IoT-MedConnect: A Time-Controlled Smart Medicine Dispenser with Real-Time Monitoring

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***Abstract*—Medication non-adherence, particularly among elderly and chronic patients, leads to significant health risks and increased hospitalization. This project presents "IoT-MedConnect," an automated system utilizing Arduino UNO, ESP32, and a SIM800L GSM module to provide time-regulated physical access to medication. Unlike traditional reminder applications, this system employs IR sensors to verify physical pill removal and synchronizes data with a real-time monitoring dashboard. The implemented system demonstrates high efficiency in preventing overdose and missed doses by utilizing a physical solenoid locking mechanism and an automated cellular alert protocol that initiates a voice call via the SIM800L module to caregivers if a dose is missed.**

***Index Terms*—IoT, Arduino, ESP32, SIM800L, GSM Module, Healthcare Automation, Physical Access Control.**

I. Introduction

Many patients struggle with complex medication schedules, leading to missed doses or accidental overdoses. Existing digital reminders can be easily ignored and lack the physical restriction necessary to prevent incorrect intake. The motivation behind this project is to provide a low-cost, automated, and reliable solution that ensures proper medicine intake through physical barriers and supports caregivers through remote monitoring. We chose to implement this to bridge the gap between software reminders and physical safety.

Standard pill organizers are passive and rely entirely on human memory. Previous IoT research has introduced smart boxes that send mobile notifications; however, few incorporate physical access control or redundant communication paths. Recent works in the field of Smart Healthcare have explored using ESP32 for cloud logging, but verified pill removal through a combination of IR sensing, physical solenoid locking, and GSM-based emergency calling remains a robust method for preventing medication errors even during internet outages.

IoT-MedConnect introduces a dual-layer verification system. Not only does the box rotate to the correct slot (Morning/Noon/Night) using an RTC module, but it also physically locks access using a solenoid valve. The most innovative feature added is the integrated SIM800L GSM module. If the IR sensor does not detect pill removal within the defined window, the system triggers a direct cellular voice call to the caregiver, providing a high-priority alert that functions independently of Wi-Fi availability.

II. Proposed Method

A. Block diagram of the overall system

The system architecture consists of a master controller (Arduino) and communication bridges (ESP32 and SIM800L) working in tandem with various sensors and actuators.

The DS3231 RTC module maintains precise time for scheduling. The Arduino compares time data with the schedule to trigger the Servo Motor for rotation and the Solenoid for locking. IR sensors verify if the medicine is removed. The

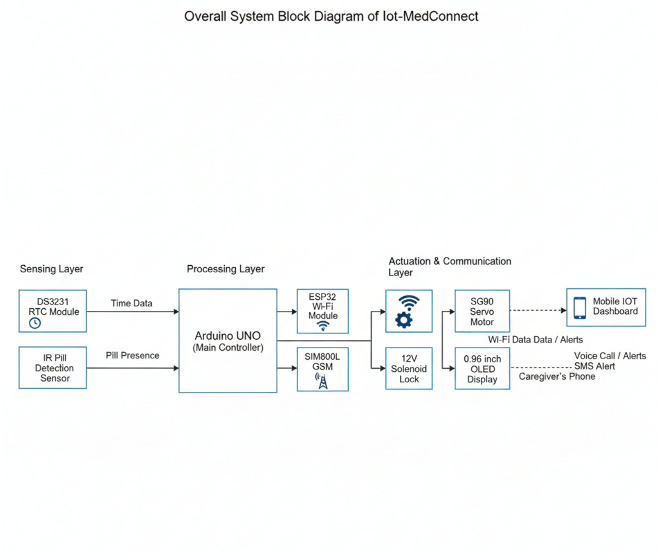

Fig. 1. Functional Block Diagram illustrating the integration of Sensing, Processing, and Communication layers.

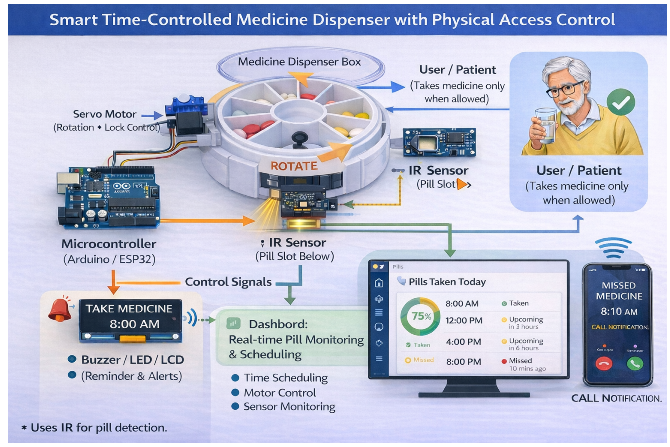

Fig. 2. Physical System Integration showing the dispenser assembly and controller units.

ESP32 updates the web dashboard in real-time. Simultaneously, the SIM800L module manages cellular communication to place emergency calls if a dose is neglected.

III. Implemented Hardware System

A. Hardware and Software Environment

The following hardware equipment was utilized:

- **Arduino UNO:** Central logic and actuator controller.
- **ESP32:** Wi-Fi module for cloud connectivity and dashboard updates.
- **SIM800L GSM Module:** For placing automated voice calls to caregivers.
- **RTC Module (DS3231):** High-precision timekeeping.
- **IR Sensor:** For pill presence detection and intake verification.
- **Servo Motor (SG90):** For rotating the dispenser groups.
- **Solenoid Lock Valve:** For physical access control.
- **OLED Display (0.96 inch):** User interface for status messages.

The project was developed using the Arduino IDE (C++) for firmware and a Web-based IoT platform for the real-time monitoring dashboard.

B. Hardware System Implementation

The hardware consists of a circular 3-compartment container mounted on a servo motor, with the solenoid lock positioned to prevent manual opening. The SIM800L is equipped with an external antenna to ensure signal stability during emergency calls.

Fig. 3. All Components Used

TABLE I
HARDWARE COMPONENT SPECIFICATIONS

Component	Model	Function
Microcontroller	Arduino UNO	Main Logic
Wi-Fi Module	ESP32	IoT Dashboard
GSM Module	SIM800L	Emergency Calling
Time Module	DS3231 RTC	Scheduling
Sensor	IR Module	Intake Verification

IV. Results

The system was tested against three daily medication schedules. Testing confirmed that the system remains physically locked outside of scheduled windows. At the trigger time, the dispenser rotated to the correct slot and unlocked the solenoid.

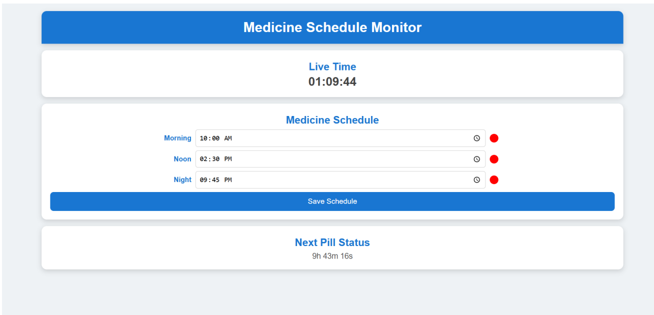

Fig. 4. Web-based "Medicine Schedule Monitor" showing Live Time and Adherence tracking.

1) **Normal Intake:** The IR sensor detected pill removal, and the dashboard updated the status indicators accordingly.
2) **Missed Dose:** When the pill was not removed after the 30-minute window, the ESP32 pushed an alert to the dashboard. Simultaneously, the SIM800L successfully initiated a cellular voice call to the registered caregiver's mobile phone.

V. Discussion

Limitations: The SIM800L GSM module requires a consistent 3.7V-4.2V power supply with a high peak current (2A) to prevent restarts during call initialization.

[P2] Conflicting Requirements: A trade-off was made between simplicity (Wi-Fi only) and reliability (GSM). We chose to integrate the SIM800L to satisfy the requirement for a fail-safe alert system that functions even when Wi-Fi is unavailable.

[P4] Impact: This project impacts the field of geriatric medicine by applying CSE principles in embedded systems to solve a regular real-world healthcare challenge.

[P7] Interdependence: The hardware modules are highly interdependent; the calling module (SIM800L) depends on software triggers generated by the sensing module (IR) and the timing module (RTC).

P1	P2	P3	P4	P5	P6	P7
✓	✓		✓			✓

TABLE II
Complex Engineering Problem Mapping.

VI. Conclusion

IoT-MedConnect effectively ensures medication adherence through automated scheduling, physical locking, and redundant communication paths. The system's ability to provide both web-based tracking and cellular-based voice alerts ensures maximum reliability for elderly patients.

Acknowledgment

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