



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** X **Month of publication:** October 2026

DOI: <https://doi.org/10.22214/ijraset.2026.85288>

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IoT Based Intelligent Medication Management System with Automated Dose Delivery and Remote Monitoring

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Abstract: *The IoT-Based Intelligent Medication Management System with Automated Dose Delivery and Remote Monitoring is a proposed system designed to improve medication adherence and support effective caretaker monitoring. The system allows users to set and modify medication schedules using an LCD display and control buttons. At the scheduled time, the medicine is automatically dispensed from the designated compartment into a collection tray. An IR sensor detects whether the patient collects the dispensed medicine, while a camera can be used for visual monitoring of the patient's interaction with the system. If the patient collects the medicine, an immediate notification is sent to the caretaker through a GSM module. If the medicine is not collected within 10 minutes, the system sends a missed-dose alert to the caretaker, and the uncollected medicine is transferred to a separate compartment for storing missed doses. This proposed system aims to provide a convenient and cost-effective solution for automated medicine dispensing, dose monitoring, and timely caretaker notification.*

Keywords: *IoT, Medication Management, Automatic Medicine Dispensing, IR Sensor, Camera Monitoring, GSM Module, Missed-Dose Detection, Caretaker Alert*

I. INTRODUCTION

Medication adherence is an important aspect of healthcare, particularly for elderly people and patients who require medicines at specific times. Forgetting scheduled doses, taking medicine at the wrong time, and depending on caregivers for regular medication management can create difficulties in daily life. Therefore, an automated medication management system can help improve the regularity of medicine delivery and support communication between patients and caregivers.

Several studies have explored automated medicine dispensers and IoT-based healthcare systems. Patil et al. presented an IoT-based smart medicine dispenser model for healthcare, demonstrating the relevance of connected technology in medication management [1]. Shanthini et al. investigated an IoT-based automatic medicine dispenser for patients [2]. Sadi et al. studied a real-time medicine reminder and dispenser intended for elderly patients [3]. These studies provide a foundation for developing systems that combine scheduled dispensing and medication reminders.

Other research has examined intelligent dispensing mechanisms and patient-oriented medication assistance. Prajwal et al. discussed the design and development of an intelligent medicine dispenser [4]. Susila Sakthy et al. presented the Automated Medicine Dispenser Assistant (AMDA) [5]. Al-Haider et al. investigated a smart medicine planner for visually impaired people, highlighting the importance of accessible medication support [6]. Athish et al. explored online doctor consultation and automatic medicine dispensers in primary healthcare centres using machine learning [7].

Accuracy in dispensing and support for elderly patients are also important research considerations. Srinivasan et al. investigated a precision medication dispenser designed to improve dosage accuracy and reduce the risk of overdose [8]. Sharanya et al. presented an IoT-based pill dispenser for elderly care [9]. Patil et al. also described an IoT-based medicine dispenser [10].

Although these studies address different aspects of medication management, there remains a need to bring scheduled dispensing, medicine collection monitoring, and caregiver notifications together in a single proposed system. Therefore, this paper proposes an IoT-based Intelligent Medication Management System with Automated Dose Delivery and Remote Monitoring. The proposed system uses an ESP32 microcontroller, a real-time clock (RTC), an LCD interface, control buttons, a motorized dispensing mechanism, an infrared (IR) sensor, and a GSM module.

The system is designed to dispense medicine according to a predefined schedule, detect whether the dispensed medicine has been collected, and send SMS notifications to a caregiver when required. If the medicine is not collected within ten minutes, the proposed mechanism is intended to move the missed dose into a separate compartment and notify the caregiver. A camera is also proposed to observe patient interaction with the system. The proposed system aims to reduce manual effort, support timely medicine delivery, and improve communication between patients and caregivers. However, detecting medicine collection does not confirm that the patient has swallowed the medicine. Implementation and experimental evaluation will be required to assess the reliability and practical performance of the proposed system.

II. RELATED WORKS

Patil et al. presented an IoT-based smart medicine dispenser model for healthcare. Their study explored the application of IoT technology to medicine dispensing and healthcare support. This work provides a foundation for developing connected medication management systems. [1]

Shanthini et al. presented a design and implementation of an IoT-based automatic medicine dispenser for patients. Their work focused on automatic medicine dispensing using IoT technology. This study provides relevant background for developing a system that delivers medicines according to a predefined schedule. [2]

Sadi et al. investigated an IoT-based real-time medicine reminder and dispenser for elderly patients. Their work addressed medication reminders and dispensing support for elderly users. Such systems can help patients maintain regular medication schedules. [3]

Prajwal et al. presented the design and development of an intelligent medicine dispenser. Their study examined an intelligent dispensing system and provided relevant background for automated medicine delivery. [4]

Susila Sakthy et al. introduced the Automated Medicine Dispenser Assistant (AMDA). Their work focused on automated medicine dispensing to reduce manual effort in medication delivery. [5]

Al-Haider et al. presented a smart medicine planner for visually impaired people. Their study highlighted the importance of accessible medication support for users with visual impairments. [6]

Athish et al. explored online doctor consultation and automatic medicine dispensers in primary healthcare centres using machine learning. Their study combined digital healthcare services with automated medicine dispensing. [7]

Srinivasan et al. presented a precision medication dispenser designed to improve dosage accuracy and reduce the risk of overdose. Their study highlighted the importance of accurate medicine delivery. [8]

Sharanya et al. presented an IoT-based pill dispenser for elderly care. Their work explored connected technology to support medicine dispensing for elderly users. [9]

Patil et al. presented an IoT-based medicine dispenser. Their study explored the application of IoT technology to medicine dispensing and provides additional background for developing connected systems that support medication management. [10]

III. PROPOSED METHOD

The proposed IoT-based Intelligent Medication Management System is designed to help patients take their prescribed medicines at the correct time and assist caregivers in monitoring the patient's medication status. Taking medicines on time is essential for maintaining good health, especially for elderly people, patients with chronic diseases, and individuals who require multiple medications throughout the day. However, patients may sometimes forget their medication schedules or fail to take their medicines at the prescribed time. To overcome these problems, the proposed system provides an automated medication dispensing mechanism along with medicine collection monitoring and SMS notification facilities. The system consists of a microcontroller, Real-Time Clock (RTC) module, LCD display, control buttons, motor, Infrared (IR) sensor, GSM module, and camera. Each component performs a specific function to ensure the proper operation of the medication management system. The microcontroller acts as the main control unit and coordinates the operation of all the connected components. The RTC module maintains the current time and helps the system identify the scheduled medication time accurately. The LCD display provides information about the current time, medication schedule, and system status, while the control buttons allow the user to configure the required medicine timings. Initially, the user can set the medication schedule using the control buttons and view the selected timings on the LCD display. The configured schedule is used by the microcontroller to determine when the medicine should be dispensed. The RTC module continuously tracks the current time and compares it with the stored medication schedule.

When the scheduled time matches the current time, the microcontroller activates the motor mechanism to dispense the medicine into the collection tray. This automated dispensing process reduces the need for the patient to remember every medication time manually and makes the process more convenient and user-friendly.

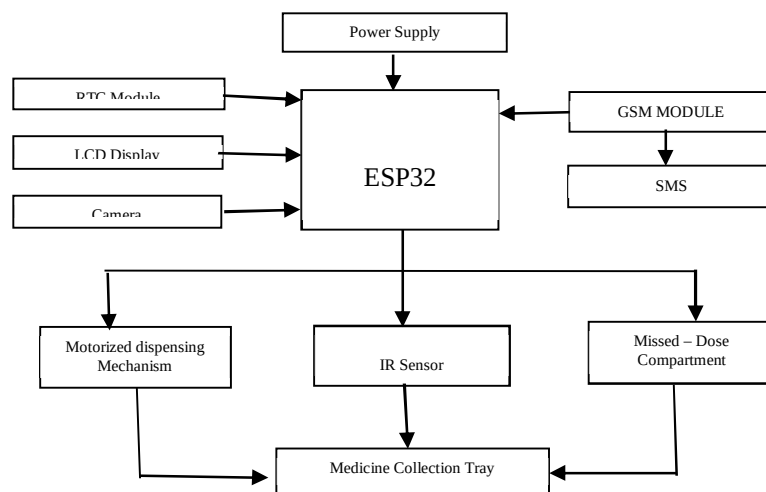
After the medicine is dispensed, the IR sensor is used to detect whether the patient has collected the medicine from the collection tray. The sensor provides feedback to the microcontroller, allowing the system to determine whether the medicine has been removed from the tray. If the patient collects the medicine within the specified time, the microcontroller recognizes the collection event and Activates the GSM module to send an SMS notification to the caregiver. The message confirms that the scheduled medicine has been collected. This notification helps caregivers stay informed about the patient's medication activity without needing to monitor the dispenser continuously. If the patient does not collect the medicine within ten minutes of dispensing, the system identifies the event as a possible missed dose and sends a separate alert message to the caregiver through the GSM module. This alert informs the caregiver that the medicine remains uncollected and that further attention may be required. Based on the notification, the caregiver can contact the patient and remind them to take the prescribed medicine. The ten-minute monitoring period provides a reasonable window for medicine collection while helping the system identify potential medication delays.

In addition to the primary dispensing mechanism, the system includes a separate compartment for storing missed doses. This compartment is intended to keep missed medicines separate from the medicines scheduled for upcoming doses, helping reduce confusion during medication management. The separate storage arrangement can also support the identification and handling of missed doses according to the patient's medication plan. However, the handling of missed medicines should follow the prescribed instructions, and patients should not automatically take a delayed dose without confirming that it is appropriate.

The proposed system also incorporates a camera to observe the patient's interaction with the medication dispenser. The camera can be used to capture visual information about the patient's interaction with the device, depending on the implemented camera functionality. This feature can provide additional monitoring support for caregivers, particularly when the patient requires assistance or supervision. The camera complements the IR sensor by providing a visual observation facility, while the IR sensor performs the actual detection of medicine collection. Appropriate privacy measures should be followed when using the camera, especially in residential environments. The GSM module plays an important role in establishing communication between the medication management system and the caregiver. It enables the system to transmit SMS notifications regarding medicine collection and possible missed doses. Through these messages, caregivers can receive timely updates even when they are away from the patient's location. This communication feature improves remote monitoring and helps caregivers respond more quickly when a scheduled dose may have been missed. The main objective of the proposed IoT-based Intelligent Medication Management System is to improve medication adherence, reduce the possibility of forgetting scheduled doses, and provide timely information to caregivers. By integrating automated medicine dispensing, real-time scheduling, sensor-based collection detection, camera-based observation, and SMS alerts, the system offers a convenient and organized approach to medication management.

Overall, the proposed system aims to improve the safety, reliability, and convenience of daily medication routines. It reduces the need for continuous manual supervision and helps patients follow their medication schedules more consistently. At the same time, it enables caregivers to monitor medicine collection remotely and take appropriate action when a dose remains uncollected. Therefore, this system can serve as a useful solution for elderly care, home healthcare, and patients who require regular medication reminders and assistance.

IV. BLOCK DIAGRAM



Block Diagram

V. PRINCIPLE OF FUNCTIONING

The proposed IoT-based Intelligent Medication Management System is designed to help patients receive their medicines at the scheduled time and enable caregivers to monitor medicine collection remotely. The system uses an ESP32 microcontroller as its main control unit, which coordinates the RTC module, LCD display, control buttons, motorized dispensing mechanism, IR sensor, GSM module, and camera. These components work together to support scheduled medicine dispensing and collection monitoring. Initially, the user or caregiver sets the medicine schedule using the control buttons. The LCD display shows the configured schedule and helps the user verify the entered timings. The ESP32 manages the schedule with the help of the Real-Time Clock (RTC) module, which continuously maintains the current time. The microcontroller compares the current time with the predefined medicine schedule to identify when a dose should be dispensed.

When the scheduled time is reached, the ESP32 activates the motorized dispensing mechanism. The motor operates the dispensing unit, which is designed to deliver the scheduled medicine to the collection tray. This automatic process aims to reduce the need for manual medicine dispensing and helps patients follow their prescribed medication schedules.

After the medicine is delivered to the collection tray, the IR sensor monitors whether the medicine has been collected. The sensor provides collection-status information to the ESP32 microcontroller. Based on this information, the system determines whether the medicine has been removed from the tray. If collection is detected, the GSM module is designed to send a confirmation SMS to the caregiver. This notification helps the caregiver stay informed about the medicine collection status.

If the medicine is not collected within ten minutes of dispensing, the system identifies the dose as unconfirmed and sends an alert SMS to the caregiver through the GSM module. This notification helps the caregiver become aware of a possible missed dose and take appropriate action when necessary. The proposed system also includes a separate missed-dose compartment. If the medicine remains uncollected after the specified period, the motorized mechanism is intended to transfer it to this compartment to separate it from the next scheduled dose.

Additionally, a camera is included to observe the patient's interaction with the dispensing unit. The camera may provide supplementary information about the patient's interaction with the system. When combined with the IR sensor and GSM notifications, this feature aims to improve caregiver awareness. However, detecting medicine collection or observing patient interaction does not confirm that the patient has swallowed the medicine.

Overall, the proposed system combines scheduled medicine dispensing, sensor-based collection monitoring, missed-dose management, and remote caregiver notifications. By integrating these functions, the system aims to support timely medicine delivery and improve communication between patients and caregivers. Since the system is currently at the proposal stage, implementation and experimental testing are required to evaluate its practical operation, reliability, and performance.

VI. ADVANTAGES OF THE PROPOSED SYSTEM

The proposed medication management system offers several advantages by combining scheduled medicine dispensing with sensor-based monitoring and caregiver notifications.

- 1) **Timely Medicine Dispensing:** The RTC module and ESP32 help manage medicine schedules and initiate dispensing at the preset time.
- 2) **Automatic Operation:** The motorized dispensing mechanism is designed to deliver medicine to the collection tray, reducing the need for manual dispensing.
- 3) **Medicine Collection Monitoring:** The IR sensor detects whether the medicine has been collected from the tray.
- 4) **Caregiver Notifications:** The GSM module sends SMS notifications to inform caregivers about detected medicine collection or an unconfirmed dose.
- 5) **Missed-Dose Management:** A separate compartment is proposed to store medicine that remains uncollected beyond the specified time.
- 6) **Patient Interaction Monitoring:** The camera provides an additional way to observe the patient's interaction with the dispenser.
- 7) **Improved Caregiver Awareness:** By combining collection monitoring and SMS alerts, the proposed system aims to help caregivers respond when a scheduled dose may have been missed.

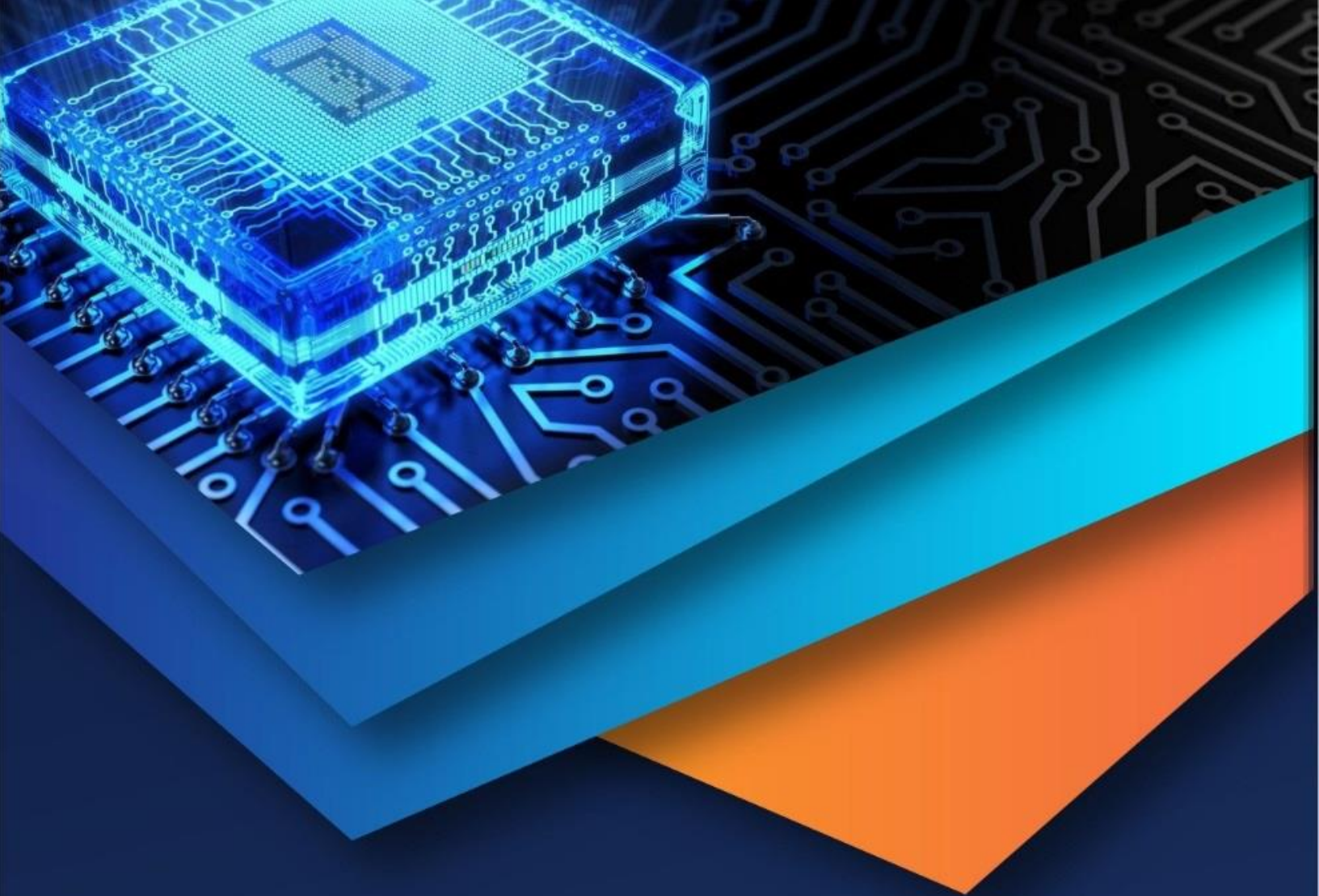
VII. CONCLUSION

This paper presents a proposed IoT-based Intelligent Medication Management System for scheduled medicine dispensing and caregiver monitoring. The system uses an ESP32, RTC module, motorized dispensing mechanism, IR sensor, GSM module, and camera to support medicine delivery, collection monitoring, and SMS notifications.

The proposed system aims to reduce manual effort, support timely medication, and improve communication between patients and caregivers. Further implementation and testing are required to evaluate its reliability and practical performance.

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