ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 12 , December 2021

An Overview of Wireless Sensor Network (WSN) and Its Applications

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ABSTRACT: In the last decade, the evolution and advances in micro, electro-mechanical systems (MEMS) have enabled the development of low cost, low-power , small-sized micro sensors and communicate in short distances Using sensor nodes in monitoring systems have attracted significant attention over the past few years. The Wireless Sensor Networks (WSN) can be applied in numerous ways within our environment, ranging from a general locality, workplace and home. In this paper, an overview of WSNs and some of WSNs applications

KEY WORDS: Application of WSNs, Sensor Nodes ,Wireless Sensor Networks (WSN) ,WSNs Development, sensor nodes; Structure of Sensor Node.

I. INTRODUCTION

The Wireless Sensor Networks (WSNs) has received substantial attention in research, leading to its application in several fields, ranging from military applications to environmental protection [1]. It is projected that the WSNs of the future will consist of several sensor nodes which will communicate over a wireless channel and perform both collaborative data processing and distributed sensing tasks for several important applications. The use of these sensors would increase the safety of the highways and the survival of wildlife, and would minimize the disaster response time. They can also be deployed as ad-hoc sensor networks for several applications to provide a continuous and spatially dense monitoring of environmental, biological and artificial systems.

All the nodes in a WSN collect data from the surroundings and send the data to the Base Station (BS) or sink node, typically through single-hop or multi hop communication. In the meantime, due to their small size and high density, the nodes will have limited energy which makes energy a scarce resource in this type of network. In this regard, the presence of high density nodes in the network area is necessary for multi hop forwarding as the transmission range of the low powered nodes is not enough to communicate with the other nodes at long distances. In this paper, comprehensive review of WSNs and its application is presented. Whereas the structure of the paper is presented as follows: section 2 illustrates the structure of sensor node. While section 3 elaborates the development of WSN. Afterwards, section 3 shows the application of WSNs . At the end, the conclusion of the paper is presented.

II. LITERATURE SURVEY

The wide application of WSNs has endeared it to several researchers, especially those in the environmental monitoring, surveillance and health fields. Different studies have been presented on WSN. In [2] a study shows the factors the effects the design of WSN such as power consumption, sensor nodes failure, connectivity and data processing. While [3] presented a comprehensive survey on underwater applications of WSN where sensor nodes in these applications are deployed in underwater, also the survey illustrates the requirements and challenges for underwater applications. In [4] a review of specific applications of WSN that takes a linear topology known as Linear Wireless Sensor Network (LWSN). [5] presented a review of WSN in health applications whereas sensor nodes are deployed in human body and collecting different type of measurements such debits, pulse rate, , blood pressure and etc.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 12 , December 2021

Senor nodes have limited energy as powered by battery therefore reduce the energy consumption of WSN is very important. Researchers in [6]–[10] optimizes the data collection of WSN through clustering scheme that aimed to reduce the energy consumption in WSN.

III. STRUCTURE OF SENSOR NODE

The evolution and advances in micro, electro-mechanical systems (MEMS) have enabled the development of low cost, low-power and small-sized micro sensors and communicate in short distances [11]. Each sensor node consists of several main components [12] which are processing capability, memory, a radio transceiver, a power source and in some cases, they are equipped with GPS as shown in Figure 1 [11].

Wireless sensor networks (WSNs) have several advantages, including easy installation, cost-effectiveness, small size and low power consumption. Each sensor node has its own power source in the form of a battery. However, this battery provides limited energy and any damage to this battery will lead to the node being turned off. Moreover, in some WSN applications, replacing or recharging the battery is a difficult task, especially when the sensor nodes are deployed in unreachable places. In this case, managing power consumption is a very important concern in WSNs [13]. Therefore, efficient power consumption among the nodes will prolong the lifetime of the whole network [14]

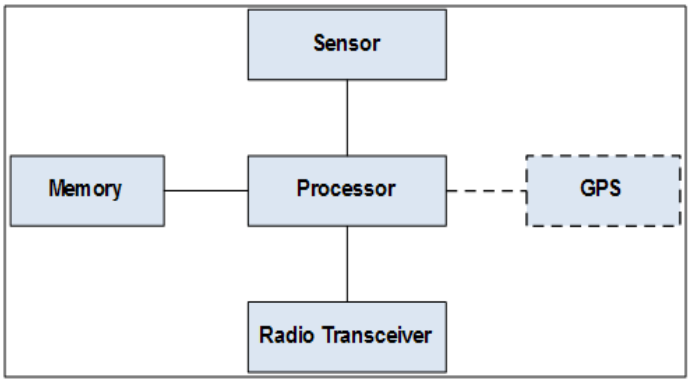

Fig 1. Overview of the main sensor node hardware components

IV. DEVELOPMENT OF WSN

Currently, WSN research is gaining attention because of the advancements of the wireless technology and embedded systems [15]. The WSN can be applied in numerous ways within our environment, ranging from a general locality, workplace and home [16]. It provides new ideas, ease and comfort in both our professional and personal lives.

The development of WSNs was started during the 1950s when the USA army launched the Sound Surveillance System (SOSUS) that was deployed in submerged acoustic sensors [17]. A number of SOSUS have still been in use even after the seismic activity surveillance was completed. After about thirty years, the US Defense Advanced Research Project Agency (DARPA) initiated the Distributed Sensor Network (DSN) program with the aim of further developing new protocols and technologies for use in the sensor networks [18]. The Advanced Research Projects Agency Network (ARPANET) simultaneously initiated research and developments in the WSNs with the collaboration of many industries and institutions [19]. NASA initiated research into the development of small sensor nodes such as Sensor

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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web project and Smart dust project in 1998 [20] with the major objective of creating an autonomous communication and sensing device within a cubic millimeter of space. The other early projects were initiated in this area in 1999 by the academia, including MIT and Berkeley and the University of Southern California [21].

V. APPLICATIONS OF WSN

Some of the applications of WSNs are discussed briefly in this section. Owing to the growing increase in the application of the WSN, a compilation of a comprehensive list of sensor network applications may be difficult. Some of the areas of application of wireless sensor networks include environmental monitoring, traffic control, home automation, healthcare, military war fields and civil engineering; while the emerging applications include water and home monitoring.

1. Military Applications

The WSN was first developed for deployment in the military field. It was developed for the monitoring of battlefields and for guiding intelligent missile systems. It was also aimed at the detection of attacks or weapons [22]. The DARPA deployed the Sensor Information Technology (SENSIT) and the National Science Foundation (NSF) programs in 1980 utilized the WSN to enhance their tracking capabilities [18]. The main aim of the sensors in this application is to collect measurements linked to other sensors and send a notification when movements are detected. In the recent military projects, the WSN has been deployed to detect the level and concentration of both chemical, nuclear and biological weapons [23].

2. Medical Application

In the medical sector, sensors are important in patients' diagnoses and monitoring [24]. Small sensor devices can be attached to the patients to monitor their physiological signs like the heart rate or blood pressure as shown in the Figure 2 . The data gathered from the SNs are transmitted to the BS and then, the medical doctor can easily diagnose the patients' status or send medication to them. This can assist the doctors to observe patients (especially the elderly) in long-term surveillance [25]. Moreover, patient monitoring systems are considered as literally lifesaving. In addition, such sensors can monitor several medical conditions continuously and reduce delays in getting test results. Such systems have a direct influence on the recovery of patients.

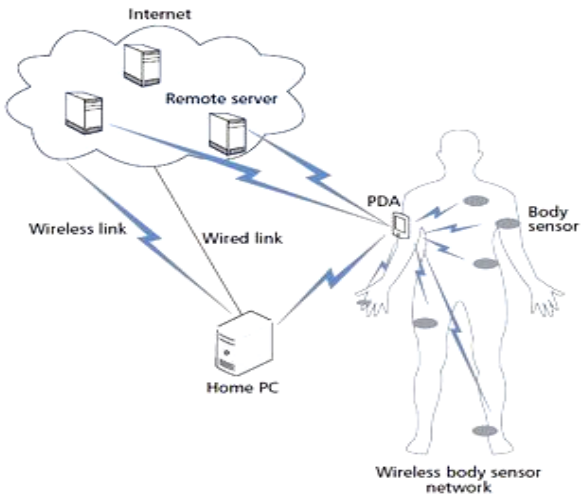

Fig 2. Using Sensor Nodes in healthcare

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 12 , December 2021

3. .Environmental Monitoring

An environmental sensor network application consists of various applications, such as sensing volcanoes, oceans, glaciers, and forests. [26]. For example, in air pollution monitoring, WSNs have been explored to detect the levels of dangerous bio-weapons in several cities (Stockholm, London or Brisbane). Also, forest fires can be detected by installing sensor network nodes. Such nodes are equipped with temperature and humidity sensors. Moreover, in greenhouse monitoring, WSNs can be deployed inside commercial greenhouses. WSNs are used to monitor the changes in the levels of temperature and humidity and notify the greenhouse manager via e-mail or text messages when the values have dropped to certain levels. Finally, in landslide detection, slight soil movements or changes in the soil parameters prior to or during a landslide can be detected by a landslide detection system equipped with WSNs. Such systems help to gather data that can be acted upon to evade the occurrence of such natural phenomenon [26], [27].

4. Industrial Applications

The WSN has also been used in commercial industries to improve machine and user performances and maintainability [18]. For example, in the industrial applications, WSN is used to monitor the machines condition such as determination of vibration and lubrication levels. Usually in the industrial applications, the placement of sensor nodes is done into regions unreachable by humans. Factories, supply chains etc. are other examples of WSNs in an industrial environment. The main aim of these industrial WSN applications is to provide real-time information sensed by several sensors in a large or small-scale network [28].

5. Precision Agriculture Applications

Precision agriculture implies controlling and monitoring the right quantity of farming inputs at the right time and location to improve production efficiency and product quality while keeping the environment safe [29]. In precision agriculture, the WSN has been designed to monitor relevant parameters, such as temperature, air pressure, humidity and soil moisture in large fields. The sensors transmit the sensed data wirelessly to the farmer's location and then, the right actions can be taken. This might help farmers by avoiding damages to their crops as well increase crop production [30]. The Figure 3 below shows an example of sensor nodes in agriculture.

Fig 3. An example of sensor nodes in agriculture [31]

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 12 , December 2021

VI. CONCLUSION

Sensor node is a low cost and low-power, deployed in an ad hoc manner to monitor the physical environment for different applications. In this paper the structure and development of sensor nodes are discussed in details. Furthermore different application of WSN is elaborated. Subsequently, for many applications, it is envisioned that WSNs will consist of between tens to hundreds of nodes operating on small batteries. Therefore a reducing the energy consumption of the sensor nodes and prolonging the lifetime of the WSN are very important for many applications.

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