International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 11, Issue 3 [May.-June. 2022] PP: 184-192

Extension in Lifespan of Wireless Sensor Networks

[1]Karmendra Bahadur Srivastava Student
Galgotias University, Noida, India

[2]Yash Gupta
Student Galgotias University, Noida, India

[3]Ms. Pravesh
Assistant Professor Galgotias University, Noida, India

Abstract— *Wireless Sensor technology is so beneficial and is being utilized by many day-to-day, even though it is quite suitable in comparison to other generation however everything has a drawback, there are some within the Wireless Sensor Network as well and our target is to improve their lifeline inside the process of creating it extra efficient and could help a variety of gadgets in the approaching long time task that are presently no longer possible because of the minimum life of WSN. Inside the present day marketplace, our aim is to create a sensory work schedule that gives as lots time as feasible for effective tracking of a selected set of POIs. Here, we present three heuristic algorithms for sensory function planning: a random and precise planning method, a cell automata-driven method, and a hyper graph model method.*
Since the result of those algorithms does not constitute the pleasant solutions and may be further improved, we use the obtained schedules as the inclusion of a local seek approach with a specific mission dealing with a selected hassle. Three forms of device interrupt operators are delivered. We also advise a sequence of benchmark check eventualities for the checking out of our algorithms and give the check outcomes with heuristic algorithms and local search strategies.

Keywords— *Sensor, Technology,algorithms, Wireless, schedule, lifespan, efficient.*

Date of Submission: 29-05-2022 Date of Acceptance: 10-06-2022

I. Introduction

Energy efficiency has become a major theme in wireless sensor systems (WSNs) research. Interest in energy efficiency may be due to limitations imposed by batteries used to power such devices. These batteries are usually the main source of energy for these devices and are characterized by limited life, after which they are recharged or discarded by WSNs forming the backbone of ubiquitous computer applications such as military monitoring, disaster, environment, structural, health and safety, and wildlife monitoring, habitat and precise farming. Transmission of sensor nodes is often out of reach, and with limited battery life it often becomes a major problem.

Several definitions have been proposed for the lifetime of the sensory network; however, the most commonly accepted explanation is when a network drops to a point where it can no longer perform its intended function. This can be when any of the following events occur: when the first sensor node dies or when a number or percentage of nodes die or when the network is broken in such a way that there is no communication between sub-networks or when coverage is lost.

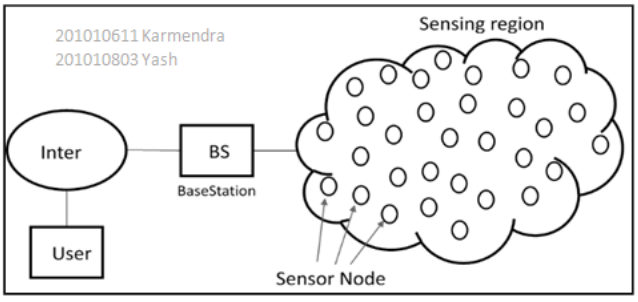

Figure 1: *Networking in Wireless System using Sensing Nodes*

To help extend the life span of nerves and networks, energy-saving methods are often used. Here, an effort is made to reduce the power used by the unit. The energy-saving programs have divided them into three main categories: Sleep/wake-up cycling, data driven, and mobility- driven strategies. Cycle activity is intended to reduce idle listening while the node radio waits for the frames and for over-hearing when the nodes are constantly listening to uninterested frames. Data- driven techniques use some of the data parameters themselves to make decisions to reduce power consumption during communication while mobility schemes consider sink movements or transmission nodes as a power factor used in a network.

A. Understanding Wireless Sensor Network

Wireless Networks (WSNs) is defined as a configured and infrastructure-less wireless networks to monitor physical or environmental conditions, like temperature, noise, vibration, pressure, motion or pollutants and to pass their information through the network to the base station where the information are often ascertained and analysed. A sink or base station (BS) acts like connecting interface between users and therefore the network. One will retrieve needed data from the network by injecting queries and gather results from the BS. Usually a wireless sensor network contains many thousands of sensor nodes. The sensor nodes will communicate among themselves using radio signals.

The wireless sensor node is equipped with sensors and computers, radio transceivers and power components. The individual nodes in the wireless sensor network have naturally in-built devices: limited processing speed, storage capacity, and network bandwidth. After the sensor nodes have been distributed, they are responsible for setting up appropriate network infrastructure usually through multi-hop interactions with them. Then the nodes begin to collect interested information. Wireless sensor devices also respond to queries sent to the "control site" to perform specific instructions or to provide sensor samples. Operating mode for sensor nodes may be continuous or be event-driven.

Global Positioning System (GPS) and native positioning algorithms are often used to get location and positioning data. Wireless detector devices are often equipped with actuators to “act” upon certain conditions.

Wireless networks require non- conventional paradigms for protocol design due to several constraints. Due to the need of device with low-complexity and low-power consumption (i.e. long network life), a balance must be obtained between the connection and signal strength / data processing. This encourages greater effort in research activities, standardization of processes, and industrial investment in the sector over the past decade. Currently, most WSN research focuses on energy sustentation and efficient-processingalgorithms and processes.

B. Algorithm of Wireless Sensor Network

i. LEACH is a hierarchical protocol in which utmost bumps transmit to cluster heads, and the cluster heads total and compress the data and further it to the base station (Gomorrah). Each knot uses a stochastic algorithm at each round to determine whether it'll come a cluster head in this round. LEACH assumes that each knot has a radio important enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy.

ii. Clustering model, the selection of cluster head (CH) in each cluster regards as it enables the system for energy effective routing, which minimizes the transmission detention in WSN. Still, the main problem dealt with the selection of optimal CH that makes the network service advisement. Till now, further exploration workshop have been recycling on working this issue by considering different constraints. Under this script, this paper attempts to develop a new clustering model with optimal cluster head selection by considering four major criteria like energy, detention, distance, and security.

iii. DV-hop algorithm is a type of algorithm which is used to find the minimum hop and the average hop distance between unknown nodes and beacon nodes are obtained by means of beacon node broadcasting. Then, the merchandise of minimum hop and therefore the average hop distance is employed to estimate the space, and therefore the location of unknown nodes is estimated by trilateral measurement or maximum likelihood estimation.

iv. The Ant colony optimization (ACO) algorithm was proposed by Italian scholars, which imitates the gesture of ant colonies as ants hunt for the shortest path from their nest to the food source. The ants deposit a certain quantum of pheromone on the path they cut during the rustling process, and the posterior ants choose their path according to the pheromone intensity. Therefore, the collaborative geste of ant colony composed of a large number of ants shows a positive feedback of information The shorter the path, the further ants will cut it, producing the upper pheromone intensity, which can increase the probability of ultimate ants choosing an original path.

II. Discovery of Wireless Sensors

WSN's story is interesting: from extremely smart scientists solving tough problems, to marketers who once again show that simple solutions (scams) have commercial potential. Larger trade. The concept of smart dust, a project

funded by the Defence Advanced Research Projects Agency in 1997, was born out of a desire to build micro robots using microelectromechanical systems (MEMS) technology.). By 1992, it was clear that three different technologies were following an exponential curve at zero cost: sensors (powered by the MEMS revolution); calculation (according to Moore's law); and communicate. Likewise, it was clear at the time that the size and power of these devices would follow similar cost trends: everything you would need to build a wireless sensor node would not be enough. in terms of size, capacity andcost.

III. Advantages of WSN

A. WSNs operate in Strict or hostile situations

It was the seed of the smart dust idea. The concept of smart dust has resonated with the entire community of people. At the Intel Developers Forum in 2001, 800 Berkeley motors were placed in the main hall, one under each seat. Self-healing was demonstrated by extracting a battery of randomly selected grains of dust and observing how the network self-reconstructs around the remaining grains of dust.

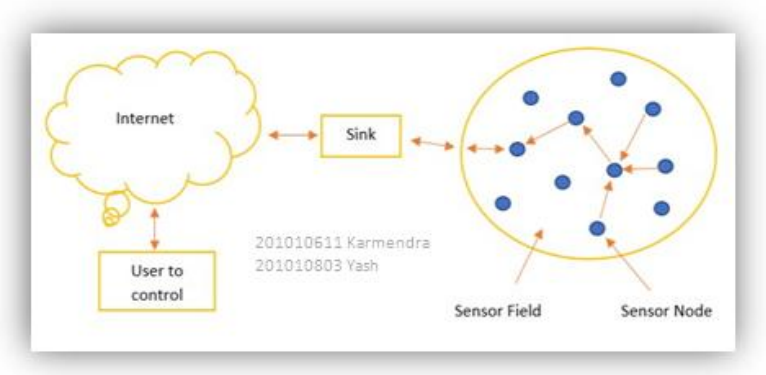

Figure 2: *How networking Works Wirelessly*

This was the birth of a multi-hop, self- organizing and self-healing wireless network. Another major demonstration in 2001 placed a wireless sensor under the wing of a drone that was programmed to drop the sensor along the road. After placing the dust particles equipped with a magnetometer, the travel time of the vehicle was recorded. The plane flew back and forth along the road, examining all sensors in its path and reporting the time the car travelled to the base station. In 2003, commercial analysts saw the success of these academic demonstrations and began to see the commercial potential of the technology.

The reason for this continued enthusiasm is that WSNs, a technology where inexpensive sensors can be placed anywhere and start reporting data without needing to run wires, can be used almost anywhere. All over the place. The application space covers areas as diverse as building automation (security, heating, ventilation, air conditioning (HVAC), automatic meter reading (AMR), lighting control, and control access control), industrial monitoring (asset management, process control, energy and environment management), body sensor networks. (Patient monitoring, exercise), home electronics (TV, VCR, DVD/CD, game console), computer interface (mouse, keyboard, joystick), application energy (lawn and garden irrigation, energy monitoring, demand response systems, smart grid), and so on.

Wireless nerve networks were first developed to survey the battlefield in military operations, situations where building a wired network of sensory devices would not be possible. These critical conditions create the need for a wireless sensor network that can be distributed at minimal risk and used to monitor environmental conditions on the battlefield. Wireless node sensors can be dropped or planted to any target location where they begin to transfer data and information back to the main area for analysis.

B. WSN Provides a Easily Measured Solution

WSN's standard network architecture makes it an easy-to-use environment-friendly solution. If you have used multiple sensors nodes to monitor a certain area and have decided to expand your monitoring area, you can set up additional sensors to connect to the same network and place them in an extended location. And there is no need to change existing ones to add new sensors to your network.

C. WSN Allows Long-distance Data Collection andTransmission

Each sensor node in the WSN acts as a transmission channel between other sensors in the network and a central point where data must be transmitted at the end. There are many WSNs implementations where most of the sensor nodes are completely out of range of the main wireless network: they rely entirely on signal transmission and collaboration from other nodes in the network totransmit their data.

D. WSNs Can Anticipate Natural Disasters

Some of the most important use cases for WSN have so far focused on the environment and global sensitivity to improve early knowledge of changes in the environment. Researchers have used wireless sensor networks to detect the onset of forest fires by changes in temperature, humidity, and emissions, as well as to anticipate landslides bysensing subtle movements that may precede major landslides.

E. WSNs Can Protect Computer Hardware AndData Assets

Companies need to use a heat sensor in their data centers to avoid data loss and random downtime that can be caused by a very hot server. These data centers are usually full of servers, and the addition of new wire sensors to the area can add a lot of clutter to the existing cable maze. Wireless sensor notes make it easy for companies to see the benefits of real-time temperature sensors in their data centers without adding a lot of extra cable to the area.

IV. Disadvantages of WSN

Wireless Sensor networks are a new technology, The simple operation of the sensor node devices makes these networks easy to operate, but also makes them vulnerable to malicious security attacks, as these sensors often lack robust security systems. WSNs can be large and cover a wide area, which means that there are many sensors that can serve as network access points for malicious attackers.

In addition to the safety risks, the natural environment for WSNs poses real problems when using them. These networks include devices that use low power and short distances which should be cheaper because there are usually multiple devices used in the same network. In general, the problem are reflecting competing needs:

i. Use sensor nodes that have ample battery lifeand transmitting capabilities
ii. Use sensor nodes that are inexpensive topurchase and operate

Availability and performance will be an ongoing problem for these low power connected devices, but engineers can use the latest diagnostic tools for embedded systems to ensure that their sensors are as efficient as possible and that no energy is wasted.

i. As it is wireless in nature, it is prone to hacking byhackers.
ii. It cannot be used for high speed communication asit is designed for low speed applications.
iii. It is expensive to build such network and hence cannot be affordable by all.
iv. There are various challenges to be considered in WSN such as energy efficiency, limited bandwidth, node costs, deployment model, andSoftware/hardware design constraints and so on.
v. In star topology based WSN, failure of central nodeleads to whole network shutdown.

V. Components of WSN

A. Applications of WSN:

i. Internet of Things (IOT)
ii. Security monitoring and supervision, detection ofthreats
iii. Environmental or System temperature, humidity,and air pressure
iv. Sound Level of the environment
v. Medical applications such as patient monitoring,drug management, Nano-informatics,
vi. Agriculture
vii. Detecting landslide
viii. Battlefield surveillance

B. Challenges of WSN:

i. Service Quality
ii. Security Issue
iii. Energy Efficiency
iv. Network Throughput
v. Performance
vi. Ability to cope with node failure
vii. Cross layer optimization
viii. Scalability to large area

C. Components of WSN:

I. *Sensors:*

Sensors in WSN are used for flexible imaging and for data acquisition. Sensor signals are converted into electrical signals.

II. *Radio Nodes:*

It is used to receive data generated by Sensors and transfer it to the WLAN access point. Contains a microcontroller, transceiver, external memory, and power source.

III. *WLAN Access Point:*

Receives data sent over Radio nodes wirelessly,usually via the Internet.

IV. *Evaluation Software:*

The data obtained by the WLAN Access Point is processed by a software called Evaluation Software to provide feedback to users in order to further process data that can be used for processing, analyzing, storing, and extracting data.

D. Architecture

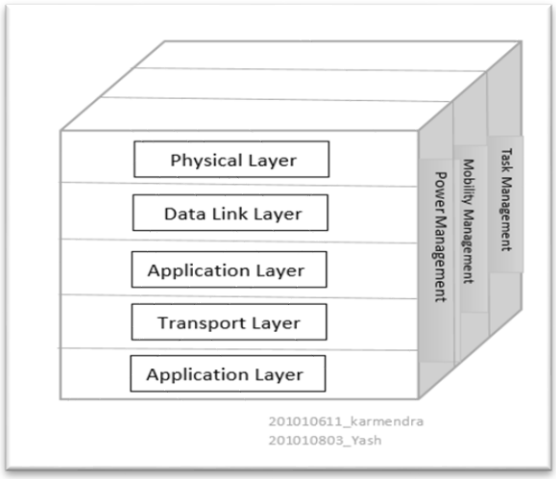

Figure 3: Architecture of WSN

V. Current Market on WSN

The market for wireless sensor networks was estimated at USD 33.80 billion in 2017 and is expected to reach USD 113.68 billion by 2025, at the CAGR of 18.55% at the time of forecasting. Wireless sensors are looked forward to change the way communication takes place in the real world. Companies need real-time visuality and intellect of their organizational and operative data to achieve this new level of productivity, accuracy, and cost effectiveness.

Year	*Growth*
2015	9.56
2016	9.65
2017	9.72
2018	11.28
2019	12.84
2020	14.77
2021	16.22
2022	17.87
2023	19.44
2024	21.03
2025	22.97
2026	23.67
2027	25.10
2028	26.54

Table 1: Statictics of US WSN market

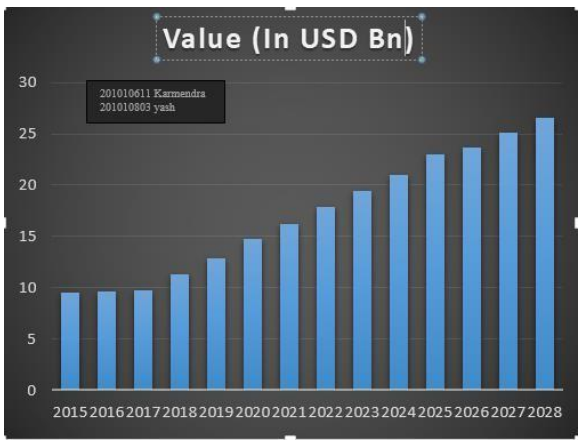

Figure 4: Estimated value of WSN in US market (2015-2028)

Wireless networks software components are cruical for collection of data or monitoring. Software is to prepared for the purpose of meeting new challenges of communication that arise due to the wide variety of devices, as well to control large amounts of data and their reliability and privacy. Factors such as the increasing number of inter-connected devices and the increasing demand for remote monitoring have led to the more and more use of software solutions.

The acceptance of image sensors is increasing rapidly in the creation of automation, automotive, retail, and some others. Safety and access managing systems have become an essential part of the safety and security of premises and their inhabitants and video inspection is critical to improving the stage of security in premises such as homes, offices and shops leading to more acceptance of image sensors in video monitoring programs.

The increased security demand, performance monitoring, and access control has led to an increase in the need for WSNs. The high adoption of flexible construction systems to maximize energy productivity and cost savings alsocontributes to the expansion of the WSN flexible construction market.

The wireless sensor network market in APAC is looked forward to expand at a higher rate compared to the market in other sectors as most people in the world are focused on APAC. As a result, the number of current M2M connections every year, the need for smart devices, and the demand for industrial change is high in this sector. IoT applications appear to have some potential to enhance the quality of life and transform the industrial region at APAC due to overcrowding in some evolving economies like China, India, and Thailand in APAC, along with the arised problems associated with health and power management.

VI. Market Dynamics

A. Drivers: Increased request for remote monitoring

WSN transforms industrial monitoring and diagnostics with low-density and low-cost wireless sensors. These networks include battery-operated motes with the ability to quickly build a network, where the sensors communicate with each other without a cable. Wireless sensor networks can be used for consumer-level applications such as smart homes, PC hardware, andremote controls.

B. Limitations: Privacy and security

With increasing communication technology, the rate of data entry is also growing rapidly. As devices and connection resume to grow rapidly, data will become more important. Network forums have recently been upgraded and are not as secure in terms of security. This serves as a major obstacle to the expansion of the wireless network marketplace because business data security is critical while developing mathematical solutions forvarious specific applications.

C: Resources Available in the Market

Tools Features	Interface	User Support	Scalability	Availability of WSNs Modules
NS-2	C++/OTcl	Open source	Limited	Excellent
TOSSIM	C++/PythonGUI support	Open source	Large	Good
OMNet++	C++/NED and Debugging	Free for academicuses	Large	Excellent
GTSNetS	C++ andVisual Support	Open source	Very Large	Excellent
OPNET	C++/Java GUI and Debugging	Free for academicuses	Moderate	Excellent

Table 2: Simulation Software of WSN

Opportunities: Increase in demand of WSN acrossall SMBs.

Some small-medium businesses and big players are willing to take advantage of wireless network solution to enhance the scalability and productivity of their work processes. SMBs have seen various advantages of WSN such as reduced operating costs, greater flexibility and durability, additional revenue, and improved performance. Thiswill lead to an increase in WSN adoption across all SMBs.

D. Challenges

The nodes in the wireless network should manage the power from compact batteries as they lack a steady infrastructure. Since periodic replacement of batteries of large number of sensors, actuators, etc. connected within the network is not practicable, the main problem is the energy management of devices that utilizes wireless technology such as Wi-Fi.

VII. Literature Survey

Recent advances in wireless and electronic technology have enabled a wide range of WSN applications in military intelligence, traffic monitoring, targeted monitoring, environmental monitoring, health care monitoring, and so on. Here we describe such developments in WSN and applications in various fields such as Local Sensor Performance and Location Awareness Services Error detection and correction services are offered at the data link layer likewise because the transport layer. One in all the wide used error-detection technique is cyclic redundancy check (CRC) [97]. CRC operates as follows in WSN. The sender and receiver should 1st agree on a hard and fast information block size before transmission. The sender splits a packet from the network layer into information blocks which can be reassembled at the receiver. Associate 8bit CRC are often used for error detection. The blocks containingthe information and also the CRC bits are packagedinto a frame.

ARQ uses acknowledgments and timeouts to supply specific feedback to the sender. Feedback are often within the sort of a positive acknowledgment (ACK) or a negative acknowledgment (NACK). Once the sender receives a NACK or timeout, it re transmit the information frame. A limitation of ARQ is that it's restricted to sleuthing frame errors. a complete frame must be re- transmitted if there's one bit error. FEC, on the opposite hand, decreases the quantity of re- transmissions. The sender adds some a lot of quantity of redundant information into every message so the receiver will notice and proper errors. The advantage of FEC is that re-transmission is reduced and also the wait time for causing associate acknowledgement and re-transmitting the information are often avoided. Hybrid ARQ could be a variation of the ARQ methodology.

A. Smart Home / Smart Office

Smart home environment can provide customized behaviour for someone. A large amount of research is provided in this article. Smart home research is now beginning to enter the market. It takes a lot of work and planning to build a smart home. There are many examples of products currently on the market that can perform individual functions that are considered part of a smart home. Many useful applications that take advantage of the information collected by WSN are presented at [5].

B. Military

New and emerging technologies, such as networks, support military operations by delivering vital information quickly and reliably to the right person or organization in a timely manner. This improves the efficiency of combat operations. New technologies must be quickly integrated into the complete design to meet current needs. Improving awareness of conditions [6] is essential. Another important application is the detection of movement of enemy units on land / sea, detection of invaders at bases, chemical / biological threats and supply of supplies in urban wars [7]. Command, control, communication, computer, intelligence, surveillance, retrieval, and identification systems are well described in [8].

C. Industry and Trade

As wireless data transfer has long been practiced in industrial systems, but more recently it has gained importance. The effective use of wireless sensors in systems such as surveillance control and data acquisition has proven that these devices can effectively address the needs of industrial applications. The most important WSN processes used in the industry are to monitor temperature, flowrate, and pressure parameters.

D. Traffic Management and Monitoring

All the major cities are suffering from heavy traffic around the world. A sincere effort was made to resolve traffic congestion. Congestion can be alleviated by planning to manage traffic. Real- time traffic data collection should be used to effectively control high-speed traffic. Research on this topic is considered part of the Intelligent Transport System (ITS) research community. It is a form of computer, communications, and sensory technology in land transport [9].

E. Agriculture

Agriculture can also benefit from WSN deployment for information on soil degradation and water scarcity [12]. With the help of WSNs we can monitor and control the fresh water used for irrigation.

F. Topology and Cover Control

Topology management is one of the key issues for WSNs. It is very important to prolong life, reduce radio interference, and increase efficiency of media access control systems and routing systems. It also ensures the quality of communication & coverage and the expansion of network service as well. Significant progress in research can be seen in controlling the topology of WSNs. Many topology control algorithms have been developed to date, but problems such as the lack of a straightforward and effective algorithm, the lack of effective measurement of network performance and the suitability of the mathematical model still exist.

G. Biomedical/Medical

The use of WSNs in biomedical and medical practice is in a growing phase. Biomedical sensor networks indicate future opportunities to support mobility while monitoring important physical and hospital activities at home. There is a need for BWSN to be developed to integrate security management, enhanced signal integration and visibility. It can also be used to achieve extended mobility outside the operating room, to monitor a number of patients / individuals at a time, and to further adaptations for the needs of medical professionals for information.

VIII. Conclusion

The role of wireless sensor networks in monitoring human activities over the past decade cannot be underestimated. Over the years, the introduction of energy management schemes that seek to prolong the lifetime of the sensor node and the overall network have been proposed, but the amount of energy required by the sensor to remain operational at all times remains a challenge.

In this paper, we have provided the trio energy management plan which if fully implemented will keep the network alive forever. The lacking of this issue is a part of its core development which makes the WSN Technology somehow lacks behind the true potential of the use case which can be life changing for us all. Being able to have a backup of a sensor to hold it up at the work that is being done by the help of it will be the real change. As the time will pass through it can be expandable to normal lives as well as in more common sectors.

Acknowledgement

I would like to thank and express my deepest gratitude to Mr. N.Partheeban (Professor) on behalf of Galgotias University along with Ms. Pravesh as our Project guide to make this work possible. There Guidance and advice along with the suggestion given by them carried us through all of these stages of writing this Research Paper based on our research about Wireless Network Sensor. I would also like to thanks the external help we got from some of the students and respected facilities ofGalgotias University.

I would also like to thanks our facilities for letting us mainly focusing on completeour research paper.

I would also like to thanks all the research and project which has been done or in completion phase that inspired us throughout the journey, Along with the online material helping us understand the core of the topic as a whole part for the growth of our knowledge and letting us add to this field.

I will also mention my parents and my siblings for being supportive and believe in me as anindividual.

Lastly, I would like to thanks the god for letting us enjoy the moments of learning new things and providing the sufficient education and knowledge for our growth in the career itself along with solving the issues with this project.

Reference

[1]. Yick, J., Mukherjee, B., & Ghosal, D. (2008).Wireless sensor network survey. Computer networks, 52(12), 2292-2330.
[2]. Bakr, B. A., & Lilien, L. T. (2014). Extending lifetime of wireless sensor networks by management of spare nodes. Procedia Computer Science, 34, 493-498.
[3]. Jamal-Deen Abdulai, Kofi Sarpong Adu-Manu, Frank Kataka Banaseka and Ferdinand Apietu Katsriku, The increasing of Lifetime of WSNs: A Review of Current Techniques, 201-345.
[4]. Noman Shabbir, Syed Rizwan Hassen,
[5]. "Routing Protocols for Wireless Sensor Networks",
[6]. October 2017
[7]. Gill, R. K., Chawla, P., & Sachdeva, M. (2014). Study of LEACH routing protocol for wireless sensor networks. In International Conference on Communication, Computing &Systems (ICCCS–2014) (pp. 196-198).
[8]. Zhao, F., Xu, Y., & Li, R. (2012). Improved LEACH routing communication protocol for a wireless sensor network. International Journal ofDistributed Sensor Networks, 8(12), 649609.
[9]. Mamalis, B. (2019). Prolonging network lifetime in wireless sensor networks with path- constrained mobile sink. arXiv preprint arXiv:1912.01146.
[10]. Singh, P., Gupta, O. P., & Saini, S. (2017). A brief research study of wireless sensor network. Advances in Computational Sciences and Technology, 10(5), 733-739.
[11]. Ahmed, S. R., Kadhim, M. A., & Abdulkarim,
[12]. T. (2019, May). Wireless Sensor Networks Improvement using LEACH Algorithm. In IOP Conference Series: Materials Science and Engineering (Vol. 518, No. 5, p. 052023). IOP Publishing.
[13]. Saini, A., Kansal, A., & Randhawa, N. S. (2019). Minimization of energy consumption in WSN using hybrid WECRA approach. ProcediaComputer Science, 155, 803-808.
[14]. Arabi, S., El Hammouti, H., Sabir, E., El Biaze, H., & Sadik, M. (2018, February). Lightweight energy-cost-efficient RAT associationfor Internet of Things. In 2018 IEEE 4th World Forum on Internet of Things (WF-IoT) (pp. 332- 337). IEEE.
[15]. Bo, Z., Dong, Y., He, J., & Dongming, L. (2021). An Energy-Efficient One-Shot Scheduling Algorithm for Wireless Sensor Networks. Journal of Sensors, 2021.
[16]. Raghavendra, C. S., Sivalingam, K. M., & Znati, T. (Eds.). (2006). Wireless sensor networks.Springer.
[17]. Stankovic, J. A. (2008). Wireless sensornetworks. computer, 41(10), 92-95.
[18]. Ko, J., Lu, C., Srivastava, M. B., Stankovic, J. A., Terzis, A., & Welsh, M. (2010). Wireless sensor networks for healthcare. Proceedings of theIEEE, 98(11), 1947-1960.
[19]. Perrig, A., Stankovic, J., & Wagner, D. (2004). Security in wireless sensor networks.Communications of the ACM, 47(6), 53-57.
[20]. Roundy, S., Steingart, D., Frechette, L., Wright, P., & Rabaey, J. (2004, January). Power sources for wireless sensor networks. In

Europeanworkshop on wireless sensor networks (pp. 1-17).Springer, Berlin, Heidelberg.
[21]. Pathan, A. S. K., Lee, H. W., & Hong, C. S.(2006, February). Security in wireless sensor networks: issues and challenges. In 2006 8th International Conference Advanced Communication Technology (Vol. 2, pp. 6-pp). IEEE.
[22]. Arampatzis, T., Lygeros, J., & Manesis, S. (2005, June). A survey of applications of wireless sensors and wireless sensor networks. In Proceedings of the 2005 IEEE International Symposium on, Mediterrean Conference on Control and Automation Intelligent Control, 2005.(pp. 719-724). IEEE.
[23]. Mainwaring, A., Culler, D., Polastre, J., Szewczyk, R., & Anderson, J. (2002, September). Wireless sensor networks for habitat monitoring. InProceedings of the 1st ACM international workshop on Wireless sensor networks and applications (pp. 88-97).
[24]. García-Hernández, C. F., Ibarguengoytia- Gonzalez, P. H., García-Hernández, J., & Pérez- Díaz, J. A. (2007). Wireless sensor networks andapplications: a survey. IJCSNS International Journal of Computer Science and Network Security, 7(3), 264-273.
[25]. Karl, H., & Willig, A. (2007). Protocols andarchitectures for wireless sensor networks. John Wiley & Sons.
[26]. Sohraby, K., Minoli, D., & Znati, T. (2007).Wireless sensor networks: technology, protocols,and applications. John wiley & sons.