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Innovative IoT Solutions for Enhanced Patient Health Monitoring and Healthcare Efficiency in Hospitals

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Abstract: Hospitals worldwide have been grappling with overcrowding, a challenge that became particularly acute during the COVID-19 pandemic. Implementing IoT devices can enhance hospital efficiency and reduce the risk of infection for healthcare providers. With IoT, remote health monitoring becomes possible, leading to more timely and improved patient care. The research employs a stratified sampling method, with survey questionnaires distributed to gather data. Based on this data, a proposed system will be developed to evaluate its feasibility and effectiveness. As IoT technology advances, the system is expected to evolve, providing users with greater confidence and ease of use. The goal of this research and proposal is to implement a solution that enhances health monitoring in hospitals, ultimately offering patients better and more timely healthcare.
Keywords: Healthcare, Health Monitoring, IoT, RFID, Wi-Fi, ZigBee.

I. INTRODUCTION

As healthcare has become increasingly accessible, the issue of overcrowding in hospitals has become more pronounced [1][32][33]. Since the onset of the COVID-19 pandemic in 2020, hospitals have been overwhelmed by patients infected with the virus, leading to a strain on resources and the inability to adequately care for other patients as facilities reach full capacity [2][3][30][34]. Moreover, medical staff are at heightened risk of contracting COVID-19 due to their close contact with infected patients [2][23][24][25]. Beyond the pandemic, [4] notes that nurses spend a significant amount of time on medication-related tasks, such as documentation, preparation, and indirect patient care. The current processes are inefficient, requiring nurses to manually check patients' statuses and administer medications when necessary [5]. This inefficiency can lead to wasted resources—both time and money—that could be better utilized to enhance patient care [4][5].

This research proposes an IoT-based health monitoring and healthcare system using ZigBee, RFID, and Wi-Fi technologies to improve efficiency and reduce unnecessary tasks for medical staff. Such a system would enable hospitals to care for more patients while remotely monitoring patient conditions, thereby reducing the risk of COVID-19 infection. Additionally, the system would store patient history in the cloud, allowing authorized personnel to access this data through a web interface. With access to a patient’s history, medical staff can make informed decisions about the best course of treatment.

II. RELATED WORK

This section of the research will review past studies related to the proposed topic. Examining previous research will help identify flaws or drawbacks in existing systems, allowing for improvements in the new proposed system. Furthermore, this section will compare several similar existing systems.

The research domains reviewed include:

1) Internet of Things (IoT)
2) Types of Patients
3) Health Monitoring
4) Healthcare
5) IoT Health Monitoring

A. Internet of Things (IoT)

The world is currently in the fourth phase of the industrial revolution, known as Industry 4.0 or the Digital Revolution [6]. According to [6][7], Industry 4.0 involves integrating complex machinery and devices with sensors and software through networks to generate information that supports informed decision-making. Essentially, Industry 4.0 is driven by the Internet of Things (IoT), which enables connected devices to communicate, capture data, and convert it into valuable information [8]. To achieve this, IoT devices are equipped with sensors, actuators, processors, and wireless communication transceivers [9][27][28]. Sensors and actuators interact with the physical environment to collect data, which is then processed to derive useful information [9][29][31]. IoT devices use various protocols for wireless communication, such as Wi-Fi, Cellular, 6LoWPAN, ZigBee, RFID, and NFC, with the choice of protocol depending on a system's requirements and limitations [9][10]. The research proposed in the article offers a comprehensive overview of utilizing IoT in health monitoring [35]..The study on plant health monitoring highlights the use of IoT across various categories of monitoring [36].

B. Types of Patients

Hospitals admit numerous patients daily, and emergency departments often face issues of overcrowding [1]. To manage this, a triage system is implemented to prioritize patients based on the severity of their symptoms [11][12]. This issue has become even more critical since the COVID-19 pandemic began, as hospitals are overwhelmed with patients, making accurate screening and prioritization essential [11][12]. Different patients require different types of care, and hospitals must provide effective and efficient treatment accordingly [1].

C. Health Monitoring

Health monitoring involves tracking an individual's health condition by measuring various parameters such as heart rate, blood pressure, body temperature, and respiration rate [13][26]. Continuous monitoring enables immediate detection of anomalies, allowing for prompt medical intervention before a patient's condition worsens [14]. Implementing a health monitoring system in hospitals can help detect illnesses early, provide continuous patient monitoring, prevent conditions from worsening, and reduce unnecessary deaths [13].

D. Healthcare

Healthcare encompasses the services provided by hospitals or other medical facilities to patients, and hospitals must strive to deliver high-quality care [15]. According to [15][16], factors that influence the quality of healthcare services include reliability, hygiene, equipment, adequate facilities, and a commitment to service. Additionally, [16] highlights that interactions between medical staff and patients significantly impact patient satisfaction. Healthcare needs can also vary based on demographics, with senior citizens requiring more comprehensive care than other age groups [17].

E. IoT Health Monitoring

Integrating IoT into health monitoring involves connecting sensors that monitor vital signs to a network or the cloud, enabling health monitoring anytime and anywhere [14]. As [18] notes, IoT integration can improve emergency response efficiency and enhance patients' quality of life. According to [19], IoT allows for continuous monitoring of a patient's health, with data stored in the cloud, enabling doctors to make better-informed decisions based on the patient's specific condition.

F. Similar Systems

This section will discuss other similar systems, focusing on smart health monitoring and healthcare.

1) *System 1:* [14] proposed a framework for an IoT health monitoring system that detects a patient's heart rate, blood pressure, temperature, respiration rate, and activity. The system includes a transmitter and a receiver section, as shown in Figure 1. Sensors are connected to an Arduino Uno microcontroller, which is powered by an external source. The microcontroller processes the sensor data before transmitting it to a web server via GSM [14]. The information is then displayed as graphs on a webpage, allowing healthcare providers to monitor patients' conditions remotely [14]. If anomalies are detected, immediate action can be taken to provide timely treatment, preventing the patient's condition from worsening [14].

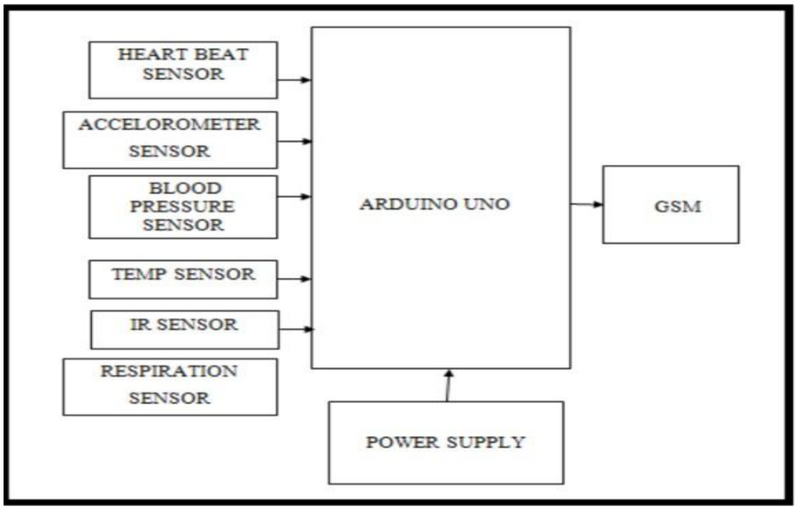


Figure 1: Block Diagram of Health Monitoring System [14]

2) *System 2:* Figure 2 below shows a health monitoring system proposed by [18] which can monitor a patient's blood pressure, heart rate and body temperature. The sensors are connected to a Raspberry Pi 3 microcomputer which is powered by a 5V USB-B cable [18]. The data collected from the sensors are processed and can be sent to a mobile application or a web server using Bluetooth, Wi- Fi, or GSM. GSM is used to send the patient's vital signs to a phone via SMS while the Wi-Fi module is used to connect the system to a web application through the MQTT protocol. Other than that, the system uses Bluetooth for short range transmission so that patients can check their health on their phone through a mobile application.

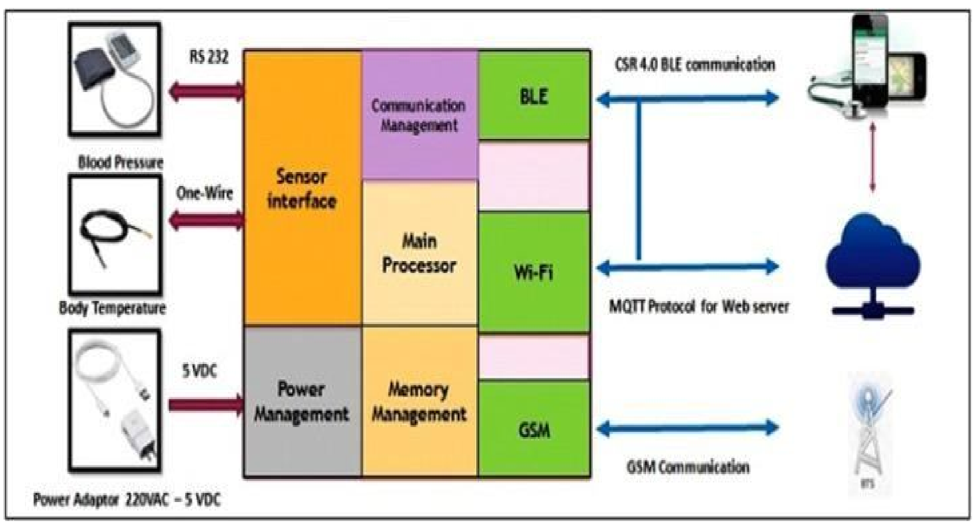


Figure 2: Functional Architecture of Health Monitoring System [18]

3) *System 3:* System 3 is a Healthcare Monitoring System proposed by [19] which has three fundamental stages, sensors, data processing and web interface. This proposed system can detect a patient's body temperature, heart rate as well as the environment of the hospital such as temperature, humidity, and gas [19]. As shown in Figure 3, the sensors are connected to a ESP32 microcontroller that is connected to a battery power supply, which will be the centre of the system and collect data from the sensors before transferring them to a web server via its built-in Wi-Fi module [19]. If a medical staff wants to access the data on the web server, they can access it though a web interface on any device that can browse the Internet [19]. The web server will also be password protected to increase security, so the medical staff must enter the correct password. On the web interface, the data will be presented graphically so the medical staff can quickly and easily understand the patient's condition or diagnosing the patient [19].

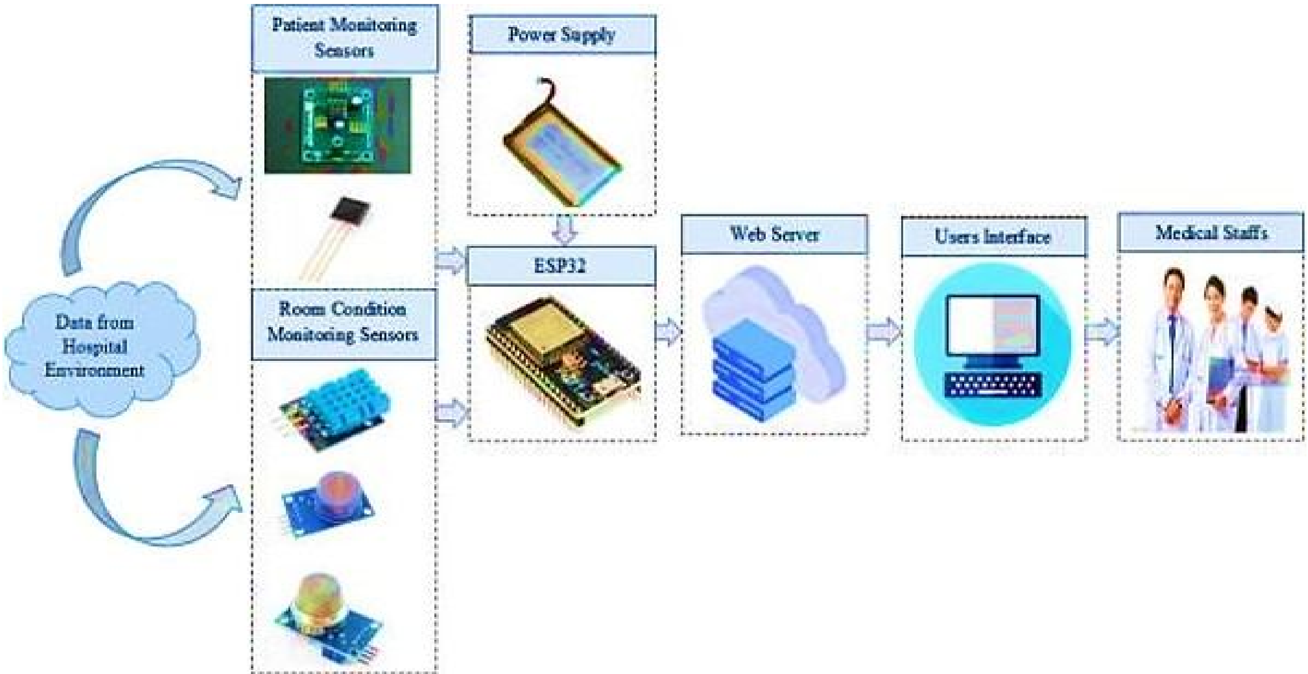


Figure 3: Overall System Architecture of Healthcare Monitoring System [19]

G. Comparison of Similar Systems

Table 1. Comparison Between Similar Systems

	System 1	System 2	System 3
Monitoring Sensors	Heartbeat, accelerometer sensor, blood pressure, body temperature, infrared, respiration	Blood pressure, heart rate, body temperature	Body temperature, heart rate, room temperature, humidity, gas
Communication Protocols	GSM	GSM, BLE, Wi-Fi	Wi-Fi
Processing Device	Arduino Uno	Raspberry Pi 3	ESP32
Server/Database	Yes	Yes	Yes
Alert	No	No	No
Patient Tracking	Yes	No	No
Remote Monitoring	Yes	Yes	No

Table 1 below presents a comparison of the features and components of three similar systems. For monitoring sensors, System 1 offers the highest number of sensors, enabling it to monitor a broader range of vital signs and detect any changes in a patient’s health condition. In contrast, System 3 extends its monitoring capabilities to include the hospital environment, providing additional context to the patient data received. System 2 employs multiple communication protocols tailored to different situations, whereas Systems 1 and 3 rely on a single protocol, which is sufficient for their specific use cases. Each system utilizes a different processing device; however, for more demanding tasks, the Raspberry Pi 3 used in System 2 would be better suited. All three systems incorporate a server or database to store data collected from the sensors, allowing medical staff to review patient history and gain deeper insights into the patient's health condition [20]. Additionally, System 1 meets most of the key criteria, including a server/database, alerting feature, patient tracking function, and remote monitoring capability. The proposed system will build on these features by incorporating multiple monitoring sensors, employing multiple communication protocols, and including a server, alert system, patient tracking, and remote monitoring. Moreover, it will introduce additional functionalities, such as an automated drug dispenser and equipment tracking [5].

III. OVERVIEW OF THE PROPOSED SYSTEM

The proposed system offers a comprehensive approach to monitoring both remote and in-hospital patients, ensuring continuous, real-time surveillance of their health status, and streamlining the delivery of healthcare services. For remote patients, the system utilizes wearable devices—specifically a health monitor and an activity monitor—that are designed to track critical health metrics such as heart rate, blood pressure, and physical activity levels. These wearables are equipped with sensors that gather real-time data, which is then transmitted securely to the hospital's cloud server via Wi-Fi or cellular networks. This remote monitoring capability allows healthcare providers to keep track of patients who are not physically present in the hospital, enabling timely interventions in case of any abnormalities in their health status. For patients within the hospital, the system employs a suite of sensors attached to the patient's body to continuously monitor vital signs, including heart rate, blood pressure, respiration rate, oxygen saturation levels, and body temperature. These sensors are connected to a local database within the hospital, which is linked to the cloud via Wi-Fi and ZigBee communication protocols. The use of ZigBee, a low-power wireless communication technology, ensures reliable data transmission over short distances, making it ideal for hospital environments where multiple devices need to communicate without interference. The integration with the cloud allows medical staff to access real-time data from any location with Internet access, providing them with the flexibility to monitor patients and respond promptly to any changes in their condition.

One of the key features of the proposed system is its ability to store patient medical histories in the database, which is connected to the cloud. This feature not only facilitates real-time monitoring but also allows healthcare providers to review a patient's past medical records, offering a comprehensive view of the patient's health. Having access to this historical data is crucial for making informed decisions about a patient's care, particularly in emergency situations where time is of the essence. In the event that the system detects any anomalies or deviations from normal health parameters, it is programmed to automatically alert the medical staff. This alert system is a critical component, as it ensures that healthcare providers are immediately notified of potential health issues, allowing them to intervene swiftly. For remote patients, this could involve dispatching an ambulance to their location, ensuring that they receive the necessary medical attention as quickly as possible. For in-hospital patients, the alert system enables rapid response, potentially preventing complications or worsening of the patient's condition.The proposed system also includes a feature for the automated administration of medication. Medical staff can schedule IV drops to be dispensed at specific times, reducing the manual workload associated with medication administration and ensuring that patients receive their medication on time. This automation not only improves efficiency but also minimizes the risk of human error, enhancing patient safety.

Additionally, the system incorporates RFID technology to optimize the management and utilization of medical equipment within the hospital. Each piece of equipment is tagged with an RFID chip, and RFID readers are strategically placed throughout the hospital to track the location of these items in real time. This feature addresses a common issue in hospitals where valuable time is often lost searching for misplaced equipment. By ensuring that medical equipment can be quickly located and accessed, the system helps to improve the overall efficiency of healthcare delivery, allowing medical staff to focus more on patient care rather than logistical challenges.

Overall, the proposed system offers a robust solution for enhancing patient monitoring and healthcare delivery, leveraging advanced technologies such as IoT, RFID, ZigBee, and cloud computing. By enabling continuous monitoring, real-time alerts, automated medication administration, and efficient equipment tracking, the system is poised to significantly improve the quality and efficiency of healthcare services in hospitals. The process flow of the proposed system, as illustrated in Figure 4, outlines the seamless integration of these components, demonstrating how they work together to support comprehensive patient care.

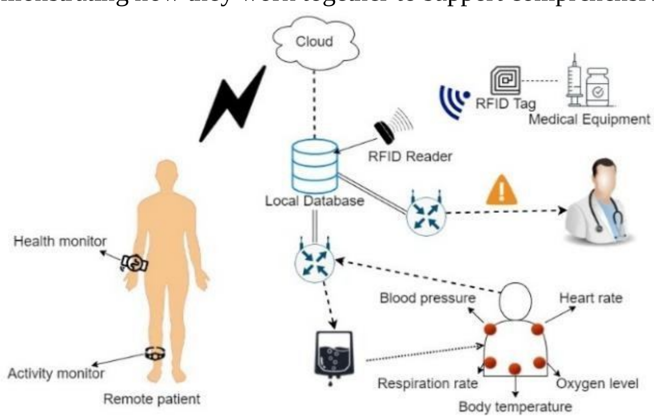


Figure 4 Overview of the Proposed System

IV. RESEARCH METHODOLOGY

This research will employ a quantitative approach to comprehensively investigate the factors contributing to inefficiencies in current health monitoring systems, specifically within hospital settings. By focusing on a quantitative methodology, the study aims to objectively measure and analyze variables that may impact the effectiveness and efficiency of these systems, providing a data-driven foundation for identifying areas of improvement. The study will involve a carefully selected sample size of 25 respondents, which includes two distinct groups: 15 hospital patients and 10 medical staff members. The rationale for including both patients and medical staff is to capture a well-rounded perspective on the health monitoring systems in use. Patients, as the primary recipients of healthcare services, can provide insights into the system's effectiveness from a user’s standpoint, while medical staff, who operate and interact with these systems daily, can offer professional assessments of the system’s operational efficiency and potential shortcomings.

To ensure the precision and reliability of the data collected, stratified sampling will be employed. Stratified sampling is a probability sampling method that involves dividing the population into distinct subgroups, or strata, that share similar characteristics—in this case, hospital patients and medical staff. By doing so, the study can target the most relevant participants who are directly involved with and affected by health monitoring and healthcare systems. This approach helps to eliminate sampling bias and ensures that each subgroup is adequately represented in the final analysis, thereby enhancing the validity of the research findings. The data collection process will be conducted through a survey questionnaire, which will be distributed to all respondents. The survey is designed to gather detailed information about the respondents' experiences and perceptions of the current health monitoring systems. To capture a broad range of responses, the questionnaire will include a variety of question types:

1) *Multiple-choice Questions:* These will allow respondents to select from predefined answers, providing clear, quantifiable data that can be easily analyzed to identify trends and patterns.
2) *7-point Likert Scale Questions:* These questions will assess respondents’ attitudes, beliefs, and satisfaction levels regarding the current health monitoring systems. The 7-point scale offers a nuanced range of options, enabling respondents to express varying degrees of agreement or disagreement with statements about the systems. This scale is particularly useful for measuring subjective experiences and perceptions, which are critical to understanding the effectiveness of the systems from the users' perspectives.
3) *Open-ended Questions:* These will provide respondents with the opportunity to elaborate on their experiences, challenges, and suggestions for improvement. Open-ended questions are valuable for capturing qualitative data that may not be fully addressed by multiple-choice or Likert-scale questions, offering deeper insights into the specific issues or benefits associated with the current systems.
4) *Closed Questions:* These will be used to gather specific, factual information about the respondents’ experiences with the health monitoring systems. Closed questions are useful for collecting binary or straightforward responses, such as yes/no answers or frequency of system use.

Once the data has been collected, it will undergo a thorough analysis to summarize the respondents’ views on the current health monitoring systems. The analysis will involve statistical methods to quantify the responses, identify significant trends, and compare the perceptions of patients and medical staff. By examining the data from these two key stakeholder groups, the research will be able to pinpoint specific areas where the current systems are falling short and where improvements can be made. Ultimately, this research aims to provide actionable insights that can inform the development of more efficient, user-friendly health monitoring systems in hospitals. By systematically investigating the factors contributing to inefficiencies, the study will contribute to the broader goal of enhancing the quality of healthcare delivery, ensuring that both patients and medical staff benefit from more effective monitoring and management tools.

V. DISCUSSION

This analysis section delves into the significance of the research, particularly in light of the COVID-19 pandemic, which has placed unprecedented strain on healthcare systems globally. The pandemic has led to severe overcrowding in hospitals, as they have been inundated with patients infected by the virus. This situation has not only overwhelmed medical facilities but has also created significant challenges in providing adequate care to other patients with different medical needs. The strain on resources—such as medical staff, equipment, and space—has highlighted the urgent need for innovative solutions that can help hospitals manage their patient load more effectively. The implementation of the proposed IoT-based health monitoring and healthcare system represents a potential solution to these challenges. By leveraging IoT technology, the system can significantly reduce the workload on medical staff, allowing them to focus on more critical tasks.

The automation of basic medication administration, for instance, ensures that patients with lower urgency receive timely treatment even when medical staff are preoccupied with more urgent cases. This is particularly important during a pandemic when the capacity to provide individualized care is stretched thin. Furthermore, the system's ability to monitor patients remotely and in real-time offers a dual benefit. For in-hospital patients, it reduces the need for constant physical check-ins by medical staff, thereby minimizing the risk of virus transmission and allowing staff to manage their time more efficiently. For remote patients, the system provides a critical link between the hospital and the patient, ensuring continuous monitoring of their health condition and enabling swift intervention if any anomalies are detected. This capability is especially valuable in situations where hospital beds are limited, and patients who might not require immediate hospitalization can be effectively monitored from home. From a resource management perspective, the system's RFID-based equipment tracking feature also addresses a common issue in hospitals: the misplacement or inefficient use of medical equipment. By ensuring that equipment is easily locatable, the system reduces time wasted in searching for necessary tools, thus improving the overall efficiency of hospital operations. In a high-pressure environment such as during a pandemic, every minute saved can make a significant difference in patient outcomes.

This research, therefore, aims to explore the transformative potential of IoT technology in the medical sector. By addressing current challenges—such as those highlighted by the COVID-19 pandemic—the study seeks to demonstrate how IoT can be harnessed to not only improve healthcare delivery but also to make it more resilient in the face of future crises. The findings of this research could have far-reaching implications, providing a roadmap for integrating IoT solutions into healthcare systems worldwide and setting the stage for more innovative, efficient, and patient-centered care in the years to come.

VI. CONCLUSION

This research proposed an IoT-based health monitoring and healthcare system for hospitals, incorporating RFID, ZigBee, and Wi-Fi technologies to enhance hospital efficiency and reduce the workload on medical staff. By enabling remote monitoring, the system minimizes the need for physical contact between medical staff and patients, thus reducing the time required for such interactions. Additionally, the use of RFID technology facilitates the real-time tracking of medical equipment, thereby reducing time wasted in locating misplaced items. As IoT technology continues to advance, it is expected that data transmission will become faster, more reliable, and robust, with improved security measures across devices, enhancing user confidence in privacy protection. However, while IoT presents significant benefits, it is still a relatively new and evolving technology with certain limitations, particularly in terms of security. The increase in the number of IoT devices on a network expands the potential entry points for hackers or malicious actors [21]. The diverse origins of these devices often result in varying security protocols, creating vulnerabilities that can be exploited by targeting the weakest link in the network [21]. Additionally, patient privacy is a critical concern, as the system stores large amounts of sensitive data [21, 22]. Some patients may prioritize their privacy over improved treatment options, leading to reluctance in adopting the technology. Furthermore, if data stored on the web server is compromised, the responsibility for the breach could fall on IT security, hospital management, or the device vendors. Future research and development should focus on addressing these critical issues of security and privacy. As security protocols are strengthened, patient privacy will concurrently improve, fostering greater trust in the system and encouraging broader adoption among both patients and healthcare providers.

REFERENCES

[1] Zachariasse J. M., Hagen, V. V. D., Seiger, N., Mackway-Jones, K., Veen, M. V. and Moll, H. A. Performance of Triage Systems in Emergency Care: A Systematic Review and Meta-analyis. BMJ Open. 2019(9), 2019. DOI: http://dx.doi.org/10.1136/bmjopen-2018-026471

[2] Bielicki, J. A., Duval, X., Gobat, N., Goossens, H., Koopmans, M., Tacconelli, E. and Werf, S. V. D. Monitoring Approaches for Health-care Workers During the COVID-19 Pandemic. THE LANCET Infectious Diseases. 20(10), 2020, pp. 1101-1216. DOI: https://doi.org/10.1016/S1473- 3099(20)30458-8

[3] Tan, C. S., Lokman, S., Rao, Y., Kok, S. H. and Ming, L. C. Public and Private Sectors Collective Response to Combat Co-vid-19 in Malaysia. Journal of Pharmaceutical Policy and Practice. 14:40, 2021. DOI: https://doi.org/10.1186/s40545-021-00322-x

[4] Glantz, A., Örmon, K. and Sandström, B. "How Do We Use the Time?" – An Observational Study Measuring the Task Time Distribution of Nurses in Psychiatric Care. BMC Nursing. 18:67, 2019. DOI: https://doi.org/10.1186/s12912-019-0386-3

[5] Joseph, S., Francis, N., John, A., Farha, B. and Baby, A. Intravenous Drip Monitoring System for Smart Hospital Using IoT. 2019 2nd International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT). 2019, pp. 835-839. DOI: https://doi.org/10.1109/ICICICT46008.2019.89932 41

[6] Dogaru, L. The Main Goals of the Fourth Industrial Revolution. Renewable Energy Perspective. Procedia Manufacturing. 46, 2020, pp. 397-401. DOI: https://doi.org/10.1016/j.promfg.2020.03.058

[7] Leong, W. D., Teng, S. Y., How, B. S., Ngan, S. L., Rahman, A. A., Tan, C. P., Ponnambalam, S. G., Lam, H. L. Enhancing the Adaptability: Lean and Green Strategy towards the Industry Revolution 4.0. Journal of Cleaner Production, 122870, 2020. DOI: https://doi.org/10.1016/j.jclepro.2020.122870

[8] Al-Ogaili, A. S., Alhasan, A., Ramasamy, A., Marsadek, M., Hashim, T. J. T., Al-Sharaa, A., Aadam, M. and Audah, L. IoT Technologies for Tackling COVID-19 in Malaysia and Worldwide: Challenges, Recommendations, and Proposed Framework. Computers, Materials & Continua. 66(2), 2020, pp. 2141-2164. DOI: http://dx.doi.org/10.32604/cmc.2020.013440

[9] Moraes, T., Nogueira, B., Lira, V. and Tavares, E. Performance Comparison of IoT Communication Protocols. 2019 IEEE International Conference on Systems, Man and Cybernetics (SMC). Bari, Italy. 6-9 October 2019. DOI: https://doi.org/10.1109/SMC.2019.8914552

[10] Shafique, K., Khawaja, B. A., Sabir, F., Qazi, S. and Mustaqim, M. Internet of Things (IoT) for Next- Generation Smart Systems: A Review of Current Challenges, Future Trends and Prospects for Emerging 5G-IoT Scenarios. IEEE Access. 8, 2020, pp. 23022-23040.DOI: https://doi.org/10.1109/ACCESS.2020.2970118

[11] Truog, R. D., Mitchell, C. and Daley, G. Q. The Toughest Triage – Allocating Ventilators in a Pandemic. New England Journal of Medicine. 382(21),2020, pp.1973-1975. DOI: https://doi.org/10.1056/NEJMp2005689

[12] Wang, Q. The Role of Triage in the Prevention and Control of COVID-19. Infection Control & Hospital Epidemiology. 2020(41), 2020, pp. 772-776. DOI: https://doi.org/10.1017/ice.2020.185

[13] Malasinghe, L. P. Ramzan, M. and Dahal, K., Remote Patient Monitoring: A Comprehensive Study. Journal of Ambient Intelligence and Humanized Computing. 10, 2019 pp. 57-76. DOI: https://doi.org/10.1007/s12652-017-0598-x

[14] Sam, D., Srinidhi, S., Niveditha, R., Amudha, S. and Usha, D. Progressed IOT Based Remote Health Monitoring System. International Journal of Control and Automation. 13(2s), 2020, pp. 268-273.

[15] Asnawi, A. A., Awang, Z., Afthanorhan, A., Mohamad, M. and Karim, F. The Influence of Hospital Image and Service Quality on Patients' Satisfaction and Loyalty. Management Science Letters. 9(6), 2019, pp. 911-921. DOI: http://dx.doi.org/10.5267/j.msl.2019.2.011

[16] Babroudi, N. E. P., Sabri-Laghaie, K., Ghoushchi, N. G. Re-evaluation of the Healthcare Service Quality Criteria for the Covid-19 Pandemic: Z- number Fuzzy Cognitive Map. Applied Soft Computing. 112, 2021, DOI: https://doi.org/10.1016/j.asoc.2021.107775

[17] Andersen, Y. M. F., Egeberg, A., Skov, L. and Thyssen, J. P. Demograohics, Healthcare Utilization and Drug Use in Children and Adults with Atopic Dermatitis in Denmark: A Population-based Cross- sectional Study. Journal of the European Academy of Dermatology and Venereology. 33, 2019, pp. 1133-1142. DOI: https://doi.org/10.1111/jdv.15424

[18] Swaroop, K. N., Chandu, K., Gorrepotu, R. and Deb, S. A Health Monitoring System for Vital Signs Using IoT. Internet of Things. 5, 2019, pp. 116-129. DOI: https://doi.org/10.1016/j.iot.2019.01.004

[19] Islam, M.M., Rahaman, A. and Islam, M.R. Development of Smart Healthcare Monitoring System in IoT Environment. SN Computer Science. 1:185, 2020, DOI: https://doi.org/10.1007/s42979-020-00195-y

[20] Lucarotti, P. and Burke, F. Patient History as a Predictor of Future Treatment Need? Considerations From a Dataset Containing Over Nine Million Courses of Treatment. British Dental Journal. 228, 2020, pp. 345-350. DOI: https://doi.org/10.1038/s41415-020-1305-4

[21] Tawalbeh, L., Muheidat, F., Tawalbeh, M. and Quwaider, M., IoT Privacy and Security: Challenges and Solutions. Applied Sciences. 10(12):4102, 2020, DOI: http://dx.doi.org/10.3390/app10124102

[22] Menard, P. and Bott, G. J., Analyzing IOT Users' Mobile Privacy Concers: Extracting Privacy Permissions Using a Disclosure Experiment. Computers & Security. 95:101856, 2020, DOI: https://doi.org/10.1016/j.cose.2020.101856

[23] Poongodi, M., Nguyen, T.N., Hamdi, M. and Cengiz, K., 2021. A Measurement Approach Using Smart-IoT Based Architecture for Detecting the COVID-19. Neural Processing Letters, pp.1-15.

[24] L. Tan, K. Yu, A. K. Bashir, X. Cheng, F. Ming, L. Zhao, X. Zhou, "Towards Real-time and Efficient Cardiovascular Monitoring for COVID-19 Patients by 5G-Enabled Wearable Medical Devices: A Deep Learning Approach", Neural Computing and Applications, 2021, https://doi.org/10.1007/s00521-021-06219-9

[25] K. Yu, L. Tan, X. Shang, J. Huang, G. Srivastava and P. Chatterjee, "Efficient and Privacy-Preserving Medical Research Support Platform Against COVID-19: A Blockchain-Based Approach", IEEE Consumer Electronics Magazine, doi: 10.1109/MCE.2020.3035520.

[26] H. Li, K. Yu, B. Liu, C. Feng, Z. Qin and G. Srivastava, "An Efficient Ciphertext-Policy Weighted Attribute-Based Encryption for the Internet of Health Things," IEEE Journal of Biomedical and Health Informatics, 2021, doi: 10.1109/JBHI.2021.3075995.

[27] Y. Gong, L. Zhang, R. Liu, K. Yu and G. Srivastava, "Nonlinear MIMO for Industrial Internet of Things in Cyber–Physical Systems," IEEE Transactions on Industrial Informatics, vol. 17, no. 8, pp. 5533-5541, Aug. 2021, doi: 10.1109/TII.2020.3024631.

[28] So-In, C., 2020. Efficient SDN-Based Traffic Monitoring in IoT Networks with Double Deep Q- Network. In Computational Data and Social Networks: 9th International Conference, CSoNet 2020, Dallas, TX, USA, December 11-13, 2020, Proceedings (Vol. 12575, p. 26). Springer Nature.

[29] Tran, D.N., Nguyen, T.N., Khanh, P.C.P. and Trana, D.T., 2021. An iot-based design using accelerometers in animal behavior recognition systems. IEEE Sensors Journal.

[30] Subramani, P., Srinivas, K., Sujatha, R. and Parameshachari, B.D., 2021. Prediction of mascular paralysis disease based on hybrid feature extraction with machine learning technique for COVID-19 and post-COVID-19 patients. Personal and Ubiquitous Computing, pp.1-14.

[31] Begum, S., Banu, R., Ahamed, A. and Parameshachari, B.D., 2016, December. A comparative study on improving the performance of solar power plants through IOT and predictive data analytics. In 2016 International Conference on Electrical, Electronics, Communication, Computer and Optimization Techniques (ICEECCOT) (pp. 89-91). IEEE.

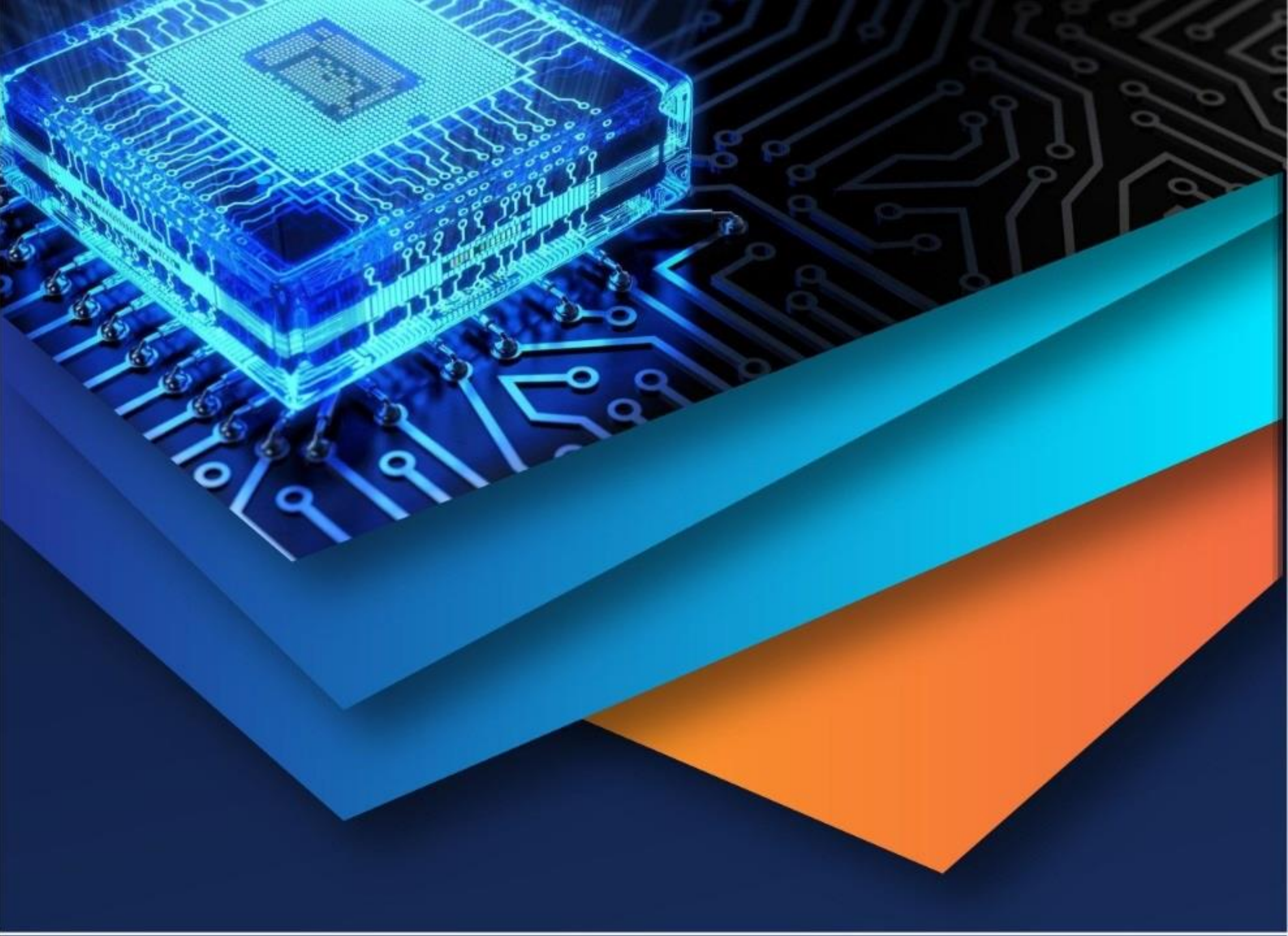
[32] Deepa J, Ranjini, Sharanya Raj, Dr. Parameshachari B D, 2018, Soldier Health and Position Tracking System using GPS and GSM Modem., INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) NCESC – 2018 (Volume 6 – Issue 13).

[33] Subramani, P., Al-Turjman, F., Kumar, R., Kannan, A. and Loganthan, A., 2021. Improving medical communication process using recurrent networks and wearable antenna s11 variation with harmonic suppressions. Personal and Ubiquitous Computing, pp.1-13.

[34] Prabu, S., Velan, B., Jayasudha, F.V., Visu, P. and Janarthanan, K., 2020. Mobile technologies for contact tracing and prevention of COVID-19 positive cases: a cross-sectional study. International Journal of Pervasive Computing and Communications.

[35] kumari, Saroj & Shrinivasa, & S, Dr & Reddy, V & P K, Manoj. (2023). HEALTH MONITORING BASED COGNITIVE IOT USING FAST MACHINE LEARNING TECHNIQUE. Shu Ju Cai Ji Yu Chu Li/Journal of Data Acquisition and Processing. 38. 405-417. 10.5281/zenodo.7648729.

[36] Manjunath, P. M., Shwetha Gurucharan, and M. D. Souza. "IoT Based Agricultural Robot for Monitoring Plant Health and Environment." Journal of Emerging Technologies and Innovative Research 6.2 (2019): 551-554.



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ISRA JIF IMPACT FACTOR: 7.129

SJIFactor TOGETHER WE REACH THE GOAL IMPACT FACTOR: 7.429

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