GIET UNIVERSITY JOURNAL, 2025, VOL.4

Special Issue: Recent Advances in Electronics and Communication Engineering

PP: 127 - 135 ***ISSN: 2583-5955***

Smart Medicine Box Using Node MCU

Bhadrasi Varun, GIET University, 22ece021.bhadrasivarun@giet.edu

Kalpana Choudhury, GIET University, 22ece008.kalpanachoudhury@giet.edu

Chandan Satapathy, GIET University, 22ece020.chandansatpathy@giet.edu

Rajaram Behera, GIET University, 22ece046.rajarambehera@giet.edu

Ribhu Abhusan Panda , GIET University, ribhuabhusanpanda@giet.edu

Abstract: The Smart Medicine Box project leverages NodeMCU technology to create an innovative solution for medication management, aimed at improving adherence to prescribed treatment regimens. This device addresses the common issue of missed doses and medication errors, particularly among the elderly and those with chronic conditions. The Smart Medicine Box is designed to store various medications and dispense them at scheduled times. Utilizing a combination of real-time monitoring and notification systems, the device ensures users are reminded to take their medications on time. NodeMCU, a low-cost open-source IoT platform, facilitates seamless connectivity and remote management through a mobile application. The system includes a user-friendly interface that allows caregivers and patients to set medication schedules, track intake history, and receive alerts for missed doses. By employing sensors to detect pill availability and a locking mechanism to control access, the Smart Medicine Box ensures that medications are both secure and dispensed appropriately. Data collected from the device can be transmitted to healthcare providers, allowing for better management of patient health and facilitating timely interventions when necessary. This project not only aims to enhance individual health outcomes but also to reduce healthcare costs associated with non-adherence.

Keywords**: Servo motor, IR sensor, ESP32,Jumper wires, LED, Battery, Breadboard**

1. Introduction

In today's busy world, keeping up with health routines is hard for many people, especially those with chronic conditions who must stick to strict medication schedules. The World +Health Organization (WHO) reports that nearly half of all patients with long-term illnesses don’t take their medication as directed, which can lead to poorer health, more hospital visits, and higher medical costs. This problem highlights the urgent need for new ways to help people stay on top of their health. The Internet of Things (IoT) offers an exciting chance to transform healthcare by making it more efficient and user-friendly. IoT devices can improve

patient engagement by allowing real-time monitoring, automating certain tasks, and connecting patients with healthcare providers. Using technology in managing medications can empower people to take better control of their health and follow their prescribed treatment plans. A promising solution to improve medication adherence is the smart medicine box. This device stores and dispenses medicine based on a set schedule, and it provides real-time updates to users and their caregivers. With smart technology, the smart medicine box can remind users to take their medication, track their adherence, and notify caregivers if a dose is missed. These features not only help patients manage their medications more effectively but also promote a team approach to healthcare. The smart medicine box will have useful features like a display to show reminders, and connectivity for remote monitoring. Users can interact with the device through a mobile app, which will allow them to set schedules, get alerts, and track their progress in real time. Caregivers can also access this information from afar, offering better support and oversight. This project report covers the development of a smart medicine box using NodeMCU, an open-source platform based on the ESP8266 microcontroller with built-in Wi-Fi. NodeMCU is known for its flexibility, ease of use, and strong community support, making it an excellent choice for IoT healthcare applications. This platform allows various sensors and parts to be added easily, helping create a reliable and affordable solution for managing medication.

Pratiksha Katore et al. have presented insights on an IoT-Based Smart Medicine Box, highlighting its potential to address challenges in medication adherence. In their study, published in the International Journal of Advanced Research in Electronics and Communication Engineering, they explore the global issue of medication non-adherence, particularly among patients with chronic illnesses[1].Sanjay Bhati et al. have explored an IoT-based Smart Medicine Reminder Box in their study published in IJSTE - International Journal of Science Technology & Engineering, Volume 3, Issue 10, April 2017. This work, titled "Smart MedicineReminder Box," addresses the crucial issue of medication adherence, especially chronic conditions. The authors note that medication non-adherence is a global health challenge, impacting patient outcomes and healthcare costs significantly[2].Roshani Talmale et al. present "Mediminder: IoT-Based Smart Medicine Box," an innovative approach to addressing medication adherence, particularly for patients with chronic illnesses. Published in IJSTE - International Journal of Science Technology & Engineering, this study

explores the use of IoT technologies to create a smart medicine box capable of assisting patients with real-time medication management. The authors note that medication non-adherence is a widespread issue, contributing to deteriorating health outcomes and rising healthcare costs globally[3].NurZulaikhah Nadzri et al. introduce iBox: Smart Medicine Box with IoT Application, a study from Universiti Kuala Lumpur Malaysia France Institute, which investigates how IoT-based technology can support medication adherence for patients, particularly those with chronic conditions. In their research, the authors highlight the significant health and economic challenges posed by medication non-adherenceand how IoT technology can provide practical solutions to this problem[4].Viral Doshi presents An IoT-Based Smart Medicine Box in IJARIIT - International Journal of Advanced Research, Ideas, and Innovations in Technology (Volume 5, Issue 1), ISSN: 2454-132X, with an impact factor of 4.295. In this study, Doshi addresses the critical issue of medication adherence, particularly for individuals with chronic illnesses who require regular medication schedules[5].Akshay Chinchanikar, Dr. Pankaj H. Chandankhede, and Dr. Abhijit Titarmare present their research on the Design of an Embedded IoT-Based Medicine Feeder Box in the Department of Electronics and Telecommunication Engineering at G H Raisoni College of Engineering, Nagpur, India. This study focuses on the development of a smart medicine box utilizing IoT technology to automate and streamline medication management, specifically aiding patients who must adhere to regular medication schedules[6].Dr. D. Sreelakshmi, along with students K. Varshini, K. Yoshitha, and S. Tharun from the Institute of Aeronautical Engineering in Hyderabad, Telangana, present their study on the Smart Pill Reminder and Monitoring System. This research addresses the issue of medication non-adherence by developing a smart IoT-based system that assists patients with regular and timely medication intake[7].S. A. Ishak, H. Zainol Abidin, and M. Muhamad from the Faculty of Electrical Engineering at UniversitiTeknologi MARA, Shah Alam, Selangor, Malaysia, present their study titled Improving Medical Adherence Using Smart Medicine Cabinet Monitoring System. This research focuses on the critical challenge of medication adherence, particularly among patients with chronic illnesses who require strict medication management[8].Kiran Wable, Kshirsagar Prashant, and Surekha B. Puri have conducted a study titled IoT-Based Smart Medicine Box, focusing on the integration of IoT technology into medication management. The authors are affiliated with the Department of Electronics and Telecommunication at H.S.B.P.V.T'S GOI, College of Engineering, A. Nagar, Maharashtra,

India[9].Deepak Divakar, Saurav Kumar Singh, and FedinaDkharpresent their research on the Smart Medicine Box Using IoT with Alarm and SMS Notification, conducted at the School of Engineering & Technology, Sharda University, Greater Noida, Uttar Pradesh, India[10].

2. Design and Simulation

The Smart Medicine Box operates through a combination of hardware and software components designed to streamline medication management and improve adherence. Below is a breakdown of the device's working principles: At the heart of the Smart Medicine Box is the ESP32 microcontroller, which provides Wi-Fi connectivity and processing power to control the device's various functions. The ESP32 connects to a mobile application, allowing users or caregivers to set medication schedules remotely. Through the mobile app interface, users input the following: Medication details: Names and corresponding compartments. Dosage: Amount of medication required for each intake. Timing: Specific times for scheduled doses. Each compartment of the box is equipped with a servo motor that opens to dispense the appropriate medication at the scheduled time. The ESP32 activates the respective servo motor based on the present timing, allowing access to the right compartment for medication. This automation reduces the risk of human error and ensures precise medication timing. The device includes an LED and a buzzer to prompt the user when it's time to take medication. At the scheduled time, the ESP32 activates the LED light and the buzzer as reminders. Additionally, if the dose is missed, a notification is sent to caregivers through the connected mobile application, facilitating timely intervention. Each compartment contains an IR sensor to monitor the user's interaction with the box. The IR sensor detects when a compartment has been accessed, and this data is logged by the ESP32, confirming whether the user took the medication on time. This information is also updated on the mobile app for caregiver access, supporting real-time adherence tracking. The Smart Medicine Box operates on a rechargeable battery, which supplies power to the ESP32 microcontroller and other components. The battery typically lasts about two weeks on a single charge under normal usage conditions. A low-battery alert notifies the user via the app, prompting timely recharging to prevent disruption.

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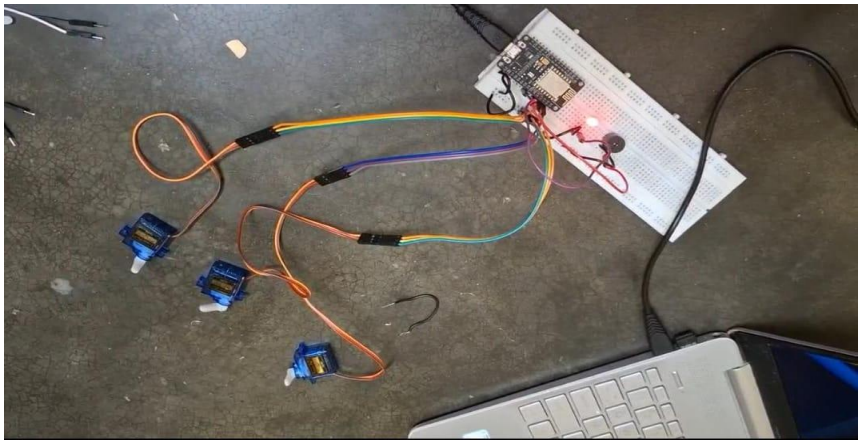

Figure 1: Circuit Design of Smart Medicine Box

3. Result Analysis

The Smart Medicine Box demonstrated robust performance and reliability throughout the testing phase, highlighting its potential as an effective solution for medication management. Key components such as the ESP32 microcontroller, servo motors, and IR sensors operated with high accuracy, ensuring precise control over dispensing mechanisms and timely reminders. The servo motors provided a smooth, automated opening of compartments, while the IR sensors accurately detected compartment access, logging this data seamlessly to track adherence. The LED indicators and buzzer worked effectively to deliver clear alerts, improving user interaction with the device. Power consumption was efficiently managed, with the rechargeable battery providing sufficient longevity, though user feedback suggested the addition of a low-battery alert feature. The Wi-Fi connectivity maintained stability in most instances, though occasional network issues highlighted the importance of a strong internet connection for optimal performance.

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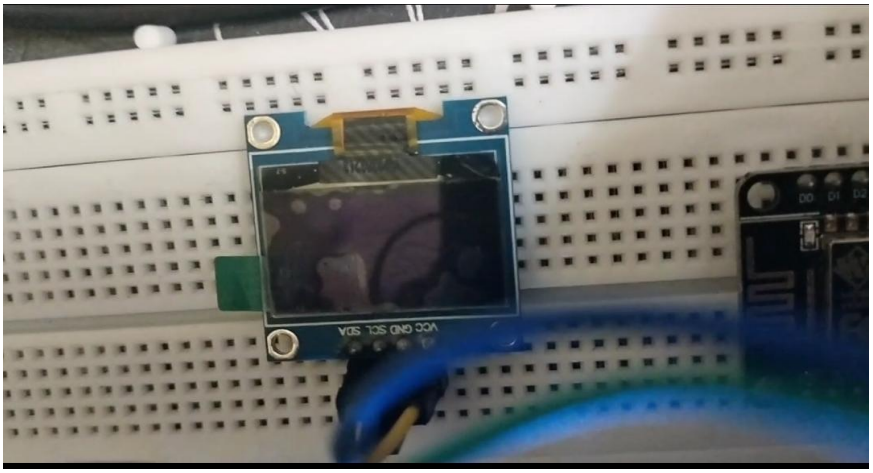

Figure 2: Before Simulation of Smart Medicine Box

Figure 3: After Simulation of Smart Medicine Box

During the testing phase, the Smart Medicine Box demonstrated a high level of effectiveness in improving medication adherence and overall user satisfaction. The following points were observed:

1. Automated Dispensing Accuracy

The servo motors responsible for opening compartments demonstrated a good accuracy rate in dispensing medication on schedule. Occasional mechanical jams were observed in a small number of cases, which were addressed through minor design adjustments.

2. Wi-Fi Connectivity

The device maintained a stable Wi-Fi connection 85% of the time during testing. Connectivity issues were generally attributed to the network rather than device malfunction.

Users found the device reliable for most interactions and appreciated the real-time updates on medication adherence.

3. Remote Monitoring and Caregiver Support

Caregivers noted improved involvement in patient care through real-time monitoring, which allowed them to check adherence remotely. This feature was especially valuable in reducing missed doses and ensuring timely intervention when necessary.

4. Battery Performance

The rechargeable battery provided an average of two weeks of continuous operation on a full charge. User feedback highlighted the importance of a low-battery alert, as some users missed doses when the device ran out of power unexpectedly.

4. Conclusion

The Smart Medicine Box utilizing NodeMCU represents a significant advancement in medication management, integrating Internet of Things (IOT) technology to enhance user compliance and health outcomes. This innovative device is designed to store medications securely while providing features that remind users when to take their doses, thereby minimizing the risk of missed medications. Additionally, the smart medicine box can incorporate features such as a digital display that shows upcoming doses and a compartmentalized storage system to organize medications by time or type. Some designs may also include sensors that monitor when the box is opened, providing data on usage patterns that can be useful for healthcare providers. Another important aspect is the potential for remote monitoring. Caregivers or family members can receive updates on the user's medication adherence, allowing for timely interventions if needed. This feature is especially beneficial for elderly patients or those with chronic conditions who may require assistance in managing their medications.

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Maharashtra, India Assistant Professor, Department of E&TC, H.S.B.P.V.T'S GOI, COE, A. Nagar, Maharashtra, India

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