Journal of Advanced Research in Computer and Communication Engineering,* 3(1).

9. Ilias Lamprinos and Marios Charalambides (2015). Experimental Assessment of Zigbee as the Communication Technology of a Wireless Sensor Network for Greenhouse Monitoring. *International Journal of Advanced Smart Sensor Network Systems (IJASSN)*, 5(3-4).