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Survey on Wireless Sensor Network for Environment Monitoring

Chetna Singh, Pinaki Ghosh

Department of Computer Science and Engineering,
Mody University of Science and Technology, Lakshmangarh, India

chetnakusingh@gmail.com, pinakighosh.cet@modyuniversity.ac.in

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Abstract: Wireless Sensor Network has been an emerging technology in the past few years. Since most problem especially in the field of environment monitoring where many factors such as environment conditions, frequent changes in temperature at remote area etc. has greatly affected the performance. This paper is concerned about the technologies that have been developed in field of environment monitoring along with challenges faced by sensor nodes.

Keywords: Environment monitoring, wireless sensor network, sensor nodes

1. INTRODUCTION

Wireless sensor network are often called as wireless sensor and actuator networks (WSAN) [1]. These consist of sensor nodes distributed over large area to detect physical or environment conditions such as sounds, temperature etc and passes the information to main location. Most of modern network are bidirectional, enabling control of sensor activity. The development of wireless sensor network was promoted in military applications such as in battlefields, and now it is being used in wide areas like in industrial monitoring, machine health monitoring and so on. The wireless sensor network consists of nodes as one of its major components which varies from few to thousands which are connected through each other by transceiver, antenna or by some of the micro-controller, such as batteries (energy providing sources)[2]. The nodes are generally of small size and have complexities designed according to their functions. WSNs use topology like star network or multi-hop wireless network and uses algorithm like routing or flooding for transmission of information. Some of the characteristics of wireless sensor network are energy harvesting, ability to overcome node failure, mobility, ease-of-use and scalability.

2. SENSOR NODE

A sensor node is called as mote (usually in North America) is a node in sensor network that are capable of performing actions related to communication, processing etc. A mote is a node but vice-versa is not true (Fig 1).

A sensor node is composed of many of the components like micro-controller, transceiver, internal memory, power source and one or more sensor.

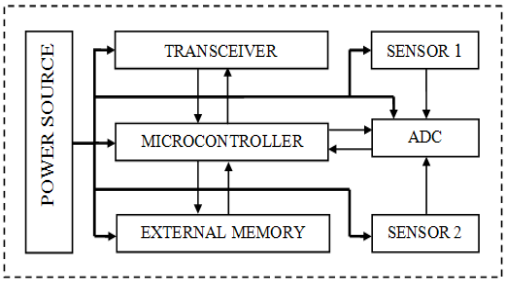

Fig 1. Sensoer node architecture

A. Controller

A controller performs all tasks of gathering and controlling of functionalities. They are used in many of embedded systems due to low cost and flexibility in connecting a device [3]. In case of broadband wireless communication digital signals processing is chosen where as in case of wireless sensor network wireless communication is suitable.

B. Transceiver

Sensor nodes uses ISM band which gives free radio and global availability and accuracy [3][4]. The possible modes for wireless transmission are Radio frequency (RF), optical communication (laser) and infrared. Laser communication uses less energy but uses line-of-sight for its communication and is affected by atmospheric conditions. Infrared like

laser not requires antenna but is limited to its broadcasting capacity. Radio frequency is more appropriate model used for wireless sensor network. A transceiver combines the property of transmitter and receiver. It lacks unique identifier. The transceiver performs following actions of transmitting, receiving, idle and sleep. Due to some inbuilt functionality it can now perform task automatically.

C. External memory

From the point of view of energy, the types of memory are on-chip memory of a micro-controller and flash memory-off-chip RAM which is hardly being used. Flash memories are used due to cost and capacity. Types of memory on basis of purpose of storage are:

- User memory for storing application.
- Program memory used for programming the devices. It often contains identifier data.

D. Power source

A wireless sensor node provides a good solution for transmitting data where it is impossible to provide power to sensor node. They are placed in a remote area and changing battery frequently can be difficult and costly [4]. An important consideration in this field is that sensor node should have sufficient energy available to power the system. A sensor node consumes power in sensing and communicating. Therefore, concept of sleep or deactivation is taken into picture where a node becomes dead when no data is to be transmitted or processed thus saving energy and extending lifetime.

E. Sensor

Sensors are the main components which captures data from the surrounding. They are the devices that provide response to the changes occurred in physical environment [4][5]. The sensor produces analog signal and is digitized by an analog-to-digital convertor and are sent to controller for further processing. Some of them also have the capability to convert the raw signals into reading which can be accessed by digital link (e.g. 12C, SP).

Within past few years, sensor network is been an important topic in research area. According to Mark Weiser Conceive a new way in the world, one that takes into account the natural human environment and allows computer themselves to vanish into the background[2]. But there are some problems associated with it among which two are major issues he limited power and the potential of deploying networks with huge number of sensor nodes. Depending on application power constrains its important issue. For e.g. in case of the Great Duck Island discussed in future section, that the off-season and it is necessary that no human should be present during that period of breeding (approx. 7-9 months). As a task during that period and should have sufficient energy to remain active and for communication and co-ordination.

The other issue involved with sensor network, i.e. the large amount of sensor nodes that are involved in processing, should have unique identifier (IP addresses). The addressing issues have impact on the media access control (MAC) protocols, and on reliable communication. The sensor node should have potential for analyzing data from raw data and provide useful information to the master[5]. Thus it should be well equipped in order to improve process of decision making. Unlike traditional model which works on TCP/OSI model for communication. One may design sensor network applications where intermediate nodes analyze all incoming data packets from neighbors and give only summary of report to sink which is sufficient for making decision. Data aggregation and sensor fusion are the two approaches that are useful in wireless sensor network. Furthermore, Transport layer are designed to maximize the probability of event detection, false alarms etc.

3. ENVIRONMENT AND HABITAT MONITORING

From past few years, a large number of projects have been developed which has drawn attention of many of researches from worldwide. These projects include the great duck island, the north temperature lake, and the vine monitoring in pickberry vineyard.

A. The Great Duck Island

In the spring of 2002, the Intel Research Laboratory at Berkeley in association with the college of the Atlantic in Bar Harbor and University of California at Berkeley implemented wireless sensor network on Great Duck Island, Maine. The sensor nodes monitor the microclimates around nesting burrows used by the leach's storm petrel [6]. The aim of this project was to develop a non-intrusive and non-disruptive monitoring of sensitive wildlife and habitat. At the end of the season in November 2002, around 1 million reading had been recorded from 32 motes deployed on island. Each mote consists of sensor for temperature, humidity, barometric pressure and mid-range infrared. These motes gather and send data to base stations on island

which are then transmitted to researches through satellites signals.
In June 2003, they deployed a second generation network with 56 nodes. The network was augmented in July 2003 with 49 additional nodes and again in August 2003 with over 60 more burrows nodes and 25 new weather station nodes. These nodes transfer data back 'bucket bridge' style through dense forest. Some nodes are more than 1000 feet deep in the forest providing data through a low power wireless transceiver. The research was successfully conducted with help of Henry Luce Foundation and Intel co-operation.

B. North Temperate Lake

This is another example of sensor network for environment monitoring [7]. The main principle is to develop an intelligent environment seasoning network for detecting 'episodic environmental events and understanding their consequences to lake dynamics'. These networks takes the measurements of the overnight Dissolve Oxygen (DO) level from the sensor and understand the interaction among physical, chemical and biological process that with external gives result in long-term dynamics within the lake. This network should have intelligent command control system to implement adaptive sampling and query the sensors for more information in case of an event.

C. Pickberry Vineyards

This is a good example of the farming using wireless mesh network performed by Accenture technology labs in Pickberry Vineyard, a 30-acer for growing grapes in California, USA. In the project the data gather by sensor nodes are sent through mesh network at the Vineyard and them via a cellular network to a server at the Accenture Technology labs [8]. The aim is to turn the measurements into useful information that could help the vineyard increase yields, cut costs, reduce dependence on chemical and save on labor. The most important challenge in front of Accenture was to build the light insides application needed to make the data useful for decision making.

4. ENVIRONMENT AND HABITAT MONITORING

Here we will discuss the applications of WSN and the challenges faced by them over past few years. The area of application includes cattle monitoring, ground water quality monitoring, lake water quality monitoring etc.

A. Ground Water Quality Monitoring

For this, we develop a small network, located 2000 km away from our lab. The aim was to measure the sanity, water level and water extraction rate at the number of bores. This is a coastal region where water extraction leads to salt water intrusion into the aquifer [8].

B. Lake Water Quality Monitoring

The aim of this project was to measure vertical temperature at large water storage that provides most of the drinking water for the city. The data from a string of temperature transducers at depth from 1 to 6 m at 1-m intervals provided information about mixing of water in lake for prediction of the development of algal blooms. Low- power wireless communication over water proved to be a challenge due to multipath as radio wave reflected from the water travelling directly. Interfacing a robotic boat to the static sensor node was quite challenging. The network comprises of floating sensor nodes and a custom expansion board for the one-wine temperature transducer string. The node is mounted on an anchored float, along with solar calls and with a whip antenna. The most novel elements in this network are a solar-powered robotic boat. Navigated by GPS and depth sounds and a laser range-finder mounted high and looking forward detects obstacles [9] [10].

C. Volcano Monitoring

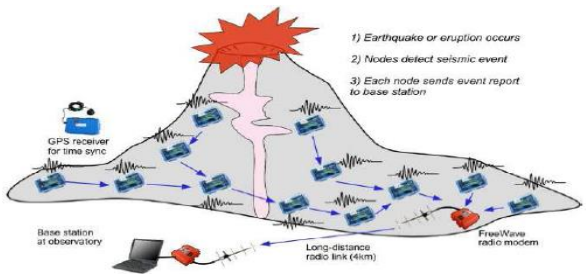

Fig 2. Volcano monitoring

In this application Wireless sensor network are equipped with low frequency acoustic sensor to monitor volcanic activity (Fig 2). While traditional system involves local storage of data, which requires a manual collection of data for further processing, the WSN based system allow real time monitoring of the activity over wireless link along with continuous monitoring of wireless links. The research implements an event detection mechanism to reduce the amount of data which had to be communicated and processed [9].

5. CHALLENGES

Although a vast effort have been made, there are still more challenges that are to be overcome. Power management in long–term operation especially, in remote area where human interaction is less. In terms of scalability, it should accommodate thousands of nodes as system installed on isolated location are not being visited frequently, therefore the nodes should be able to manage, reprogram and to configure wsn easily and should become easier to understand and monitor [10]. The storage capacity and redundancy should be increased by adding more nodes on the network. Increasing the storage nodes and configure them to capture overlapping areas of the sensor nodes ensures that there are mutual copies of data, thus providing redundancy in case some of the storage nodes fails. Battery size and radio power reduces size with which proves beneficial in many applications along with it should be cheaper, reliable and disposable sensor platform is also a big challenge [11].

6. CONCLUSION AND FUTURE WORK

In this work, a survey on environment monitoring is carried out. Some of the projects which have been deployed are discussed and challenges are analyzed [9].WSN continues to emerge as s technology that will transform the way we measure, understand and manage the natural environment. For the first time different types of data are place and merged together to access from anywhere. Effort are been made to reduce the gap between theoretical and practical deployment.

Future work in WSN energy management should include further investigation into node platform, the balancing of unequal energy distribution and long term behavioral studies of system in real world deployment.

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