A Study of Monitoring the Environmental Changes Using Wireless Sensor Networks

[1]Deep Mala, [2]Dr. Suhas H. Patil
[1]JJTU, Rajasthan, India
[2]Bharti Vidyapeeth University, (College of Engineering), Pune, Maharashtra, India

Abstract
Traditionally, environmental monitoring is achieved by a small number of expensive and high precision sensing unities.The implementation of a wireless sensor network provides an alternative solution by deploying a larger number of disposable sensor nodes. Nodes are equipped with sensors with less precision.However, the network as a whole provides better spatial resolution of the area and the users can have access to the data immediately. This paper provides a brief overview of the wireless sensor networks technology for environmental monitoring applications.The Wireless Sensor Networks (WSN) is one of the most significant technologies in the 21st century. In recent years, achievements in micro-sensor technology and low-power electronics make WSN become realities in applications. The various environmental parameters such as underground water level, barometric pressure, ambient temperature, atmospheric humidity, wind direction, wind speed and rainfall etc.can be monitored using WSNs.

Keywords
Environmental Monitoring, network, Sensors, Technology, Wireless.

I. Introduction

The environmental care has become one of the biggest concerns for almost every country in the last few years. Water and air quality are essential to maintain the equilibrium between human development and a healthy environment [1]. The Sensor nodes are small embedded devices which are mainly able to perform simple computations and to send/receive data. Their typical usage is to gather information about their environment via sensors, to potentially pre-process these data, and to finally transmit them. An autonomous set of such nodes is called a Wireless Sensor Network (WSN). Because of cost and energy constraints, only one node is generally able to transmit data from the sensor network to the "outside world" by means of a longer-range connection (e.g., GPRS). This node is called a sink since it acts as such with regards to the data stream coming from the network. Although sensor networks have many applications, environmental monitoring is a domain in which they may have a huge impact [4]. Recent technologies in wireless communications and electronics have brought the vision of Wireless Sensor Network (WSN) into reality which has increased the growth of low cost, low power and multi-functional sensors that are small in size and can communicate in short range. Each node consists of microcontrollers, memory and transceiver. The microcontrollers are used to execute task, data processing and assist the functionality of other components in the sensor node. For the memory, it is mainly used for data storage while the transceiver acts from the combination of transmitter and receiver functions. Natural phenomena data such as temperature, light, sound and pressure are collected by sensors and then transmitted to a server. These battery powered nodes are used to monitor and control the physical environment from remote locations. In the past few years, the applications of Wireless Sensor Network have been widely used and applied in medical, military, industrial, agricultural and environmental monitoring. For the past few years, Wireless Sensor Network has been applied in various fields and mostly in environment monitoring applications. Environmental monitoring is the main autonomy which may contribute large effects. The unstable weather conditions recently demonstrated how important a deep understanding of our surroundings and its development is for human being [3].

II. Environment Monitoring System Applications

Recently, the development of environmental monitoring system has been applied in many applications in order to assist people in their job and reduce cost and time. The applications of environmental monitoring have grown rapidly in agricultural monitoring, habitat monitoring, indoor monitoring, greenhouse monitoring, climate monitoring and forest monitoring. It is a good effort and brings advantage because the community has realized the importance of the wireless sensor network technologies in their life.

A. Cattle Monitoring

Now-a-days many animals lack proper treatment and there are also cases where these animals' diseases are not detected. Therefore, it is important to have a monitoring system to monitor animal behavior and produce a report regarding their health or behavior in real-time system. There are many identification methods in monitoring animal health, but some of them either fail or lacking in and efficiency and also not user-friendly. The design of RFID-based Mobile Monitoring System (RFID-MMS) helps users control animal behavior and movement. It will monitor the habitat, pattern of movement and animal behavior. The sensor nodes built around the collars will collect the position of GPS and data of multimodal sensor, distribute via the system to the client. From tests done, it shows that the range of signal communication can be achieved from 200 - 250 meters and this should be in consideration in order to design a self-sustainable system which is more efficiency in the future.

B. Habitat Monitoring

Habitat monitoring is one of the essential parts in environmental monitoring. Habitat means a place in which an animal or plant naturally grows or lives. Therefore, habitat monitoring is important to make sure their species autonomies and prevent any ecological disturbance for animals and plants. Pollution can cause negative impact to health and ecological balance. Therefore, it is important to manage a system that can monitor pollution so that it is under controlled.

C. Indoor Living Monitoring

Sensor technologies for security in living monitoring have become one of the main options for people for safety indoor environment. It has provided many benefits to the user in terms of security. This system consists of relay nodes, control nodes and a control

system that can be placed in a room in a building. When certain events happen, such as an intruder entering a security area illegally, the sensor and relay nodes will detect the events and report to the control nodes. Then, control nodes send the report to local security control system. From there, it replies ACK message to the corresponding nodes. In the end, they manage to develop applications program which can integrate the Bluetooth module with the HCI interface and also used tree topologies for network configuration and routing. Furthermore, wireless home security system is also designed to detect any intruder in the house.

D. Greenhouse Monitoring

The greenhouse effect occurs when solar radiation which is sun heat, is trapped by the gases in the earth's atmosphere and reflected back from the earth. Thus, it will heat the surface of earth and leads to global warming. Therefore, greenhouse monitoring system is important to ensure the stabilization of the environment. The greenhouse monitoring system can be developed using TinyOS as the based platform to measure and monitor environmental parameters including temperature, light and humidity. The system collects sends and controls the parameters information automatically and it is proven that the performance of the system is efficient as the user can collect high precision data of the environment without any disturbance. The implementation of greenhouse environment monitoring is based on ZigBee wireless sensor network.It collects the humidity, temperature and carbon dioxide concentration which are the parameters of greenhouse environmental parameters, and demonstrate the nodes and network coordinator communications, perform network stabilization, and compliance between theoretical data and real situations. Greenhouse monitoring system can also be web-based system (remote system) to allow user access, control and monitor of greenhouse laboratory using Internet connection.

E. Climate Monitoring

The climate change of the world nowadays have brought many effects such as the breaking of sea ice, increasing in sea water level, heat waves, glacier melting, lake temperature warming, and many more. Thus, in an effort to control and monitor the climate change, develop a monitoring system that manages and keeps data in real time and focuses on the processing of spatiotemporal query. They are using spatial and existing temporal approach to assist spatiotemporal queries and keep sensor data and build a system for environmental monitoring sensor network. The incoming data is kept as a segment and labeled with timestamp if changes occur in the value of item.

F. Forest Monitoring

Forests are important sources for biodiversity and ecological balance. They provide many benefits and it is the main functions for water and soil conservation, genetic resources for plant and animal, and also source of wood supply and other forest goods. However, recently the green forest environment has been interrupted by non ethical activities such as illegal logging and also country development activities that decrease the benefits of the forest contribution. Thus, in order to ensure long term forest autonomy, it is important to implement a monitoring system that is responsible in providing effective monitoring for forest environment. Rather than using disposable batteries as power supplies, use node solar power system and lithium-ion battery for power continuity and introduce the regulator control of the system method and design of software system briefly. Their system can improve the lithium-ion battery life to ensure business continuity of system [3].

III. How Many Sensors are Needed?

In general, environmental monitoring applications involve large areas of the order of several hundreds of square kilometers. To achieve good coverage it is necessary to install a large number of sensors. In fact, this number with today's technology may be too expensive to implement. One would expect that achieving a good coverage of a large area (e.g., a forest) will require a huge number of sensors. Even though in the sensor networks literature the concept of a sensor network suggests the existence of a huge number of nodes, in practice, large scale sensor networks are not yet available. To resolve this problem, it may be necessary to also complement the network operation with some mobile nodes which will move around and complete possible missing information. Of course in this case, an interesting problem is to design the paths of the mobile nodes in order to maximize the coverage area with the smallest possible number of sensors [1].

IV. Technical Requirements in Environment Monitoring System

Environmental monitoring has been an important part of Wireless Sensor Network applications. It grows widely along with the development of recent technology. In general, environmental monitoring system controls and monitors environment parameters such as temperature, humidity, light and pressure. Thus, it is necessary to understand the requirements for the development of monitoring applications.

A. Autonomy

Batteries must be able to power the weather stations during the whole deployment. Because the radio transceiver is a massive energy consumer, the network has to be energy-wise, even if a renewable source of energy is used (e.g., solar power).

B. Reliability

The network has to perform simple and predictable operations, to prevent unexpected crashes. Human maintenance should be avoided, first, because end users may not have networking knowledge, second, because areas of interest are most often remote. Achieving reliability is difficult because packet losses are more likely to happen during harsh weather conditions (e.g., heavy rain, intense cold).

C. Robustness

The network must account for a lot of problems such as poor radio connectivity (e.g., in case of snow fall) or hardware failures. For instance, humidity can frequently cause short-circuits leading to unexpected reboots of stations.

D. Flexibility

One must be able to quickly add, move, or remove stations at any time depending on the needs of the applications. For instance, it may turn out that the current location of the stations is not correct to gather the required data, or that new stations should be added at new points of interest [4].

V. Challenges Using Sensor Networks for Environmental Monitoring

There are various challenges that come across during the environmental monitoring is given above:

A. Power Management
This is essential for long-term operation, especially when it is needed to monitoring remote and hostile environments. Harvesting schemesand new power storage devices are presented as possible solutions to increase the sensors lifetime.

B. Scalability
A wireless sensor network can accommodate thousands nodes. Current real WSN for environment proposes the use of tens to hundreds nodes.

C. Remote Management
Systems installed on isolated locations cannot be visited regularly, so a remote access is necessary to operate, to manage, to reprogramming and to configure the WSN, regardless of manufacturer.

D. Usability
The WSNs are to be deployed by users who buy them off the shelf. So, the WSN need to become easier to install, maintain and understand. It is necessary to propose new plug and play mechanisms and to develop more software modules with more user-friendly interface.

E. Standardization
The IEEE 802.15.4 represents a millstone in standardization efforts. It is important to specify standard interfaces to allow interoperability between different modules to reduce the costs and to increase the available options.

F. Mesh Routing Support
The mesh networks topologies can both provide multi-hop and path diversity.

G. Size
Reducing the size is essential for many applications. Battery size and radio power requirements play an important role in size reduction. The production of platforms compatible with the smart dust can be determinant in WSN environmental monitoring.

H. Price
Available sensor platforms on the market are expensive which precludes its use widely. To produce cheaper and disposable sensor platforms is also a challenge.

I. Support Other Transducers Types
Environmental monitoring usually uses limited type of transducers, such as temperature, light, humidity and atmospheric pressure. New environmental monitoring applications will be developed and new transducers will be necessary to measure new physical phenomena, for example image and video [2].

VI. Conclusion
Wireless sensor networks have been a big promise during the last few years, but a lack of real applications makes difficult the establishment of this technology. This paper reviews the wireless sensor network applications which focus mainly on the environmental monitoring system. These systems have low power consumption, low cost and are a convenient way to control real-time monitoring. Moreover, it can also be applied to indoor living monitoring, greenhouse monitoring, climate monitoring and forest monitoring. These approaches have been proved to be an alternative way to replace the conventional method that use men force to monitor the environment and improves the performance, robustness, and provides efficiency in the monitoring system.

References
[1] [Online] Available: http://www.eng.ucy.ac.cy/Christos/Papers/PFM_WMCCS.pdf
[2] [Online] Available: http://www.jocm.us/uploadfile/2013/0403/20130403030225404.pdf
[3] [Online] Available: http://www.sciencedirect.com/science/article/pii/S1877705812027026
[4] [Online] Available: http://stanford.edu/~gsfr/pdf/izs2008.pdf

Deep Mala received her M.A (English) degree from Punjabi University Patiala (Punjab). She completed MCA from Guru Jambheshwar University Hissar (Haryana) and B.Ed from Jammu University Jammu. She is Pursuing Ph.D in computer Science from JJT University, Rajasthan. She has published 20 papers in National and international journals and conferences. She has attended 24 conferences and workshops.Areas of interests are computer networking, Database management System and wireless Communications.

Prof. Dr. Suhas Patil received his BE degree from the Shivaji University, Warna Institute of Technology, in 1989. The ME degree from the University of Pune, in 1992, and the PhD degree from the Bharati Vidyapeeth Deemed University, Pune in 2009. He is associated with the field of teaching for the past 22 years (from 1989 till date). He is currently Professor and Head in the Department of Computer Engineering at Bharati Vidyapeeth University College of Engineering, Pune. His research interests are in operating systems, computer networks, expert systems and distributed systems. He is a Member of Reviewer Board of IAENG International Conference on Computer Science. He serves as Observer University Grants Commission (India) in number of autonomous Colleges and Universities. He is Associate Member of International Association of Information Technology Trainers (IT-Train) and Member of International Society of Computer Associations (ISCA). Apart from being Project Evaluator and Expert Faculty for National Open Universities and State Level Universities, he has published 207 papers in national and international journal and conferences. He has guided successfully more than 60 post graduate students and currently 08 Research Scholars are pursuing Ph.D.