

MediMind: A Low-Cost ESP32-Based Smart Pill Reminder System for Elderly Medication Adherence

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Abstract - Elderly individuals managing illnesses and chronic conditions such as hypertension, arthritis, diabetes, etc., often need to take multiple medicines at fixed times every day, and it is very common for those doses to be missed because they were forgotten due to not only old age, but also the diseases causing them to forget. This paper presents Medi Mind, a low-cost, battery-powered smart pill reminder device built around the ESP32-WROOM-32D microcontroller. The device uses a DS3231 real time clock module to keep accurate time, a 0.96-inch OLED display to show the current time and the set reminder, three push buttons to set the reminder time, and a buzzer with an LED to alert the user audibly and visually. It is powered by a rechargeable, 3.7 V, 1500 mAh Lithium-Ion battery charged through a TP4056 module through USB Type-C, making it fully portable. Because the ESP32 has built-in Wi-Fi, the device is also designed to be used with a smartphone application that will let a caregiver set schedules remotely through the app and view whether a dose was taken or not. This paper documents the ideation, design, circuit schematic, and working of the prototype, and presents it as a simple, affordable piece of assistive technology for elderly medication adherence.

Keywords - ESP32; Pill Reminder; Elderly Care; Assistive Technology; DS3231 RTC; OLED Display; IoT Healthcare; Medication Adherence

I. INTRODUCTION

Forgetting to take medicine on time is one of the most common and most preventable reasons for elderly patients to end up with poor health outcomes. As people age, it becomes harder to keep track of multiple prescriptions, each with its own timing, and a missed or delayed dose of medicine for conditions like high blood pressure or Alzheimer's can have serious consequences. Most existing solutions are either too expensive for everyday households, such as automatic pill dispensers, or rely on the elderly person owning and actively using a smartphone for a reminder app, which is not always realistic.

This project began as a personal and hands-on attempt to solve this problem with a device that meets these criteria: it should be simple enough for an elderly person to use, it does not depend on a smartphone to function, and it is inexpensive enough to build using easily available components. The result is our product MediMind, a compact ESP32-based device that keeps real-world time, lets a caregiver set a daily reminder using three buttons, and alerts the user with a buzzer and an LED when it is time to take medicine. Because the ESP32 has built-in Wi-Fi, the same

hardware can later be extended with a mobile app, without any change to the physical device.

II. RELATED WORK

A few IoT-based medicine reminders and pill-dispensing systems have been seen in recent technology. Existing work ranges from smart pill dispensers connected to a caregiver facing mobile application that schedules and fills the pillbox remotely, to dispensers that add sensors and even facial recognition or fingerprint recognition to confirm the correct patient is taking the dose. Other systems combine a Wi-Fi-enabled microcontroller with cloud logging, so caregivers can remotely verify adherence, while some designs add RFID-based authentication to prevent an incorrect medicine from being accessed.

Most of these systems are aimed at fully automatic dispensing and therefore involve motorized compartments, sensors, and cloud infrastructure, which increases both cost and complexity. MediMind takes a much simpler approach on purpose: rather than dispensing the medicine itself, it focuses on being a reliable, low-cost reminder which keeps the bill of materials small while still leaving room to add remote scheduling through Wi-Fi in the future.

III. PROPOSED SYSTEM

A. System Overview

MediMind is built around the ESP32-WROOM-32D development board, which reads three push buttons for user input, communicates with a DS3231 real-time clock module and a 0.96-inch OLED display over the I2C bus, and drives a buzzer and an LED to generate the reminder alert. The whole system runs off a 3.7 V, 1500 mAh Li-ion battery, charged through a TP4056 module via a USB Type-C port, which keeps the device cordless and rechargeable like any modern portable gadget.

B. Hardware Components

Table I lists the main components used in the prototype and the role each one plays in the system.

TABLE I. MAIN HARDWARE COMPONENTS

Component	Function
ESP32-WROOM-32D (30-pin)	Main microcontroller; handles timing logic, button input, display output, and future Wi-Fi connectivity
DS3231 RTC module (with AT24C32 EEPROM)	Keeps accurate real-world time via I2C, independent of microcontroller resets or power loss
0.96" OLED display (SSD1306, I2C)	Displays current time and the set reminder time to the user
3 × tactile push buttons (SET, +, −)	Used to enter time-setting mode and increment/decrement the reminder time
Active buzzer (9×4 mm)	Provides an audible alert when the medicine reminder time is reached
Status LED with current-limiting resistor (R1, 330Ω)	Provides a visual alert alongside the buzzer
TP4056 Li-ion charging module (USB Type-C)	Charges the battery safely and regulates charge current
3.7 V, 1500 mAh Li-ion battery	Powers the device, allowing portable, cordless operation

C. Firmware Development

The firmware for MediMind was written and uploaded using the Arduino IDE, chosen for its simplicity. Support for the ESP32-WROOM-32D was added to the IDE through the ESP32 board manager package, after which the board was selected as an "ESP32 Dev Module" and programmed directly over USB using the onboard CP2102/CH340 USB-to-serial interface. Standard open-source libraries were used to interface with the peripherals: the *Wire* library for I2C communication, an *RTCLib*-based library to read and set time on the DS3231 module, and the *Adafruit_SSD1306* and *Adafruit_GFX* libraries to render text on the 0.96-inch OLED display. The three push buttons were read using simple digital input pins with software debouncing, while the buzzer and LED were driven directly through *digitalWrite()* calls. The Arduino IDE's built-in Serial Monitor was also used during development to debug RTC readings and button states before finalising the logic shown in Fig. 2.

IV. CIRCUIT DESIGN

Fig. 1 shows the complete circuit schematic of the device, drawn in EasyEDA. The three push buttons (SET, + and −) are wired to GPIO pins on the ESP32 and read as digital inputs by the firmware, with the SET button used to enter and confirm time-setting mode and the + / − buttons used to increase and decrease the hour and minute values. The buzzer and the status LED are each driven directly from a GPIO pin. The OLED display and the DS3231 RTC module share the same I2C bus (SDA/SCL lines), which keeps the wiring minimal since both peripherals can be addressed over the same two wires. On the power side, the TP4056 module takes 5 V from a USB Type-C connector to charge the 3.7 V Li-ion battery, whose output feeds the ESP32's VIN pin, with the

board's onboard regulator supplying the 3.3 V rail used by the RTC and OLED.

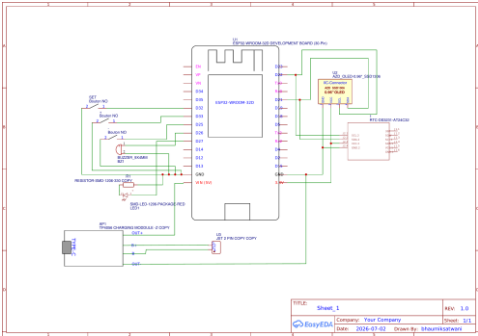


Fig. 1. Circuit schematic of the MediMind pill reminder device.

V. WORKING PRINCIPLE

A. Setting the Reminder Time

The user presses the SET button to enter time-setting mode. The + and − buttons are then used to increase or decrease the hour and minute values shown on the OLED display. Pressing SET again confirms the chosen time, which is then held by the DS3231 RTC module, so the reminder time is retained even if the device is reset or momentarily loses power.

B. Generating the Alert

In normal operation, the ESP32 continuously reads the current time from the RTC module and compares it against the stored reminder time. When the two match, the ESP32 activates the buzzer and the status LED, giving the user both an audible and a visual cue, which is useful given that many elderly users have some degree of hearing or vision difficulty, that it is time to take their medicine

C. Display and Power

The OLED continuously shows the current time alongside the set reminder time, so that a caregiver can glance at the device and confirm it is configured correctly without needing to press any buttons. The entire circuit is powered from a 1500 mAh Li-ion battery, which is charged through the TP4056 module whenever the device is plugged in over USB Type-C, similar to charging a power bank.

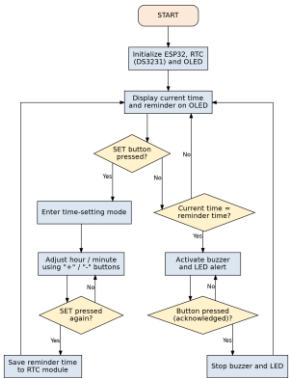


Fig. 2. Working flow of the MediMind firmware, covering time setting and reminder alerts.

VI. FUTURE SCOPE: WI-FI COMPANION APP

The ESP32 was specifically chosen for this project for its built-in Wi-Fi communication, which is not yet used in the current prototype but is central to where this project is headed next. The planned companion smartphone application will allow a caregiver to connect to the device over Wi-Fi and remotely configure multiple daily reminders, each labelled with the name of the medicine to be taken, instead of the single reminder that can currently be set using the physical buttons alone. The app is also intended to log whether a reminder was acknowledged, and to notify a caregiver if a dose appears to have been missed, turning the standalone device into a connected medication-adherence system without changing any of the underlying hardware.

VII. RESULTS AND OBSERVATIONS

The prototype was assembled and tested on breadboard-level hardware matching the schematic in Fig. 1. The DS3231 module reliably kept accurate time, the OLED correctly displayed both the current time and the set reminder, and the buzzer-and-LED alert triggered as expected once the current time matched the configured reminder time. The button-based interface (SET, +, -) proved simple enough to operate without instructions, which was an important design goal given the target users. Battery-powered operation through the TP4056 charging circuit also worked as intended, confirming that the device can run untethered from a USB power source once charged.

VIII. CONCLUSION

MediMind demonstrates that a genuinely useful piece of assistive technology for elderly medication reminders can be built from a small set of inexpensive, readily available components: an ESP32, a DS3231 RTC, an OLED display, a few buttons, a buzzer, an LED, and a rechargeable battery circuit. The current prototype reliably keeps time and reminds the user with an audible and visual alert, and its use of an ESP32 leaves a clear, low-effort path toward a Wi-Fi-connected companion app for caregivers. Future work will focus on building that application, adding support for multiple daily medicine reminders, and packaging the electronics into a compact, elderly-friendly enclosure.

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