AMERICAN JOURNAL OF MANAGEMENT AND IOT MEDICAL COMPUTING
Peer Reviewed, Referred & Indexed Journal
E-ISSN: 3069-0110
Vol.5, No.2(1) (2026)
www.ajmimc.com

IoT-enabled Smart Drug Despencing Unit with Synchronized Real-time Monitoring

Ch. Jyothi[1*], Devandla Yamini[2], Mahenderkar Sahithi[2], B. Pradeep Reddy[2]
[1]Assistant Professor, [2]UG Student, [1,2]Department of Computer Science and Engineering
[1,2]Kommuri Pratap Reddy Institute of Technology, Ghanpur, Ghatkesar, 501301, Telangana, India.
*Correspondence: Ch. Jyothi (vampu.jyothi9@gmail.com)

Abstract

The increasing need for reliable and timely medication management has led to the development of intelligent healthcare solutions that minimize human dependency and reduce errors in drug administration. This study introduces an Internet of Things (IoT) enabled system designed to support accurate and automated delivery of prescribed medications, particularly for elderly individuals, patients with chronic conditions, and those following complex treatment schedules. These groups are often vulnerable to missed doses or incorrect intake, which can significantly impact health outcomes. The system is centered around an ESP-32 microcontroller integrated with a Real-Time Clock (RTC) module to maintain precise scheduling of medication routines. A user-friendly mobile application interface allows caregivers and medical professionals to remotely monitor and manage medication timings, ensuring continuous supervision even from distant locations. A Liquid Crystal Display (LCD) unit provides real-time information regarding scheduled doses, while a speaker module enables audible alerts to notify users at the appropriate time, improving adherence and awareness. To further enhance automation, compartment drive mechanisms are incorporated to release the correct medication at predefined intervals. The system also leverages IoT cloud connectivity to enable remote tracking, data logging, and alert notifications in case of missed doses or irregularities. A Regulated Power Supply (RPS) ensures consistent and uninterrupted operation of all components. By combining automation, real-time monitoring, and remote accessibility, this approach offers a practical and scalable solution for modern healthcare needs. It significantly reduces the risks associated with manual medication handling and provides a dependable support system for both patients and caregivers across home and clinical environments.

Keywords: Medicine Dispensing, Drug Administration, RTC, Mobile Application, Medication Adherence, Smart Healthcare, IoT, ESP-32, Automated Dispenser, CD Drive Mechanism.

1. Introduction

Ensuring that patients follow their prescribed medication schedules remains one of the most complex challenges in healthcare delivery. Medication adherence, which refers to how accurately a patient follows medical instructions regarding dosage and timing, directly influences treatment effectiveness and long-term health outcomes. Despite advancements in medical science, a significant proportion of individuals fail to take medications as recommended, leading to worsening conditions, avoidable complications, and increased healthcare burdens. Poor adherence not only affects individual well-being but also places substantial strain on healthcare systems through increased hospital visits, prolonged treatments, and rising costs. For conditions such as diabetes, cardiovascular diseases, neurological disorders, and infectious illnesses, consistent medication intake is essential for maintaining stability and preventing severe health risks. The issue becomes more pronounced among elderly individuals, who often require multiple medications to manage coexisting health conditions. Handling numerous prescriptions with varying schedules can be overwhelming, especially when combined with age-related cognitive decline, reduced memory retention, and physical limitations. As a result, many individuals unintentionally skip doses, take incorrect quantities, or fail to follow proper timing, which can significantly reduce treatment effectiveness.

Such inconsistencies may lead to serious consequences, including disease progression, emergency medical situations, and reduced quality of life.

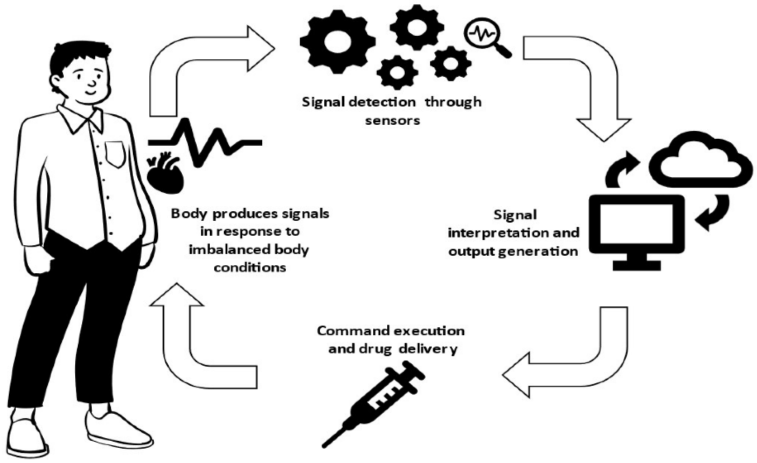

Figure. 1: Smart drug dispensing.

Medication management also presents challenges within clinical environments such as hospitals and care centers, where healthcare professionals must administer drugs to multiple patients under strict time constraints. Manual processes, reliance on documentation, and high workload levels increase the likelihood of errors, particularly in settings with limited resources or staffing shortages. In such scenarios, even minor mistakes in drug administration can lead to adverse patient outcomes. With the rapid growth of connected technologies, there is increasing potential to improve medication adherence through intelligent automation. Systems integrating embedded controllers, real-time scheduling, and wireless communication can streamline the entire medication process by ensuring timely alerts, accurate dispensing, and continuous monitoring. These advancements provide a more dependable and efficient approach to medication management, offering enhanced support for both patients and healthcare providers while reducing the risks associated with traditional methods.

2. Literature Survey

Dayer et al. [1] explored the effectiveness of smartphone-based applications designed to support medication adherence through reminder notifications and tracking features. Their analysis highlighted that mobile applications can play a significant role in improving patient awareness regarding medication schedules. The systems typically provide alerts, dosage tracking, and basic reporting functionalities to assist users in following prescribed routines. Their findings indicated a measurable improvement in adherence levels, particularly among younger and tech-savvy populations who are comfortable using smartphones regularly. However, these applications largely depend on user engagement and self-discipline, which limits their effectiveness in certain patient groups. The absence of automated dispensing mechanisms means that users must still manually take the medication after receiving reminders. Additionally, these systems are not capable of preventing incorrect dosing or intentional skipping of medication. The reliance on manual confirmation also introduces the possibility of inaccurate reporting. Despite these limitations, the work demonstrates the potential of digital tools in enhancing adherence behavior.

Kaur and Bhatt [2] introduced an IoT-based smart medicine dispenser built using Arduino UNO, a Real-Time Clock module, and GSM communication. Their design focused on automating medication dispensing while simultaneously notifying caregivers through SMS alerts. The integration of a real-time clock ensured accurate scheduling, allowing medications to be dispensed at predefined times without human intervention. The GSM module enabled remote communication, making it possible to inform caregivers in case of missed doses or irregularities. The system was particularly beneficial for elderly users who require assistance in managing daily medication routines. The automated dispensing mechanism reduced the dependency on memory and minimized the risk of missed doses. Furthermore, the use of simple hardware components made the system cost-effective and easy to implement. The design demonstrated improved compliance and reliability compared to manual methods. However, the system's functionality was limited by its reliance on GSM communication and lack of advanced user interaction features. Ramesh and Kumar [3] developed an automated pill dispensing system utilizing ESP8266 Wi-Fi connectivity along with a servo motor mechanism for controlled medicine release. Their approach enabled real-time monitoring through a web-based interface, allowing caregivers to track medication status remotely. The use of Wi-Fi communication enhanced system flexibility and eliminated the need for GSM-based messaging. The servo motor ensured precise dispensing of pills, improving the accuracy of medication delivery. The system also supported scheduling features that allowed users to define multiple medication timings. By integrating web connectivity, the system provided better accessibility and control compared to standalone devices. The design demonstrated high efficiency in both dispensing accuracy and communication reliability. Additionally, remote monitoring reduced the need for constant physical supervision. However, the system required stable internet connectivity, which may not always be available in all environments.

Pawar and Shinde [4] presented a Raspberry Pi-based smart medication system incorporating voice recognition capabilities for user interaction and confirmation. Their design emphasized reducing missed doses by requiring user acknowledgment through voice input. The system generated reminders and waited for user confirmation before proceeding, ensuring that medication intake was actively verified. Voice recognition made the system more accessible for elderly users who may have difficulty interacting with traditional interfaces. The Raspberry Pi platform enabled higher computational capability, allowing integration of advanced features. This approach improved user engagement and reduced the likelihood of unintentional non-adherence. The interactive nature of the system added an additional layer of reliability compared to simple reminder-based systems. Furthermore, the system supported real-time monitoring and logging of medication events. However, environmental noise and speech recognition accuracy posed challenges in certain conditions. Gupta et al. [5] proposed a cloud-integrated medication management system utilizing ESP-32 and MQTT communication protocol for real-time data exchange. Their design enabled seamless interaction between the device and cloud platforms, allowing remote monitoring and dynamic schedule updates. The system supported real-time logging of medication events, providing a comprehensive record for caregivers and healthcare providers. The use of MQTT ensured efficient and lightweight communication suitable for IoT environments. This approach enhanced scalability, making it possible to manage multiple devices simultaneously. Cloud integration also allowed access to historical data and analytics for better decision-making. The system demonstrated improved flexibility and remote accessibility compared to traditional standalone solutions. Additionally, it enabled timely notifications and alerts in case of missed doses. However, the reliance on cloud infrastructure introduced concerns related to data security and network dependency.

Bharathi and Shanmugam [6] implemented an RFID-based multi-compartment pill dispensing system designed for use in environments with multiple patients. Their approach ensured correct patient identification before dispensing medication, thereby reducing the risk of administering drugs to the wrong individual. The system required users to authenticate using RFID tags, which were linked to specific medication profiles. This added a layer of security and ensured personalized medication delivery. The multi-compartment design allowed storage of different medications for multiple users within a single unit. This made the system particularly suitable for nursing homes and healthcare facilities. The use of RFID technology improved accuracy and reduced human errors in patient identification. Additionally, the system supported efficient management of medication schedules for multiple individuals. However, the requirement of RFID tags introduced additional hardware dependency and cost.

Shafi and Medha [7] proposed an enhanced IoT-enabled medication system that incorporated fall detection and emergency alert features alongside drug dispensing. Their design extended beyond medication management to address overall patient safety. The system utilized sensors to detect sudden movements or falls and triggered emergency notifications when such events occurred. This integration provided additional support for elderly individuals living independently. The medication dispensing mechanism was synchronized with alert systems to ensure timely reminders. The combined functionality improved both adherence and safety monitoring. The system also enabled remote communication, allowing caregivers to respond quickly in emergencies. This multi-functional approach increased the overall reliability and usefulness of the system. However, integrating multiple features increased system complexity and required careful calibration of sensors. Vyas et al. [8] designed a smart pillbox incorporating biometric authentication to enhance security and prevent unauthorized access. Their system ensured that only authorized users could access and retrieve medication, which is particularly important for controlled or sensitive drugs. The biometric module, such as fingerprint recognition, provided a reliable method of user identification. The system also maintained secure logs of access and medication events for monitoring purposes. This approach improved accountability and reduced the risk of misuse or accidental consumption by others. The design was especially useful in shared living environments or clinical settings. Additionally, it supported automated scheduling and dispensing features. The inclusion of biometric security significantly enhanced system safety. However, biometric systems may face challenges related to accuracy and maintenance over time.

Hussain et al. [9] developed a voice-controlled medicine dispensing system that leveraged IoT and natural language processing techniques. Their approach allowed users to interact with the system through voice commands, making it highly accessible for elderly individuals. The system could interpret spoken instructions and provide responses accordingly, simplifying user interaction. This eliminated the need for complex interfaces and improved usability. The integration of IoT enabled remote monitoring and communication with caregivers. The system also supported scheduling and automated dispensing functionalities. Voice interaction enhanced user engagement and reduced dependency on manual controls. Additionally, the system could provide feedback and reminders through audio output. However, speech recognition accuracy and language variations posed certain challenges in real-world environments. Nalini et al. [10] proposed an automated medication dispensing system integrated with hospital management systems to streamline clinical workflows. Their approach eliminated the need for manual entry of medication schedules by directly linking prescription data with the dispensing unit. This integration reduced human errors and ensured accurate medication administration. The system supported centralized monitoring and control within healthcare facilities. It also improved efficiency by automating routine tasks for medical staff. The design enabled real-time tracking of medication usage and patient compliance. Additionally, it supported data synchronization across multiple systems. This approach significantly enhanced operational efficiency in clinical environments. However, integration with existing hospital infrastructure required careful implementation and compatibility considerations.

Taghipour et al. [11] introduced a machine learning-based smart medication system capable of predicting adherence patterns and adjusting alert intensity accordingly. Their system analyzed user behavior over time to identify trends in medication intake. Based on this analysis, it dynamically modified reminder frequency and intensity to improve adherence. The use of predictive analytics enhanced system intelligence and adaptability. This approach allowed personalized interaction tailored to individual user behavior. The system demonstrated high accuracy in identifying potential non-compliance scenarios. Additionally, it provided insights that could be used by healthcare providers for better patient management. The integration of machine learning improved overall system performance. However, the approach required sufficient historical data for accurate predictions. Singh and Kaur [12] designed a dual-compartment medication system specifically aimed at managing insulin and oral drugs for diabetic patients. Their system ensured precise dosing and timing for both types of medication, which is critical in diabetes management. The dual-compartment design allowed simultaneous handling of different medication forms. The system automated dispensing and provided timely reminders for each dose. This improved treatment consistency and reduced the risk of complications. The design also supported monitoring features for tracking medication intake. It was particularly beneficial for patients requiring strict adherence to treatment schedules. The system demonstrated improved health outcomes through reliable operation. However, its application was limited to specific use cases involving dual medication types.

Rathore and Jain [13] proposed a blockchain-based medication management system to ensure secure and tamper-proof recording of medication data. Their approach utilized decentralized storage to maintain integrity and transparency of records. Each medication event was securely logged, preventing unauthorized modification. This enhanced reliability in both clinical and legal contexts. The system supported traceability and auditability of medication history. It was particularly useful in environments where data security is critical. The use of blockchain technology improved trust and accountability. Additionally, it enabled secure sharing of data among stakeholders. However, the complexity of blockchain implementation posed challenges in terms of scalability and resource requirements. Koh et al. [14] conducted a clinical evaluation of automated medication dispensing systems and observed improved health outcomes among elderly users. Their findings indicated a reduction in missed doses and better adherence to prescribed schedules. The use of automated systems minimized human errors and improved consistency. Patients using such systems experienced fewer hospital visits and complications. The study highlighted the importance of automation in supporting independent living. Additionally, caregivers reported reduced workload and improved monitoring capabilities. The results demonstrated the practical benefits of adopting intelligent dispensing systems. However, the effectiveness depended on proper system usage and maintenance.

3. Proposed System

The proposed methodology presents a structured and integrated framework for automated medication scheduling, monitoring, and dispensing using embedded systems and Internet of Things technologies. The analytical workflow begins with system initialization, followed by real-time clock synchronization and schedule configuration through wireless communication. Predefined medication timings are stored using non-volatile memory to ensure persistent operation. A real-time monitoring mechanism continuously compares system time with stored schedules to trigger appropriate actions. Upon reaching scheduled intervals, automated dispensing is executed through actuator mechanisms, accompanied by alert notifications. A communication module enables remote interaction and notification delivery, while a display interface provides real-time system status and scheduling information, as illustrated in Figure. 2.

AMERICAN JOURNAL OF MANAGEMENT AND IOT MEDICAL COMPUTING
Peer Reviewed, Referred & Indexed Journal
E-ISSN: 3069-0110
Vol.5, No.2(1) (2026)
www.ajmimc.com

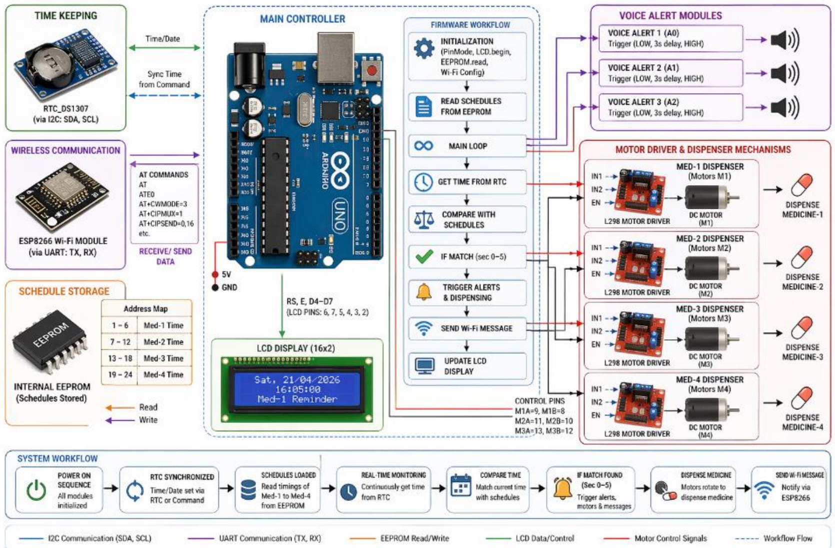

Figure. 2: System architecture.

User Interface and Control Input

- The system accepts configuration inputs through a serial communication interface connected to a wireless module.
- Users can define medication schedules including hours, minutes, and seconds using structured input commands.
- These inputs are processed and parsed to extract scheduling parameters for multiple medication slots.
- The interface enables flexible reconfiguration of timing schedules without modifying the embedded firmware.

Wireless Communication Module

- A WiFi-enabled communication module facilitates data exchange between external devices and the embedded controller.
- It operates using standard AT command protocols to establish and maintain network connectivity.
- The module enables remote transmission of configuration data and notification messages.
- It also supports sending real-time alerts when medication dispensing events are triggered.

Real-Time Clock Synchronization

- A dedicated real-time clock module maintains accurate system time independent of the main controller.
- It provides continuous tracking of hours, minutes, seconds, date, and day information.
- Time synchronization can be performed through external commands to ensure correct scheduling.
- This module ensures precise timing required for reliable medication administration.

Non-Volatile Memory Storage

- The system utilizes EEPROM for storing medication schedules permanently.
- Stored values include multiple time slots corresponding to different medication intervals.
- The memory retains data even during power loss, ensuring uninterrupted operation.
- Retrieved values are converted and used for real-time comparison during execution.

Time Monitoring and Decision Logic

- The controller continuously reads current time values from the clock module.

- A comparison mechanism checks whether the current time matches any predefined medication schedule.
- Conditional logic ensures that dispensing is triggered only within a specific time window to avoid repetition.
- This decision-making process forms the core automation logic of the system.

Automated Dispensing Mechanism

- Actuator units in the form of motor-driven compartments are used to dispense medication.
- Each motor corresponds to a specific medication slot and is activated when its scheduled time is reached.
- Controlled rotation ensures accurate release of medicine from the designated compartment.
- The mechanism operates in forward and reverse directions to manage dispensing cycles effectively.

Alert and Notification System

- Audio alert modules are used to notify users when medication is dispensed.
- Visual feedback is provided through an LCD display showing reminder messages and system status.
- The communication module transmits alert messages to connected remote systems.
- These notifications enhance user awareness and improve adherence to medication schedules.

Display and Monitoring Interface

- A liquid crystal display unit presents real-time information such as current time, date, and system status.
- It also displays configuration confirmations and medication reminder messages.
- The interface ensures clear and continuous feedback for user monitoring.
- Dynamic updates provide immediate visibility of system operations.

Remote Monitoring and Control Workflow

- The architecture supports remote configuration through wireless communication channels.
- External systems can send scheduling commands to update medication timings.
- The controller processes incoming data and updates memory accordingly.
- This enables flexible and location-independent system management.

System Reliability and Adaptability

- The methodology incorporates persistent storage and real-time synchronization for reliable operation.
- Automated processes reduce dependency on manual intervention and minimize errors.
- The modular design allows easy extension for additional features such as sensors or mobile integration.
- Continuous operation and adaptability make the system suitable for long-term healthcare assistance.

System Initialization and Configuration: At system startup, all hardware components including the microcontroller, RTC module, LCD, and communication interfaces are initialized to their default states. The controller establishes serial communication with the WiFi module and verifies connectivity using predefined AT commands. Previously stored scheduling data is retrieved from EEPROM memory to restore medication timings. This step ensures the system is ready for continuous operation with valid configuration parameters.

AMERICAN JOURNAL OF MANAGEMENT AND IOT MEDICAL COMPUTING
Peer Reviewed, Referred & Indexed Journal
E-ISSN: 3069-0110
Vol.5, No.2(1) (2026)
www.ajmimc.com

Time Acquisition and Monitoring: The controller continuously reads real-time data from the RTC (Real-Time Clock) module, including hours, minutes, seconds, and date information. These values are updated dynamically and displayed on the LCD interface for user visibility. The system maintains precise timing independent of power interruptions due to the RTC backup mechanism. This continuous monitoring forms the basis for accurate schedule tracking.

Schedule Comparison and Decision Logic: The current time obtained from the RTC is compared with predefined medication schedules stored in EEPROM. Conditional checks are applied to determine whether the current time falls within the scheduled dispensing window. The system ensures that actions are triggered only once within a specific time interval to prevent repeated dispensing. If a match is detected, control signals are generated to initiate alert and dispensing mechanisms.

Alert Generation and Notification: Upon successful schedule matching, the system activates audio alert modules to notify the user about the medication time. Simultaneously, visual messages are displayed on the LCD to indicate the specific reminder. The WiFi module transmits notification messages to remote systems or connected devices. These alerts ensure timely awareness and improve adherence to prescribed schedules.

Automated Dispensing Mechanism: Following alert generation, the controller activates motor drivers corresponding to the specific medication slot. The motors rotate in controlled directions to release the required medicine from designated compartments. After dispensing, the motors return to their initial positions to prepare for the next cycle. This automated actuation eliminates manual intervention and ensures accurate delivery.

4. Results and Discussion

The results and discussion section presents the performance evaluation of the developed system in terms of accuracy, reliability, and operational efficiency. The implemented design was tested under various conditions to verify its ability to deliver medications at scheduled times without delay or error. Observations indicate that the integration of real-time clock and memory modules ensures consistent timing and stable operation. The automated dispensing mechanism demonstrated precise actuation, reducing the chances of missed or incorrect doses. Alert and notification feature effectively enhanced user awareness and response to medication schedules. The communication module enabled successful remote updates and monitoring, improving overall system flexibility. These outcomes highlight the effectiveness of the proposed approach in providing a dependable and user-friendly medication management solution.

Figure. 3. Hardware Architecture.

The IoT Based Medicine Dispenser is an intelligent healthcare assistance system designed as shown in Figure. 3 to ensure that patients take their medicines at the correct time without missing doses. The system uses a Real Time Clock (RTC) module to maintain accurate timing, a microcontroller (ESP32/Arduino) to control the system, an LCD display to show medication schedules, and an APR voice module to provide voice reminders. This system is especially useful for elderly patients, individuals with memory problems, and those who require strict medication schedules.

The RTC module continuously keeps track of the current date and time even when the main power is turned off, using its internal backup battery as shown in Figure 4. The microcontroller reads the time from the RTC and compares it with the programmed medicine schedule. When the scheduled time matches the current time, the system triggers the medicine dispensing mechanism and alerts the user.

Figure. 4. System Intialization.

The LCD display provides clear information to the user, such as the system title, current time, medicine schedule, and reminder messages as shown in Figure 5. It helps the user understand when the next dose should be taken and confirms when medicine is being dispensed.

Figure. 5. Medicince Reminder Outcome.

5. Conclusion

The IoT Enabled Medicine Drug Administration System presented in this project represents a significant technological advancement in addressing one of healthcare's most persistent and costly challenges medication non-adherence and drug administration errors. By integrating the ESP-32 microcontroller with an RTC module, mobile application interface, LCD display, speaker alert system, dual CD drive dispensing mechanisms, and IoT cloud connectivity, all powered by a regulated supply, the proposed system delivers a comprehensive, end-to-end automated medication management solution that is simultaneously affordable, reliable, and feature-rich. The system's ability to autonomously dispense correct medications at programmed times, provide multi-channel patient alerts, log all medication events with precise timestamps, and deliver real-time caregiver notifications via a mobile application fundamentally transforms medication management from a fallible human process into a dependable automated one. The dual-compartment dispensing architecture accommodates complex multi-drug regimens without cross-contamination, while the mobile application interface empowers caregivers and physicians to remotely configure, monitor, and adjust medication schedules without physical access to the device. The IoT cloud integration creates a transparent, auditable medication compliance record that supports clinical decision-making, enables proactive intervention for at-risk patients, and satisfies regulatory requirements for drug administration documentation in clinical settings. At a hardware cost accessible to individual patients and small healthcare facilities, the system democratizes the precision medication management that was previously available only in well-funded institutional settings. The successful implementation of this system has the potential to prevent thousands of medication-related hospitalizations, improve treatment outcomes for millions of patients with chronic diseases, reduce the economic burden of medication non-adherence on healthcare systems, and significantly enhance the quality of life for elderly and chronically ill patients who depend on consistent, accurate pharmacological therapy for their health and survival.

References

[1] Dayer, L., Heldenbrand, S., Anderson, P., Gubbins, P. O., & Martin, B. C. (2013). Smartphone medication adherence apps: Potential benefits to patients and providers. Journal of the American Pharmacists Association, 53(2), 172–181.

[2] Kaur, G., & Bhatt, U. (2018). A Review on IoT based Smart Medicine Reminder and Dispenser System. International Journal of Advanced Research in Computer Science, 9(2), 481–485.

[3] Ramesh, M. V., & Kumar, S. (2019). Automated Pill Dispenser with Wi-Fi Connectivity and Mobile Application Interface. IEEE Transactions on Consumer Electronics, 65(3), 324–332.

[4] Pawar, S., & Shinde, R. (2020). Smart Medicine Reminder and Dispenser System Using Raspberry Pi and Voice Recognition. International Journal of Engineering Research and Technology, 9(5), 712–717.

[5] Gupta, M., Singh, A., & Sharma, P. (2021). Cloud-Integrated Automated Medication Management Using ESP-32 and MQTT Protocol. IEEE Access, 9, 45678–45690.

[6] Bharathi, S., & Shanmugam, M. (2017). RFID-Based Multi-Compartment Pill Dispenser for Nursing Home Applications. International Journal of Advanced Engineering Technology, 8(3), 201–208.

[7] Shafi, I., & Medha, R. (2020). IoT-Based Automated Medicine Dispenser with Fall Detection and Emergency Notification Using ESP-32. Journal of Healthcare Engineering, 2020, Article 8842513.

[8] Vyas, D., Patel, K., & Shah, M. (2021). Smart Pill Box with Biometric Authentication and Mobile Application for Secure Drug Administration. International Journal of Biomedical Engineering and Technology, 35(1), 78–94.

[9] Hussain, A., Mkpojiogu, E., & Hussain, Z. (2019). Voice-Controlled Smart Medicine Dispenser Using IoT and Natural Language Processing. In Proceedings of the 2019 IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA), IEEE.

[10] Nalini, C., Prabha, V., & Rema, G. (2018). Automated Drug Dispensing System with Online Monitoring for Hospital Environments. Journal of Medical Systems, 42(7), 119–128.

[11] Taghipour, H., Rezaei, F., & Aghazadeh, A. (2022). Machine Learning-Enhanced Smart Pill Dispenser for Predictive Adherence Monitoring. Computers in Biology and Medicine, 145, 105467.

[12] Singh, R., & Kaur, J. (2020). Dual-Compartment Automated Insulin and Oral Medication System for Diabetic Patient Management. Diabetes Technology and Therapeutics, 22(5), 378–386.

[13] Rathore, H., & Jain, A. (2019). Blockchain-Integrated Drug Administration System for Tamper-Proof Medication Compliance Records. Journal of Medical Internet Research, 21(10), e14982.

[14] Koh, Y., Cheng, L. J., & Lim, W. S. (2020). Randomized Controlled Trial of Smart Pill Dispenser Effectiveness in Elderly Hypertensive Patients. Journal of the American Geriatrics Society, 68(4), 789–795.