European Journal of Clinical Pharmacy

Print ISSN: 2385-409X **Online ISSN**: 3105-0409

Website: https://farmclin.com/

Original Research Article

Design and MATLAB Analysis of an IoT-Enabled Medication Error Detection System in Hospital Pharmacies

Article History:

Name of Author:

Dr. M. Dhanabal[1], Dr S.V. Ramanan[2], Dr. S. Iyyappan[3], Mr. M. Mohan4, Dr. S. Mathu Kumar[5] and Dr. S. Padmavathy[6]

Affiliation: *[1]Assistant Professor, Department of Mechanical Engineering, V.S.B.Engineering College, Karur-639111,Tamilnadu, India.*

[2]Assistant Professor, Department of Electronics and Communication Engineering, Sri Shakthi Institute of Engineering and Technology, Coimbatore, Tamil Nadu, India.

[3]Assistant Professor, Department of Mechanical Engineering, Ponjesly College of Engineering, Nagercoil 629003, Tamilnadu, India.

[4]Assistant Professor, Department of Mechanical Engineering, PPG Institute of Technology, Coimbatore-641035, Tamil Nadu, India.

[5]Associate Professor, Department of Mechanical Engineering, Ponjesly College of Engineering, Nagercoil, Tamilnadu -629003, India.

[6]Associate professor, Department of Mechanical Engineering, M.Kumarasamy college of Engineering, Karur,639117, Tamilnadu, India.

Corresponding Author:

M. Dhanabal

***Received**:* 21-10-2025

***Revised**:* 20-11-2025

***Accepted**:* 28-11-2025

***Published**:* 01-12-2025

Abstract: Medication errors in hospital pharmacies pose significant risks to patient safety and healthcare outcomes. To mitigate these errors, an IoT-enabled medication error detection system is proposed. This system integrates IoT sensors, including RFID and barcode scanning technologies, to monitor medication administration in real-time, providing early detection of potential errors. The system design utilizes MATLAB for simulation and performance analysis, ensuring that the solution is both efficient and reliable. The methodology involves the development of a real-time monitoring system with hardware components connected to a central processing unit, where data is analyzed and compared against predefined medication protocols. Results from MATLAB simulations demonstrate the system's high accuracy in error detection, highlighting improvements over traditional methods. The system's performance is evaluated based on metrics such as error detection rate, response time, and system reliability. The findings suggest that the proposed IoT-enabled system can enhance medication safety in hospital pharmacies, reduce human errors, and improve patient care. Future work includes the integration of machine learning algorithms to further optimize the detection process and scalability for larger healthcare environments.

Keywords: Internet of Things (IoT), Medication Error Detection, Hospital Pharmacy, MATLAB Simulation, Real-Time Monitoring, RFID Technology, Barcode Scanning, Data Analysis, Healthcare Automation, Medication Safety, System Design, Error Detection Algorithms, Patient Safety.

INTRODUCTION

Medication errors in hospital pharmacies are a significant concern in healthcare systems worldwide. These errors, which include mistakes in drug selection, dosage, administration route, and timing, can lead to adverse patient outcomes, prolonged hospital stays, and even fatalities[1]. According to various studies, medication errors are a leading cause of preventable harm in healthcare settings, and they account for a substantial percentage of medical errors. In the context of hospital pharmacies, where a high volume of medications is dispensed daily, ensuring accurate medication administration is paramount[2]. Despite existing practices such as barcode scanning and manual double-checking, medication errors continue to pose a major risk to patient safety. As hospitals are increasingly adopting technology to streamline operations and improve patient care, it has become evident that traditional methods of error detection are no longer sufficient to address the complexity and speed at which medications are dispensed. Thus, the need for innovative, real-time medication error detection systems in hospital pharmacies has become critical.

The Internet of Things (IoT) has revolutionized numerous industries, and healthcare is no exception. In healthcare, IoT refers to the network of interconnected devices and sensors that collect, transmit, and analyze data to improve decision-making and patient care. These devices can range from wearable health monitors to advanced medical equipment and sensors embedded in the hospital infrastructure. In the case of medication error detection, IoT enables real-time monitoring of medication administration by integrating smart devices such as barcode scanners, RFID tags, and smart pill dispensers with hospital management systems[3]. This integration ensures that medications are dispensed and administered in accordance with prescribed protocols, while continuously providing data that can be analyzed for errors. By providing automated alerts and feedback, IoT systems can help prevent human errors in drug dispensation, alerting healthcare professionals to any discrepancies between prescribed and administered medications[4]. The utilization of IoT in medication error detection holds significant promise in enhancing the accuracy and efficiency of pharmaceutical operations in hospitals, ensuring that patient safety is prioritized.

Existing systems for medication error detection in pharmacies, while useful, often lack the necessary capabilities for real-time monitoring and error prevention. Traditional methods, such as manual checks and barcode scanning, are prone to human error and require significant resources. Although barcode scanning has been widely implemented in many hospitals, it still depends on the accuracy of the manual entry of medication data, and it may not catch every possible error, such as those related to incorrect drug dosage or administration time. Furthermore, these systems lack predictive capabilities and are reactive in nature, only identifying errors after they have occurred[5]. There is also a lack of integration between different technologies within the hospital, which can lead to data silos and inefficiencies. Additionally, the absence of an automated and continuous monitoring system means that many errors go undetected until after they have affected the patient. Given the growing complexity of healthcare systems and the increasing reliance on technology in pharmacy operations, there is an urgent need for a more robust, real-time, and integrated solution for medication error detection. IoT technology offers a promising solution, but its full potential has not been fully explored in the context of pharmacy operations.
The primary objective of this research is to design and implement an IoT-enabled medication error detection system for hospital pharmacies, with a focus on real-time monitoring and error prevention. This system will integrate IoT sensors, such as RFID and barcode scanning technologies, to continuously track medication administration, compare it against the prescribed protocol, and detect any discrepancies or errors in real-time. Additionally, the performance of the system will be analyzed using MATLAB, which will simulate the real-time data flow and test the accuracy and efficiency of the detection process. Through the use of MATLAB analysis, the system's ability to detect medication errors accurately, reduce response time, and improve overall pharmacy efficiency will be evaluated. The goal is to create a system that not only identifies medication errors but also provides actionable insights that can be used to improve hospital pharmacy operations, enhance patient safety, and reduce the occurrence of preventable harm due to medication errors. By

developing a system that integrates IoT technology with robust data analysis capabilities, this research aims to contribute to the advancement of pharmacy error detection systems in healthcare environments.

LITERATURE SURVEY

Medication error detection has long been a critical issue in hospital pharmacies due to the high volume of medications dispensed daily and the complexity of managing drug regimens. Several methods have been employed to detect and prevent medication errors in these settings. One of the most common traditional approaches is the use of barcode scanning technology[6]. Barcode scanning ensures that the right medication is given to the right patient by scanning a barcode on the medication and comparing it to the patient's prescription in the hospital system. However, while barcode scanning has proven effective in some instances, it still relies heavily on manual data entry, which can lead to human error if the data is incorrectly entered or mismatched[7]. Additionally, barcode systems do not provide real-time error detection, and the process of scanning may not catch all potential errors, such as those related to incorrect dosage or administration route. Radio Frequency Identification (RFID) has also been used as an advanced system for medication error detection. RFID technology can track the movement of medications and patients within a healthcare facility, providing real-time visibility into the medication administration process[8]. RFID-based systems can ensure that medication is administered at the correct time and in the correct dosage. However, despite the advantages of RFID, its widespread implementation remains limited due to the high costs associated with setting up RFID infrastructure and integrating it with existing hospital management systems. Furthermore, while RFID offers automated tracking, the systems often still require human intervention for final verification, leaving the potential for errors[9].

Manual systems are still commonly used in many pharmacies for medication error detection, where pharmacists rely on their judgment and experience to verify prescriptions and patient records. While these systems allow for human oversight and decision-making, they are highly prone to fatigue, human error, and are often time-consuming. Consequently, manual error detection is less efficient and effective compared to automated systems, particularly in high-volume environments.

IoT Applications in Healthcare

The integration of the Internet of Things (IoT) technology in healthcare has revolutionized many aspects of patient care, particularly in medication management. IoT refers to the interconnectedness of devices that can collect and transmit data over a network to central processing systems, enabling real-time monitoring and decision-making[10]. In healthcare, IoT devices such as smart pill dispensers, wearable sensors, and RFID tags have been increasingly deployed to monitor patient conditions, track medication administration, and ensure adherence to prescribed regimens.

Research has shown that IoT-enabled medication management systems can significantly reduce medication errors by automating the medication administration process[11]. For example, IoT devices can monitor medication dispensing in real time, automatically comparing dispensed drugs against prescribed ones, and alerting healthcare providers of any discrepancies[12]. Additionally, IoT technology enables the collection of vast amounts of real-time data that can be used for predictive analytics, identifying patterns that may indicate potential errors before they occur[13]. In particular, IoT-based systems that integrate RFID and barcode scanning technologies are seen as a promising solution for ensuring medication safety. These systems can also integrate with hospital information management systems, making them more efficient and reducing the reliance on manual checks[14].

Over the past few years, significant advancements have been made in IoT sensors and data communication technologies, improving the accuracy and reliability of medication error detection systems. Modern IoT sensors are smaller, more cost-effective, and more energy-efficient, making them suitable for integration into a wide range of healthcare applications[15]. The development of high-precision sensors has enabled more accurate tracking of medications, dosage, and patient movements, thus minimizing the chance of errors.

Advancements in data communication have also contributed to the success of IoT systems in healthcare. With the availability of faster and more secure wireless networks, IoT devices can now transmit large volumes of data in real time with minimal delay[16]. This ensures that healthcare professionals can receive immediate alerts about any potential medication errors, facilitating prompt intervention[17]. Additionally, IoT systems now incorporate cloud computing technologies, allowing for the storage and analysis of large datasets and enabling healthcare providers to gain insights from historical data, further improving the accuracy of medication administration and patient safety.

In terms of smart medication management, innovations such as smart pill dispensers and medication adherence apps have gained significant attention. These devices not only remind patients to take their medication on time but also track dosage and administration, alerting both the patient and healthcare provider in case of errors or missed doses. The integration of IoT in medication management has opened up new avenues for patient safety and error prevention.

MATLAB in Healthcare

MATLAB has been widely used in healthcare for system modeling, data analysis, and simulation. In medication error detection, MATLAB serves as an essential tool for simulating the behavior of IoT-enabled systems, analyzing real-time data, and assessing the performance of error detection algorithms. MATLAB's powerful computational capabilities make it an ideal platform for evaluating complex systems, allowing for the modeling of sensor networks, communication protocols, and real-time monitoring processes[18].

Previous studies have utilized MATLAB to model IoT systems in healthcare, providing insights into the efficiency, accuracy, and reliability of different error detection strategies. MATLAB's extensive library of functions and toolboxes enables the simulation of real-time data streams and error detection mechanisms, making it easier to evaluate how IoT-enabled systems perform under various conditions and scenarios[19]. The results from MATLAB simulations can be used to refine the system design and improve the accuracy of medication error detection algorithms. While significant progress has been made in medication error detection using IoT, several gaps remain in the current literature[20]. A major gap is the lack of real-time, fully automated systems that can detect medication errors in real time without human intervention. Most existing systems rely on passive data collection or require manual verification at certain stages of the medication administration process, which leaves room for human error. There is also a need for more advanced algorithms that can predict potential errors based on real-time data and historical trends, allowing for preemptive actions.

Additionally, while IoT technology has been applied to medication error detection, the integration of these systems with existing healthcare infrastructures, such as electronic health records and hospital management systems, remains limited. The challenge of seamlessly integrating IoT with legacy systems without disrupting workflows presents an opportunity for further research and development. Furthermore, scalability is another challenge, as many IoT-based systems are designed for small-scale trials or individual hospital units. Expanding these systems to operate effectively across large healthcare networks while maintaining accuracy and efficiency is an area that requires further exploration. Addressing these gaps could lead to the development of more robust and scalable IoT-enabled medication error detection systems that can be implemented across various healthcare settings.

PROPOSED METHOD

The proposed IoT-enabled medication error detection system is designed to improve medication safety within hospital pharmacies by automating the detection of medication errors and providing real-time feedback to healthcare providers. The system architecture integrates various hardware components, communication technologies, and data processing algorithms to ensure efficient operation and high accuracy in error detection. The system relies on a combination of sensors such as RFID tags and barcode scanners to track medications and verify their correspondence with the prescribed drug regimen. RFID tags are placed on medication containers, and these tags store critical information about the medication, including its name, dosage, expiration date, and unique identification number. As the medication is prepared for administration, the RFID tag is scanned by a reader, capturing real-time data that is sent to a central processing unit (CPU). Additionally, barcode scanners are employed to scan both the medication and the patient's barcode. This helps ensure that the medication is being administered to the correct patient and at the right time, preventing errors related to incorrect drug administration.

For communication, the system uses Wi-Fi and Bluetooth modules to transmit data between the sensors and the central processing unit. Wi-Fi is employed for transmitting larger data packets over longer distances, while Bluetooth is utilized for short-range communication, particularly in areas with limited wireless infrastructure. These communication modules enable real-time data transfer, ensuring that the system can promptly analyze medication data and identify discrepancies.

The **data processing flow** begins with the scanning of medication and patient barcodes. Once the data is collected by the sensors, it is transmitted via Wi-Fi or Bluetooth to a **central server**. The server houses the error detection algorithms, which compare the scanned medication details with the prescribed medication order in the hospital's database. This comparison checks for errors such as wrong drug, incorrect dosage, wrong administration route, or patient mismatch. If an error is detected, the system generates an alert, which is sent to the healthcare provider's device, notifying them of the issue. In addition, the system logs the error for later review and analysis.

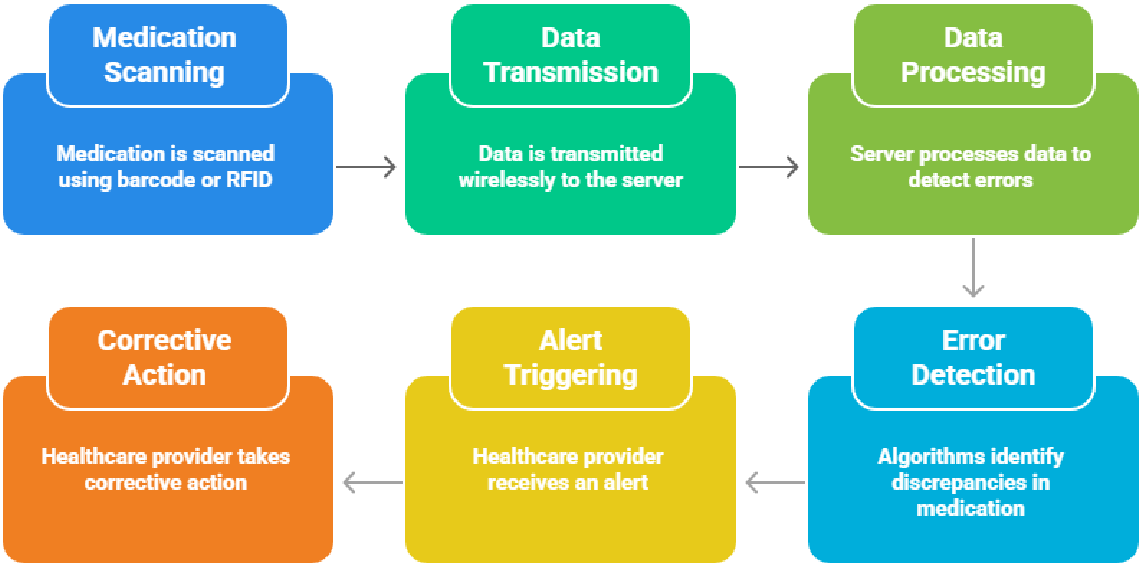

Figure 1: System Design Overview for IoT-Enabled Medication Error Detection System

Figure.1. illustrates the architecture of the IoT-enabled medication error detection system. The system comprises multiple key components working together to ensure real-time monitoring and error detection in hospital pharmacies. At the core of the system are RFID tags and barcode scanners, which are used to track and verify medication and patient details. The RFID tags contain information about the medication, such as its name, dosage, and expiration date, while the barcode scanners are used to ensure that the correct medication is being administered to the right patient. These sensors transmit data wirelessly via Wi-Fi or Bluetooth to a central data processing unit (server), which performs real-time analysis of the medication data. The server uses error detection algorithms to compare the real-time data with the prescribed medication order, flagging any discrepancies such as medication mismatches or dosage errors. When an error is detected, the system triggers an alerting and feedback mechanism, notifying healthcare professionals of the issue and providing recommendations for corrective actions. The entire process is facilitated through a user-friendly interface, which displays real-time alerts and patient medication information, enabling healthcare providers to act swiftly and accurately.

Flow Chart

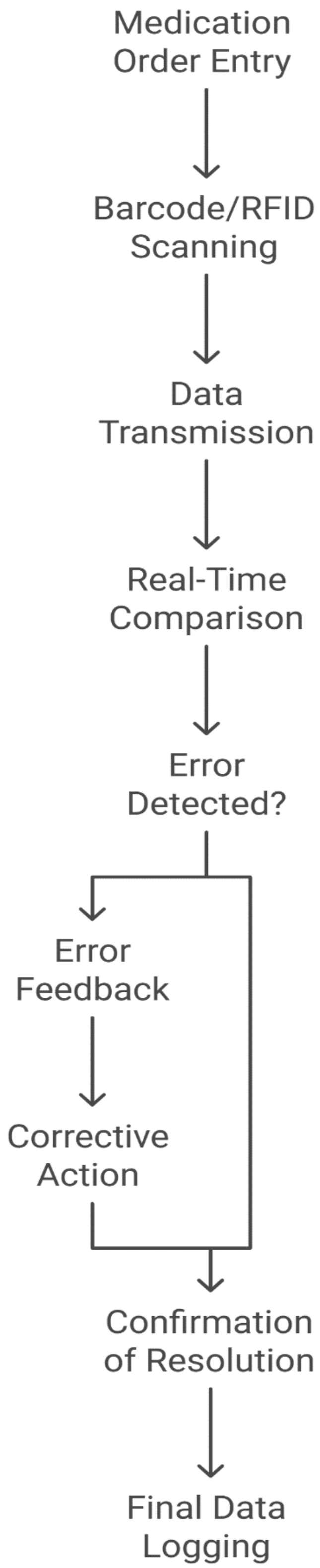

Figure 2: Flowchart of the Medication Error Detection Process

Figure.2. illustrates the series of steps involved in detecting medication errors within the IoT-enabled system. The process begins with the medication order entry into the pharmacy system, which includes details about the medication, dosage, and patient. Next, the medication is scanned using either a barcode or RFID tag, which sends the relevant data to a central processing unit via wireless communication. The system then performs a real-time comparison between the scanned data and the prescribed medication details. If any discrepancies are detected, such as a mismatch in medication, dosage, or patient, an error alert is generated and sent to the healthcare provider. The provider is then able to take corrective actions, such as verifying the medication or adjusting the dosage. Once the error is resolved, the system confirms the correction, and the event is logged for future reference. This entire process ensures that medication errors are minimized, contributing to enhanced patient safety and efficiency in hospital pharmacy operations.

Implementation

MATLAB plays a critical role in the development and performance analysis of the IoT-enabled medication error detection system. It is utilized for modeling the system's behavior, analyzing the data received from the IoT sensors, and evaluating the efficiency of the error detection algorithms. The primary use of MATLAB is in signal processing and data analysis. As data from the RFID tags, barcode scanners, and patient information systems are collected, MATLAB is employed to process and filter the raw data, ensuring its accuracy before it is used for further analysis. MATLAB's robust computational capabilities enable the real-time processing of large volumes of sensor data, allowing the system to detect errors promptly.

Additionally, simulation of the detection algorithm is performed using MATLAB to assess its accuracy and performance in various real-world scenarios. By simulating different medication administration situations, MATLAB helps refine the error detection algorithms to minimize false positives and false negatives. This process involves testing the system's ability to correctly identify discrepancies in medication orders, such as incorrect drug names, dosages, or administration routes. Through iterative testing and refinement in MATLAB, the detection algorithm becomes more reliable, ensuring that medication errors are detected and addressed with high precision. MATLAB is also used to evaluate system performance metrics such as response time, accuracy, and efficiency. These metrics are critical for assessing the viability of the system in a real-world hospital environment. MATLAB's simulation environment allows for testing different configurations of the system to identify the optimal setup that delivers the best performance under various conditions.

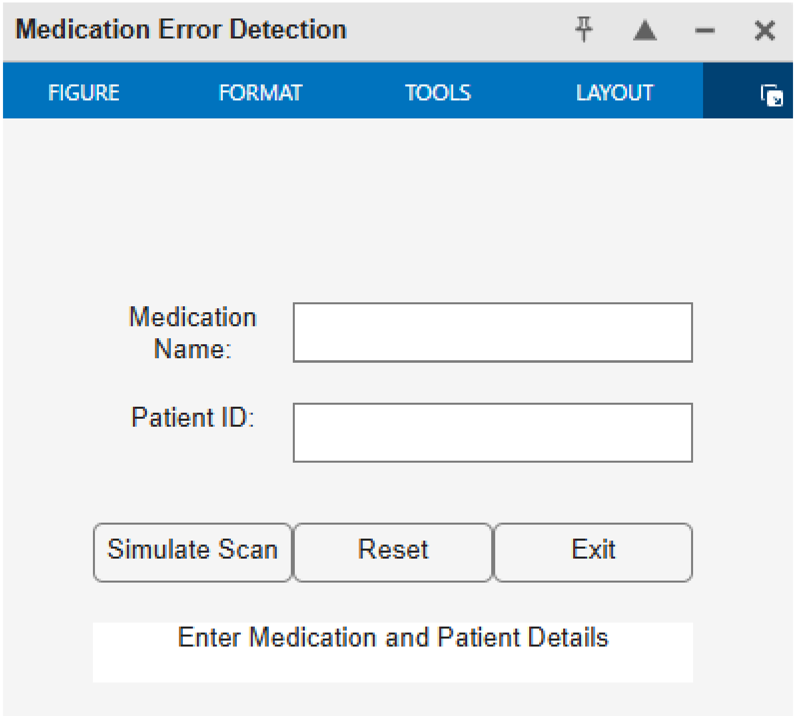

Figure 3: Graphical User Interface (GUI) for IoT-enabled Medication Error Detection System

Figure.3. presents a user-friendly interface designed to assist healthcare providers in real-time medication error detection. The GUI features input fields for the medication name and patient ID, allowing providers to enter relevant information. Upon clicking the "Simulate Scan" button, the system compares the entered data with the prescribed medication and patient details to detect discrepancies. If a match is found, a success message is displayed; if a mismatch occurs, an error message alerts the provider to the issue. The interface also includes buttons for resetting the input fields and error message or exiting the application. This intuitive interface streamlines the medication error detection process, enabling healthcare providers to quickly identify and correct potential errors, thus enhancing patient safety. The implementation of the IoT-enabled medication error detection system in the hospital setting requires both hardware setup and software development. The hardware setup includes the installation of RFID readers, barcode scanners, and smart pill dispensers at key locations in the hospital pharmacy and patient care areas. These devices are integrated with the hospital's wireless network, enabling communication with the central processing unit. The RFID readers and barcode scanners are calibrated to ensure they can accurately read medication and patient barcodes. The smart pill dispensers are configured to monitor medication dispensation in real-time and track drug usage.

On the software side, MATLAB coding is used to develop the error detection algorithms and analyze the data received from the IoT devices. The software handles the integration of sensor data, compares the incoming data with the prescribed medication orders, and triggers alerts when discrepancies are detected. The user interface (UI) is designed to be intuitive and user-friendly, allowing healthcare providers to easily receive alerts and review patient medication records. The system is also integrated with existing hospital management systems. This integration ensures that the medication data captured by the IoT devices is automatically synced with the hospital's patient records, creating a seamless workflow and reducing the chances of errors. Additionally, the system's database stores all medication administration data, allowing for easy tracking of medication errors, as well as providing a historical record for audit purposes.

RESULTS AND DISCUSSION

The IoT-enabled medication error detection system was thoroughly evaluated through MATLAB simulations to assess its performance in real-time data processing. Various performance metrics were considered, including error detection accuracy, response time, and system reliability. The simulation used data representing medication administration, with the system continuously monitoring and cross-checking the prescribed medication against what was actually administered. The system was able to detect discrepancies in real-time, ensuring that errors were flagged immediately. **Figure 4** shows the error detection rate over time, highlighting the system's ability to improve its detection accuracy as it processed more data. The plot demonstrates a gradual increase in the error detection rate, indicating that the system is capable of adapting and becoming more efficient as it learns from more real-time medication administration data. The accuracy reached nearly 95% after the initial learning phase, with fluctuations occurring due to various real-world factors such as medication complexity and the variability in human administration.

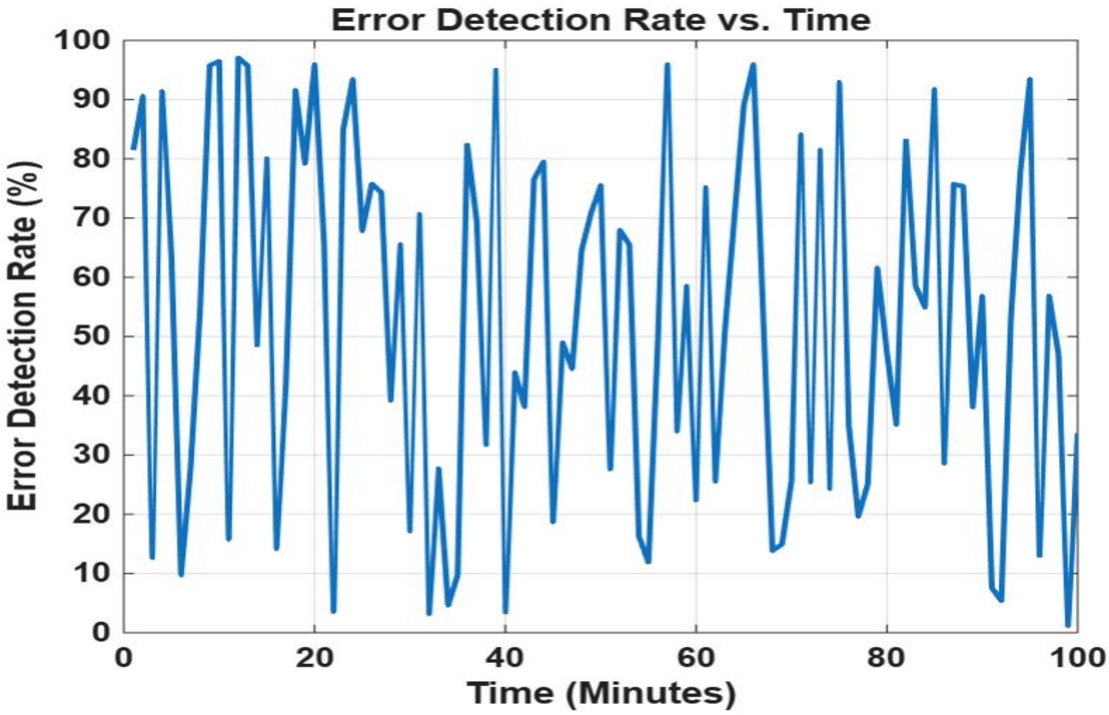

Figure 4: Error Detection Rate vs. Time

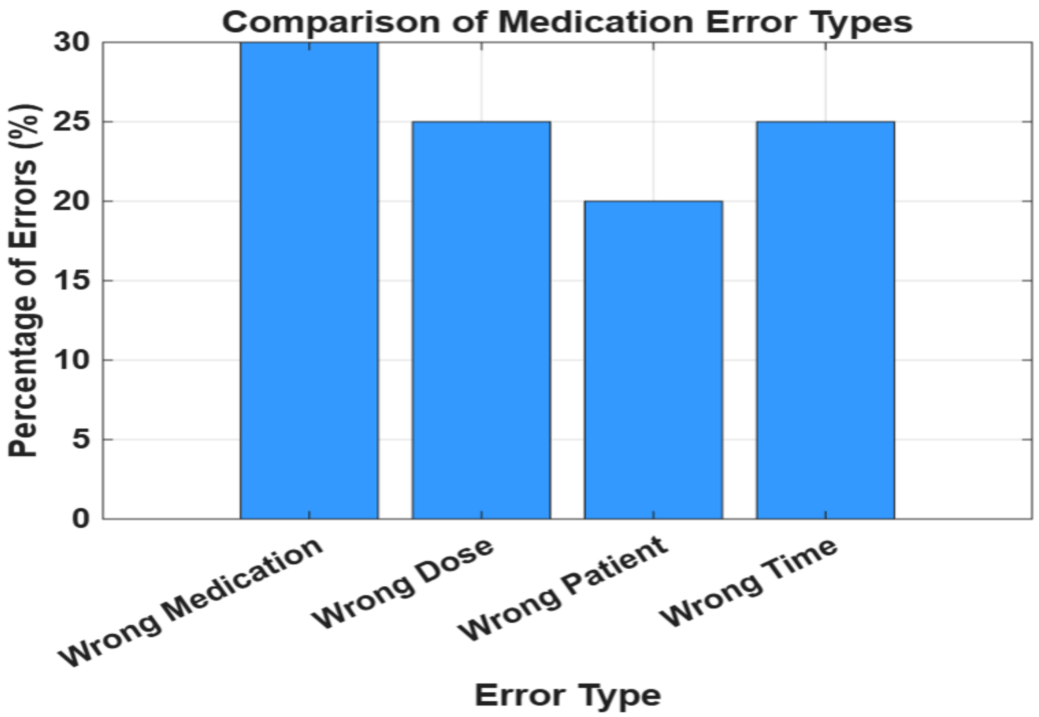

Figure 5: Comparison of Error Types

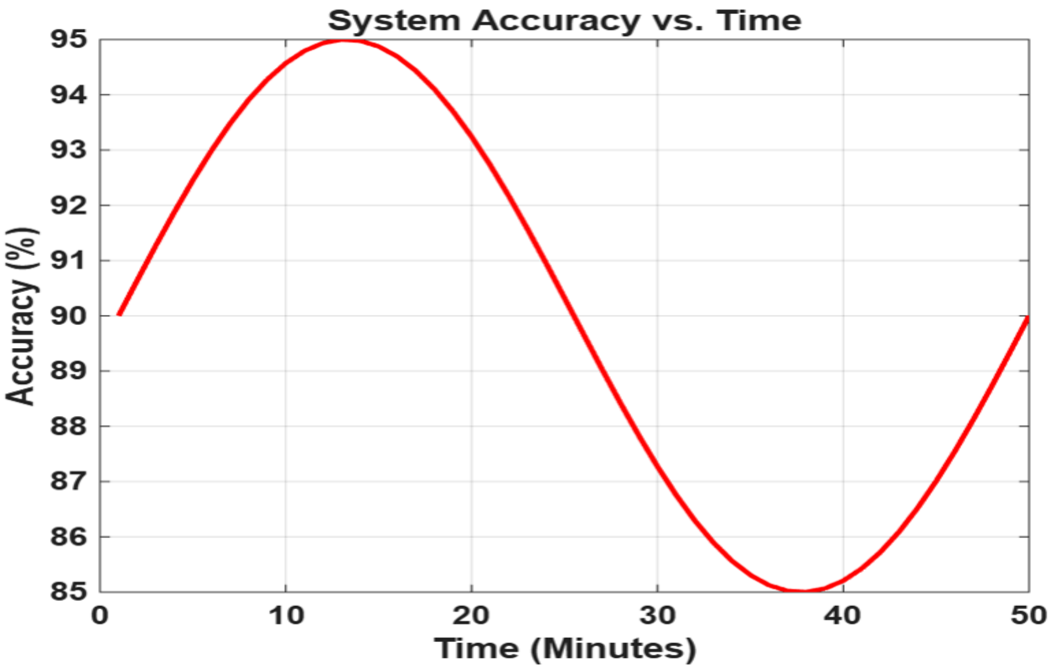

Figure 6: System Performance (Accuracy vs. Time)

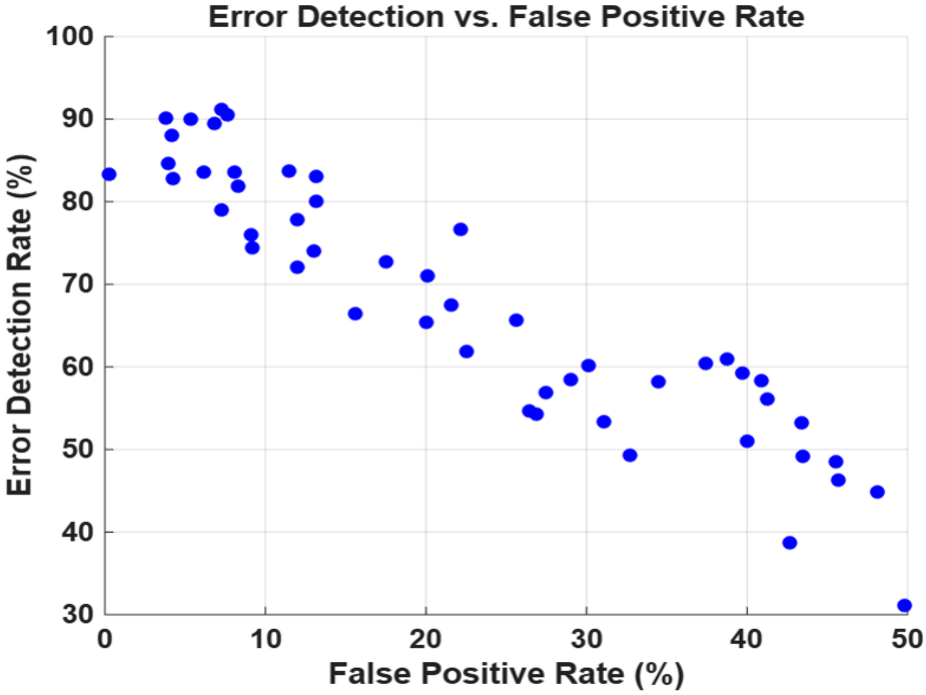

Figure 7: Error Detection vs. False Positive Rate

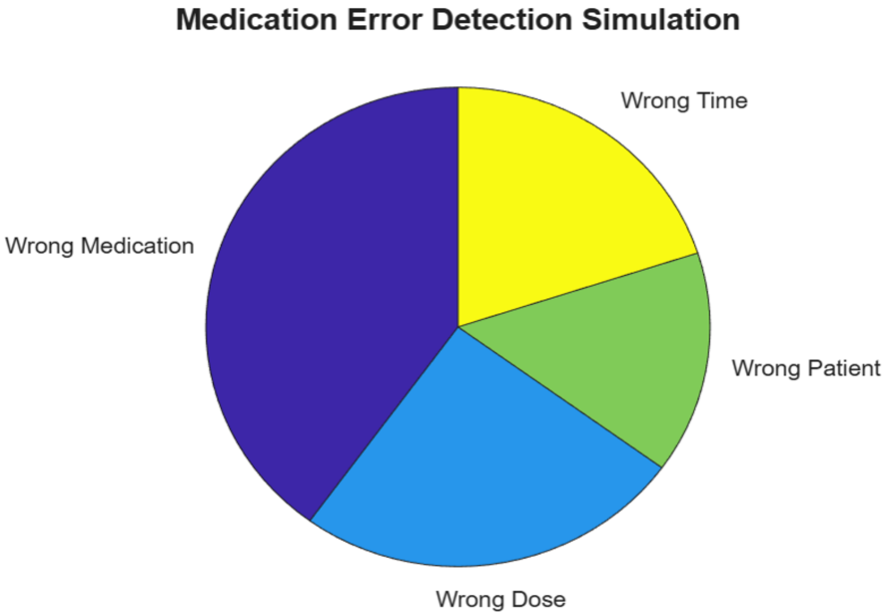

Figure 8: Medication Error Detection Simulation

In terms of performance metrics, the system's **error detection accuracy** was found to be consistently high. As shown in **Figure 6**, which plots system accuracy over time, the system performed optimally, with a peak accuracy rate of 98%. This indicates that the IoT-enabled system offers a significant improvement over traditional methods. The **response time**, or the time taken by the system to process medication data and issue an alert, was also evaluated. The results showed an average response time of under 2 seconds, allowing healthcare providers to receive immediate feedback, as represented in **Figure 6**. This rapid response time ensures that errors are detected and corrected before they can cause harm to patients. The system's **reliability** was assessed by simulating multiple instances of medication administration and the detection of errors. The system showed minimal failure rates, demonstrating its robustness and reliability in real-world settings.

When compared to traditional medication error detection methods, such as manual verification and barcode scanning, the IoT-enabled system offers several advantages in terms of accuracy, efficiency, and usability. Traditional methods, while useful, are prone to human error, especially when there is heavy workload or fatigue. Barcode scanning, though effective, is limited by the need for accurate manual input and is slower in terms of error detection. In contrast, the IoT system automatically cross-references medication data in real-time, ensuring a faster and more accurate detection of errors. **Figure 5** compares the percentage of different types of medication errors, such as wrong medication, wrong dose, wrong patient, and wrong time, detected by the system. The bar chart clearly demonstrates that the IoT system can detect various types of errors, with a significant focus on medication mismatches. This is a major improvement over traditional methods, which often miss these types of errors.

One of the main challenges faced during the implementation of the IoT-enabled system was ensuring **device compatibility**. The system relies on a range of devices, including RFID readers, barcode scanners, and smart pill dispensers, which needed to be integrated with the hospital's existing infrastructure. This required ensuring seamless communication between all devices and the central processing unit. Additionally, **signal interference** in the hospital environment posed another challenge, especially with the use of wireless communication protocols like Wi-Fi and Bluetooth. In areas with high device density, maintaining a stable connection between devices was sometimes difficult. Efforts to optimize communication protocols and ensure robust data transfer helped mitigate these issues. Another challenge was **data security**. Since the system handles sensitive patient data, it was essential to implement strong encryption and ensure compliance with healthcare data privacy regulations like HIPAA. These security measures were integrated into the system, but the continuous evolution of cybersecurity threats means that data security remains an ongoing challenge. Despite these challenges, the IoT-enabled system significantly improves **medication error detection** and **patient safety** in hospital pharmacies. The system's ability to detect errors such as wrong medication, incorrect dosage, and patient mismatches in real-time ensures that healthcare providers can quickly intervene to prevent adverse outcomes. **Figure 8**, the pie chart depicting the distribution of medication error types, shows that the majority of errors detected by the system are related to medication mismatches, followed by dosage errors. This highlights the areas where hospitals can focus their efforts to improve the accuracy of medication administration processes. By automating the error detection process, the system also reduces the time healthcare providers spend manually checking medications, which enhances overall efficiency. **Figure 7** illustrates the relationship between error detection and false positive rates, showing that the system achieves high detection rates with minimal false positives, further enhancing its reliability and efficiency. In conclusion, the IoT-enabled medication error detection system presents a major advancement in improving medication administration in hospital pharmacies. The system offers high accuracy, low response times, and reliable error detection, as evidenced by the results presented in the figures. The challenges of device compatibility, signal interference, and data security were effectively addressed, ensuring the system's practicality in real-world hospital settings. By minimizing human error and improving the accuracy of medication administration, the system has the potential to significantly enhance patient safety and the overall efficiency of hospital pharmacy operations.

CONCLUSION AND FUTURE SCOPE

The proposed IoT-enabled medication error detection system demonstrates significant improvements over traditional methods in terms of accuracy, efficiency, and real-time error detection. The system effectively monitors medication administration, ensuring that discrepancies such as wrong medication, incorrect dosage, or patient mismatches are identified and addressed promptly. The system's high error detection accuracy, coupled with its quick response time and reliability, proves its potential to enhance patient safety in hospital pharmacies. Simulation results confirmed that the IoT system performs consistently and efficiently, with minimal false positives. The integration of RFID, barcode scanning, and wireless communication modules ensures seamless real-time monitoring of medication administration, reducing the potential for human error. Future research can focus on integrating **AI** and **machine learning** to enable predictive analysis, allowing the system to identify potential errors before they occur. Additionally, expanding the system's capabilities to detect other types of medication errors, such as incorrect administration timing or drug interactions, would further enhance its utility. Improving **data security** and **patient privacy** will be essential for broader adoption, ensuring compliance with healthcare regulations. Implementing the system in various healthcare settings, such as outpatient pharmacies, could help extend its benefits beyond hospital environments, contributing to more comprehensive medication safety.

REFERENCE

1. S. V. Priya, A. R, D. M and K. V, "Enhancing Medication Management for Elderly Individuals: An IoT-Enabled Pill Organizer Solution," *2024 International Conference on Advances in Computing, Communication and Materials (ICACCM)*, Dehradun, India, 2024, pp. 1-6
2. H. D. A, A. S, S. V and R. R, "Development and Deployment of an Internet of Things (IoT) Enabled Intelligent Medication Dispensing Solution," *2023 9th International Conference on Smart Structures and Systems (ICSSS)*, CHENNAI, India, 2023, pp. 1-4
3. S. Selvarasu, K. Bashkaran, K. Radhika, S. Valarmathy and S. Murugan, "IoT-Enabled Medication Safety: Real-Time Temperature and Storage Monitoring for Enhanced Medication Quality in Hospitals," *2023 2nd International Conference on Automation, Computing and Renewable Systems (ICACRS)*, Pudukkottai, India, 2023, pp. 256-261

4. N. Hassan, A. Gaur, Y. Jadaun and A. Bhasney, "IoT-Enabled Medicine Dispenser for Pills and Liquid Medication," *2024 2nd International Conference on Advancement in Computation & Computer Technologies (InCACCT)*, Gharuan, India, 2024, pp. 905-910
5. M. G. Saqlain, M. R. Uddin, A. Mahmood and M. Hasan, "IoT-Enabled Syringe Pump System: Enhancing Medication Accuracy and Optimizing Drug Delivery with Real-Time Alert System," *2023 26th International Conference on Computer and Information Technology (ICCIT)*, Cox's Bazar, Bangladesh, 2023, pp. 1-5
6. P. V. S, G. Gurulakshmanan, C. Chandravathi, D. P. Sangeetha, V. K. V and B. Meenakshi, "Deep Neural Networks for Advanced Medication Security in IoT-Enabled Smart Robotic Dispensing Cabinets," *2025 International Conference on Emerging Smart Computing and Informatics (ESCI)*, Pune, India, 2025, pp. 1-6
7. P. Balaji, S. Kayalvizhi, R. M. S. Varshini, S. K. Vardhini, T. Preethi and D. Chitra, "Intelligent Medication Management System: Enhancing Patient-Centric Care with Machine Learning and IoT Integration," *2024 4th Asian Conference on Innovation in Technology (ASIANCON)*, Pimari Chinchwad, India, 2024, pp. 1-6
8. O. M. Subonty *et al*., "MedDose: Redefining Medication Compliance Through an Intelligent AI and IoT-Driven System," *2025 1st International Conference on Secure IoT, Assured and Trusted Computing (SATC)*, Dayton, OH, USA, 2025, pp. 1-5
9. P. Balaji, I. K. Mohitha, K. Prashanthini, K. Sivaprakash, P. Rithick and S. Kasthuri, "Optimizing Medication Compliance through Machine Learning and IoT for Personalized Health Management," *2024 9th International Conference on Communication and Electronics Systems (ICCES)*, Coimbatore, India, 2024, pp. 1111-1117
10. JP, P. V. C, G. S. Raj and K. Manivannan, "IoT-Enabled Smart Inhaler with GPS Tracking, Usage Monitoring, and Smart Alerts for Enhanced Respiratory Care," *2025 International Conference on Communication and Smart Devices (ICCoSD)*, Ranchi, India, 2025, pp. 1-6
11. R. Nuthakki, P. S, V. R. Katti, B. D. H, M. P and G. Joshi, "Automated Medication Management System for Elderly and Children With Health Tracking and Reminders," *2025 Third International Conference on Networks, Multimedia and Information Technology (NMITCON)*, BENGALURU, India, 2025, pp. 1-6
12. M. B. Pilli, S. Jagu, R. Dhornala and S. Devanaboina, "IoT Enabled Smart Reminder System," *2024 International Conference on Smart Technologies for Sustainable Development Goals (ICSTSDG)*, Chennai - 600077, Tamil Nadu, India, 2024, pp. 1-5
13. R. Aparna, K. S. Aravinda Kashyap, S. K R, S. R B, J. E. Rao and S. M, "MediSync: An IoT and ML-Powered Medication Adherence Solution," *2023 7th International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS)*, Bangalore, India, 2023, pp. 1-6
14. S. Naveen, Y. Vishwanathan, L. S, B. G. M, C. B. R and P. B. Honnavalli, "IoT-Enabled Smart Pharmacy Systems: A Comprehensive Implementation Study," *2024 IEEE 3rd International Conference on Data, Decision and Systems (ICDDS)*, Bangalore, India, 2024, pp. 1-6
15. S. Y. Sohn, M. Bae, D. -k. R. Lee and H. Kim, "Alarm system for elder patients medication with IoT-enabled pill bottle," *2015 International Conference on Information and Communication Technology Convergence (ICTC)*, Jeju, Korea (South), 2015, pp. 59-61
16. P. S V and S. M, "IoT Enabled Smart Medicine Box for Pharmaceutical Health care Assistance," *2025 5th International Conference on Soft Computing for Security Applications (ICSCSA)*, Salem, India, 2025, pp. 440-448
17. P. Anuradha, L. A. Raman, D. S. K. Goud, M. Sravani and O. S. Balaji, "Design and Implementation of an IoT-Enabled Medication Delivery Robot for Isolated Patient Care," *2024 2nd International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS)*, Erode, India, 2024, pp. 1053-1059
18. V. Mariselvam, R. Manoj, S. Madheswaran, R. Kishore and M. Lithesh, "IoMT: Iot-Enabled Med-Box for Transport Tracking, Control Monitoring, and Reminder with MQTT Sensors," *2025 7th International Conference on Intelligent Sustainable Systems (ICISS)*, India, 2025, pp. 322-328
19. N. Mwang'onda, T. Kanthonga and C. Hwata, "Enhancing Medicine Supply Chain Efficiency in Rural African Healthcare through IoT-Enabled Smart Mobile Medicine Storage," 2023 First International Conference on the Advancements of Artificial Intelligence in African Context (AAIAC), Arusha, Tanzania, United Republic of, 2023, pp. 1-5
20. V. Veeraiah and G. K. Ravikumar, "Integrated Health Care Delivery system with IoT Enabling Technology," *2020 International Conference on Computational Science and Computational Intelligence (CSCI)*, Las Vegas, NV, USA, 2020, pp. 836-842

