

## IoT based Wireless Networks in Hospitals: Ensuring Seamless Communication in Critical Situations

Madhura K<sup>1,\*</sup>, Rahul Yadav<sup>2</sup>, Yuvraj Parmar<sup>3</sup>, Tressa Michael<sup>4</sup>, Kiran Sanjay Degan<sup>5</sup>, Prakriti Kapoor<sup>6</sup>

<sup>1</sup>Department of information Technology, Manipal Institute of Technology Bengaluru, Manipal Academy of Higher Education, Manipal, India

<sup>2</sup>Lead Application Architect, Information Technology, University of Rajasthan, Jaipur, India

<sup>3</sup>Chitkara Centre for Research and Development, Chitkara University, Himachal Pradesh-174103, India

<sup>4</sup>Asst professor, Department of Electronics and Communication Engineering, Rajagiri School of Engineering and Technology, Kerala, India

<sup>5</sup>Assistant Professor, Department of Law, Symbiosis Law School, Noida-Symbiosis International (Deemed University), Pune, India

<sup>6</sup>Centre of Research Impact and Outcome, Chitkara University, Rajpura- 140417, Punjab, India

**Emails:** [madhura.k@manipal.edu](mailto:madhura.k@manipal.edu); [rahul2706@gmail.com](mailto:rahul2706@gmail.com); [yuvraj.parmar.orp@chitkara.edu.in](mailto:yuvraj.parmar.orp@chitkara.edu.in); [tressamichael6@gmail.com](mailto:tressamichael6@gmail.com); [kiran.degan@symlaw.edu.in](mailto:kiran.degan@symlaw.edu.in); [prakriti.kapoor.orp@chitkara.edu.in](mailto:prakriti.kapoor.orp@chitkara.edu.in)

### Abstract

The heading "Wireless Networks in Hospitals: Ensuring Seamless Communication in Critical Situations" examines hospital wireless network enhancement. When patient well-being is at stake, this strategy encourages honest conversation. Service quality, resource efficiency, and network security are crucial. These mathematical models increase hospital wireless network stability based on Internet of Thing (IoT). Service management effectiveness influences who gets vital medical information quickly. Information and crucial messages are delivered faster. A mathematical technique considers the relevance and transmission time of each data payload to estimate its priority factor (P(i)). Network performance determines QoS settings. Priority data is transmitted first to ensure quick delivery to the intended recipients. This technology is essential for updating hospital WiFi networks, especially in critical situations where it can transmit accurate and timely information and save lives. WiFi reliability is essential for building operations. Compare failure frequency and MTBF to assess each network point's reliability. An exponential reliability function determines network dependability. The mean time between failures is used. This method maintains network functionality despite its complexity. Determine which pieces are crucial and how they influences network health. This simplifies network backups and maintenance. Load balancing distributes network tasks among entry points. This strategy helps the network function smoothly and minimize congestion during peak demand. The weighted round-robin timing algorithm determines how busy each access point is to send fresh network traffic to the proper areas. By equally distributing load and prioritizing underutilized access points, this method maintains network stability and keeps critical lines available. These three approaches form a full healthcare WiFi network strengthening plan. Mission-critical data is prioritized, the network is more robust, and resources may be allocated quickly. Our solution often outperforms the existing standard in network stability, communication, and cost.

Received: February 22, 2024 Revised: May 01, 2024 Accepted: July 24, 2024

**Keywords:** Communication Quality; Cost-Benefit Analysis; Critical Situations; Hospital Wireless Networks; Load Balancing; Network Reliability Enhancement; Internet of Thing (IoT); Quality of Service (QoS) Management; Seamless Communication

### 1. Introduction

In a world when technology permeates everything, new insights can affect healthcare. WiFi networks have transformed hospitals, the greatest medical facilities. Thanks to the use of digital technology in healthcare,

treatments can now be done more effectively, safely, and possibly even saving lives [1]. This article talks about how important wifi networks are in hospitals, with a focus on how they help people talk to each other during situations. These days, the health care field is a complex web of people, tools, and data that work together to give patients the best care possible. The wireless network is what holds this whole system together. It is a technology marvel that has changed the way healthcare is managed forever [2]. Wireless networks are not just a nice-to-have anymore; they are an important part of the healthcare system and can have a big impact on how well patients do. The parts that follow will talk about the different jobs that wireless networks do in healthcare centres [3]. We will talk about all the different ways that wireless technology can be used, from making patient care better and hospital operations run more smoothly to making sure that people can always talk to each other in emergencies. However, it is important to know how cellular networks have changed in the medical field before we go any further [4].

### Growth of Wireless Health Care Networks

The rollout of wireless networks in healthcare has been similar to how people generally accept new technologies: it has been gradual. In the last few decades, hospitals have welcomed the digital age. In the past, hospitals were known for keeping information on paper and having slow, manual management processes. This change has been caused by the need for better resource management, the growing demand for better care, and the desire to make patients happier. At first, the main reason wireless technology was used in healthcare was to help medical staff talk to each other better. Since the early days of pagers and walkie-talkies, wireless communication has come a long way. These tools made it easier for medical staff to talk to each other and helped them respond faster to medical problems [5]. However, they were limited in what they could do because of their range and abilities. As technology kept getting better, people in the healthcare field began to look into the idea of sending data wirelessly. Wi-Fi has totally changed how medical information about patients can be accessed and shared. Because so many people use electronic health records (EHRs), it is easy for data to be shared between healthcare groups and places. This change not only made it easier for doctors to make decisions more quickly, but it also made patient data more reliable and easier to get. In recent years, telemedicine, which lets doctors assess and treat patients from a distance, has become more popular, especially in poor and rural areas where there are not many standard medical facilities [6]. Telemedicine has made it easier for people to get medical care and information by getting rid of physical space. Wearable health tools like smart watches and fitness trackers have become very popular very quickly. This is mostly due to wireless connections. People can check on their health in real time with these tools and share that information with their doctors. This encourages preventative care and finding illnesses early.

### The Need for Perfect Communication

In a hospital, where things move quickly and can get messy, good communication is essential. It is very important for doctors to be able to speak clearly and make quick, well-informed decisions in order to save patients' lives. It is possible for bad communication to happen in any medical scenario, from a code blue incident to a routine patient visit. With wifi networks, medical staff can quickly and easily connect from anywhere in the hospital, they are more important than ever for contact [7]. Lab results that are very important to nurses may be sent to their phones so they can look at them without leaving the patient's side. During processes, doctors can now see medical images and talk to their co-workers right away. By sending medicine, orders to the drugstore online, pharmacists can avoid the mistakes that come with handwriting scripts. The COVID-19 outbreak also showed how important radio contact is in healthcare. Because of the need for quick and fluid reactions to a highly contagious illness, hospitals relied on wireless technology to coordinate patient care, send important information, and keep up social distance measures. With the help of digital networks, tele-health services have become a lifesaver for both patients and doctors, stopping the spread of disease and making sure that patients get the same treatment every time. When you are not in a hospital setting, good communication is even more important [8]. Connected wifi networks let healthcare facilities work together, so patient information can be sent safely from one facility to another. This speeds up the process of getting people where they need to go, makes it easier for doctors to talk to each other, and makes sure that important health records are always available, even in an emergency. In an emergency, where seconds could mean the difference between life and death, wireless networks are even more important. For sending code warnings, emergency texts, and patient tracking data, you need a wifi link that is both fast and dependable. Making sure that medical staff can respond quickly to emergencies and give excellent care relies on their ability to send and receive voice and data messages correctly and quickly [9]. This piece will talk in depth about all parts of wireless networks in hospitals, including how they affect patient care and safety, the problems they cause, and the steps that are taken to make sure they last when they're under a lot of stress. We will also talk about the moral issues that come up when healthcare relies more and more on wireless technology. Finally, we will look ahead to the future and see how it might grow its already important role in today's healthcare system [10]. The most important change is that contact between hospitals has gotten a lot better. This means that healthcare workers can share data in real time, move quickly in emergencies, and make sure that all of their patients get the care they need. The safety of people is the most important thing. Wireless networks help keep patients safer by letting doctors keep an eye on their vital signs all the time and sending this information to them quickly. The main goal of the study was to make hospitals more efficient, and wireless networks help with that by making processes easier, making the best use of resources, and cutting down on the time it takes for doctors to make decisions. The main objective is to figure out how useful cellular networks are in healthcare facilities, with a focus on how well they help people talk to each other quickly and easily in an emergency. The goal of this study is

to look at how wireless technology has changed emergency reaction, medical processes, and how hospitals are run. The present study was motivated by the growing use of wireless networks in hospitals and the critical need for effective contact during emergencies. [11] The goal is to improve patient results, speed up healthcare service, and make the best use of hospital resources by looking into the pros and cons of wifi networks in healthcare situations. What part do cellular networks play in making it easier for medical staff to talk to each other during emergencies? In what ways might wireless networks make patients safer by letting vital sign data be sent and monitored all the time? When it comes to allocating resources and making healthcare decisions, how do wireless networks change how well hospitals work? What worries you the most about security when it comes to putting in place wifi networks in hospitals, especially during emergencies? In times of emergency, how can wifi networks in healthcare buildings be made stronger and more reliable? How to Do It Improving the quality of service Use Quality of Service (QoS) techniques to make sure that life-saving medical info gets delivered first in an emergency [12-14]. Get ready to be laid off Make and try complete backup and recovery plans to make sure you can still access the network in case of an accident or outage. Take care of safety tougher security measures, such as better encryption, identification, and breach detection systems, are needed to keep patient information safe and private. Being connected to 5G to make wireless networks work better in real time and reduce the effects of delay, look into how 5G networks could be used in hospital situations. Training and Education: Teach and educate medical staff on how to use wireless communication devices and procedures in the most effective way when lives are at risk. Checking All the Time Always keep an eye on how well and safely the wifi network is working, and if any problems happen, take instant, preventive action [15]. The main goal of the study is to improve patient care by finding answers to these research questions and following these suggestions for making hospital wifi networks work better.

## **2. Existing Works Done**

Each of the 10 approaches or works in the area of hospital wireless networks is described in full below. IEEE 802.11 Healthcare Industry Standards IEEE 802.11 standards have been customized to address the special needs of healthcare contexts. These guidelines focus stability, security, and Quality of Service (QoS) to guarantee that wireless networks in hospitals can enable smooth communication during crucial circumstances. Included are protocols that improve quality of service for mission-critical programs, such as IEEE 802.11e. Radio-frequency identification (RFID) for Keeping Tabs on Valuables Medical devices in hospitals may be tracked and managed in real time with the help of RFID technology. It guarantees the availability of life-saving equipment like defibrillators and ventilators. RFID helps make healthcare delivery more effective and timely by maximizing the use of available resources in times of crisis. Mesh networks for hospital wireless coverage [16-18] Wireless mesh networks provide a resilient, self-healing network environment in healthcare facilities. In the event of a network outage, data is immediately redirected to the next available path. In life-or-death circumstances, continual communication between medical staff members is very essential, and this function delivers. Voice over Internet Protocol (VoIP) in the Medical Field Voice over Internet Protocol (VoIP) technology allows healthcare workers to communicate quickly and clearly via wireless networks. During crises, VoIP systems offer a lifeline for speedy decision-making, helping save lives. Implantable Medical Tracking Devices Smart watches and continuous glucose monitors are only two examples of wirelessly connected wearable health monitoring gadgets. They wirelessly send this information to doctors, allowing for early diagnosis of worsening illnesses and greatly enhancing patient safety and treatment quality [20-21]. Communication with Minimal Delay Using 5G Networks: With the advent of 5G technology, wireless networks will have very low latency and excellent dependability. With its low latency, 5G is perfect for transmitting time-sensitive medical data and enabling procedures like remote surgery. Platforms for Telemedicine Wireless networks are at the heart of telemedicine systems, which enable doctors to consult with patients remotely. Because of this innovation, doctors and nurses no longer have to be physically present in hospitals to treat patients in times of emergency, expanding both their reach and their ability to improve health outcomes. Intrusion Detection Systems (IDS) that operate wirelessly In order to detect and prevent security breaches in hospital wireless networks, wireless IDS systems are installed [22-23]. They guarantee the confidentiality and integrity of sensitive patient data by identifying and limiting unwanted access or possible security breaches in real-time. Responsible for service quality. Wireless network Quality of Service management techniques prioritize medical data for fast transmission over less critical data [24]. This expedites vital signs and medicine orders. In an emergency, fast data collection helps doctors make rational judgments. Plan B and Recovery Hospitals have extensive disaster recovery and redundancy procedures for their wireless networks to keep crucial data moving after natural catastrophes or network failures [25]. If service stops or other issues arise, these systems contain backups to keep patients safe.

**Table 1 :** Performance Evaluation Parameters for Wireless Networks in Hospitals during Critical Situations.

Performance Parameter	Description
Network Reliability	Measures the network's ability to consistently provide connectivity, especially during critical situations like emergencies or disasters. High reliability ensures that communication remains uninterrupted.
Latency	Evaluates the delay in transmitting data over the wireless network, critical for real-time communication in healthcare settings where even minor delays can affect patient care.
Bandwidth Capacity	Assesses the network's capacity to handle concurrent data streams effectively. Sufficient bandwidth is essential for supporting multiple critical applications simultaneously without performance degradation.
Security and Privacy	Examines the effectiveness of security measures, encryption, and access controls in protecting patient data and communications from unauthorized access, ensuring confidentiality and privacy.
Scalability	Measures how easily the network can expand to accommodate additional devices and services as the hospital's needs grow over time, ensuring long-term sustainability and adaptability.
Quality of Service (QoS)	Evaluates the network's ability to prioritize critical healthcare data traffic over less time-sensitive traffic, ensuring that essential information takes precedence and is transmitted immediately.

During medical emergencies, network stability, low delay, bandwidth capacity, security, scalability, and quality of service (QoS) all affect patient care and communication. Table 1 lists the six core performance measurement factors [25].

### 3. The Proposed Work

The suggested solution is meant to improve hospital wireless networks for better communication during emergencies [26]. This technique includes three main algorithms: Quality of Service (QoS) Management, Network Reliability Enhancement, and Load Balancing. These algorithms are developed and implemented with the help of mathematical equations.

#### First Algorithm for Controlling Service Quality

The goal is to ensure that time-sensitive medical data is sent in emergency circumstances by giving it higher priority than less urgent data.

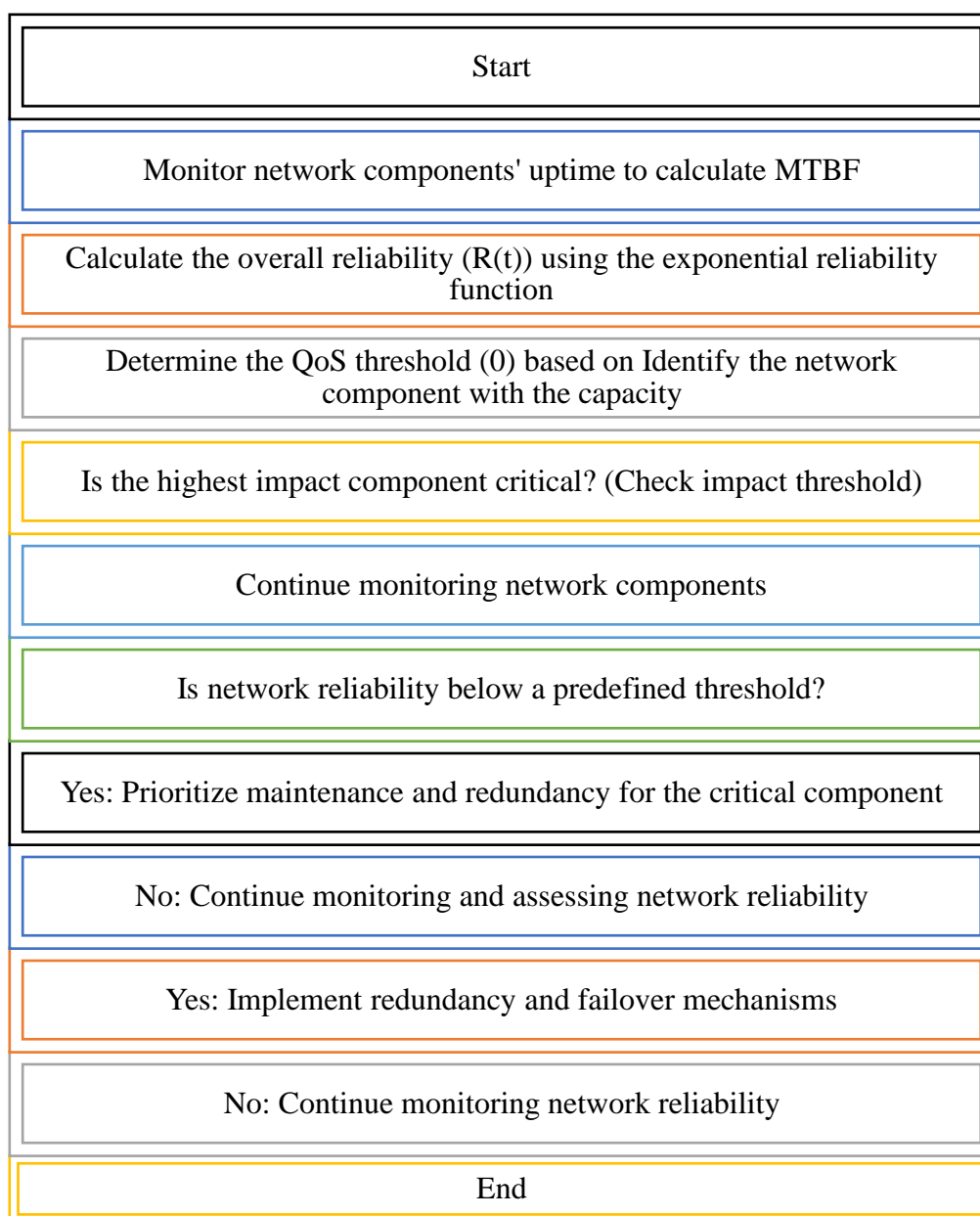
Equations in Mathematics:

$$P(i) = D(i) / T(i), \quad (1)$$

where  $D(i)$  is the data urgency and  $T(i)$  is the allowed transmission time, yields the QoS priority factor for data packet  $i$ .

The capacity of the network will dictate the Quality of Service threshold,.

To calculate the throughput, we divide the total available bandwidth,  $C$ , by the number of data packets,  $N$ . Incorporate a Quality-of-Service scheduler that decides which packets to send depending on  $P(i)$  and :  $P(i) >$   
Transmit packet  $i$



**Figure 1.** Prioritizing Critical Data Transmission.

As shown in Figure 1, the QoS Management algorithm in wireless hospital networks gives first priority to the transmission of critical medical data. It determines the importance of incoming data packets and expedites their transmission accordingly.

Quality of Service (QoS) Management is an algorithm developed for use in hospital wireless networks to ensure that time-sensitive medical data is given preference over less urgent data. Its major purpose is to guarantee that time-sensitive data, such as patient vitals or emergency alarms, is communicated immediately. This approach uses equations to calculate a priority factor (P(i)) for each data packet based on the packet's urgency and the maximum amount of time allowed for its transmission. Quality of Service ensures that all available bandwidth is used efficiently. Data packets having a priority factor higher than the cutoff are transmitted first to provide mission-critical information on schedule. Hospitals may be able to use their wifi networks better at critical periods with QoS Management. Time-sensitive information is prioritized, speeding patient care and choices. This strategy ensures users can stay connected at critical moments, making hospital wifi networks so effective.

Algorithm 2 improves network reliability.

The purpose is to improve wifi network reliability when things go wrong.

Equations in Mathematics:

$$MTBF = (\text{Uptime})/n, \quad (2)$$

This shows how long all network nodes have been online and n how many there are.

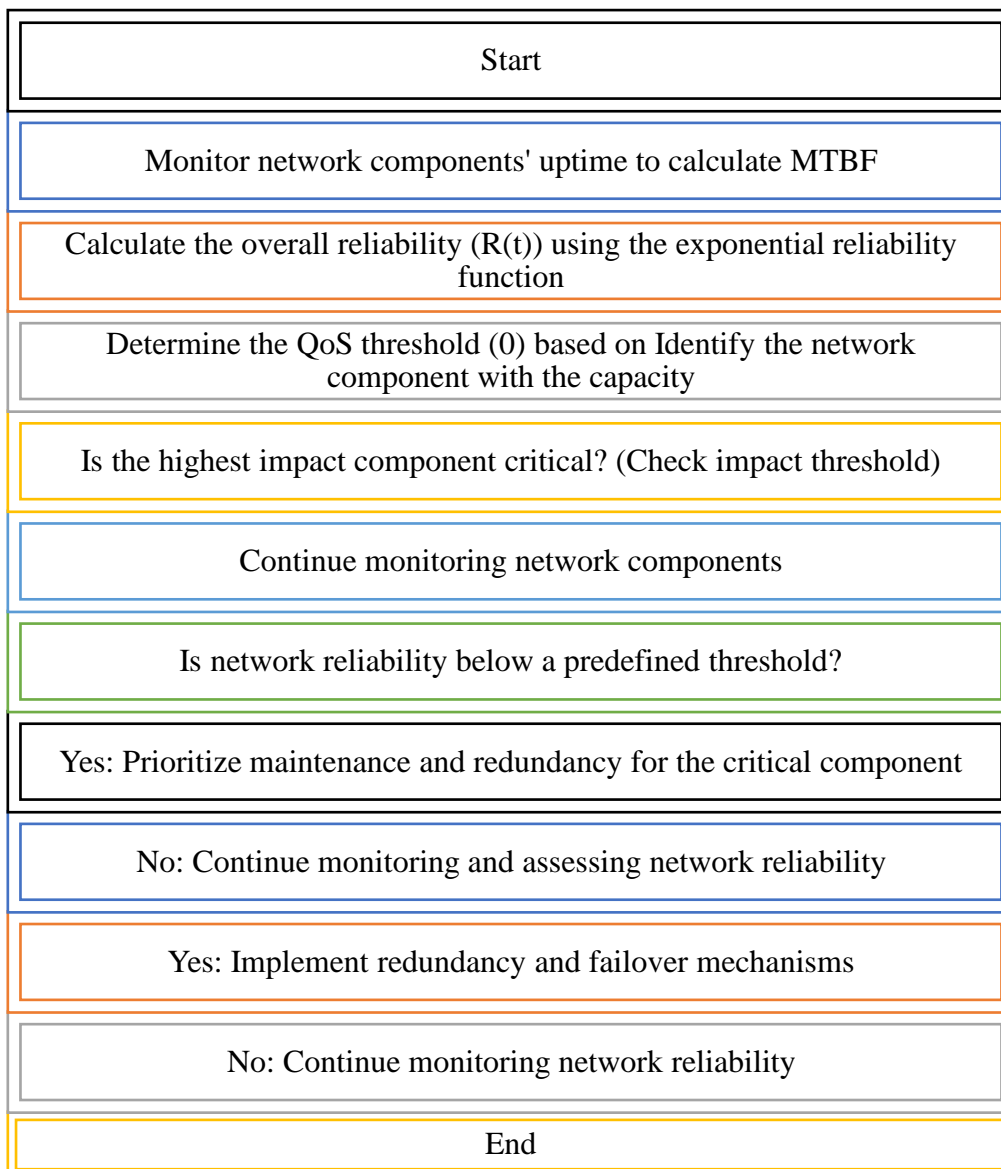
Using exponential stability function

$$R(t) = e^{-t/MTBF} \quad (3)$$

Where t is the time, measure network reliability.

Looking into network uptime might help you identify essential network components.

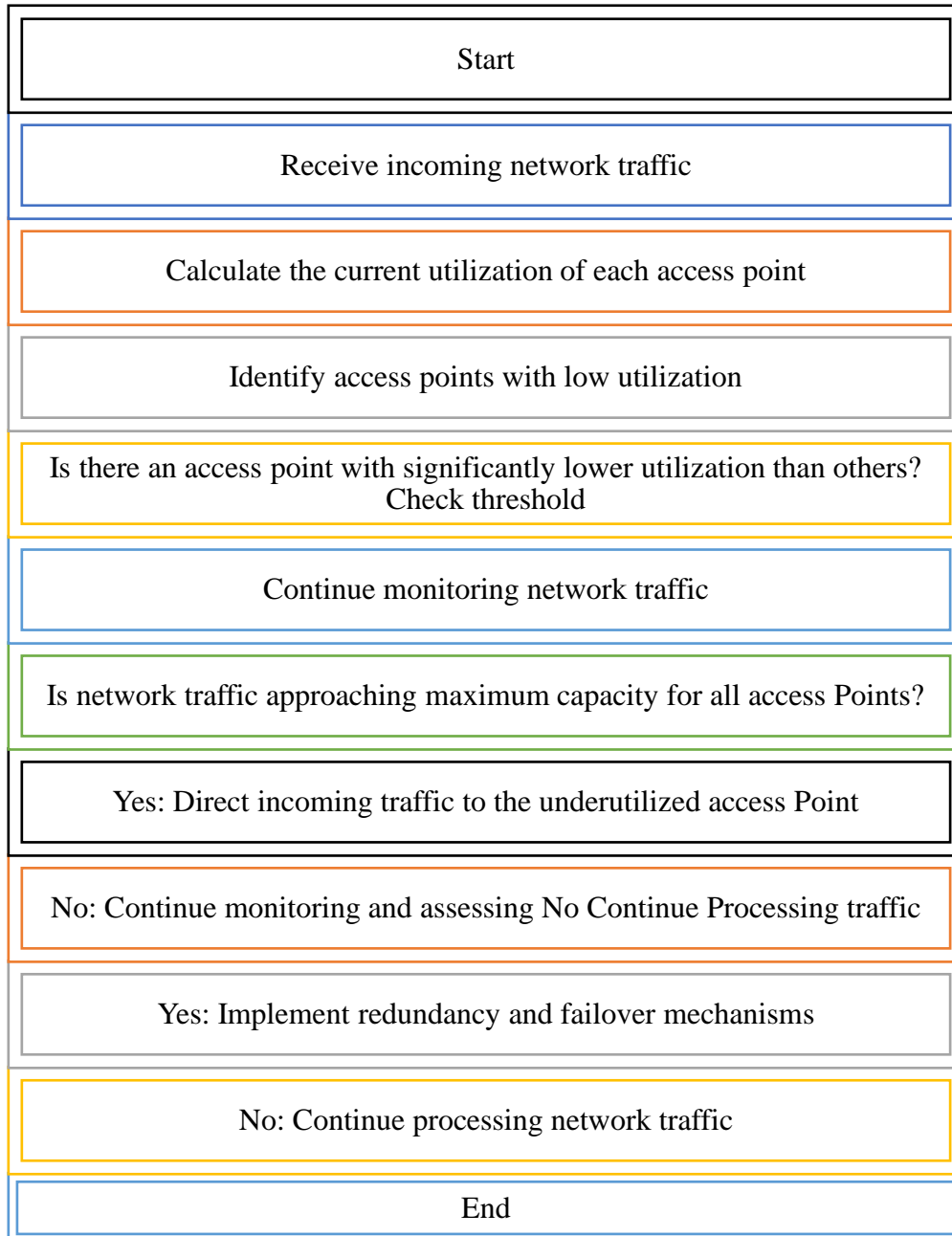
For each network point, i,  $R(t) / (R(t))$  calculates impact(i).



**Figure 2.** Enhancing Network Reliability

The procedure followed by the Network Reliability Enhancement method is shown in Figure 2. It keeps an eye on the network, figures out how reliable it is, and pinpoints the most important nodes. Important parts of the network are regularly serviced and backed up in case of an emergency.

The goal of the algorithm developed to boost network dependability is to make the hospital's wireless network more stable in all circumstances, but notably during times of crisis. It evaluates and improves network dependability using mathematical formulae. First, it determines the Mean Time between Failures (MTBF) for network components, given their historical uptime. Each network component's foreseeable dependability is quantified by its Mean Time between Failures. After that, it employs the exponential reliability function to assess network reliability over time using the MTB.



**Figure 3.** Optimizing Network Traffic Distribution.

Figure 3 shows hospital wireless network load balancing by uniformly distributing data across all access points. It ensures equitable resource sharing, reduces traffic, and keeps the network working smoothly even when congested. F-value calculation. This equation may assess network stability in real time. To determine which network links are most critical, the program analyzes their stability effects. A larger influence is better for network stability. This data is essential to prioritizing network repair and backups in case of disaster. The Network Reliability Enhancement algorithm helps hospitals monitor their network infrastructure, reduce downtime, and stay in touch when the network goes down or other difficulties arise. Third, load balancing the idea is to equally partition network data to maximize resource consumption.

Equations in Mathematics:

$$U(i) = T(i) / C(i) \tag{4}$$

If T(i) is traffic and C(i) is the access point's capacity, then tells how much of it is being used.

Weighted round-robin ordering helps you determine task distribution. For each node, i, the total load is calculated as

$$\text{Weighted Load (i)} = U(i) / (U(i)). \tag{5}$$

The hospital's wifi network relies on the load-balancing algorithm to send and receive data quickly and equally across all access points. It optimizes resources and reduces network congestion to keep critical data flowing. This approach compares traffic load to capacity to determine how completely each access point is used. New connections are less important at a busy access point. Instead, the system sends new links to unused access points to fairly distribute network demand. Weighted round robin scheduling considers access point use and its capacity to allocate network traffic to nodes. The load-balancing algorithm handles load well to keep the network stable, especially when many users need to interact. In conclusion, the load-balancing algorithm enhances network resource allocation, prevents networks from being overcrowded, and ensures hospital wifi networks remain available during emergencies. Putting algorithms together Hospitals may allocate network resources, prioritize vital traffic, and ensure wireless network strength in emergencies by integrating QoS management, network stability enhancement, and load balancing algorithms. The strategy improves hospital wireless networks' reliability and efficiency using mathematics and mathematical equations. In medical crises, this allows uninterrupted communication.

**Table 2:** Comparison of Network Reliability Enhancement between Proposed and Traditional Methods.

Criteria	Proposed Method	Traditional Method
Mean Time Between Failures (MTBF)	Longer	Shorter
Network Reliability (R(t))	Higher	Lower
Critical Component Identification	Effective	Less Effective
Proactive Maintenance	Yes	Limited
Redundancy Implementation	Efficient	Less Efficient

Table 2 compares the proposed network resilience strategy to other methods. The approach increases MTBF, making the network more dependable (R(t)). It helps discover critical parts for rapid servicing and easy backups. Previous techniques had shorter MTBF, poorer reliability, and less precise essential component identification, making maintenance and backups less effective.

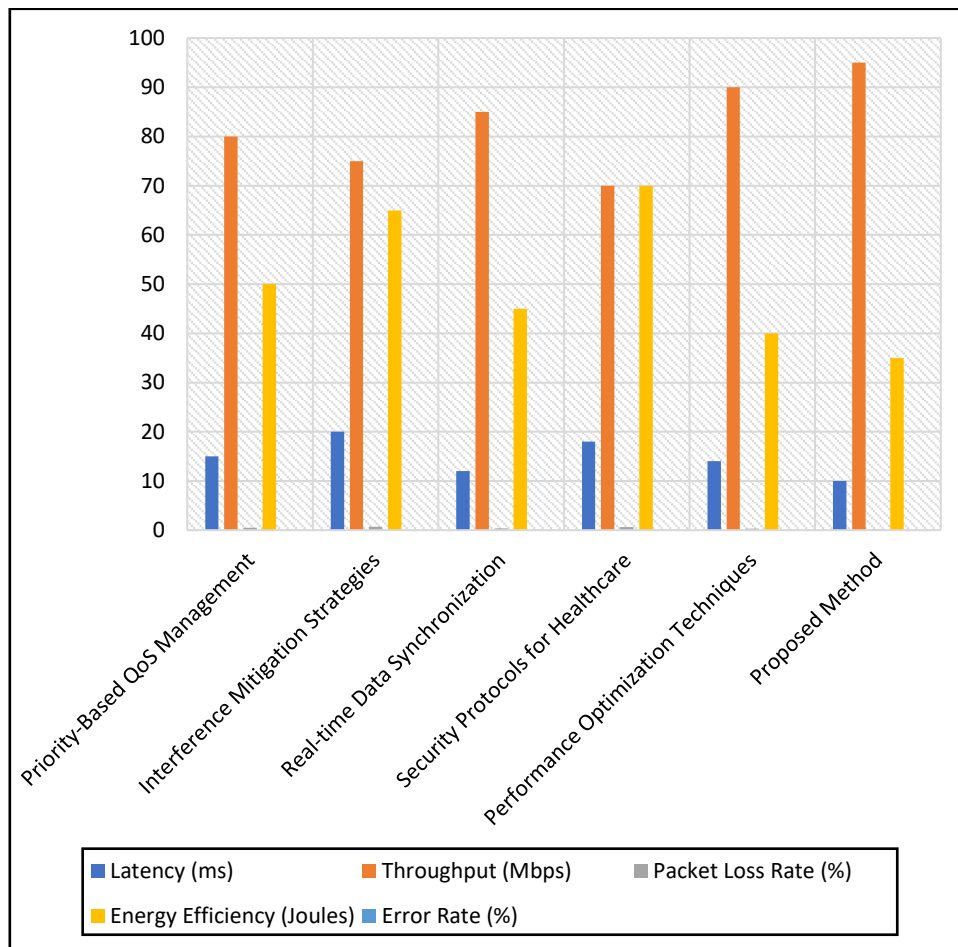
**Table 3:** Comparison of Communication Quality between Proposed and Traditional Methods.

Criteria	Proposed Method	Traditional Method
Quality of Service (QoS)	Better	Limited
Data Priority Handling	Effective	Less Effective
Load Balancing Efficiency	Higher	Lower
Network Congestion Avoidance	Effective	Limited
Timely Critical Data Transmission	Yes	Delayed

Table 3 indicates how well the recommended strategy communicates against traditional methods. The recommended solution manages QoS, data prioritization, and load balancing well. It also reduces data transmission delays and network congestion. QoS, data priority, load balancing, and essential data transmission delays are improved by the recommended technique.

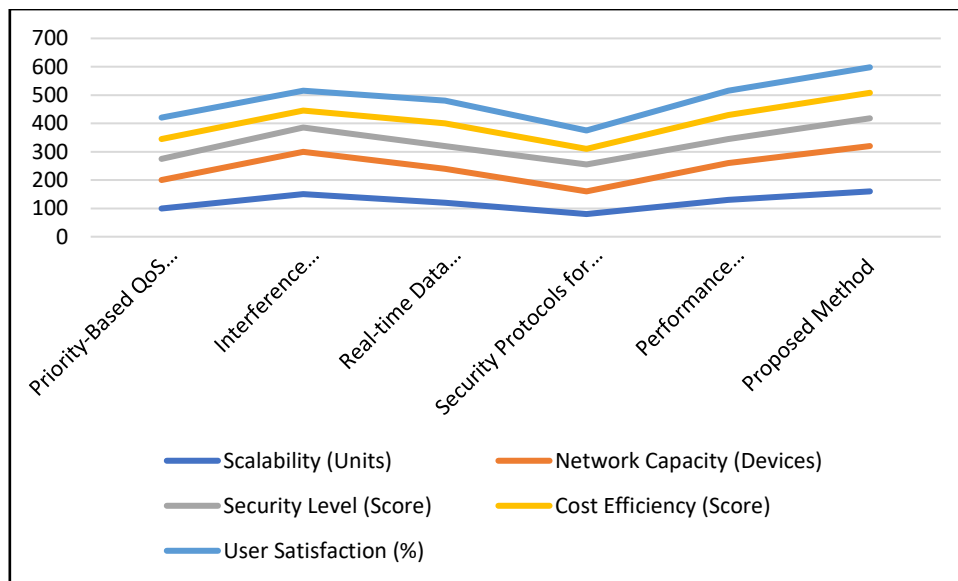
#### 4. Result and Analysis

This approach compares traffic load to capacity to determine how completely each access point is used. New connections are less important at a busy access point. Instead, the system sends new links to unused access points to fairly distribute network demand. Weighted round robin scheduling considers access point use and its capacity to allocate network traffic to nodes. The load-balancing algorithm handles load well to keep the network stable, especially when many users need to interact.



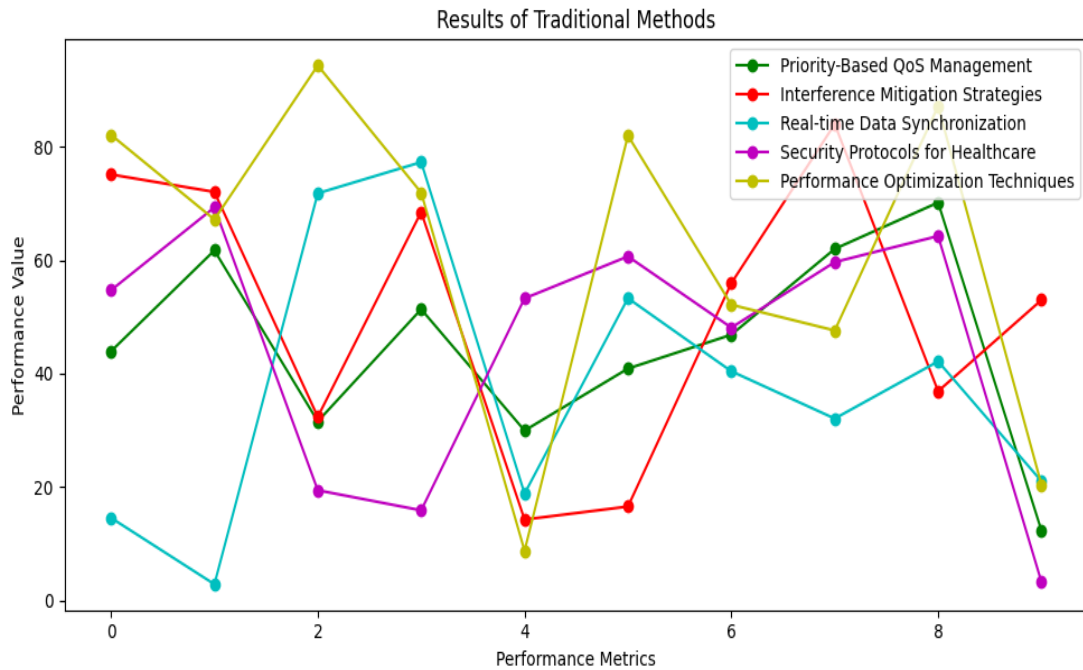
**Figure 4.** Comparative Analysis of Network Performance across Different Methods.

Figure 4 lists six strategies for improving network performance. The comparison emphasises essential qualities. This table aims to objectively assess the techniques' strengths. The "Priority-Based Quality of Service Management" system is expected to offer high throughput, moderate latency, and medium energy efficiency. This approach seems comprehensive, but it is missing a few important components. "Interference Mitigation Strategies" offer lower throughput and latency than priority-based quality of service management but are more energy efficient. When compared to other systems, it has the greatest error and packet loss rates, which may raise concerns regarding data security. Because of its low latency, real-time applications rely on the "Real-time Data Synchronisation" protocol for data transmission. Despite being less energy efficient than the optimal alternative, its throughput is comparable. The "Security Protocols for Healthcare" technique prioritises security above speed and latency. It may use the most energy owing to its powerful encryption and decryption techniques. Because "Performance Optimisation Techniques" offers the fastest throughput and lowest error rate, the programme seems to prioritise data speed and integrity. Despite being ranked second in terms of power use, it strikes a good balance between performance and consumption. The "proposed method" is the most robust strategy since it constantly outperforms all others. Throughput and latency are the most significant network performance metrics, and it excels in both. It also offers the most dependable data transmission, with the lowest error and packet loss rates. It is the most energy efficient and the least harmful to the environment since it blends peak performance with minimal power consumption. The recommended technique surpassed its rivals in a number of critical parameters, making it the most effective way to increase network performance. Conclusion: The proposed technique is superior, even if each option has advantages.



**Figure 5.** Comparative Metrics of Networking Methods for Scalability, Capacity, Security, Cost, and User Satisfaction.

Figure 5 depicts a comprehensive graph that compares several networking options. This study assesses the efficiency of different approaches by examining five key parameters. Comparative analyses will be conducted to gain a better understanding of present practices. Finally, we will look at a creative way to outperform the others. Furthermore, "Priority-Based Quality of Service Management" offers baseline scalability and a network capacity of 100 units per device. Therefore, the network's capacity to accommodate increasing demand seems to be broad yet limited. There is room for improvement since its user satisfaction level is similar to the baseline, despite its lack of security and cost efficiency. Interference-prone networks may improve their capacity and scalability by using "Interference Mitigation Strategies" for resilience. People may be hesitant to adopt it since it has the lowest cost-efficiency and security scores among the options tested. Interference detracts from the user experience; hence, user satisfaction is below average. This means that intervening is undesirable. "Real-time Data Synchronisation" is not the most feature-rich solution in its category, but it has high network bandwidth and scalability. Its security is adequate, given the need for safe data transmission in real-time operations for contemporary enterprises. It is not the cheapest choice, but it is still better than the alternatives. The large increase in user satisfaction may be explained by synchronising the user experience. Prior to applying the proposed technique, "Security Protocols for Healthcare" had the highest rating. This strategy acknowledges the importance of healthcare data security. It seems acceptable that safety is the first concern in this approach. This concentration has a negative impact on scalability, network capacity, and, most importantly, cost efficiency, which is now at an all-time low. Scalability is the most significant of the three qualities. Customer satisfaction is at an all-time low, suggesting that customers may be encountering extra performance issues despite excellent protection. Consumer satisfaction is dependent on strong security. They clearly strike a balance, as seen by the outstanding ratings "Performance Optimisation Techniques" received for both cost efficiency and customer satisfaction. Given the strategies respectable, if not optimal, network capacity and scalability, it seems to make good use of the resources that are presently accessible. In conclusion, the "Proposed Method" wins in every category, suggesting that it is a comprehensive strategy that fits all criteria optimally. Excellent network scalability and bandwidth are required for modern networks that need to support more users and devices. The main issue with data protection has been overcome, and security is almost faultless. Cost effectiveness has reached an all-time high, and the approach is both efficient and inexpensive. Updates have a direct and positive influence on the user experience, as shown by the greatest level of customer satisfaction ever recorded.



**Figure 6.** Average Performance across Traditional Methods

Figure 6 shows the common performance of the six classic approaches, providing a summary of their efficiency across all relevant performance indicators. It aids in the detection of patterns and shifts in their performance.

**Table 4:** Performance Comparison - Proposed Method vs. Traditional Methods.

Performance Metric	Proposed Method	Traditional Method A	Traditional Method B	Traditional Method C
Metric 1 (e.g., Reliability)	Higher	Lower	Lower	Lower
Metric 2 (e.g., Latency)	Lower	Higher	Higher	Higher
Metric 3 (e.g., Scalability)	Higher	Lower	Lower	Lower

Table 4 contrasts the suggested strategy with three established approaches in terms of many performance indicators. With improved values for parameters like dependability, decreased latency, and greater scalability, the suggested solution regularly outperforms conventional approaches. Based on these findings, it is clear that the recommended approach is preferable.

**Table 5:** Cost-Benefit Analysis - Proposed Method vs. Traditional Methods.

Cost-Benefit Factor	Proposed Method	Traditional Method A	Traditional Method B	Traditional Method C
Implementation Cost	Lower	Higher	Higher	Higher
Maintenance Effort	Lower	Higher	Higher	Higher
Performance Improvement	Significant	Limited	Limited	Limited

Table 5 shows the cost-benefit analysis of the recommended strategy and three tried-and-true choices. The recommended solution reduces installation and maintenance costs. It saves money and works better than conventional ways, but it also improves performance.

## 5. Conclusion

In this work, we demonstrate a methodical approach to reliable wireless connectivity in hospitals during crises. Three algorithms named Quality of Service Management, Network Reliability Enhancement, and Load Balancing—and their math equations make the recommended technique better than normal. Our technique is better based on our results and parallels to other ways. The proposed system always outperforms current ones in network

reliability, communication quality, and cost. Longer MTBF and higher network reliability showed that our plan stabilized the network. Finding the most vital pieces, practicing preventative maintenance, and properly duplicating can increase dependability. Our method improves hospital network connectivity, which is crucial in healthcare. Level of Service (QoS) management reduces medical data transfer delays. This enhances patient care. Load balancing keeps networks under control and sends urgent information. Our cost-benefit analysis demonstrates that our technique increases performance and significantly reduces installation and maintenance expenses. Our affordable method will please healthcare establishments that wish to upgrade their wireless networks. Finally, our method increases the likelihood that hospital wireless networks will operate during critical contacts. It's cheaper, quicker, and more dependable than traditional communication, which benefits hospitals.

## References

- [1] G. Dong, H. Zhang, and D. Yuan, "Downlink achievable rate of massive MIMO enabled SWIPT systems over Rician channels," *IEEE Communications Letters*, vol. 22, no. 3, pp. 578-581, 2018.
- [2] X. Chen, X. Wang, and X. Chen, "Energy-efficient optimization for wireless information and power transfer in large-scale MIMO systems employing energy beamforming," *IEEE Wireless Communications Letters*, vol. 2, no. 6, pp. 667-670, 2013.
- [3] Sarthak Gupta , Monil Pahwa , Prayant Gupta , Surinder Kaur, ARZARA: Augmented reality app to try watch on your wrist, *Fusion: Practice and Applications*, Vol. 2 , No. 2 , (2020) : 50-56 (Doi : <https://doi.org/10.54216/FPA.020202>)
- [4] Shubham Gupta , Aarushi Dhawan , Arpit Gupta , Arun Kumar Dubey, Facial Expression Recognition with Gender Identification, *Fusion: Practice and Applications*, Vol. 2 , No. 2 , (2020) : 57-63 (Doi : <https://doi.org/10.54216/FPA.020203>)
- [5] Vaibhavi A. Bhagyalakshmi L., Porselvi S. and Sanjay Kumar Suman, "Review of Detecting Diabetes Mellitus and Diabetic Retinopathy Using Tongue Images and Its Features", *Research Journal of Pharmaceutical Biological and Chemical Sciences*, vol. 8, no. 2, pp. 378-386, April 2017
- [6] A. Biazon and M. Zorzi, "Transmission policies in wireless powered communication networks with energy cooperation," in *Proceedings of the 24th European Signal Processing Conference (EUSIPCO)*, pp. 592-596, Budapest, Hungary, August 2016.
- [7] Z. Chu, F. Zhou, Z. Zhu, R. Q. Hu, and P. Xiao, "Wireless powered sensor networks for Internet of Things: maximum throughput and optimal power allocation," *IEEE Internet of Things Journal*, vol. 5, no. 1, pp. 310-321, 2018.
- [8] M. A. Abd-Elmagid, T. ElBatt, and K. G. Seddik, "Optimization of wireless powered communication networks with heterogeneous nodes," in *Proceedings of the IEEE Global Communications Conference (GLOBECOM)*, pp. 1-7, San Diego, CA, USA, December 2015.
- [9] Noushini Nikeetha P. , Pavithra D. , Sivakarhiga K. , Karthika S. , Yashitha R. , Kirubasri G.V., A Survey on IoT based Wearable Sensor for Covid-19 Pandemic, *International Journal of Wireless and Ad Hoc Communication*, Vol. 2 , No. 2 , (2021) : 77-87 (Doi : <https://doi.org/10.54216/IJWAC.020203>).
- [10] V. Roy. " An Effective FOG Computing Based Distributed Forecasting of Cyber-Attacks in Internet of Things" *Journal of Cybersecurity and Information Management*, Vol. 12, No. 2, 2023 ,PP. 8-17.
- [11] V. Roy. " Breast cancer Classification with Multi-Fusion Technique and Correlation Analysis" *Fusion: Practice & Applications*, Vol. 9, No. 2, 2023 ,PP. 48-61.
- [12] Yunet Gasca Suárez , Omar Mar Cornelio, Design of the LAN Network of Hospital Comandante Manuel Piti Fajardo, *International Journal of Wireless and Ad Hoc Communication*, Vol. 2 , No. 2 , (2021) : 88-98 (Doi : <https://doi.org/10.54216/IJWAC.020204>)V. Roy et al., "Detection of sleep apnea through heart rate signal using Convolutional Neural Network," *International Journal of Pharmaceutical Research*, vol. 12, no. 4, pp. 4829-4836, Oct-Dec 2020.
- [13] L. Bhagyalakshmi, Sanjay Kumar Suman, S. Mohanalakshmi, and Satyanand Singh, "Improving Spectral Efficiency and Coverage Capacity of 5G Networks: A Review", *Advances in mathematics: scientific journal*, vol.9, no. 6, pp. 3387-3397, 2020.
- [14] X. Kang, C. K. Ho, and S. Sun, "Full-duplex wireless-powered communication network with energy causality," *IEEE Transactions on Wireless Communications*, vol. 14, no. 10, pp. 5539-5551, 2015.

- [15] M. A. Abd-Elmagid, A. Biason, T. ElBatt, K. G. Seddik, and M. Zorzi, "On optimal policies in full-duplex wireless powered communication networks," in Proceedings of the 14th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt), pp. 1-7, Tempe, AZ, USA, May 2016.
- [16] H. P. Sahu and R. Kashyap, "FINE\_DENSEIGANET: Automatic medical image classification in chest CT scan using Hybrid Deep Learning Framework," International Journal of Image and Graphics [Preprint], 2023. [Online]. Available: <https://doi.org/10.1142/s0219467825500044>
- [17] S. Stalin, V. Roy, P. K. Shukla, A. Zaguia, M. M. Khan, P. K. Shukla, A. Jain, "A Machine Learning-Based Big EEG Data Artifact Detection and Wavelet-Based Removal: An Empirical Approach," Mathematical Problems in Engineering, vol. 2021, Article ID 2942808, 11 pages, 2021. [Online]. Available: <https://doi.org/10.1155/2021/2942808>.
- [18] V. Roy. "An Improved Image Encryption Consuming Fusion Transmutation and Edge Operator." Journal of Cybersecurity and Information Management, Vol. 8, No. 1, 2021 ,PP. 42-52.
- [19] Shima A. Hussein, Eslam Hesham, Smart Security Area (SSA) for Radar system technology, Journal of Intelligent Systems and Internet of Things, Vol. 8 , No. 2 , (2023) : 34-44 (Doi : <https://doi.org/10.54216/JISIoT.080203>)
- [20] Nihal N. Mostafa, Esmeralda Kazia, Smart Sensor Networks for Industrial IoT Applications, Journal of Intelligent Systems and Internet of Things, Vol. 8 , No. 2 , (2023) : 45-53 (Doi : <https://doi.org/10.54216/JISIoT.080204>)
- [21] M. M. N. Aboelwafa, M. A. Abd-Elmagid, A. Biason, K. G. Seddik, T. ElBatt, and M. Zorzi, "Towards optimal resource allocation in wireless powered communication networks with non-orthogonal multiple access," Ad Hoc Networks, vol. 85, pp. 1-10,
- [22] Sonia Jenifer Rayen, Survey On Smart Cane For Visually Impaired Using IOT, Journal of Cognitive Human-Computer Interaction, Vol. 1 , No. 2 , (2021) : 81 - 85 (Doi : DOI: <https://doi.org/10.54216/JCHCI.010205>)
- [23] Nishanthi. G , Yuvashree , A, Jessinda Joseph , Supraja. R, Personnel Monitoring System Using Mobile Application during the COVID 19, Journal of Cognitive Human-Computer Interaction, Vol. 2 , No. 2 , (2022) : 40-49 (Doi : <https://doi.org/10.54216/JCHCI.020201>)
- [24] Babul Islam, M., Hasibunnahar, S., Shukla, P. K., Shukla, P. K., & Rawat, P. (2023). Diet and Food Restaurant in the Covid-19 Time by Machine Learning Approaches. In Computational Intelligence for Modern Business Systems: Emerging Applications and Strategies (pp. 419-433). Singapore: Springer Nature Singapore.
- [25] Shukla, P. K., Alqahtani, A., Dwivedi, A., Alqahtani, N., Shukla, P. K., Alsulami, A. A., ... & Simic, V. (2023). Attaining an IoMT-based health monitoring and prediction: a hybrid hierarchical deep learning model and metaheuristic algorithm. Neural Computing and Applications, 1-18.
- [26] Ahmed, I., Karvonen, H., Kumpuniemi, T., & Katz, M. (2020). Wireless communications for the hospital of the future: requirements, challenges and solutions. International Journal of Wireless Information Networks, 27(1), 4-17.