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Depth Analysis Study On Wireless Sensor Network: Introduction, Types, Features, Advantages, Disadvantages, Application And Challenges

Ms. Devika Bawane[1] Prof. D. G. Ingale

[1]Student, Dr. Rajendra Gode Institute of Technology and Research, Amravati, MH,

[2]Guide, Department, Dr. Rajendra Gode Institute of Technology and Research, Amravati, MH

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ABSTRACT

A wireless sensor network is a specialized type of wireless network consisting spatially distributed autonomous devices are called sensor nodes. Its type of wireless network. Nodes have limited resources (battery power, storage, communication) capabilities. The sensor node utilizes radio interfaces to communicate with each other to forming an interconnected network. It also commonly implemented in Internet of Things (IoT) application.

In this paper we discuss about introduction, features, advantages, disadvantages, application, and research challenges of the wireless sensor networks (WSNs)

1] INTORDUCATIONS

Wireless network use wireless data connections instead of cable. The sensor nodes are often tiny devices working together to detect and collect data about environments. They help avoiding costly cable installation in building or between equipment. Ex (It includes wireless tech like Bluetooth, Wi-fi, Wi-Max and 3G cellular)

- A wireless sensor network has many small low-cost nodes with limited memory, energy and processing power.
- Advances in wireless tech enables low cost, low-power sensor networked wireless. And wireless sensor network

cooperatively passes their data through the network to its main location. The more networks are bi- directional, also enabling control of sensor action.

Sensor Node Components:

Each sensor node consists the following basically components:

- Sensor Unit: Detects environmental parameters like temperature, pressure, sound and humidity.
- Processing Unit: Microcontroller used form data controlling and processing.
- Transceiver Unit: Handles wireless transmission and reception of data using radio frequencies among nodes.
- Energy Unit: A battery harvesting mechanisms that provides power to node.
- Optional Unit: Storage unit for data and also transforms analog sensor signals into digital data.

2] LITERATURE REVIEW

Many recent studies have looked at wireless sensor network can be used to various applications. These are helpful for creating application uses in different way and manners using application we can updates system.

I.F Akyildiz, W. Su and Y. Sankara Subramaniam [1] explain in this paper they provide a comprehensive information about overview of sensor network.

S. Lindsey and C. Raghavendra [2] In this they introduced in details power efficient gathering in sensor information system, and it focusing data collection and saving data.

Adeel Iqbal and Muhammad Bilal [3] This paper its mainly focuses on different application of wireless sensor networks and advantages and advancements in it. Since wireless sensor network used in different application in required condition

S. Sharma and A. Kaur [4] focused on wireless sensor network application in the detailed and issues in it.

J. B. Mukherjee and D. Ghosal [5] in this they discuss about routing protocols for wireless sensor networks, this highting how data navigates through network.

All these studies support the idea that Wireless Sensor Networks are flexible in nature, reliable, and it avoid plenty wiring, easily accommodates new devices at any time, It can accessed by using centralized monitor.

3] How Wireless Sensor Network Works?

A wireless sensor networks works small distributed sensor node wirelessly it collects environmental data like temperature, sound or pressure. transmit data to sink node, which send it to gateway for internet access by end users. Each node contains a sensor, processor, a transceiver and energy unit that allowing them to monitor the activity and its form a self-organizing network with limited energy and resources.

4] TYPES OF WIRELESS SENSOR NETWORK

It categorized by environment, mobility, topology and node types.

By Environments

A] Terrestrial WSNs: Typically deploy on land. Its commonly used for monitoring the activity like agriculture and infrastructure tracking.

B] Underground WSNs: Sensor are placed beneath the surface for applications like detection seismic activity and monitoring soil.

C] Underwater WSNs: These networks operate in aquatic environments and use acoustic signals for communication, though they face challenges with communication and power limitation.

D] Multimedia WSNs: these type networks include in sensor like camera and microphones to capture video and images with requiring higher bandwidth.

By Mobility

A] Statics WSNS: It consist of sensor node deployed at fixed location to monitor physical or environmental conditions these nodes communicate wirelessly with base station for data collection and analysis.

B] Mobile WSNs: Its moving nodes that adapt to dynamic environments, offering better coverage and energy efficiency but with more complex routing.

By Topology

1] Star Topology: It involves sensor node connecting multiple directly to switch and central hub. And manage data transmission and network function.

2]Mesh Topology: In devices are interconnected with multiple direct links, creating a mesh pathway.

B] Tree Topology: Sensor node organized in hierarchical structure, with data flowing up the hierarchy to sink nodes.

By Node

A] Homogenous WSNs: All sensor nodes in the network are identical, with same capabilities and function

B] Heterogeneous WSNs: The network contains different types of sensor nodes, each with varying capabilities and functionalities, which can enhance the network overall performances.

5] FEATURES WIRELESS SENSOR NETWORK:

1. Energy Efficiency: Sensor nodes are designed to separate with low power consumption, its often energy harvesting techniques to extend battery life.
2. Scalability: It accommodates a large number of nodes, often thousand and deployed.
3. Fault Tolerance: Failures are in WSNs like its sensor node failures, communication failures. Its despite considering these factors in application design, WSNs still need to reconfigure and recover on their own with minimal human intervention, especially when deployed hard-to-reach environments.
4. Network Topology: It refers actual layout and capability of sensor nodes to achieve connectivity. Since nodes can fail due to energy depletion and new nodes can join, the network needs to reconfigure itself periodically.

6] WIRELESS SENSOR NETWORK CHALLENGES:

WSNs to design a better protocols or algorithm, firstly it necessary to understand challenges. The challenges are following summarized.

1. Ad-hoc Deployments: Sensor node randomly deployed in required

monitoring field without any infrastructure. Example A typical way of deployment in forest would be tossing the sensor nodes forms an aeroplane. In such situation, it up to the nodes to identify its connectivity and distribution.

Physical Resources constraints: Sensor Nodes have limited battery power in attended environments where replacing batteries is not possibles. This limited network lifetimes. Nodes have also limited computational power, memory, and bandwidth and light weight protocols.

Fault Tolerance: Some nodes are failure because of unattended environments, and then it considers factor like application design and it still need reconfigure and recover itself without human intervention.

7] APPLICATION WIRELESS SENSOR NETWORK:

It has lots of applications like monitoring, security and other. And basic this application used when it needed in emergency conditions. The application categorized into various way such as Environments data collection, Military application, Health application.

1] Deployment: Sensor networks monitor real world phenomena in details and at scale using embedded wireless nodes. Deploying operational sensor networks in real environments is challenging. Deployment is often intensive due to environmental factors causing bugs or performance issues not seen in lab tests. Real world conditions affect sensor output by impacting wireless links and putting strain on nodes. These factors are hard to fully model in simulators setups.

1] Power Usage: Wireless sensor are nodes useful when mains power supply is not feasible. Since they often in hard reach spots, regularly changing batteries is not practical. Ensuring enough energy for system is crucial. Sensor power usage varies greatly based on communication protocols. The Gossip Based Sleep Protocols routes and handles function like mac to save energy.

2] Process Managements: Area monitoring using WSNs for detecting phenomena in a region. Examples include military use for detecting enemy intrusion and civilian use for geo-fencing of gas

3] Healthcare Monitoring: Using wearable and implantable medical devices for monitoring body position, patient health in hospitals and homes.

4] Environmental Sensing: Monitoring the environmental parameters with challenges due to harsh environments and reduced power supply.

8] ADVANTAGES OF WSNs:

Why the people like wireless sensor networks might be summarized below

- Networks can be setup without needing fixed infrastructure.
- They are suitable for hard-to-reach places like seas, mountains, and rural areas.
- They are flexible when you need extra workstation in random situations.
- Implementing them is budget friendly.
- They reduced the needs for lots of wiring.
- It can access by central monitor.
- It can accommodate with new devices at any time.

9] DISAVANTAGES OF WSNs:

- They are less secure since hacker can access the network easily information.
- They are slower in speed as compared to wired network.
- Its communication speed is low.
- It costly in nature.
- Them configuring is trickier than wired network.

10] CONCLUSION:

Wireless Sensor Network have been identified as one of the most prospective technologies in this century. And its essential technology in today world due to their ability to sense, process, and it transmit data wirelessly. They are characterized by scalability, energy efficiency and self-organization. But it also faces challenges and despite these challenges, the integration of WSNs, particularly in IoT systems, enhances real data time collection, responsiveness and cost-effectiveness in application ranging from smart cities to healthcare system.

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