A SURVEY ON APPLICATIONS OF WIRELESS SENSOR NETWORKS

Geeta Bhatia
Pusa Institute of Technology, Department of Electronics and Communication Engineering

Abstract: Wireless sensor networks (WSNs) have gained in popularity in recent years and have a wide range of applications, including health, the environment, agriculture, and the military. Wireless sensor networks are made up of highly distributed, compact, and light wireless sensor nodes that use physical measurements to monitor the environment or systems. Wireless sensor networks (WSNs) are used in a variety of multidisciplinary applications because they combine distributed computation, sensing, and communication powerfully. At the same time, they pose several concerns, owing to their haphazard deployment and reliance on nonrenewable energy sources. Existing linked WSN development methodologies are remembered and classified. Our research's major goal is to look into the viability and use of high-level-based techniques to make WSN design easier. Wireless sensor networks have a lot of possibilities for increasing network control, conservation, convenience, efficiency, adaptability, and safety.

Keywords: **Wireless sensor networks (WSNs)**

1. BACKGROUND

WSNs have become a critical component of a wide range of applications, including environmental monitoring, military surveillance **(Durisic, Tafa, Dimic, Milutinovic, 2012)**, and medical **(Furtado, Trobec, 2011)**, by enabling reliable communication, inspection, and application execution. WSNs are made up of a large number of sensor nodes that are densely distributed and communicate wirelessly to send and receive environmental data. One or more sensors, a radio transceiver, a processor, and a power supply portion are all included in each sensor node. Due to the complexity of such systems, developing WSNs becomes a difficult challenge. In addition, during the design of WSN, various critical requirements must be met, including the power consumption requirement, which is the fundamental key. As a result, several current research projects focus on surveying WSNs. The notion of WSNs and their properties were described in **(Akyildiz, Sankarasubramaniam, Cayirci, 2002)**. WSN's generations, routing, architecture, and storage management were all documented. Other studies **(Jiang, Manivannan, 2004)** provide an overview of existing sensor network routing protocols. The authors of **(Molla, Ahamed, 2006)** provided a variety of existing sensor network middleware.

Sensor networks can be used in a variety of ways. Frustration-inducing tasks include dropping sensor focus from a plane over a rapidly growing fire, where each location records the temperature to create a "temperature map." These sensors can also be used to create biodiversity maps and monitor wildlife. Based on the created stickiness, ventilation, and cooling control, intelligent networks (or expansions) can assist reduce centrality waste. This allows you to estimate the number of people in a room, the temperature, and the direction of the wind. After earthquakes, such networks can detect mechanical faults and provide machine recognition for preventative maintenance. Embedded sensing/control differentiates changes in systems, such as tire weight checks or identifying the status of compost/pesticides/watering systems with precision. Long-term perception of continuously impaired individuals or the elderly are examples of such applications in the health industry. As a result, an attempt will be made in this paper to present an overview of WSNs machinery, some of the primary applications and values, structures in WSNs projects, developments, and challenges based on some evidence and meta-data-based survey and assessments, which is expected to serve as an introduction to WSNs applications and challenges for those interested in WSNs.

2. CHARACTERISTICS OF WSN:

Some of the main characteristics of a WSN include :

1.Ability to cope with node failures • Power consumption limitations for nodes employing batteries or energy harvesting

2.Node mobility and heterogeneity

3.Dynamic network topology, large-scale deployment scalability, and ability to tolerate extreme weather conditions.

3. TYPES OF WIRELESS NETWORKS

According to Tiwari et al. (2015), there are essentially five categories of WNs as illustrated in Figure 1

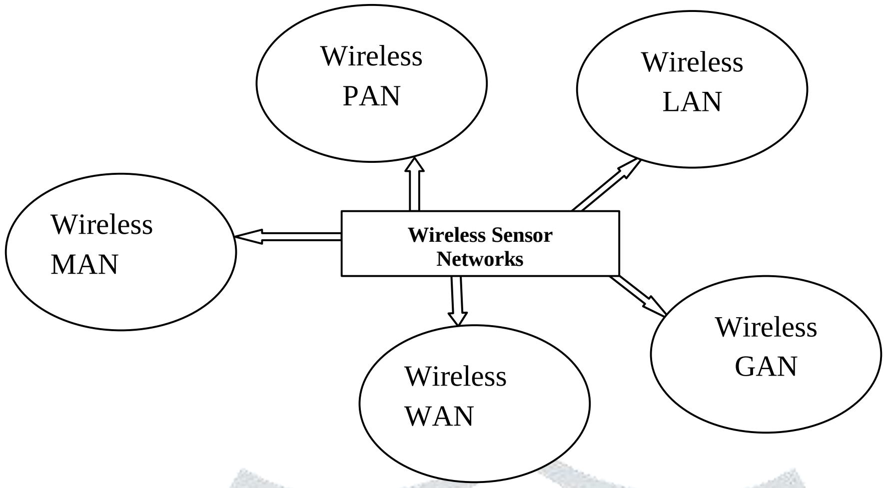

Figure 1 Five categories of WNs

3.1 Wireless personal area network (wireless PAN)

This is a WSN that uses a low-power, short-range WN technology like Bluetooth, IrDA, wireless USB, or ZigBee to communicate. A wireless PAN's range varies from a few meters to several kilometers.

3.2 Wireless local area network (wireless LAN)

This is a WSN or wireless computer network (WCN) that uses wireless communication (WC) to link or connect two or more devices to form a LAN within a confined area such as a computer research laboratory, home, institution, or office. This allows users to move from one area to another while being connected to the WN. Through a gateway, wireless LAN could also provide access to the wider cyberspace (internet). Most modern wireless LANs are marketed under the Wi-Fi product name and are based on IEEE 802.11 standards. Because of their ease of installation and use, wireless LANs have become popular in many houses. They're also common in business physiognomies that provide wireless access to employees and customers.

3.3 Wireless metropolitan area network (wireless MAN)

This is a computer network (CN) that links and communicates users with various computer resources in a geographic region the size of a city. The word MAN refers to the integration of LANs in an urban region into a single larger network that may link to a wide area network effectively (WAN). The term "wireless MAN" is also used to describe the usage of "point-to-point connections" to connect several LANs in an urban area **(IEEE Standard 802-2002)**.

3.4 Wireless wide area network (wireless WAN)

This is a different type of WN. A WAN's larger scale compared to a LAN necessitates technological changes. Web pages, phone calls, and streaming videos are all delivered by WNs of various dimensions. A wireless WAN varies from a wireless LAN in that it transfers data via mobile telecommunication cellular networks (MTCN) technology such as 2G, 3G, 4G LTE, and 5G. Wireless WAN is also known as mobile broadband (MBB). These pieces of equipment can be found across the country, regionally, or even globally, and are provided by a wireless service provider (WSP). Several CNs may be able to help with the integration of wireless WAN capabilities. A wireless WAN could also be a private network that spans a large geographic area. A "mesh network or MANET," for example, with nodes on towers, trucks, planes, and skyscrapers. It could also be a "low-power, low-bit-rate (LBR) wireless WAN, (LPWAN)," which is designed to transport small packets of data between devices, typically in the form of battery-powered sensors. Because RMSs rarely provide a physically secure connection path, wireless WANs frequently include "encryption and authentication" techniques to improve security.

3.5 Wireless global area network (Wireless GAN)

Any network that is made up of multiple interconnected CNs (WANs) and covers an unconstrained geographical area is referred to be this. It is eerily similar to the Internet, which is classified as a GAN. GANs, in contrast to LANs and WANs, span a significantly broader geographical region. One of the key issues for any wireless GAN is transferring user communications from one LAN to another because GANs are used to support MTCNs over a variety of wireless LANs. A broadband (BB) wireless GAN is one of the most popular wireless GAN types. The BB wireless GAN is a global satellite internet network (SIN) that uses telephone terminals that can be transferred.

4. APPLICATIONS OF WIRELESS SENSOR NETWORKS

(i) For Health Care and Engineering

Wrapped sensors that screen physical phenomena or steady circumstances to monitor phenomena such as temperature, sound, and weight and push their measurements across the network to a target region make up a WSN, also known as a wireless sensor or WSAN. To facilitate sensor control, most existing networks are bidirectional. Two or three of the following are involved in the development of WSNs: (1) data for air collection, harvesting, and soil, (2) coursed zone monitoring, (3) various yields from an area, (4) various fertilizers and water essentials to separate sections of an uneven zone, (5) various harvesting requirements for various air and soil conditions and (6) proactive strategies instead of responsive blueprints. Sensors have been around for some time in various networks. The rule indoor controller was created in 1883, and many people consider it to be the foundation for today's sensors. Infrared sensors have been around since the late 1940s and have recently become commonplace. For many years, progression markers have also been used.

(ii) Agriculture

The benefits of using WSN can greatly improve interaction with other current agricultural gear. In this regard, one of the most sophisticated businesses is winemaking, because even minor variations in product quality can have a large impact on earnings, and farmers are interested in using new technology to achieve the best possible outcome. (**Butenko, Nazarenko, Sarian, Sushchenko, Lutokhin, 2014**)

(iii) Applications in Area Monitoring

The sensor nodes are positioned over an area where a display is to be monitored in this case. When the sensors detect an occurrence (such as temperature, pressure, or other factors), the information is relayed to one of the base stations (BSs), which subsequently takes necessary action.

(iv)Transportation Applications:

WSNs collect real-time traffic data to feed transportation models later and to keep drivers informed about probable congestion and traffic issues.

(v) For indoor Temperature Regulation

The scientific community has lately introduced intelligent smart home frameworks **(Zhang, Zhang, Su, Wang, 2012)**. The suggested systems monitor and report various characteristics in a home environment, such as temperature, humidity, and light, as well as control various electrical equipment for lighting, air conditioning, and heating. Energy optimization is based on a dynamic programming algorithm that limits energy usage and sells it back to the smart grid **(Khan, Mouftah, 2012)**. The authors propose using the variogram to analyze temperature readings to forecast the temperature at each conceivable position in the room. A WSN based on star-topology is utilized for temperature monitoring in a greenhouse **(Stojkoska, Davcev, 2009)**. Because the nodes' radio range is 100 meters, they may send data straight to the base station. The authors **(Demirbas, Chow, Wan, 2012)** describe a web-based WSN interface for effective habitat monitoring that employs cutting-edge technologies.

Temperature and humidity levels in commercial greenhouses are also controlled via wireless sensor networks. The greenhouse manager must be notified through e-mail or cell phone text message when the temperature and humidity fall below particular thresholds, otherwise, host systems can trigger misting systems, open vents, turn on fans, or regulate a wide range of systems responses.

(vi) Military applications

These are very closely related to the concept of wireless sensor networks. It is very difficult to say for sure whether motes were developed because of military and air defense needs or whether they were invented independently and were subsequently applied to army services. Regarding military applications, the area of interest extends from information collection, generally, to enemy tracking, battlefield surveillance, or target classification **(Wong, Hu, Sayeed, 2002; Meesookho, Narayanan, Raghavendra, 2002).** The authors propose using the variogram to analyze temperature readings to forecast the temperature at each conceivable position in the room. A WSN based on star-topology is utilized for temperature monitoring in a greenhouse **(Stojkoska, Davcev, 2009)**. Because the nodes' radio range is 100 meters, they may send data straight to the base station. The authors **(Demirbas, Chow, Wan, 2012)** describe a web-based WSN interface for effective habitat monitoring that employs cutting-edge technologies. **(Krishnamurthy, Stankovic, Abdelzaher, Luo, et al.,2004).**

(vii)Environmental Applications

The name "Environmental Sensor Networks (ESNs)" was coined to encompass a variety of WSN applications in environmental and earth science research. Environmental Sensor Networks (ESNs) make it easier to analyze basic processes and create danger response systems. They've progressed from passive logging systems that require a manual download to 'intelligent' sensor networks, which are made up of a network of automatic sensor nodes and communications systems that actively communicate data to a Sensor Network Server (SNS), where it can be combined with other environmental datasets.

Wireless sensor networks have been deployed in several cities 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.

In order to identify when a fire has begun, a network of Sensor Nodes can be constructed in a forest. Sensors for measuring temperature, humidity, and gases created by fires in trees or vegetation can be installed in the nodes. Early detection is critical for firefighters' success; thanks to Wireless Sensor Networks, the fire department will be able to determine when a fire starts and how it spreads.

A landslide detection system employs a wireless sensor network to detect tiny soil movements and changes in numerous parameters that may occur before or during a landslide. And, using the data gathered, it may be possible to anticipate the occurrence of landslides well in advance.

(viii)Structural Applications

Wireless sensor networks are also used to control the temperature and humidity in commercial greenhouses. Otherwise, host systems can trigger misting systems, open vents, turn on fans, or regulate a wide range of system reactions unless the greenhouse manager is notified through e-mail or cell phone text message when the temperature and humidity fall below specific criteria.

(xi)Industrial Applications

WSNs have been proposed for "Technological Condition-based Maintenance (TCBM)" because they might provide significant cost savings and unique functionality. The installation of suitable sensors in wired classes is frequently limited by the amount of wiring needed.

(x)Agricultural Applications

The employment of WSNs has been reported to assist farmers in various aspects such as the maintenance of wiring in a problematic environment, irrigation mechanization which aids more resourceful water use, and reduction of wastes.

5. CONCLUSION

Wireless Sensor Networks are explored in this paper in terms of their different applications. Such applications are influenced by a number of issues, the most important of which being the application's requirements. Finally, it is advised that a vision of future research trends and opportunities, such as MDE approaches on WSNs, be established. Because many sensor networks perform mission-critical functions, it is evident that security must be considered during the design process. For the following reasons, security will be critical for most applications. Often these sensor networks continuously review their settings, and information other than the data being watched is frequently straightforward to discern. This type of unfortunate information leakage frequently occurs.

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