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Smart Notification System on Medicine Dispenser

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Abstract

The principal objective of this project is to develop an intelligent medicine dispenser which has the capacity to automatically remind and supply medicine to the right person at the right time. It is useful to individuals who forget and make delays in taking their medication. This may cause severe health issues due to a lack of doses or the usage of the wrong type of medicine. The dispensing machine is placed on a NodeMCU ESP32 microcontroller. It is programmed in such a way that it dispenses medicine and reminds patients whenever they need to take it. In case the patient fails to consume the medicine, the system may be updated to notify of skipped doses. This intelligent system will make it easier for the patient to adhere to the medication schedule and be less dependent on family or caregivers' assistance. It is also equipped with Wi-Fi, which offers mobile notifications and remote viewing, giving it the convenience, stability, and simplicity.

1. Introduction

Health is an essential part of our lives. Keeping the machine in proper functioning has become more difficult in the modern age. Life is hectic for people as they have many daily responsibilities. Therefore, they are likely to miss many significant things. For patients with mild but manageable conditions, taking daily medication as prescribed is essential and should be regularly monitored. A family member or a caregiver should work together to make sure the patient takes the medicine at the right time. There is a problem if the house cannot be locked or unlocked because nobody is around to do so. Taking medicine with reminders or supervision is not always easy for families. The proposal aims to simplify the use of medicine by introducing a system that allows caregivers to keep track of when to give medication and remind the patient to take the right medicine at the right time. As the Internet of Things develops, items that were not connected before can now be linked. The Internet of Things (IoT) is both a theory and a design structure that unites people, systems, and devices in one network. In healthcare, IoT helps enhance our surroundings and lets us better keep track of health issues. This is aimed primarily at people who regularly need to take many medicines. They could forget to take their medicine or choose to take the wrong one by mistake. If patients take the wrong medicine, they may experience harmful effects. This system allows people to be reminded when to use their medicine by means of notifications on their smartphones. They proposed an advanced medicine box monitoring, analysis, and control system. The design is based on a smart and safe medical box that assists patients in taking their pill treatment on time [1]. Two main functionalities characterize this system's safety, which assures the well-being of the patient and the good functionality of the system. This system includes monitoring of the patient's medicine timing by linking up with their mobile phone application. The author discusses the IoT-based smart medical reminder device that is designed for the adult patient based on [2]. This project is designed to solve problems faced by patients. The paper explains the important role of the device and how IoT-based smart medical reminders are solving problems faced by patients with mild conditions.

2. Problem Statement

For patients with mild but manageable conditions, taking daily medication consistently is essential and should be closely monitored to ensure effective treatment and prevent complications. Medication non-adherence is a big medical issue, as well as failure to take medicines according to the prescription of the doctor. Approximately one-half of the people with illnesses have been reported not to take medicine in the right way, normally due to forgetfulness, busy schedules, or just being perplexed [3]. It becomes more difficult when the family members are not at home because of work, and they are unable to monitor the patient throughout the day. A family member or caregiver may help with the daily follow-up of the missed doses or time changes. Features like medication reminders and remote monitoring can help make medication management easy for both the patient and the caregiver, since they will ensure that the patient takes their medicine at the correct time.

3. Literature Review

The 2023 article Intelligent Medicine Box for COVID-like Pandemic presents a medication dispenser using IoT technology to work in the context of a pandemic [4]. It employs an Android application which can be used to manage prescriptions, arrange appointments, and get reminders on time. Its cost and reminder feature aid in reminding one of taking medicine. The target of the project is elderly and health-oriented people who need to adhere to medication. The Arduino Uno-based smart box has an LCD display, a buzzer, an LED, a GSM module, and a real-time clock. It also alerts the caregivers or suppliers again and again until it gets the treatment, and is also able to alert the caregivers or suppliers when the medicine is low [5]. As much as it is good, the paper does not take a detailed review of the existing technologies and research thereof.

Other solutions that have been presented by professionals include medicine dispensers that have a 4-container storage capacity, alerts, and text messages to aid patients when managing medication schedules [6]. Nonetheless, patients, in their turn, and particularly elderly patients, can have some difficulty with filling the pills and running the stationary models. The Covid-19 pandemic brought IoT-based automated dispensers where patients could receive medicine by scanning the QR code, but some older users had trouble operating mobile applications [7]. The simpler versions that use alerts and sensors in LED were created to know whether medicine was consumed [8]. The alternative solutions were dispensers with caregiver remote monitoring through mobile apps [9]. Even more developed solutions involve a six-container system supported by pulse sensor, sound and light signals, caregiver monitoring and a movement system to facilitate access to medicine by patients [10].

4. Research Methods

This section provides an inventory of all the techniques used to finish the development prototypes of an IoT-based system on the Smart Notification system on the Medicine Dispenser. This project includes an overview of the proposed system, circuit design and 3D hardware design. Fig.1 shows the overall flowchart of the work.

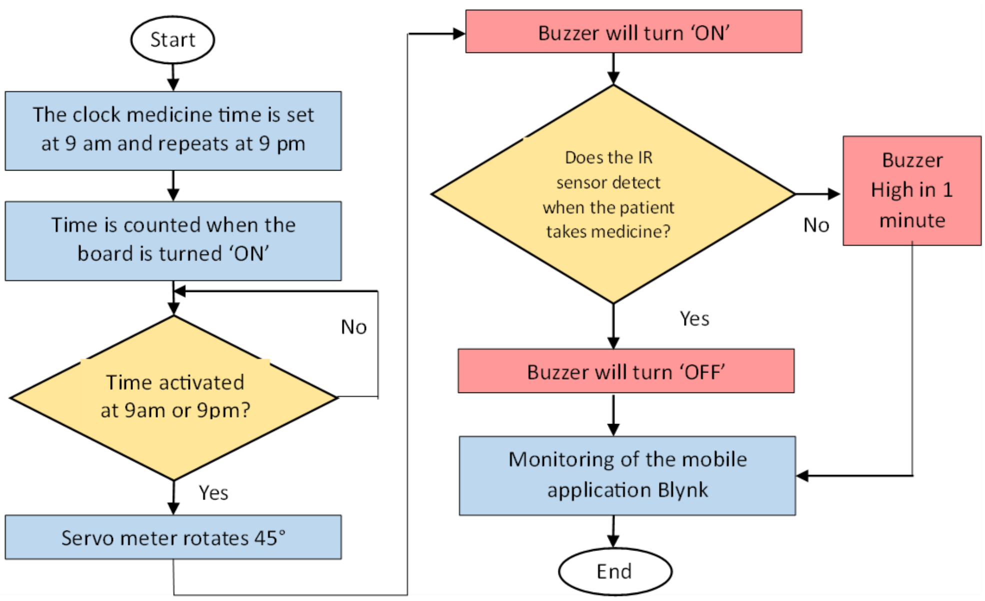


Fig. 1 *Overall flowchart of the work*

5. Circuit Design

The fundamental parts of a Wi-Fi-based smart notification system are the NodeMCU ESP32 Wi-Fi module, IR sensor, LCD I2C, buzzer as an alarm system, servo motor, and Blynk application. The Blynk application is considered one of the methods in the smart notification system. The system started with internet pairing between Wi-Fi devices and the NodeMCU ESP32 Wi-Fi module. After pairing, the data transmitted was then converted from analog to digital form. Detection is triggered by the IR sensor module over I2C. The circuit holds an audio buzzer and a servo motor, and both are controlled using GPIO pins on the ESP32. Fig. 2 shows the schematic diagram of the main control and appliances.

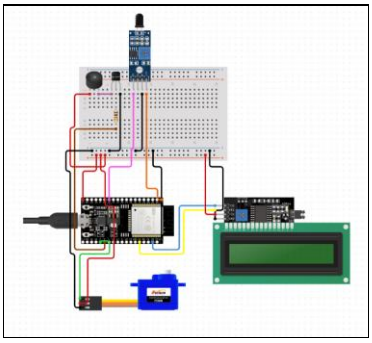


Fig. 2 *Schematic diagram of the main control panel and appliances*

6. Overview of the system

Fig. 3 shows the Serial Data (SDA) line runs on GPIO 21, with the Serial Clock (SCL) clock line running on GPIO 22. Most ESP32 boards rely on these pins for I2C communication, which is why they are often set up by the libraries. The IR sensor is connected to GPIO 14 and can work as an input or an output, so it's perfect for capturing sensor details. GPIO 12 is linked to the buzzer, which turns it on or can control the Pulse Width Modulation (PWM). However, take care with GPIO 12, as it is part of the ESP32 bootstrapping process. When the chip is inserted at the very start of booting, the system may not recognize the board. The problems should run with Boot; using a different GPIO might be a good solution. The servo control signals are PWM and are handled from GPIO 13. Always give power to servos from 5V or a different source, and do not use the 3.3V pin on the ESP32.

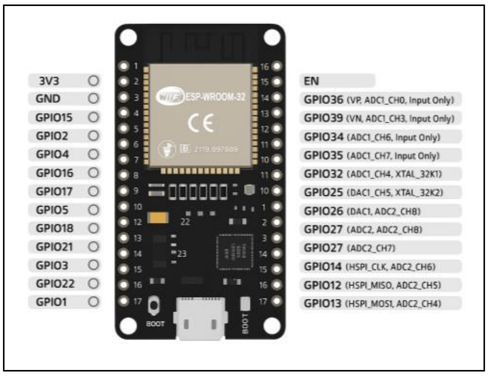
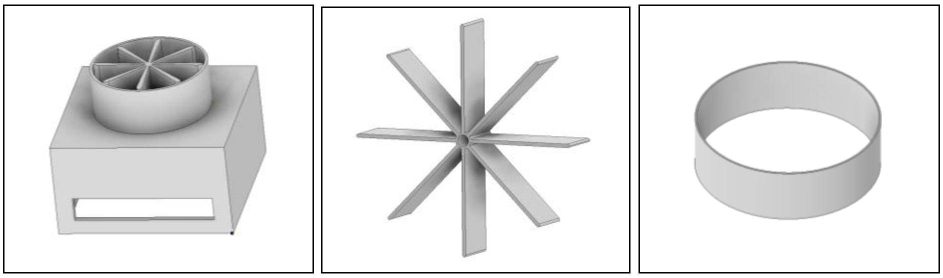


Fig. 3 *ESP32 NodeMCU Development Board*

7. 3D Design of Project Using Software Autodesk Inventor

Fig. 4 shows the 3D design of the project implementation using Autodesk Inventor. This software is advanced software for computer-aided design, which is widely applied for mechanical design.



(a) **(b)** **(c)**

Fig. 4 *3D design using Autodesk Inventor (a) Design of project; (b) Blade design for a medicine dispenser; (c) Circular compartment design for a medicine dispenser*

8. Hardware Setup

Fig. 5 shows the hardware implementation of the system, consisting of a few pieces of electrical equipment. The circuit starts with the NodeMCU ESP32, which acts as a microcontroller. The NodeMCU ESP32 provides 5V from its Vin pin, which can be used to power components like the LCD, IR sensor, and servo motor. However, all the GPIO pins on the NodeMCU ESP32 only output 3.3V logic signals. The LCD I2C and IR sensor use 5V for power, but still communicate using 3.3V signals. The servo motor is powered by 5V and controlled by a 3.3V PWM signal. The buzzer also works with a 3.3V signal from the GPIO pin. So, power is mostly 5V, but all signals come from the NodeMCU ESP32's 3.3V GPIO. In this system, the Wi-Fi module relates to a computer that acts as a smart notification system.

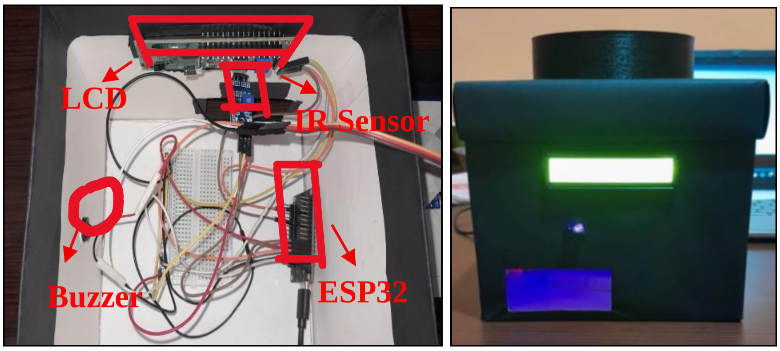
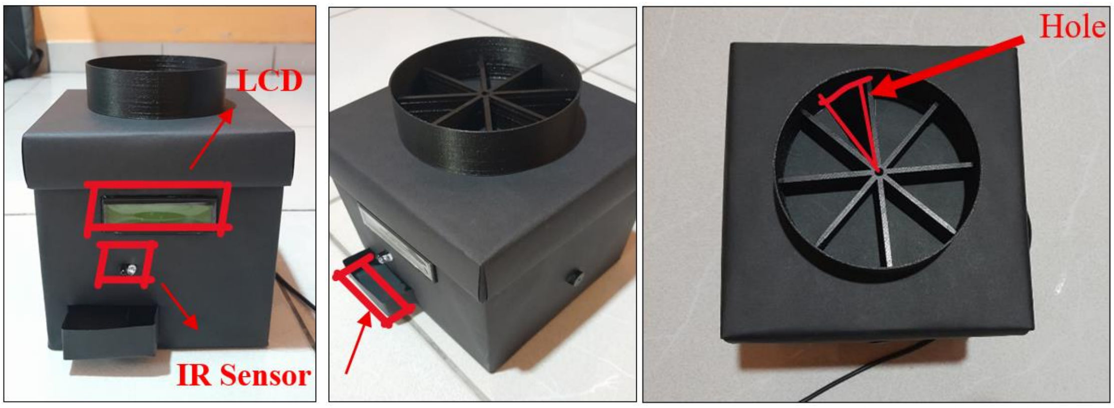


Fig. 5 *The Smart notification System on Medicine Dispenser Wi-Fi based circuit connection and hardware implementation*

9. 3D Design

The final 3D design in Fig. 6 includes both the mechanical and electronic parts. The mechanical part consists of the servo motor that rotates to release pills. It focuses on the dispensing mechanism.



(a) **(b)** **(c)**

Fig. 6 *Final 3D design (a) 3D design completes with LCD and IR sensor; (b) A place where patients are taking pills; (c) A hole where the pill falls and slides when released by the servo motor*

9.1 Component Testing

This part shows the test results for each of the components.

9.2.1 Connecting Wi-Fi to NodeMCU

Fig. 7 shows that the component testing for connecting Wi-Fi to the NodeMCU ESP32 involves verifying the module's ability to detect and connect to available wireless networks. This includes ensuring that NodeMCU's firmware is up-to-date and correctly configured for Wi-Fi operations. Testing begins with loading a basic Wi-Fi connection sketch onto the NodeMCU using the Arduino IDE or another compatible platform. This sketch should include functions for scanning nearby networks, selecting the appropriate SSID, and inputting the correct password.

Fig. 7 *Wi-Fi connected to NodeMCU ESP32*

9.2.2 LCD Testing

Fig. 8 shows the LCD testing with NodeMCU and Wi-Fi, which involves controlling the LCD through wireless commands sent to the NodeMCU. This setup typically includes NodeMCU. A real-time clock is used for alarm settings to synchronize time for medication timing display on the LCD screen. The testing process starts by writing and uploading a sketch to the NodeMCU that connects to the Wi-Fi network. Testing verifies that the LCD responds to the commands and that the NodeMCU maintains a stable connection to the network.

Fig. 8 *LCD connected to the circuit*

9.2.3 IR Sensor and Servo Motor Testing

Fig. 9 shows the IR sensor and servo motor testing with NodeMCU and Wi-Fi focusing on the real-time clock, which is used for alarm settings to synchronize time for medication timing display. Once it's the time set for medicine, the system triggers the buzzer with a beeping alarm. Similar to LCD testing, this setup requires the NodeMCU; the system tells a servo motor to spin and release a pill.

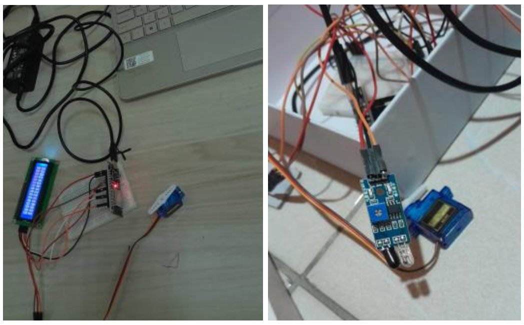


Fig. 9 *IR sensor and servo motor connected to the circuit*

9.2.4 Instruction on LCD Display

The LCD display will show the medicine time and the instruction as in Fig. 10 after the IR sensor detects the hand when the patient takes their medicine at the correct time.

Fig. 10 *Display on the LCD (a) When time interval to take medicine; (b) When the time interval to the medicine time; (c) When the time interval to the medicine taken; (d) When the time interval for the medicine is not taken*

9.2.5 Blynk Application

This smart notification system is controlled by using an Android phone. Thus, mobile applications are developed as monitoring devices. The Blynk application is used because it is an open-source web application that allows users to create their own application on Android. The Android software development kit started by creating an account in Blynk. The Blynk can be downloaded from the Android Play Store and the web server. After creating an account, the notification will be sent on the smartphone application, such as "Medicine Taken" and "Medicine Missed," to the user or the patient's family member. Fig. 11 shows the interface of the Blynk Notification System on a smartphone. Fig. 12 shows the interface of the Blynk Notification System Through Email.

Fig. 11 *The Interface Blynk Notification System on Smartphone*

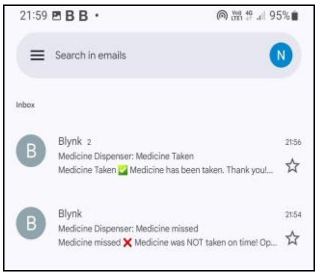


Fig. 12 *The Interface Blynk Notification System Through Email*

10. Discussion

This project aims to address an emerging serious healthcare challenge, that of medication non-adherence. Memory issues, busy lifestyles and absence of monitoring often cause many patients to forget, postpone or fail to take their medication. It may lead to a lack of efficacy of treatment or even grave health hazards. This project will dispense the medication and remind the user to take it on time, which will allow for the development of a method that is reliable in terms of dispensing in case the patient forgets to take medication or runs out of medication. Some of the parts used in the creation of the system during the development process led to the creation of the interacting and responsive device, which includes LCD I2C, IR sensor, servo motor, and buzzer. This system was made to administer the medicine at definite intervals and include buzzer system signals as reminders for the patient. In a case where the patient forgets to take the medicine, the system can be further developed to record the missed dose or alert family members via mobile notifications through Wi-Fi connection. Customization and scalability are two of the greatest advantages of the project. The time of dispensing medicine is easily customized depending on the prescription of the patient. Moreover, the application of IoT characteristics enables monitoring remotely, which is beneficial to those taking care of the patient and who are not always physically present. But one of the problems that were faced was the right timing and precision of synchronization between the programmed schedule and the hardware components. Although there were certain shortcomings, such as reliance on a stable Wi-Fi connection to send mobile notifications, the overall functioning of the system was effective in automating medication reminders and dispensing. Introducing the modules of a real-time clock, or the integration of a mobile application, could make the smart medicine dispenser even more productive and manageable.

11. Result and Analysis

According to the graphs, which were shown in Fig. 13 and Fig. 14, the analysis of the notification system results shows that patients respond positively towards the medication adherence. As shown in Fig. 13, most of the captured events were classified as *Medicine Taken* (25 occurrences), while only 6 instances were categorized as *Medicine Missed.* It implies that the reminder system is also effective, as it helps to make the patients take their medicine on time. This is further proved in Fig. 14, which charts all the responses through the device, in which the medicine dispenser recorded 25 successful intakes and 6 missed intakes. Table 1 shows the reminder log where the patient demonstrated inconsistent medication adherence, with several missed doses noted in both morning and evening schedules. Specifically, morning doses were more frequently missed compared to evening doses, as highlighted in the log.

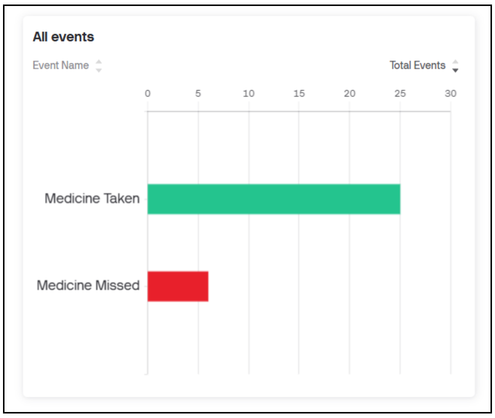


Fig. 13 *Timing Notification Graph*

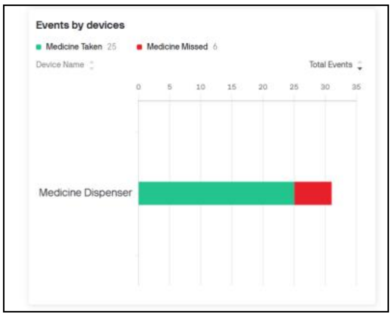


Fig. 14 *Sum up all of the Responses in the Notification System*

Table 1*: Reminder Log*

Date	9 AM	9 PM	Remarks
27/5/2025	Missed	Taken	Patient missed 9 AM
1/6/2025	Taken	Taken	Successfully taken
5/6/2025	Missed	Taken	Patient missed 9 AM
6/6/2025	Taken	Missed	Patient missed 9 PM
7/6/2025	Missed	Taken	Patient missed 9 AM
11/6/2025	Taken	Taken	Successfully taken
16/6/2025	Taken	Missed	Patient missed 9 PM
18/6/2025	Taken	Taken	Successfully taken
20/6/2025	Taken	Missed	Patient missed 9 PM

12. Conclusion

The design of a smart medicine dispenser is an effective solution to one of the most frequent issues of incorrect or missed medication consumption, which may result in the development of severe health conditions. With the central control unit serving the role of the NodeMCU ESP32 microcontroller, the system can automatically deliver the proper medication at the correct time and remind the patient of it with alerts. Also, it is possible to extend the functionality of the system to cover such functions as tracking missed doses and notifications using mobile devices on Wi-Fi connections. This means that family members or the healthcare givers can easily observe the medication schedule of the user remotely. Smart medicine is particularly useful to patients. Comprehensively, the project indicates that technology can enhance medication management as well as limit the amount of human error to achieve greater health outcomes. The system is comfortable, dependable, and easy to operate, thereby improving the quality of life among patients and helping them to largely comply with given treatments.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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