ORION
SCHOLAR JOURNALS

International Journal of Multidisciplinary Research Updates

Journal homepage: https://orionjournals.com/ijmru/

ISSN: 2783-0179 (Online)

(REVIEW ARTICLE)

Check for updates

Wireless sensor networks a relevant tool for environmental development: A review

Oladimeji TT, Folayan GB * and Idowu OD

Department of Electrical/Electronic Engineering, Federal Polytechnic, Ado-Ekiti, Nigeria.

International Journal of Multidisciplinary Research Updates, 2022, 03(02), 004–010

Publication history: Received on 12 June 2022; revised on 20 July 2022; accepted on 22 July 2022

Article DOI: https://doi.org/10.53430/ijmru.2022.3.2.0050

Abstract

Information is critical, just as assessing the information available is equally important. The need to easily and quickly assess data securely, that could be processed for information as soon as they are available, is what communication engineers work towards every day. This paper is aimed at identifying areas where further work is needed. As such, a proper understanding of WSNs is needed and different definitions were looked at. Review of previous literatures and research were assessed, the characteristics and applications of WSNs were highlighted done. Finally, the design and topology problems that WSNs encounter as well as the advantages and disadvantages were considered. We then concluded that, the gap between technology and application can be bridged, by addressing these difficulties.

Keywords: Configure; Environment; Networks; Sensor; Wireless

1 Introduction

WSNs, which stand for Wireless Sensor Networks, are self-configured, infrastructure-free wireless networks that monitor environmental or physical conditions such as temperature, pressure, motion, sound, vibration, or pollutants and transmit their data or information directly to a sink, also known as the primary location where the data is frequently observed and analyzed. A new class of wireless networks known as wireless sensor networks (WSNs) is quickly gaining popularity with both military and commercial uses. A wireless sensor network (WSN) is a wireless network made up of numerous independent sensor devices that are deployed throughout the network and are used to track environmental or physical parameters. A WSN is made up of a collection of interconnected, tiny sensor nodes that may exchange data and communicate with one another. These nodes collect environmental data, including temperature, pressure, humidity, and pollution levels, and communicate it to a base station. Depending on the type and volume of data being watched, the latter transfers the information to a wired network or triggers an alarm or an action [1]. Due to recent developments in radio frequency, computer, and sensing technology, the size and complexity of Wireless Sensor Networks (WSN) are growing quickly. Applications can use hundreds or thousands of sensor nodes because to this technology. Applications of WSN are utilized in many different contexts. For instance, in the military, they are employed to monitor patient health in a room or to conduct observations on the battlefield. Many of these sensor networks will need to function successfully and efficiently in a signal-deficient environment. For low data rate and low power communication network applications, the IEEE 802.15.4 standard low-rate wireless personal area network (LR-WPAN) medium access control standard is suggested [2,3]. Centerless, self-organizing, multi-hop wireless networks are referred to as wireless sensor networks (WSNs). It is made up of a great deal of miniature, inexpensive, multi-functional sensors, and it is used in unique application scenarios. WSNs have been extensively deployed during the past ten years in a variety of industries, including traffic control, smart homes, environmental and medical monitoring, and military defense [4–7]. Typically, the node of a WSN is powered by separate batteries. Therefore, reducing energy consumption and extending the lifespan of WSNs remain crucial research issues. Researchers are primarily using two approaches: one is to equalize network node energy consumption, and the other is to increase node energy efficiency. Although this

* Corresponding author: Folayan GB
Department of Electrical/Electronic Engineering, Federal Polytechnic, Ado-Ekiti, Nigeria.

strategy does not lessen the energy consumption during each communication processing, the equilibrium of network energy consumption [8, 9] could prevent one node from rapidly depleting its energy and dying when its data is transmitted often. The method for increasing nodes' energy efficiency focuses on lowering each node's energy consumption by altering the network communication, such as by lowering idle listening[10, 11], lowering sent data[11, 12], and improving receiving and sending transmission elements.

2 Review of Relevant Works

It was discussed in [13] how to implement adaptive wireless sensor networks that can carry huge amounts of data via narrowband channels. When inserted in medium having random dissipative properties, the magnetic front-end is especially made to maintain radiation efficiency. Narrow band channels offer robustness against interferences, decreased signal susceptibility, and non-line-of-sight coverage. It is also possible to lower the carrier below to 180 MHz (highly compatible with regulatory authorizations). For all of these reasons, this platform is being used in cultivations to create a powerful and affordable tool that supports sustainable agriculture. The research reported in this paper demonstrates the efficacy of an ad-hoc wireless sensor nodes, which employs bandpass communication channels to transmit huge amounts of data even for a little period of time. The two components may appear to be in opposition to one another at first glance, yet every set of various has been carefully considered and adjusted to ensure optimal performance. The wireless signal may be propagated even in non-line-of-sight situations with the help of a dynamic protocol, and more importantly, it is feasible to deploy effective energy harvesting devices, which ensures a nearly endless life for the sensor node [13].

For mobile ad hoc and sensor networks, this paper present an energy-efficient on-demand multiplex routing protocol (EMP) in [14]. The goal of the design is to increase the network lifetime of these networks. EMP introduces the energy crucial avoidance approach for this reason during the on-demand creation of multicast routing trees. In other words, multicasting tasks are prohibited for those network nodes that require a lot of energy. In order to lower the cost of the trees, EMP also adds the destination-driven functionality into their tree production process. We now provide a thorough description of the EMP design. In terms of network longevity, simulation findings demonstrate that EMP can attain great performance.

For wireless ad hoc and sensor networks, we suggested an energy-efficient destination-driven on-demand multicast routing protocol in this study (EMP). In the on-demand process of building multicast trees, EMP integrates the properties of energy criticality avoidance and destination-driven property. EMP requires extremely little information to be retained at nodes and is straightforward and simple to implement. According to the simulation results, EMP can significantly extend the network lifetime compared to current methods [14].

Because of their use in e-healthcare monitoring systems, wireless sensor networks (WSNs) have become a significant topic for study and development.

With a few modifications to the protocol and appropriate tuning settings, this paper introduces and discusses the performance of the slotted and unslotted CSMA/CA protocol WSN for medical systems. To determine the effects of protocol parameters like Superframe Order (SO), Beacon Order (BO), Backoff Exponent (BE), and Maximum Backoff Exponent, CSMA/CA performance was assessed and examined for various network setups (maxBE). Throughput, Power Consumption, Average Delay, and Packet Success Probability are the four metrics used to measure the Quality of Service (QoS) of a network. Network Simulator 2 is used to implement the suggested work (NS2). For WSN star topology, the protocol CSMA/performance CA's was assessed. The simulation findings demonstrate that, in terms of network success probability, energy usage, and delay, unslotted CSMA/CA is superior to slotted CSMA/CA. While in terms of throughput, slotted CSMA/CA is superior to unslotted CSMA/CA [15].

Wireless sensor network and control applications that are focused on the performance of IEEE 802.15.4 standard for star and cluster topology are one application taken into consideration for IEEE 802.15.4 standard Low Rate-Wireless Personal Area Network (LR-WPAN). By comparing the throughput, latency, and energy consumption results for the compass mode on star and cluster topologies of the IEEE 802.15.4 standard, this study compares the performance in order to use the best topology model as necessary.

Using node counts ranging from 10 to 100, we examine each topology model's throughput, delay, energy use, and chance of a successful transmission. According to the simulation results, cluster topology has a greater lifetime node and capacity than star topology. This study analyzes the performance of an IEEE 802.15.4 wireless sensor network that supports beacons (WSN). We compare the throughput, average delay, energy usage, and packet delivery probability of the start and cluster tree topologies. We discovered that the cluster tree topology has a higher throughput than the star topology based on the results of the simulation. Because the cluster topology depends on how many nodes and how many levels we divide the node to be the end device and coordinator, the average delay in the cluster is not the same and is not uniform. There is only one layer in a star topology, and it has 10 to 100 nodes. The average delay data are just somewhat off as a result. The requirement for energy consumption on a star topology is greater than the need for energy consumption on a cluster topology in the comparison of energy consumption. Finally, a cluster tree topology has a higher success rate for data transmission than a star topology. [16].

Researchers are constantly trying to figure out how to make wireless sensor networks (WSNs) last longer. Two key strategies for extending the lifespan of WSNs have been established in recent years: one is to balance network energy consumption, and the other is to increase network node energy efficiency. A multi-hop routing protocol based on the LAR algorithm and a cross-layer mechanism was proposed by the authors in this study. The proposal takes into account the residual energy of a node as well as the distance to the next hop node using various equilibrium weighting factors. The analysis and stimulation results demonstrate that our idea is effective in balancing the nodes' energy usage and lowering the rate of network packet loss.

Additionally, networks have a longer lifespan than LAR. The paper's first section concentrated on the LAR principle and explained that frequent data transmissions are to blame for the network's energy consumption imbalance. Then, this article suggested a multi-hop energy equilibrium routing protocol for WSN, called CLMHR, based on cross-layer design. In order to select the next hop node, this protocol considered both the candidate node's leftover energy and its distance from the destination node. CLMHR protocol addresses the drawbacks of some nodes excessive energy consumption and data transfer as compared to LAR protocol. The protocol promised superior network energy balance based on simulation results. Additionally, CLMHR succeeded in its goals of extending network lifespan and reducing network packet loss, particularly in larger size networks. [17].

In [18] a slope monitoring implementation report using an IEEE802.15.4-based Wireless Sensor Network (WSN) system (ZigBee) was presented. The goal of this research is to build a WSN system that can use radio communication and sensor devices to sense and monitor the ground deformation brought on by heavy rain in mountainous areas. There are various electrical and environmental issues that need to be resolved for stable data gathering. The approaches for dynamically changing the communication mode based on battery capacity, a methodology for shielding wireless nodes from light, and a WSN antenna design that is optimized are all suggested in this work. The suggested system's installation at a real test site produced experimental results that demonstrate the nature of wireless network configuration. Additionally, the data acquired from the upgraded system can be used to predict the state of the field. The WSN system was used to build the remote slope monitoring system. It was discovered that actual outer field surveillance has a number of undesirable elements. The adaptive charging control for the nodes. Nodes has also been suggested to operate the system for years. Additionally, the information gleaned from the suggested approach can be used to predict the state of the field. It is necessary to improve the stability of communication, the availability of power, and the impact of the environment. [18].

3 Classification of Wireless Sensor Networks

Classification of Wireless Sensor Networks are as follows

3.1 Single Base Station and Multi Base Station WSN

A single base station that is situated close to the sensor node region is utilized in single base station WSNs. In the case of a multi-base station WSN, more than one base station is employed, and a sensor node can transfer data to the closest base station. All nodes connect with this base station.

3.2 Mobile Base Stations and Static Base Stations WSN

Similar to sensor nodes, even the WSN base stations are frequently either stationary or mobile. A permanent position, typically near to the sensing area, is present in a static base station. Because the load on the sensor nodes is balanced, the mobile base station WSN moves across the sensing area.

3.3 Static and Mobile WSN

In many applications, these are static networks since all of the sensor nodes are connected and remain stationary. Mobile sensor nodes are required in some applications, particularly those involving biological systems. We refer to these as mobile networks. Animal monitoring is an illustration of a mobile network. [19].

3.4 Deterministic and Nondeterministic WSN

Deterministic wireless sensor networks have computed and fixed sensor node positions. A select few applications allow for the deployment of sensor nodes. Due to a number of reasons, such as hostile operation conditions or severe settings, determining the position of sensor nodes is not possible. These networks require a complicated architecture because they are non-deterministic.

3.5 Homogeneous and Heterogeneous WSNs

In homogeneous WSNs, each sensor node uses the same amount of energy and has the same storage and processing power. Furthermore, in heterogeneous WSNs, the processing and communication activities are distributed in accordance with which sensor nodes have higher computational demands and energy requirements. [19].

3.6 Solitary and Multi-hop Heterogeneous networks

In solitary WSNs, the base station and sensor nodes are in direct communication. Additionally, peer nodes and cluster heads are utilized in multi-hop WSNs to transmit the information in order to spend less energy.

3.7 Self-Reconfigurable and Non-Self Configurable Wireless Sensor Networks

In non-Self Customizable WSNs, sensor networks must rely on a control unit to organize themselves into a network and collect data. In many WSNs, the sensor nodes can manage the connection, keep it up, and cooperate with other sensor nodes to complete the task.

4 Applications of wireless sensor network

Worldwide, wireless sensor networks are used extensively. The following are examples of wireless sensor network applications:

4.1 Environmental tracking

Wireless sensor networks have been extensively used in the study of environmental changes and their monitoring. These networks are used for commercial applications such as seismic activity prediction and monitoring, forest identification, animal tracking, weather forecasting, flood detection, and water quality monitoring.

4.2 Health applications

Applications for the health sector: Doctors typically utilize these networks to follow and monitor their patients.

4.3 Transport systems

The most common application for wireless sensor networks is in transportation systems. Examples include dynamic routing management, traffic and parking lot monitoring, and more.

4.4 Military applications

In addition to being the main area of human activity where WSNs are deployed, the military domain is also thought to have inspired the beginning of sensor network research. These kinds of networks are used by tracking and surveillance apps that monitor the environment. A user can remotely manipulate the sensor nodes from sensor networks that are dropped to the area of interest. These networks are also used for adversary tracking and security detection.

4.5 Threat detection

Many additional WSNs are also utilized for threat detection, and the Wide Area Tracking System (WATS) is a device and a prototype network for detecting a ground-based nuclear device like a nuclear bomb.

These networks are used for things like industrial process monitoring, quick emergency response, automated building climate control, area monitoring, civil structural health monitoring, ecosystem and habitat monitoring, etc.

5 Characteristics of Wireless Sensor Network

The following are some fundamental features of wireless sensor networks [19]: For nodes that primarily employ batteries or energy harvesting, there are power consumption restrictions.

- Suppliers include ReVibe Energy and Perpetuum, for instance.
- Heterogeneity of nodes,
- Homogeneity of nodes,
- Ease of use,
- Cross-layer optimization,
- Resilience to node failures,
- Some mobility of nodes (for highly mobile nodes see Mobile Wireless Sensor Networks), Scalability to large scale deployment,
- Resistance to extreme climatic conditions

6 Wireless Sensor Networks Problems

Wireless sensor networks WSNs are experiencing a number of problems, including design, topology, and other problems. [19]

The following factors can complicate the design of various wireless sensor networks:

- low bandwidth
- access to large volumes
- Malfunction
- range issues
- adaptability

The following are some issues with wireless sensor networks' topology.

- Sensing Holes
- Penetration Topology
- Location-Based Routing

The principal problems with wireless sensor networks following are examples of WSNs. The design and functionality of wireless sensor networks are primarily impacted by these problems [19].

- Hardware & Operating System for WSN
- Deployment
- Medium Access Schemes
- Middleware
- Wireless Radio Communication Characteristics Architecture
- Calibration
- Database-focused querying in the network.
- Localization
- Application Of techniques for Sensor Networks
- Synchronization
- Transmission Control protocol (TCP)
- . Data Processing & Dissemination

7 The Advantages and Disadvantages of wireless sensor networks:

The advantages of wireless sensor networks WSNs are as follows [19]:

- It is appropriate for remote locations such as those above the sea, in mountains, in rural areas, or in thick forests.
- It doesn't use a lot of wiring.
- It might at any moment be able to support new devices.
- A central monitor can be used to access it as well.
- Be adaptable in case a sudden need for an extra workstation arises.

- Implementation costs are reasonable.
- It is flexible enough to move over physical partitions.

The disadvantages of Wireless sensor networks are as follows:

- Less secure due to the possibility of hackers accessing the access point and stealing all the data.
- Less rapidity in comparison to a wired network.
- Hackers can easily break into it since we are unable to control how waves move.
- In comparison to a wired network, it is even trickier.
- Easily upset by the environment (walls, microwave, large distances because of signal attenuation, etc).
- Relatively slow communication speed.
- Is easily sidetracked by many things, such as Bluetooth.
- Still Expensive (most importantly).

8 Conclusion

In contrast to other networks, WSNs are intended to serve certain purposes. Environmental monitoring, industrial machine monitoring, surveillance systems, and military target tracking are just a few examples of applications. The characteristics and needs of each application vary. To accommodate such a wide range of applications, new communication protocols, algorithms, architectures, and services are required. In this research, we examined reviewed relevant articles, looked at different applications, classifications, characteristics as well as problems WSNs encounter. Many difficulties with WSN applications remain unresolved, such as security, communication architectures and management. By addressing these difficulties, we can bridge the gap between technology and application.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

References

[1] Mohammad S. Obaidat and Sudip Misra Principles of Wireless Sensor Networks. 1 – 13.

[2] IEEE 802.15.4, Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs), IEEE standard for information technology. September 2006.

[3] MUH Al Rasyid, IU Nadhori, A Sudarsono, R uberski. Analysis of slotted and unslotted CSMA/CA Wireless Sensor Network for E-healthcare system. International Conference on Computer, Control, Informatics and Its Applications (IC3INA). 2014; 53-57.

[4] A Chandrakasan, R Amirtharajah, S Cho, J Goodman, G Konduri, J Kulik, W Rabiner. A Wang. Design considerations for distributed micro-sensor systems, Proceedings of the IEEE 1999 Custom Integrated Circuits Conference, San Diego, CA. May 1999; 279–286.

[5] P Bonnet, J Gehrke, P Seshadri. Querying the physical world, IEEE Personal Communications. October 2000; 10–15.

[6] B. Warneke, B. Liebowitz, K. S. J. Pister, Smart dust: communicating with a cubic-millimeter computer, IEEE Computer, January, 2001; 2 –9.

[7] Fei GAO, Hongli Wen, Lifen Zhao, Yuebin Chen. Design and optimization of a cross-layer routing protocol for multi-hop wireless sensor networks, PROCEEDINGS OF International Conference on Sensor Network Security Technology and Privacy Communication System. 2013; 5-8.

[8] Jie ma, Xue wu. Based on energy metrics cross-layer protocol research for Wireless sensor networks, Computer Era. 2008; 2: 14-18.

[9] Ning hu, Dengyun zhang. Energy balanced routing for wireless sensor networks, Journal of Xi'an Jiaotong University. 2006; 6: 676-680.

[10] Ye W, Heidemann J, Est rin D, Medium Access Control With Coordinate Adaptive Sleeping for Wireless Sensor Networks, IEEE/ACM Transaction on Networking. June 2004; 493-506.

[11] Guoqiang Zheng, Ruoyu Sun, Jishun Li, Cross Layer Energy Efficient MAC Protocol for Wireless Sensor Networks, Journal of Wireless senor networks. 2009; 1: 95-98.

[12] Li Chen. Based on the Zigbee protocol environment monitoring measurement node's design in Wireless senor networks, Shanghai, Shanghai Jiaotong University. 2008.

[13] Adaptive Wireless Sensor Networks for High-Definition Monitoring in Sustainable Agriculture. Abel Rodriguez de la Concepcion, Riccardo Stefanelli, Daniele Trinchero.

[14] J Hao, G Duan, B Zhang, C Li. An energy-efficient on-demand multicast routing protocol for wireless ad hoc and sensor networks," 2013 IEEE Global Communications Conference (GLOBECOM). 2013; 4650-4655.

[15] MUH Al Rasyid, IU Nadhori, A Sudarsono, R Luberski. Analysis of slotted and unslotted CSMA/CA Wireless Sensor Network for E-healthcare system. 2014 International Conference on Computer, Control, Informatics and Its Applications (IC3INA). 2014; 53-57.

[16] M Udin Harun Al Rasyid, FA Saputra, ZS Hadi A Fahmi. Beacon-enabled IEEE 802.15.4 wireless sensor network performance. IEEE International Conference on Communication, Networks and Satellite (COMNETSAT). 2013; 46-49.

[17] Fei Gao, Hongli Wen, Lifen Zhao, Yuebin Chen. Design and optimization of a cross-layer routing protocol for multi-hop wireless sensor networks," PROCEEDINGS OF International Conference on Sensor Network Security Technology and Privacy Communication System. 2013; 5-8.

[18] Nishikawa Y, Sasamura T, Ishizuka Y, Sugimoto S, Iwasaki S, Wang H, Fujishima T, Fujimoto T, Yamashita K, Suzuki T, Kurihara K. Design of stable wireless sensor network for slope monitoring. 2018 IEEE Topical Conference on Wireless Sensors and Sensor Networks (WiSNet). 2018; 8-11.

[19] https://www.tescaglobal.com/blog/what-is-wireless-sensor-network-and-types-of-wsn/