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Automatic Pillbox System

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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, buzer, ESP8266,Jumper wires, LED, Battery, Breadboard

I. 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.

Key contributions of this endeavour include:

Design and Implementation of a Smart Pill Dispensing Mechanism. A programmable, microcontroller-based pill box capable of dispensing medication a user-defined intervals,reducing dependency on manual intervention.Integration of Real-Time Alerts and Reminders Development of an intuitive alert system using audiovisual signals to notify user of scheduled dosages, thereby enhancing adherence and minimizing missed doses.IoT- Enabled Monitoring and Notification System

Implementation of connectivity features that allow remote monitoring and real-time notifications to caregivers or family members, improving oversight for dependent users.User- Centric Interface for Configuration and Customization A simple yet robust interface enabling users or healthcare providers to configure medication schedules and adjust settings as per individual requirements.

Problem Statement

Medication adherence is a critical component of effective healthcare management, yet it remains a significant challenge, particularly among the elderly and patients with chronic conditions who are prescribed complex medication regimens. Traditional pillboxes lack the intelligence and interactivity required to ensure timely and accurate medication intake, often leading to missed doses, overdoses, and adverse health outcomes. Furthermore, the absence of real-time monitoring and alert mechanisms places an additional burden on caregivers and healthcare providers.

There is a pressing need for a smart, automated solution that can bridge the gap between prescription and consumption, ensuring that medications are taken correctly and on schedule. The Automatic Pill Box System aims to address this challenge by leveraging embedded systems and IoT technologies to automate pill dispensing, deliver timely reminders, and provide real-time compliance tracking. This research seeks to design, implement, and evaluate a robust and user-centric system that enhances medication adherence, promotes patient independence, and reduces preventable healthcare risks associated with non-compliance

II. LITERATURE REVIEW

Abdallah Kassem, et. al., (2019) provide a comprehensive approach for a Smart Medicine Dispenser (SMD) prototype.The main purpose of the proposed system is to help patients, mainly seniors, and elderly people, take their medications on time in an easy manner without the possibility of skipping pills and thus reducing the risk of accidental over/under dose treatment.

An Android application is developed that is responsible for controlling the whole system as it constitutes a database awaited to be synchronised and on synchronisation the data is sent by the application that determines which motor should be rotated.Nidhi Solanki, DR. P.

H. Zope (July 2020) desiged a Smart Pill Box using GSM technology by which the system sends SMS alerts to the consumers or patients on their mobile phones like a reminder message. They used a pillbox system containing three separate small pillboxes. Each box has a led display placed on the box. For the pill system, the user can store up to three different types of pills, which can be stored in those three small separate boxes. Their main objective was to provide fast curing of patients by taking medicines on time in an appropriate dosage and in an efficient manner Diaa Salama, Abdul Minaam. (2019) studied that consists of the conception, design and creation of a pillbox prototype intended to solve the deficiency in the medical area as it has the ability to sort out the pills by itself. The medication pill box is focused on patients who frequently take medications or vitamin

supplements, or attendants who deal with the more seasoned or patients. It has 9 compartment boxes as the previous paper consists of three and it has alert remainder set through Android application. The pillbox will remind clients or patients to take pills utilising sound and light.

III. METHODOLOGY

Overview of Development Approach

The automated pill dispensing system operates through a well-defined sequence of steps, integrating hardware and software to deliver medications accurately and reliably. Understanding its working principle requires examining both the setup phase and the operational cycle, as well as the interactions between its components.

Step 1: Initialization and WiFi Connection

Upon powering on, the NodeMCU initializes its hardware components and establishes a connection to a local WiFi network. The user must preconfigure the system with the network's SSID and password, which are stored in the firmware. Once connected, the NodeMCU retrieves an IP address, which is displayed on the LCD for reference. This IP address

serves as the entry point for accessing the web interface. The WiFi connection is critical, as it enables both NTP time synchronization and remote scheduling.

Step 2: Time Synchronization

After establishing connectivity, the system uses the NTPClient library to query an NTP server (e.g., pool.ntp.org) and fetch the current time. This process ensures that the system operates on a precise, real- time clock rather than an internal counter, which could drift over time. The synchronized time is updated periodically (e.g., every hour) to maintain accuracy and is displayed continuously on the LCD in a 24-hour format (e.g., "14:35"). This step is foundational, as the entire dispensing schedule depends on accurate timing.

Step 3: Schedule Configuration

Users access the web server by entering the NodeMCU's IP address into a browser on any connected device, such as a smartphone or laptop. The web interface presents a form where users can specify dispensing times for each of the three medications (e.g., "Medicine 1: 08:00, Medicine 2: 12:00, Medicine 3: 18:00"). These schedules are stored in the NodeMCU's memory and can be updated as needed. The system supports daily recurring schedules, with a reset mechanism triggered at midnight to prepare for the next day.

Step 4: Dispensing Operation

At each scheduled time, the NodeMCU compares the current NTP-synchronized time with the stored schedule. When a match occurs (e.g., 08:00), the corresponding servo motor activates. The motor rotates a predetermined angle (e.g., 90 degrees) to release a pill from its compartment, then returns to its resting position. Simultaneously, the LCD updates to display a message such as "Dispensing Medicine 1," and the buzzer emits a short, attention-grabbing tone (e.g., a 1-second beep). This multi-sensory feedback ensures the user is aware of the dispensing event.

Step 5: Daily Reset

To support recurring schedules, the system includes a reset function that clears the "dispensed" flags for each medication at midnight (00:00). This reset is triggered by the NTP clock and ensures that the system is ready to repeat the schedule the following day without requiring manual intervention. If a scheduled time is missed (e.g., due to a power outage), the system skips that event and resumes normal operation upon reconnection.

Key Components of the Solution:

Hardware Components Microcontroller Unit (MCU)
The system is centered around a microcontroller (e.g., Arduino Uno, ESP32), which orchestrates all the peripheral components, manages timing, and executes programmed logic for pill dispensing.

Pill Storage and Dispensing Mechanism

Pills are stored in separate compartments corresponding to dosage times. Servomotors or stepper motors are employed to control the release of pills from the respective containers based on the schedule.

Real-Time Clock (RTC) Module
An RTC module (e.g., DS3231) ensures precise timekeeping, enabling the system to trigger dispensing actions and reminders at pre-set times.

Alert and Notification System
The system uses buzzers, LED indicators, and optionally a speaker to alert the user when it is time to take medication. These signals enhance usability, especially for elderly users.

Display Unit
An LCD or OLED screen is integrated to show the current time, next scheduled dose, and system status. This improves user interaction and transparency.

Power Supply
The system is powered via a rechargeable battery or direct AC adapter, ensuring continuous operation.
Optional Connectivity Modules To support remote monitoring or app-based control, modules such as Wi-Fi (ESP8266/ESP32), GSM, or Bluetooth may be incorporated.

Software Components Scheduling Algorithm
Custom algorithms are implemented to manage medication timings. The schedule is user-defined and stored in the microcontroller's memory.

Embedded Firmware
The firmware controls the hardware components, executes timing logic, and handles inputs/outputs. Written in C/C++ (for Arduino) or MicroPython (for ESP-based boards), it forms the core of the system's intelligence.

User Interface (Optional)
In systems with connectivity, a mobile or web-based UI allows users or caregivers to input schedules, receive alerts, and monitor compliance.

Notification and Logging
Advanced systems may include features for SMS/email notifications and logging of pill dispensation events for review by caregivers or medical professionals.

Advantages
Improved Medication Adherence
The system ensures timely dispensing of medications, significantly reducing the chances of missed or incorrect doses, especially in elderly or cognitively impaired patients.

Enhanced Patient Safety
By minimizing human error in medication timing and dosage, the system helps prevent overdoses, underdoses, and drug interactions.

Convenience for Users and Caregivers
Automating the medication routine relieves both users and caregivers of the need to constantly remember and monitor medication times.

Real-Time Alerts and Notifications
Built-in buzzers, lights, and optional mobile notifications ensure users are reminded to take their medication even if they forget or are distracted.

Data Logging and Monitoring
Some systems can track medication history and generate compliance reports, aiding healthcare providers in treatment evaluation.

Remote Monitoring Capabilities
When integrated with IoT features, caregivers and family members can receive updates and alerts remotely, enhancing care for patients living alone.

Cost-Effective Long-Term Solution
Reduces the need for constant human supervision or nursing support, making it a scalable solution for home-based healthcare.

Customization and Flexibility
Supports multiple medication schedules, dosage configurations, and user profiles, accommodating a wide range of patient needs.

User-Friendly Interface
Many systems feature intuitive displays and interfaces that make it easy for users to understand the schedule and follow instructions.

Limitations of the Proposed System

Technical Limitations

Power Dependency: Most automatic pillboxes require a continuous power supply or regular battery charging.

Limited Storage: They often have a limited number of compartments, restricting how many days or doses they can manage.

Complex Medication Schedules: May struggle with handling irregular or complex dosing regimens (e.g., alternate day medications, variable dosages).

Mechanical Failures: The dispenser mechanism can jam or malfunction, leading to missed or incorrect doses.

User-Related Limitations

Elderly or Disabled Usability: Some elderly or disabled users may find it hard to operate or refill the device.

Lack of Technical Literacy: Not suitable for users who are uncomfortable with technology or smartphones if the system includes app integration.

Refill Responsibility: The system doesn't usually track pill levels or automatically refill, requiring manual intervention.

Cost & Accessibility

High Initial Cost: Smart pillboxes can be expensive compared to traditional methods like pill organizers.

Availability: Advanced models may not be readily available in all regions, especially in rural or underdeveloped areas.

Security and Privacy

Data Privacy: If connected to apps or cloud services, user medication data could be exposed to privacy risks.

Unauthorized Access: Without proper locking, others might access or tamper with the medication.

Future Scope

- **Integration with Smart Healthcare Systems** Connect with hospital databases or Electronic Health Records (EHRs) to automatically update prescription schedules. Enable remote monitoring by doctors or caregivers for real-time compliance tracking
- **AI and Machine Learning Enhancements** Use AI to learn user behavior and optimize reminder timings. Predict missed doses and alert users or caregivers proactively.
- **Advanced Medication Management**

Supportfor liquid or injection-based medications with add-on modules.Voice control for accessibility (e.g., Alexa/Google Assistant integration).

- **Telemedicine Compatibility**

Sync with telehealth platforms for virtual consultations and automated prescription updates.

- **Mobile App and Cloud Integration**

Offer mobile apps with personalized health analytics and adherence reports.

Enable cloud backup and multi-device access for caregivers and family.

- **Real-Time Refill Alerts and Automation**

Alert pharmacies or caregivers when medication is running low. Automate refills through integration with online pharmacies.

- **Security Improvements**

Use biometric authentication (fingerprint/face recognition) to ensure only the patient accesses the medication.

- **Scalable and Modular Designs**

Develop modular pillboxes for different user needs (e.g., weekly vs. monthly schedules, multiple users).

Use 3D printing for customized compartments.

IV. CONCLUSION

The Automatic Pillbox System represents a significant advancement in the domain of patient-centered healthcare technologies. By automating the process of medication dispensing and incorporating intelligent reminders, the system addresses critical challenges related to medication adherence, particularly among the elderly and patients managing chronic illnesses. It minimizes the risk of human error, enhances treatment efficacy, and empowers users to manage their health more independently.Despite certain

limitations—such broader e-health ecosystems. Future enhancements involving IoT connectivity, artificial intelligence, and cloud-based health record synchronization could further elevate its functionality, transforming it into a holistic and intelligent medication management solution.In essence, the project not only contributes to the field of assistive medical technology but also lays the foundation for more adaptive and responsive healthcare systems in an increasingly digital world.

REFERENCES

1. Abdallah Kassem, A Comprehensive Approach for A Smart Medication Dispenser, International Journal of Computing and Digital Systems, March 2019, ISSN 2210- 142X.
2. Nidhi Solanki, and DR. P. H. Zope "Smart Pill Box Health Care System" International Research Journal of Engineering and Technology, Volume: 05, Issue: July 20120, e-ISSN: 2395-0056.
3. Diaa Salama Abdul Minaam, and Mohamed Abd-ELfattah, Smart drugs: Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System, Future Computing and Informatics Journal, Volume 3, Issue 2, 2019, ISSN 2314-7288.
4. Ekbal Rosli and Yusnira Husaini, "Design and Development of Smart Medicine Box" 2022 IOP Conf. Ser.: Mater. Sci. Eng. 341 012004.
5. Mohammed Asad Fasahate, International Journal of Scientific & Engineering Research, Volume 9, issue 2, February 2020, ISSN 2229-5518.
6. Jabeena, A. K. Sahu, R. Roy and N. S. Basha, "Automatic pill reminder for easy supervision," 2019 International Conference on Intelligent Sustainable Systems (ICISS), Palladam, 2020, pp. 630-637, doi: 10.1109/ISS1.2017.8389315.