A Comprehensive Survey of Wireless Sensor in Precise Applications

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## ABSTRACT

Wireless Sensor Networks (WSNs) are built of nodes which consist of a radio transceiver, micro controller and sensors. Sensors having different applications can be used so that it can perform well in any area. Mainly sensors are classified according to the readiness for field deployment that focuses in the field deployment in terms of economy and engineering efficiency, scalability and cost. The main categories of sensors are given as physical, chemical and biological sensors. The Wireless Sensor Networks consist of data acquisition network and data distribution network. The network will be managed and controlled by a central station. The data acquisition network in the wireless sensor network is used to acquire data from different fields. The acquired data is transmitted to the master station by means of different wireless distribution techniques..

**Keywords**—Wireless Sensor Networks (WSN);Sensor;Applications ;( (keywords)

## INTRODUCTION

A WSN consists of spatially distributed sensors, and one or more sink nodes (also called base stations). Sensors monitor, in real-time, physical conditions, such as temperature, vibration, or motion, and produce sensory data. A sensor node could behave both as data originator and data router. A sink, on the other hand, collects data from sensors. For example, in an event monitoring application, sensors are required to send data to the sink(s) when they detect the occurrence of events of interest. The sink may communicate with the end-user via direct connections, the Internet, satellite, or any type of wireless links.

## EASEOFBUILDING BLOCKS OF SENSOR NETWORKS

## The use of wireless technology has increased rapidly due to its convenience and cost effectiveness. A wireless sensor network (WSN) usually consists of a large number (hundreds or thousands) of sensor nodes deployed over a geographical region. Typically, sensors are deployed in a high-density manner and in large quantities. The wireless sensor nodes are compact, light-weighted, and battery-powered devices that can be used in virtually any environment.The major components of a typical sensor network are

1. **Sensor Field**

A sensor field can be considered as the area in which the nodes are placed.

## Sensor Nodes

Sensors nodes are the heart of the network. They are in charge of collecting data and routing the information.

1. **Base Station**

The base station is a centralized point of control within the network, which extracts information or data from the network and disseminates control information back into the network. It serves as a gateway to other networks, a powerful data processing and storage centre and an access point for a human interface. The base station is either a laptop or a workstation. Data is streamed to these workstations either via the Internet, wireless channels, satellite etc.

1. **User**

User is the user of the data or information of wireless sensor network that uses to do desired task or take decision.The sensor nodes monitor physical or environmental conditions such as temperature/heat, humidity, sound, vibration, pressure, light, object motion, pollutants, presence of certain objects, noise level or characteristics of an object such as weight, size, speed, direction, and its latest position. Each sensor node is made up of four components: a power unit, a transceiver unit, a sensing unit, and a processing unitThe node may also have some application-dependent components such as power generator, location finding system, and mobilizer. Communication among the nodes is done in a wireless fashion, and thus, the name wireless sensor networks. WSNs belong to the general family of sensor networks that employ distributed sensors to collect information on entities of interest. In general, there may be both sensing and non-sensing nodes in a WSN; i.e. all sensors are nodes but not all nodes are sensors. A sensor has four operating modes: transmission, reception, idle listening, and sleep. Collision occurs when there are two or more nodes transmitting at the same time.



**Figure 1: Blocks of WSN**

## CHALLENGES

Although healthcare applications of WSN have significant benefits, they faces some challenges such as low power, limited computation, low bandwidth, reliable data transmission, continuous operation, interference, node mobility support, vulnerability, security, timely delivery of data, security, privacy, congestion, and regulatory restraints. WSN devices are generally limited in terms of power, computation, and communication. The low amount of power directly limits computation. WSNs are vulnerable to various sensor faults and this vulnerability hinders efficient and timely response in healthcare applications. Security is an important issue for any system, especially in healthcare WSNs, where we are dealing with sensitive medical data of individuals. Security breach in healthcare applications of WSNs is a major concern. Privacy is another major concern of patients and the greatest barrier to electronic healthcare deployment. Healthcare applications impose constraint on end-to-end reliability, which measures how well they system performs in the presence of disturbances. Congestion must be curbed since it affects flow of data and delay in data delivery. The integration of multiple sensing devices operating at different frequencies cause interoperable problem.

Energy efficiency of the WBANs sensor nodes are the main critical issue in ubiquitous mobile health monitoring systems. The rechargeable batteries may be one of the solutions but recharging the batteries of several sensor nodes may be a burden for the patients. Especially the elderly patients may forget to get recharge on time. So the auto rechargeable systems may be applied to overcome this issue. There is a need of studying energy scavenging techniques.. The researchers from biochemistry side are trying to apply the techniques to optimize the energy of the battery by some phosphates presents in a human body. The computer science researcher has applied the multiple approaches during the data transmission at RF radio frequency bandwidth. They applied these techniques for the better data transmission including CDMA, FDMA, CSMA and TDMA, the best one found among these are TDMA.

Security is one of the concerned topics in WBANs network to protect privacy of medical data. Security of the WBANs depends upon data confidentiality, data authentications, and secures localization secure management. These are the main factors to secure any wireless network. There are variety of security attacks like Denial of Service Attacks (DOS), privacy violation and physical attacks. When applied on the network and different results have been answered.

There are different best securities methods have been applied to secure the data. Welch Gong (WG) technique employs for the designed ubiquitous computing and produces good result for the security. Other modern public key cryptography techniques like lattice based cryptography, elliptic curve cryptography and quantum cryptography are also used for secure the network.

Architecture of the WBANs has its own importance and it is divided into three levels. 1. Level – 1 (Lowest level – contains intelligent sensors) 2. Level – 2 (Devices communicate with external low level devices) 3. Level – 3 (External servers which provide different tasks and services) Server keeps the record for managing the data of the patients and provided when user demanded. Data management of sensor node is another issue. It reduces the usage of sensor node. At the same time, the data management and security assistance of the architecture is another main issue.

Quality of Service (QoS) is a major aspect in WBANs. The main concern of QoS is optimal utilization of resources over wireless networks and Internet. Unfortunately, this area did not get lot of interest from the researchers like other areas such as energy efficiency and security. There is limited work available in the area of QoS. The major QoS Challenges are resource limitations, Unpredictable traffic pattern, network instability, data redundancy and energy balance

**Figure 2: Applications of WSN**

1. **APPLICATION**

WSNs are composed of individual embedded systems that are capable of interacting with their environment through sensors, processing information locally, and communicating this data wirelessly with their neighbour. There are different wireless technologies used in medical applications such as WBAN, WPAN, WWSN etc., the Wireless Body Area Network (WBAN) is a technology widely used in medical applications with continuously operating sensors. It measures the patient physiological signals such as mobility, blood pressure, heart rate and sugar levels, etc., This survey is presented with Wearable Wireless Sensor Networks (WSN). The performance analysis of the wireless sensors networks on how they perform in healthcare. Body sensor network (BSN) systems can help people by providing healthcare services such as medical monitoring, medical data access, and communication with the healthcare provider or the doctor in emergency situations via SMS or GPRS.Continuous health monitoring with wearable or implantable body sensor networks will increase the detection of emergency conditions in case of risk patients. Also, these systems provide some useful methods to acquire and monitor the physiological signals without the need of interruption of the patient’s normal life, thus improving life quality

## Wireless Body Sensor Network

The WBSN is a wireless network that is designed to allow communication through sensor nodes that are attached to a human body to monitor body’s vital signals, parameters and environment. The design and development of such WBSN systems for health monitoring have received a large amount of attention in research and industry. This attention is mainly motivated by costly health care and by recent advances in the development of miniature health monitoring devices as well as emerging technologies. Model checking approach that is based on a model transformation to validate the automatically derived behavior of a WBSN for health monitoring. This model driven approach will check whether the derived system behaves correctly according to its global specification, while the objective is to increase the system’s performance and QoS. This approach allows the developer to reason about a model of the global system rather than about the system itself [1].

## Healthcare Monitoring System Using Wireless Sensor Network

By building a bridge between a WS and public communication networks, and being compatible with an onboard data decision system and a lightweight database, their smart gateway system is enabled to make patients' health state decisions in low-power and low-cost embedded system. It also used to get faster response time o the emergencies. They have also designed the communication protocols between WSN, gateway and remote servers. Additionally Ethernet, Wi-Fi and GSM/GPRS communication module are integrated into the smart gateway in order to report and notify information to care-givers. This new technology has potential to offer a wide range of benefits to patients, medical personnel, and society through continuous monitoring in the ambulatory setting, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information. This system can be placed in a hospital or a patient’s house, through this wireless sensor network the sensor nodes collect Some physiological indexes of the patients or monitor the running state of the medical devices and transmit the data to the sink node or the local computer. The wireless sensor network can connect to the remote central server by several means. This remote health care system has good scalability and high flexibility and may have a widely application in the community medical service system, care unit and so on. An even bigger, more widely used remote medical service system can be built by connecting the wireless sensor networks to the Internet. This thinks it is very important to serve the patients better. Certainly, some kind of special wireless sensor networks can be developed for special medical use to perfect the remote care system based on wireless sensor networks. Tasks like sensor data database, DDS and real-time report are conducted in a low power embedded system. Hardware and software design of the gateway are presented and transmit protocols are designed for this gateway central system. Optimizing the interconnection by employing GPRS communication between gateway and remote server to extend the available coverage of the health care system and upgrade the DDS. Then, it may consider for integrating internet base webpage and voice call function in the gateway [2].

1. **Wireless Body Area Networks (WBAN)**

Healthcare systems have been facing various new challenges due to increasing and rising aging population in healthcare. Advance information and communication technologies have introduced Wireless Body Area Networks (WBANs) for healthcare systems. WBANs provide different monitoring services in healthcare sector for monitoring their patients with more convenience. WBANs are economical solutions and non-invasive technology for healthcare applications. These networks contain intelligent and small bio-medical sensors which are implanted in patient body or on patient body. These sensor nodes process the information and further send to a medical server where this information is stored and analyzed by doctors or medical specialists. Different types of monitoring applications in WBANs provide easy and cost effective solutions in healthcare. These advance systems facilitate the patients with physical mobility support without stay long in hospitals. In WBANs, the system has different monitoring sensors nodes such as sensors and actuators. The sensor nodes are used to measure the certain body parameters whereas the actuators act on received data from other sensor nodes. The personal devices act as control unit to collect data from sensor nodes and transmit to the medical server using wireless link [3].

1. **Precision Agriculture**

Precision agriculture aims at building cultural operations more resourceful, while reducing environmental impact. The information collected from sensors is used to appraise most favorable sowing density, estimate fertilizers and other inputs needs, and to more precisely predict crop yields. WSN plays an inevitable role in the field of agriculture. The architecture consists of the field provided with a number of wireless sensor nodes which are used for the collection and monitoring of data like temperature, humidity, carbon dioxide gas levels, soil moisture etc. The sensed and collected data is sent to the human expertise through the cloud computing technology or by Internet. The researchers present in the central station can analyze and take further actions to improve the crop yield with low cost.Many researches are ongoing by including the sensors in agriculture. In a real time monitoring of data using Zigbee to monitor the climate and other environmental properties are done using the wireless sensors. The main objective of the paper is to report all the design, construction and testing of all the environmental properties that is required for the precision agriculture using wireless sensor networks. The network is comprised of a number of automated measuring stations and it aids in monitoring the soil moisture in real time. Thus the use of wireless sensor networks in the field of agriculture helps in the collection of weather, crop and soil information, monitoring of the crops and land[4].

1. **Wireless Sensor Network Air Pollution Monitoring System (WAPMS)**

The use of Wireless Sensor Networks (WSN) for air pollution monitoring are of widely used in the fast growing industrial activities, becoming a major concern for the health of the population. The proposed systemWireless Sensor Network Air Pollution Monitoring System (WAPMS) to monitor air pollution makes use of an Air Quality Index (AQI). In order toimprove the efficiency of WAPMS, The system have designed and implemented a new data aggregation algorithmnamed Recursive Converging Quartiles (RCQ). The algorithm is used to merge data to eliminateduplicates, filter out invalid readings and summarize them into a simpler form which significantly reducethe amount of data to be transmitted to the sink and thus saving energy. For better power management it has been used a hierarchical routing protocol in WAPMS and caused the motes to sleep during idle time.Air pollution monitoring is considered as a very complex task but nevertheless it is veryimportant. Traditionally data loggers were used to collect data periodically and this was verytime consuming and quite expensive. The use of WSN can make air pollution monitoring lesscomplex and more instantaneous readings can be obtained.The flexibility of the system and makes it difficult to ensure proper control and monitoring.WAPMS will try to enhance this situation by being more flexible and timely. Moreover, accurate data with indexing capabilities will be able to obtain with WAPMS. Analysis of monitoring data allows us to assess how bad air pollution is from day to day, which areas are worse than others and whether levels are rising or falling [5].

1. **Underwater Ecological Mapping**

It is of great significance to establish a space-earth based integrated monitoring system to enhance the ability for water environmental risk prevention. Modern remote sensing technology has been used in surveying and providing urban water environment information combined with GIS spatial analysis and information management capabilities of water bodies such as lakes and reservoirs. With the use of satellite image, aerial photography and other means providing all-weather, omni-directional, multi-bands, multi-temporal remote sensing image information, the water temperature, total suspended solids, particulate matter, chlorophyll, transparency (turbidity), thermal pollution and other information could be obtained; secondly, with integrated methods of laboratory testing, water quality monitoring sites, the crosssection of the routine monitoring of benzene, phenol, COD, ammonia nitrogen, total phosphorus concentrations could be assessed;thirdly, with the use of online monitoring of toxic chemical substances, the arsenic, mercury concentration could be monitored. The traditional monitoring of lakes and such water bodies is mainly a point monitoring. It’s hard to reflect the space change of water environment and attain an objective analysis. The rapid and objective space monitoring of RS overcomes the deficiencies of traditional methods, in providing a scientific solution for surface water quality monitoring. A large number of simultaneous observation experiments about remote sensing satellites transit and simulation experiments about hydrology, water environment, coupled with the migration characteristics and laws of apparent optical properties/ inherent optical characteristics of water bodies and chlorophyll, suspended solids, organic pollutants, integrated with different platforms of conventional optical remote sensing, hyper spectral remote sensing and radar remote sensing and other multi-source data, could be applied to study the monitoring techniques of lakes quality, and establish the remote sensing inversion model of lakes water quality, so that remote sensing inversion, monitoring and evaluation of lake environment in different periods could be achieved. The establishment of space-earth based integrated monitoring system of water bodies is the most efficient way to promote means of using three types of monitoring data and analysis capabilities for water environment management of water bodies, so as to provide an effective basis for information management and decision-making. But this system should be improved from the following four aspects: (1) satellite remote sensing monitoring for environmental quality, (2) environmental emergency monitoring based on unmanned aerial vehicle, (3) protection of communication security system, (4) integration of GIS and computational models for environmental emergency management. This system will play an important role on environmental emergency response.And the construction framework of the space-earth based integrated monitoring system for water environment was discussed. A whole scheme integrated online monitoring device, communication system, and software support system was proposed [6].

1. **Intelligent transportation systems**

Transportation information collection and communication plays a key role in Intelligent Transportation System (ITS). Unfortunately, most conventional ITSs can only detect the vehicle in a fixed position, and their communication cables and power cables elevate the cost of construction and maintenance. Because of the advantages of the wireless sensor network (WSN) such as low power consumption, wireless distribution, and flexibility without cable restrictions., the usage of WSN in ITSs is expected to be able to overcome the above difficulties.The significant advances in hardware manufacturing technology and the advent of the MicroElectro-Mechanical-Switches (MEMS) paved the way for building smart sensor nodes that are capable of performing three important functions: sensing, processing, and wireless communication.These wireless sensor nodes are characterized by being intelligent, small-sized, low in cost, battery-driven, and easy to install and repair. These characteristics opened wide doors for a broad range of applications attained by deploying wireless sensor nodes in a dense, distributed manner to form specialized Wireless Sensor Networks (WSNs). The main objective of WSNs is to monitor physical or environmental phenomena like temperature, sound, vibration,relative humidity, pollutants, etc. They also collect data to be reported to a central processing unit that analyses the gathered data and take certain measures accordingly. Starting withcritical military applications like battlefield surveillance, WSNs eventually entered enormous number of civil applications such as motion tracking, traffic monitoring, fire detection, seismic sensing, home automation, to mention only few [7].

1. **Building Energy Conservation systems**

The proposed system consists the integration of WSNs with Ethernet/Internet/XML/Web Service communications into a ‘knowledge and information services’ platform to support energy management which can be accessed via a Web service to support inhabitant actions to reduce energy demand. The hardware components which are needed for a system using one specific communication standard cannot be used directly within another system, due to differences in firmware, radio components, communication standards, and in some cases profile parameters. This is problematic because the components of different systems cannot be mixed and used in combination in order to take advantage of the most useful aspects of products from multiple vendors. The concept and initial testing of the WSN presented in this system goes beyond current approaches as it uses various wireless devices operating with different communication standards, which can support Web based services for building managers, owners and inhabitants.The WSNs used in intelligent building management systems consist of different types of sensor nodes measuring parameters such as temperature, humidity, light, asphyxiating gases/smoke, occupancy, and energy consumption. In addition, the systems may include actuators, gateways, servers and communication and application software on different levels as well as different home appliances. A large amount of research has been conducted focusing on different aspects of WSN for building management and control.This system presented theinitial testing of a wireless sensor network (WSN) to support energy management utilizing Web services and middleware technologies. The experimental work presented illustrates that a combination of commercially available WSN from different vendors operating with several communication standards can be employed to monitor and measure real time data such as temperature, light, humidity and power consumption. A single Web site was developed to illustrate the concept of how monitoring sensor parameters and energy measures stored in different repositories could be used. This demonstration illustrated that it is possible to remotely switch on/off electrical appliances from this Web site utilising the integrated Web user interfaces of each of the WSNs. The open architecture of the concept allows for easy and continuous updates and unlimited expandability. Therefore, the model’s design allows for its application in a large number of building categories.The capabilities offered by the type of wireless sensor system presented provide the managers, owners and inhabitants of buildings feedback on the energy consumption of buildings to support improved building control and inhabitant behavioural change. Improvements in the systems sensors could also be integrated into the different type of WSN.WSN to provide additional information and remote functionalities such as number of occupants, appliances and window opening, allowing a real-time evaluation of the energy balance of a room. A WSN using the IR vision system, developed within the IntUBE project, is capable of supporting energy saving initiatives designed to encourage changes in inhabitants’ behaviours. Such initiatives could include supplying information (e.g. displayed on a Web interface) about the use of mechanical ventilation systems and window opening and /or by making visible the energy used by appliances and equipment needlessly left running[8].

## Table 1: Comparative Analysis

|  |  |
| --- | --- |
| **Applications** | **Analysis** |
| Wireless Body Sensor Network | Increase the system’s performance and QoS. |
| Healthcare Monitoring System Using Wireless Sensor Network | It has good scalability and high flexibility and may have a widely application in the community medical service syst |
| Wireless Body Area Networks (WBAN) | It provides economical solutions and non-invasive technology for healthcare applications |
| Precision Agriculture | It reports all the design, construction and testing of all the environmental properties |
| Wireless Sensor Network Air Pollution Monitoring System (WAPMS) | It is of more flexible and timely accurate. |
| Underwater Ecological Mapping | Integrated monitoring system for water environment conservation as well as living being monitoring |
| Intelligent transportation systems | The sysytem comprises of small-sized, low in cost, battery-driven, and easy to install and repair. |
| Building Energy Conservation systems | The system support inhabitant actions to reduce energy demand. |

## CONCLUSION

## For designing a WSN, we need to consider different factors such as the flexibility, energy efficiency, fault tolerance, high sensing fidelity, low-cost and rapid deployment, above all the application requirements. We hope the wide range of application areas will make sensor networks an integral part of our lives in the future. However, realization of sensor networks needs to satisfy several constraints such as scalability, cost, hardware, topology change, environment and power consumption. Since these constraints are highly tight and specific for sensor networks, new wireless ad hoc networking protocols are required. To meet the requirements, many researchers are engaged in developing the technologies needed for different layers of the sensor networks protocol stack.

## Future research on WSN will be directed towards maximizing area throughput in clustered Wireless Sensor Networks designed for temporal or spatial random process estimation, accounting for radio channel, PHY, MAC and NET protocol layers and data aggregation techniques, simulation and experimental verification of lifetime-aware routing, sensing spatial coverage and the enhancement of the desired sensing spatial coverage evaluation methods with practical sensor model.

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