A Comprehensive Overview on Different Applications of Wireless Sensor Network

P.Rajeswari, S.Pratheeba, S.R.Karthika

Abstract— The Wireless Sensor Network is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a micro controller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size. It detects things like temperature, sound, vibrations, pressure, motion, or pollutants through autonomous sensors. They are currently being used for industries and civilian use such as industrial process monitoring and control, machine health monitoring, monitoring of the environment, health care applications, home automation, tracking and traffic control. More specific applications would be things like habitat monitoring, tracking objects, detecting fires or landslides, and monitoring traffic. Generally a WSN would be scattered in an area where its sensor nodes collect data.

Index Terms—Applications of Wireless Sensor Network, Area Monitoring, Wireless Sensor Network.

I. INTRODUCTION

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. In computer science and telecommunications, wireless sensor networks are an active research area with numerous workshops and conferences arranged each year [1].Wireless Sensor Networks has been emerging from the vision of Smart dust project in 1998 that required enabling both communication and sensing capabilities in order of cubic millimeter. Data for smart environments are obtained through Wireless Sensor Networks (WSN), where thousands of sensors are deployed at different locations operating in different modes [2].

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A sensor network is capable of sensing, processing and communicating which helps the base station or command node to observe and react according to the condition in a particular environment (physical, battle field, biological) [3]. Recent research in many scientific areas, like physics, microelectronics, control, material science etc. and the collaboration of scientists which used, traditionally, to work towards totally different directions, has lead to the creation of the Micro-Electro-Mechanical Systems, commonly referred to as MEMS [4]. MEMS have succeeded in augmenting the limits of what was considered to be a System-On-a-Chip (SoC). Smart environments represent the next evolutionary development step in building, utilities, industrial, home, shipboard, and transportation systems automation. Like any sentient organism in WSN, the smart environment relies first and foremost on sensory data from the real world. Sensory data comes from multiple sensors of different modalities in distributed locations[5].

A. BASIC COMPONENTS OF WIRELESS SENSOR NETWORK

A WSN can be broken down into three components: sensors, signal processing, and communications.

Sensors: The maximum frequency output of each sensor in the system is 24 kHz. In many cases, this may be able to be reduced by decimation, since human movement rarely exceeds 20-25 Hz and generally is below 10 Hz [Bout97]. To see how this would lower data rate, we can assume a user has 40 motion tracking sensors, with each sensor keeping track of position and orientation (6 variables at 2 bytes each) at a data rate of 50 Hz. Under these conditions, we require a raw data rate of only 192 kbps.

Signal Processing : It is a necessary component of any wireless communication system. In order to ensure a quality signal, the system will have to include noise filters and error correction. In order to reduce bandwidth, the system will have to include decimation filters. This signal processing will introduce some latency but will also reduce bandwidth. The amount of latency will be dependent on many factors, including processor capabilities, the number of sensors, where the processing is located in the system, and what type of processing needs to be done.

Communications : The communications component is where the interference problems will occur. The actual communication of the data will introduce the much latency into the system. Also, the amount of interference that occurs will directly influence how much latency due to the communications system is present. This is due to the fact that the more interference there is, the greater the number of packet retransmissions there will be. Because of this, communication protocol that is used must keep interference to a minimum. [6].

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II. APPLICATIONS OF WIRELESS SENSOR NETWORK

A. *AREA MONITORING:*

Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. Monitoring a large area with stationary sensor networks requires a very large number of nodes implying a prohibitive cost and excessive radio interference. The main objective of area monitoring is to develop an efficient system that employs a smaller number of stationary nodes that will collaborate with a small set of mobile nodes in order to improve the sensor area coverage and event detection. The main strength of this collaborative architecture stems from the ability of the mobile sensors to sample areas not covered (monitored) by stationary sensors. An important element of the proposed system is the ability of each mobile node to autonomously decide its path based on "local" information which is essential in the context of large, distributed WSNs. The main contribution is the development of a distributed collaborative area monitoring framework in the context of mixed WSNs using multiple cooperative mobile sensor nodes to patrol a sparse stationary sensor network field area and locate events as fast as possible**[7].** A military example is the use of sensors detect enemy intrusion; a civilian example is the Geo-fencing of gas or oil pipelines.

III. APPLICATION OF AREA MONITORING:

A. *HABITAT MONITORING:*

Researchers in the Life Sciences are becoming increasingly concerned about the potential impacts of human presence in monitoring plants and animals in field conditions**[8]**. At best it is possible that chronic human disturbance may distort results by changing behavioural patterns or distributions, while at worst anthropogenic disturbance can seriously reduce or even destroy sensitive populations by increasing stress, reducing breeding success, increasing predation, or causing a shift to unsuitable habitats. Seabird colonies are notorious for their sensitivity to human disturbance. Research in Maine **[9]** suggests that even a 15 minute visit to a cormorant colony can result in up to 20% mortality among eggs and chicks in a given breeding year. Repeated disturbance will lead to complete abandonment of the colony. On Kent Island, Nova Scotia, researchers found that Leach's Storm Petrels are likely to desert their nesting burrows if they are disturbed during the first 2 weeks of incubation.

B. APPLICATION OF WSN IN ENVIRONMENTAL /EARTH MONITORING

The Environmental Sensor Networks has many applications of WSNs for earth science research. This includes sensing volcanoes, oceans, glaciers, forests , etc. Some of the major areas are listed below. Using a WSN, a number of sensors can continuously monitor factors like temperature and luminosity and will process, store and transmit data co-operatively and wireless with other sensors to generate data that can then be collected and made available to users virtually anywhere on the globe[10].The environmental monitoring system based on a wireless sensor network (WSN hereafter) platform called Cookies [11], to measure both gas emissions and waste water quality in an instant coffee factory in Spain. Even though there are myriad other approaches that are now being used, WSNs can offer a cheaper solution while having data acquisition in real time, working in an unattended way.

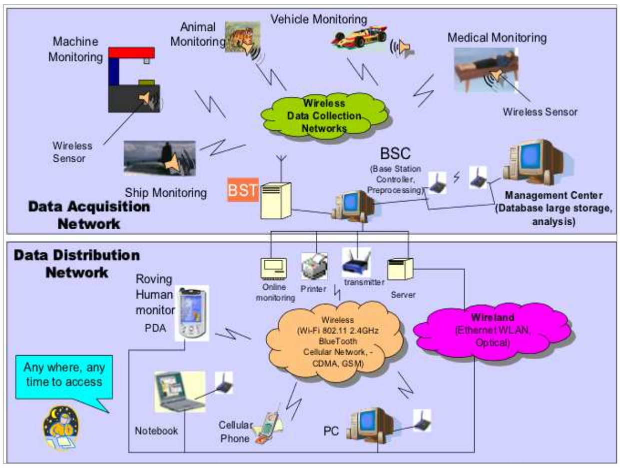

Fig 1 Wireless Sensor Network

C. *NATURAL DISASTER PREVENTION:*

The consequences of natural perils like floods can be effectively prevented with wireless sensor networks. Wireless nodes are distributed in rivers so that changes of the water level can be effectively monitored. Wireless sensor networks can effectively act to prevent the consequences of natural disasters, like floods. Wireless nodes have successfully been deployed in rivers where changes of the water levels have to be monitored in real time.

D.AGRICULTURE MONITORING:

Using wireless sensor networks within the agricultural industry is increasingly common; using a wireless network frees the farmer from the maintenance of wiring in a difficult environment. Gravity feed water systems can be monitored using pressure transmitters to monitor water tank levels, pumps can be controlled using wireless I/O devices and water use can be measured and wireless transmitted back to a central control center for billing. Irrigation automation enables more efficient water use and reduces waste. Using wireless sensor networks within the agricultural industry is increasingly common, as it provides many benefits to the farmer, impacting both the quality of the crops and the overall operating costs. WSN address the traditional monitoring problems related to outdoor areas, by removing the need of cables and of power sources in locations where no infrastructure is available. WSN are also specially suitable for temporary or problem-solving deployments, and to gather more numerous and more consistent data. [12]

E. *ACCURATE AGRICULTURE:*

Wireless sensor networks let users to make precise monitoring of the crop at the time of its growth. Hence, farmers can immediately know the state of the item at all its stages which will ease the decision process regarding the time of harvest.

F. *GREENHOUSES :*

Wireless sensor networks are also used to control the temperature and humidity levels inside commercial greenhouses. When the temperature and humidity drops below specific levels, the greenhouse manager must be notified via e-mail or cell phone text message, or host systems

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can trigger misting systems, open vents, turn on fans, or control a wide variety of system responses. Recent research in wireless sensor networks in agriculture industry give emphasis on its use in greenhouses, particularly for big exploitations with definite crops. Such micro climatic ambiances need to preserve accurate weather status at all times. Moreover, using multiple distributed sensors will better control the above process, in open surface as well as in the soil.

G.IRRIGATION MANAGEMENT :

When real time data is delivered, farmers are able to achieve intelligent irrigation. Data regarding the fields such as temperature level and soil moisture are delivered to farmers through wireless sensor networks. When each plant is joined with a personal irrigation system, farmers can pour the precise amount of water each plant needs and hence, reduce the cost and improve the quality of the end product. The networks can be employed to manage various actuators in the systems using no wired infrastructure.

H. FOREST FIRE DETECTION :

A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for a successful action of the firefighters; thanks to Wireless Sensor Networks, the fire brigade will be able to know when a fire is started and how it is spreading.

G. LANDSLIDE DETECTION:

A landslide detection system makes use of a wireless sensor network to detect the slight movements of soil and changes in various parameters that may occur before or during a landslide. Through the data gathered it may be possible to know the occurrence of landslides long before it actually happens.[13]

I. AIR QUALITY MONITORING :

The degree of pollution in the air has to be measured frequently in order to safeguard people and the environment from any kind of damages due to air pollution. In dangerous surroundings, real time monitoring of harmful gases is an important process because the weather can change rapidly changing key quality parameters.

J. INTERIOR & EXTERIOR MONITORING:

Observing the gas levels at vulnerable areas needs the usage of high-end, sophisticated equipment, capable to satisfy industrial regulations. Wireless internal monitoring solutions facilitate keep tabs on large areas as well as ensure the precise gas concentration degree. External air quality monitoring needs the use of precise wireless sensors, rain & wind resistant solutions as well as energy reaping methods to assure extensive liberty to machine that will likely have tough access.

K.AIR POLLUTION MONITORING :

Wireless sensor networks have been deployed in several cities (Stockholm, London and Brisbane) to monitor the concentration of dangerous gases for citizens. These can take advantage of the ad hoc wireless links rather than wired installations, which also make them more mobile for testing readings in different areas. There are various architectures that can be used for such applications as well as different kinds of data analysis and data mining that can be conducted .[14]

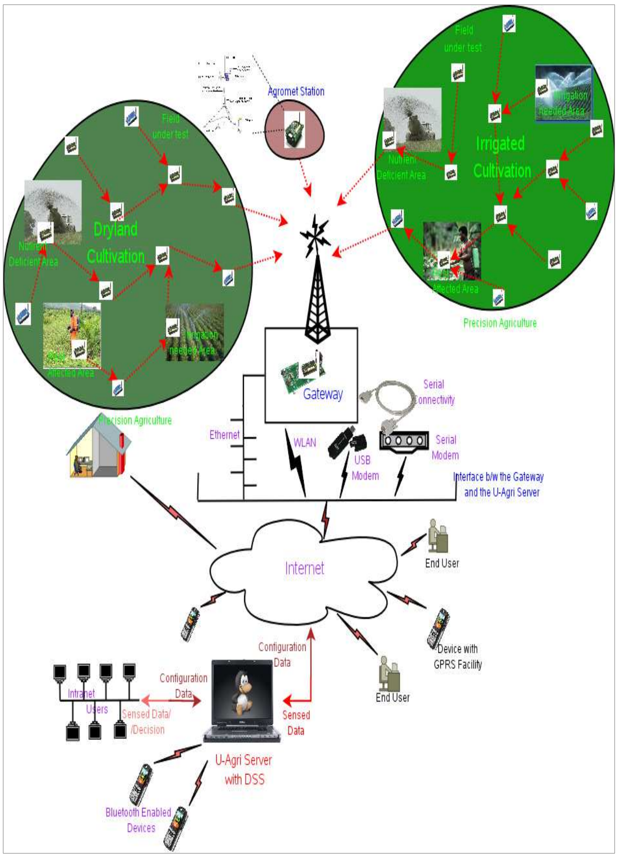

Fig 2 Application of WSN in Agriculture

L. WATER QUALITY MONITORING :

Water quality monitoring involves analyzing water properties in dams, rivers, lakes & oceans, as well as underground water reserves.[15] The use of many wireless distributed sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.

IV. APPLICATION OF WSN IN INDUSTRIAL MONITORING

A. MACHINE HEALTH MONITORING :

Wireless sensor networks have been developed for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionality. In wired systems, the installation of enough sensors is often limited by the cost of wiring. Previously inaccessible locations, rotating machinery, hazardous or restricted areas, and mobile assets can now be reached with wireless sensors.

B. DATA LOGGING :

Wireless sensor networks are also used for the collection of data for monitoring of environmental information, this can be as simple as the monitoring of the temperature in a fridge to the level of water in overflow tanks in nuclear power plants. The statistical information can then be used to show how systems have been working. The advantage of WSNs over conventional loggers is the "live" data feed that is possible.

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C. INDUSTRIAL SENSE AND CONTROL APPLICATIONS :

In recent research a vast number of wireless sensor network communication protocols have been developed. While previous research was primarily focused on power awareness, more recent research have begun to consider a wider range of aspects, such as wireless link reliability, real-time capabilities, or quality-of-service[16]. These new aspects are considered as an enabler for future applications in industrial and related wireless sense and control applications, and partially replacing or enhancing conventional wire-based networks by WSN techniques.

D. WATER/WASTE WATER MONITORING :

Monitoring the quality and level of water includes many activities such as checking the quality of underground or surface water and ensuring a country's water infrastructure for the benefit of both human and animal. The area of water quality monitoring utilizes wireless sensor networks and many manufacturers have launched fresh and advanced applications for the purpose. Water monitoring involves many different activities, from ensuring the quality of surface or underground water, both for human beings and animal life, to the monitoring of a country's water infrastructure. Wireless sensor networks are becoming increasingly popular in WSN [17] .

E. WATER DISTRIBUTION NETWORK MANAGEMENT :

Manufacturers of water distribution network sensors concentrate on observing the water management structures such as valve and pipes and also making remote access to water meter readings. Water quality and water distribution network health is a basic requirement of human life and economy. To cope with the ever-growing threat of water pollution, determine water quality by testing for specific chemicals, perform timely detection of source of contamination and solid formation, and monitor and protect the health of waterways and water distribution networks, a system for real time measurements of water quality and detection of health-related events is required [18**]**.

F. LEAK DETECTION AND MONITORING:

The main objective of Water Sense is the development of a Wireless Sensor Network (WSN) System for the continuous monitoring of the water supply urban networks aiming to the early detection of water leaks in order to accomplish reduction of water loses. The integration and automation of several leak-finding and water supply network management methods is expected to lead to the optimization of the networks' operation. The performance of this innovative system will be evaluated through a pilot deployment in a controlled environment under real conditions. The results of this research in conjunction with ongoing research activities for the development of Geographic Information System (GIS) software will contribute to the early detection of underground water pipes leaks/destruction achieving even more efficient water resources management in urban networks**[**19**].**The whole process includes examining water properties in rivers, dams, oceans, lakes and also in underground water resources. Wireless distributed sensors let users to make a precise map of the water condition as well as making permanent distribution of observing stations in areas of difficult access with no manual data recovery.

G. PASSIVE LOCALIZATION AND TRACKING :

The application of WSN to the passive localization and tracking of non-cooperative targets (i.e., people not wearing any tag) has been proposed by exploiting the pervasive and low-cost nature of such technology and the properties of the wireless links which are established in a meshed WSN infrastructure.[20]

H. SMART HOME MONITORING :

Monitoring the activities performed in a smart home is achieved using wireless sensors embedded within everyday objects forming a WSN. State changes to objects based on human manipulation is captured by the wireless sensors network enabling activity-support services[21].

I. CHARACTERISTICS OF WSN :

- Power consumption constrains for nodes using batteries or energy harvesting.
- Ability to cope with node failures .
- Mobility of nodes.
- Communication failures .
- Heterogeneity of nodes.
- Scalability to large scale of deployment.
- Ability to withstand harsh environmental conditions.
- Ease of use [22].

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, sensors or MEMS (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery [23]. Other possible inclusions are energy harvesting modules, secondary ASICs, and possibly secondary communication interface (e.g. RS-232 or USB). The base stations are one or more components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user as they typically forward data from the WSN on to a server. Other special components in routing based networks are routers, designed to compute, calculate and distribute the routing tables.

V. CONCLUSION

This paper explains about the various applications of wireless sensor networks. Wireless Sensor networks are used in day today life and its has various application and uses. This paper explains about two categories of applications namely category 1 wireless sensor networks applications and its uses and category 2 wireless sensor networks applications.

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