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IoT-Based Automated Medication Management System

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Abstract

An Internet of Things (IoT)-based automated medication dispenser with an integrated alert system is presented in this research. The device is managed by an ESP32 microcontroller, which is paired with a Real-Time Clock (RTC) module to ensure medication is dispensed at the correct time. To facilitate the dispensing process, the system uses servo and stepper motors to rotate the medication carousel and release the appropriate dosage. To determine whether the drug has been taken, an LDR sensor is integrated. Through the Blynk app, the system notifies the caregiver if the medication is not taken. The battery-operated system is lightweight and easy to use. An LCD display presents crucial information such as the medication name, dosage, and scheduled time for the next dose. There is a switch to turn the system on and off when necessary. This technology aims to improve medication adherence, particularly for elderly patients or those with chronic illnesses, by ensuring timely medication intake. Additionally, it helps reduce the caregiving workload by automating medication management. The suggested system provides a workable way to improve medication compliance and patient care.

Keywords: IoT, medicine dispenser, ESP32, RTC module, Internet of things.

INTRODUCTION

The Internet of Things (IoT) is a rapidly evolving technology that allows commonplace items to be linked to the internet so they may interact, share, and gather data without direct human assistance. To enable automation, data analysis, and control, the Internet of Things (IoT) uses sensors, devices, and software that enable items to "sense" their environment and interact with other devices. To put it simply, IoT connects the digital and physical worlds, providing opportunities for increased convenience, productivity, and efficiency in several industries, such as manufacturing, transportation, healthcare, and agriculture. IoT is important because it may improve decision-making, decrease human error, and streamline operations. By providing real-time data and feedback, IoT contributes to increased efficiency and cost-effectiveness, making it a critical enabling of innovation and digital transformation in today's connected world. Healthcare is one of the most important sectors where IoT has demonstrated enormous promise. With the advent of IoT, the healthcare industry has been revolutionized by creating systems that can monitor patient health remotely, automate medical processes, and ensure the timely delivery of services. One such promising innovation is the IoT-based automatic medicine dispenser; a device designed to improve medication adherence and ensure that patients receive the correct dosage of prescribed medications at the right times [1].

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To maintain patient medication regimens, administer drugs automatically, and notify patients or caregivers when it is time for the next dosage, the Internet of Things-based automatic medicine dispenser connects to the internet. Elderly patients, people with chronic illnesses, and people who struggle to follow complicated prescription schedules would especially benefit from this novel technology. It improves patient outcomes and

overall healthcare management by lowering the likelihood of missed doses, pharmaceutical mistakes, and the requirement for human intervention. An important advancement in the endeavor to improve healthcare's accuracy, accessibility, and efficiency is the Internet of Things-based automated medication dispensers. In addition to making patients' lives easier, automating the medicine delivery procedure also lessens the workload for medical staff and caretakers. Additionally, the gadget may be connected to healthcare systems by including real-time data transfer, enabling ongoing monitoring and treatment plan modifications as needed. Because physicians can monitor a patient's drug compliance and use the information to guide their decisions, this improves the customization of healthcare. Additionally, it encourages the creation of smarter healthcare settings where gadgets interact with one another to provide a smooth and integrated patient care experience [2].

By enabling automated medication dispensers that enhance patient adherence and lower human error, the Internet of Things (IoT) has completely transformed the healthcare industry. These gadgets guarantee that patients take their prescriptions accurately and on schedule by providing remote access and real-time monitoring. Additionally, they give medical experts and caregivers useful information that enables more effective treatment planning and prompt interventions. IoT increases productivity, but it also brings with it technical and security issues that need to be resolved. One of the key advantages of IoT in automatic medicine dispensers is improved medication adherence. These devices send reminders and dispense the correct dosage, minimizing the risk of missed or incorrect doses. Additionally, remote monitoring allows caregivers to track a patient’s medication intake, ensuring that they follow their prescribed regimen. The collection of usage data also enables healthcare providers to analyze trends and make necessary adjustments to treatment plans. Additionally, automated dispensing improves safety by lowering the possibility of taking the incorrect drug or overdosing. However, despite these benefits, IoT-powered medicine dispensers come with certain disadvantages. Security and privacy risks are a major concern, as these devices store and transmit sensitive health data, making them vulnerable to cyber threats. Technical failures, such as device malfunctions or internet connectivity issues, can disrupt medication schedules and potentially harm patients. Additionally, the high initial cost of these dispensers and their maintenance may be a barrier for some individuals and healthcare facilities. Another drawback is the dependency on technology; if users are not adequately trained to handle technical issues, they may struggle in situations where manual intervention is required [3–5]. In conclusion, while IoT-enabled automatic medicine dispensers offer significant advantages in medication management, they also pose security, cost, and technical challenges. By enabling real-time monitoring and secure data exchange, they present a promising solution for improving patient safety and healthcare efficiency.

The extent to which a patient takes their medications as directed is known as medication adherence. It is a critical factor in managing chronic illnesses, but it can be challenging for patients to adhere to their medication regimens, especially those who are elderly, have multiple medications to take, or have complex medication schedules [6]. By delivering medication at the appointed time and alerting the patient if they have missed a dose, automatic medicine dispensers can assist patients in improving their medication adherence. Automatic medicine dispensers can also help to reduce the workload of caregivers by managing the patient's medication regimen In this study, an Internet of Things (IoT)-based automated medication dispenser with an alarm system is proposed. An RTC module is used by the ESP32 microcontroller, which controls the dispenser and keeps track of time to deliver medication at the appointed time. The medicine carousel rotates, and the right amount of medication is dispensed using servo and stepper motors. To determine whether the drug has been taken, an LDR sensor is employed. The Blynk app is used by the system to notify the patient's caregiver if the medication is not taken. All things considered, IoT technology is transforming a number of industries, with the healthcare sector setting the standard. An excellent example of how IoT may be used to address practical issues like medication management is the Internet of Things-based automated medicine dispenser. This technology has enormous potential to enhance patient care, save healthcare costs, and eventually raise the standard of living for people everywhere by boosting drug adherence, minimizing human error, and providing real-time data.

LITERATURE REVIEW

The literature on Internet of Things (IoT)-enabled automated medication dispensers with alarm systems is briefly and thoroughly reviewed in this study. The following subjects are covered in the survey:

- *System architecture:* This refers to the overall design or structure of the automatic medicine dispensers that use IoT (Internet of Things) with alert systems. It explains the connections between the system's various parts and the data flow between them. In IoT-based dispensers, the system architecture includes sensors, controllers, connectivity (e.g., Wi-Fi, Bluetooth), and cloud services for communication and data storage. The goal is to outline different approaches and models that have been used to build these systems [7].
- *Hardware and software components:* This section examines the hardware and software components that enable autonomous medication dispensers to operate. Sensors (like RFID or motion sensors), actuators (like medicine-dispensing motors), microcontrollers (like Arduino or Raspberry Pi), and communication modules (like Wi-Fi or Bluetooth) are examples of hardware. The operating system, firmware, IoT platforms (like MQTT and cloud-based dashboards), and alert system apps (such sending users push or SMS alerts when it is time to take their medications) are examples of software components.
- *System implementation:* Here, the study discusses the practical ways in which automatic medicine dispensers are built and put into action using IoT technology with alert systems. This could involve step-by-step procedures or methods used by researchers or engineers to design, prototype, and deploy these systems. It covers both the theoretical designs and how those designs are turned into functioning devices that users can interact with, and it could involve case studies or examples of actual deployments [8].
- *System performance:* The performance of automatic medicine dispensers using IoT with alert systems is measured in terms of accuracy, reliability, and usability.

SYSTEM DEVELOPMENT

Figure 1 illustrates the system development.

PROPOSED METHODOLOGY

Initialization

The initialization process involves setting up all the essential components of the system. The ESP32 microcontroller is first turned on and set up to regulate the system's general operation. The drug is physically dispensed via servo motors, which are another component of the system [9]. The *real-time clock module* is initialized to keep track of the time accurately, which is crucial for scheduling medication dispensing. *Wi-Fi connectivity* is established by connecting to the network using predefined credentials, ensuring that the system can communicate with external services or be monitored remotely.

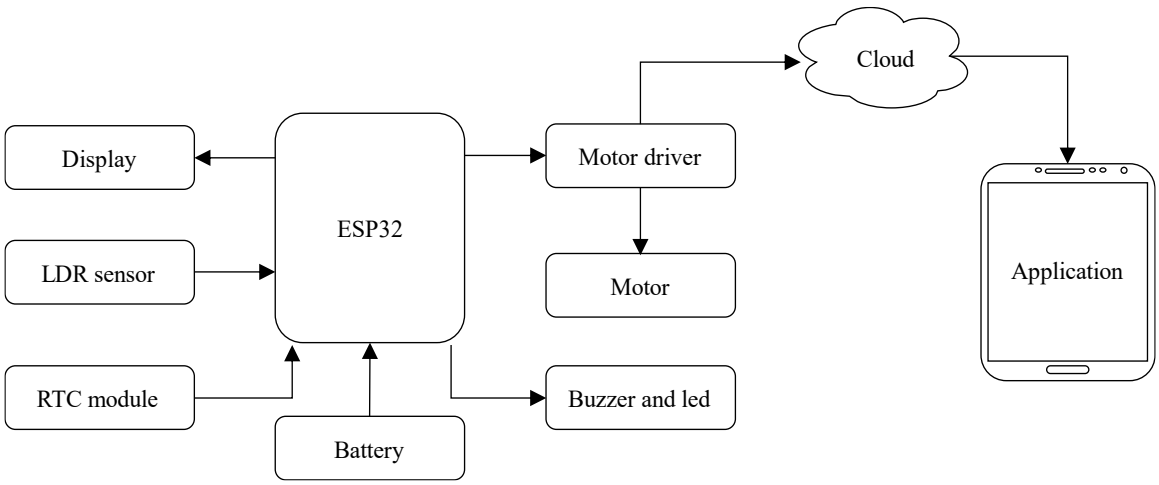

Figure 1. Block diagram of IoT-based automatic medicine dispenser.

Medication Schedule Setup

The medication schedule defines when specific medications should be dispensed throughout the day. This schedule is inputted into the system, specifying exact times for each medication event. The schedule can be stored in an array or another data structure, where each entry corresponds to a specific time and medication slot. This setup ensures the system knows exactly when it needs to trigger dispensing events based on predefined times.

Time Synchronization

The real-time clock module, a hardware part intended to maintain time even when the system is turned off, provides the current time to the system. This guarantees that the internal clock of the system is precise and in line with the current time. To maintain accuracy, the system will periodically update its internal clock by referencing the real-time clock module, ensuring that time-based functions like medication dispensing are accurate and reliable.

Medication Dispensing Logic

The core of the medication dispensing process is based on iterating through the medication schedule stored in the system. The present time and the planned medication times are compared by the system. When the system detects that the current time matches a scheduled medication time and that the medication has not yet been dispensed, it triggers the servo motor to release the appropriate medication from the correct compartment. Once the medication is dispensed, the system marks the specific medication slot as "dispensed" to prevent it from dispensing again, avoiding errors or duplication in dispensing.

Network Connectivity Handling

Continuous and stable Wi-Fi connectivity is essential for the operation of the system, particularly if it involves remote monitoring or communication with a central server. To make sure the Wi-Fi connection is maintained, the system continuously checks its condition. If the Wi-Fi connection is lost, the system attempts to reconnect to the network at regular intervals. Any issues related to network connectivity are logged, enabling developers or users to analyze and troubleshoot the problem later, ensuring minimal downtime [10].

User Interface Interaction

The system provides real-time feedback to the user through a user-friendly interface. This can include visual indicators, such as LED lights, that show the system's status, such as whether medication has been dispensed or if there are any issues with the system. Additionally, a web-based dashboard can be provided to display more detailed information, including the medication schedule, real-time updates on medication dispensing, adherence to the schedule, and overall system health, allowing users to stay informed and manage the system remotely.

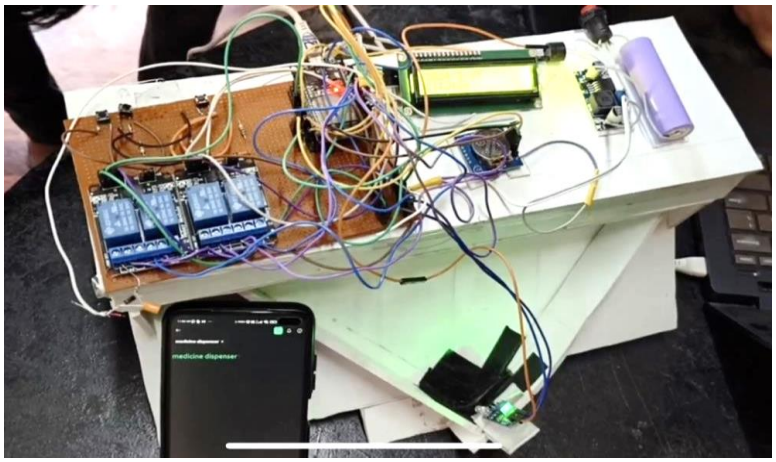

Figure 2. Upper view of IoT-based medicine dispenser.

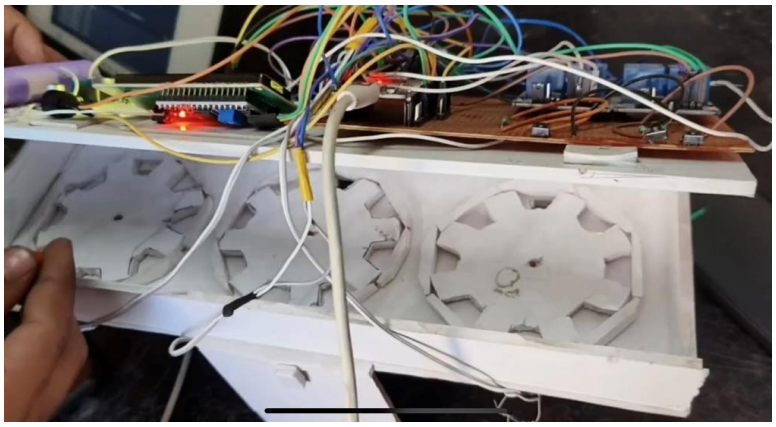

Figure 3. Inner medicine dispensing view of IoT-based automatic medicine dispenser.

IoT technologies are integrated into the system to allow for remote monitoring and control. To make sure the Wi-Fi connection is maintained, the system continuously checks its condition. This means that users or caregivers can check the status of the system, view updates on the medication dispensing events, and potentially adjust the medication schedule or settings from a remote location [11]. This feature enhances the system's functionality by allowing users to manage their medication schedules from anywhere, offering more flexibility and convenience. Furthermore, Figure 2 shows the IoT-based medicine dispenser and Figure 3 shows the inner medicine dispensing view of IoT-based automatic medicine dispenser.

CONCLUSION

After exploring various technologies in the field of robotics and IoT, we can conclude that an IoT-based medicine dispenser using ESP32 represents a notable advancement in healthcare technology. By seamlessly integrating IoT capabilities with the ESP32's robust functionality, it provides a comprehensive solution to medication management challenges. With its precision in dispensing medications, real-time monitoring capabilities, and remote access for caregivers and healthcare providers, this device not only improves patient adherence but also ensures their safety and well-being. Looking ahead in healthcare, the IoT-based medicine dispenser using ESP32 has the potential to reduce medication errors, decrease healthcare expenses, and enhance overall patient outcomes. It illustrates how technology can revolutionize healthcare delivery by making it more accessible, patient-centered, and efficient. With ongoing advancements and enhancements, this innovation holds the promise of significantly impacting the lives of individuals managing chronic illnesses and those requiring complex medication regimens. In the years to come, we can expect further progress in this field, contributing to a healthier and more interconnected healthcare landscape.

REFERENCES

1. Nigade MM, Nate S, Patki R, Rajankar SO. Automated Medication Dispenser with Alert Mechanism. International Journal of Computer-Aided Manufacturing (IJCAM). 2024; 10(1): 46–54.
2. Pandey S, Gogate MM. IoT based smart automatic juice vending machine. Int Res J Eng Technol. 2019 Nov; 6(11): 171–6.
3. Elkhwesky Z, Elkhwesky EF. A systematic and critical review of internet of things in contemporary hospitality: a roadmap and avenues for future research. Int J Contemp Hosp Manag. 2023 Jan 27; 35(2): 533–62.
4. Penna M, Gowda DV, Jijesh JJ. Design and implementation of automatic medicine dispensing machine. In 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT). 2017 May 19; 1962–1966.
5. Bai YW, Kuo TH. Medication adherence by using a hybrid automatic reminder machine. In 2016 IEEE International Conference on Consumer Electronics (ICCE). 2016 Jan 7; 573–574.

6. Sharma N, Ramachandran RK, Naz H, Sharma R. Tea vending machine from extracts of natural tea leaves and other ingredients: IoT and artificial intelligence enabled. In: Singh A, Kukreja V, Gandomani TJ, editors. Machine Learning for Edge Computing: Frameworks, Patterns and Best Practices. Boca Raton (FL): CRC Press; 2022. p. 37–52. doi: 10.1201/9781003143468.
7. Vishnupriya K, Mamatha NP. Health Automatic Medicine Vending Machine. Perspectives in Communication, Embedded-systems and Signal-processing (PICES). 2019 Feb 5; 2(10): 245–7.
8. Antoun W, Abdo A, Al-Yaman S, Kassem A, Hamad M, El-Moucary C. Smart medicine dispenser (smd). In 2018 IEEE 4th middle east conference on biomedical engineering (MECBME). 2018 Mar 28; 20–23.
9. Dhukaram AV, Baber C. Elderly cardiac patients' medication management: Patient day-to-day needs and review of medication management system. In 2013 IEEE International Conference on Healthcare Informatics. 2013 Sep 9; 107–114.
10. Reidenberg MM. Essential medicines for everybody in the world: the World Health Organization essential medicines program. In: Finkel ML, editor. Public Health in the 21st Century. Volume 1: Global Issues in Public Health. Santa Barbara (CA): Praeger, ABC-CLIO, LLC; 2010. p. 109-116.
11. Gray SL, Mahoney JE, Blough DK. Medication adherence in elderly patients receiving home health services following hospital discharge. Ann Pharmacother. 2001 May; 35(5): 539–45.

