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Smart Pill Management System for Elderly Patients

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Peer Review Information	Abstract
<p><i>Submission: 28 Jan 2026</i></p> <p><i>Revision: 20 Feb 2026</i></p> <p><i>Acceptance: 06 March 2026</i></p>	<p>Abstract</p> <p>This paper presents a Smart Pill Management System for Elderly Patients is developed to assist individuals particularly senior citizens and patients with strict medication routines in taking their medicines on time. Many elderly patients often forget their daily doses due to memory issues, busy schedules, or complex medication charts. Missing doses or taking incorrect dosages can lead to serious health risks. Therefore, an automated and reliable solution becomes essential to ensure proper medication adherence.</p> <p>This project uses an Arduino Nano as the main controller and integrates electronic components reminders and remote notifications. Each LED is assigned to a specific medicine time slot, such as morning, afternoon, and evening. At the scheduled time, the corresponding LED glows, the buzzer activates, and the LCD displays a message indicating which medicine should be taken. This ensures that the patient receives a clear and timely reminder.</p> <p>To enhance safety and supervision, the system also features a GSM-based alert mechanism. If the patient does not take the medicine within a predefined duration, the GSM module automatically sends an SMS alert to a caregiver or family member. This remote monitoring feature ensures accountability, provides peace of mind to caregivers, and reduces the chances of missed doses.</p> <p>The system is cost-effective, easy to operate, and highly reliable, making it suitable for home-based healthcare. It reduces dependency on memory, prevents medication errors, and promotes consistent medicine intake. The project demonstrates how simple, low-cost embedded components can be combined to create an efficient solution to a real-world healthcare challenge.</p>
<p>Keywords</p> <p><i>Smart Pill Management System, Elderly Patients, Medication Reminder, Arduino Nano, GSM Module, Automated Healthcare.</i></p>	

Introduction

Medication adherence is a critical factor in elderly healthcare, where timely consumption of prescribed medicines significantly influences treatment outcomes. Many elderly individuals require multiple medications throughout the day, increasing the chances of missed or incorrect doses. Traditional methods such as pillboxes, mobile alarms, or caregiver supervision are often insufficient because they lack automated

tracking or communication capabilities. To overcome these limitations, smart medication reminder systems have emerged as an effective technological solution. These systems use embedded electronics and wireless communication to guide patients and inform caregivers. The Smart Pill Management System presented in this work aims to provide an affordable and user friendly approach that ensures timely medication intake through alerts,

acknowledgment, and remote monitoring. The system integrates simple and lowcost components like an Arduino Nano, buzzer, LEDs, LCD module, and GSM modem to create an automated reminder device capable of notifying caregivers in case of missed doses. This enhances patient safety, reduces dependency, and helps improve overall medication adherence.

Background and Related Work

Literature Review and Background: Elderly patients face increasing challenges in managing complex medication regimens due to factors such as memory decline, vision impairment, and cognitive disorders. Traditional pill organizers, such as weekly pillboxes, are widely used among elderly individuals but heavily depend on the user's memory and offer no mechanism to alert users or verify medication intake. To address these limitations, researchers have explored various electronic and automated pill management systems. Early advancements include alarm- based reminders and digital pillboxes with buzzers or lights, which provide scheduled alerts but lack real-time monitoring or caregiver integration. In response, embedded systems using microcontrollers like Arduino and Raspberry Pi scalability and are not connected to cloud platforms for remote monitoring. Several smart medicine boxes have been developed in recent years to improve medication adherence. Savithaa N. et al. (2021) designed a box with an Android app that alerts users and uses LEDs to indicate the correct compartment. Divya Sai K. et al. (2021) integrated IoT with sensors and a buzzer for scheduled alerts. Anandhapadmanaban S. et al. (2020) included a cold storage option and vital sign monitoring. Nur Zulaikhah et al. (2020) used Blynk app with magnetic and LDR sensors to track medicine intake. Harshitha V. et al. (2020) implemented RFID and IR sensors for pill tracking and automated doctor appointments.

Materials and Methods

1. System Design and Implementation Platform

Development Tools and Environment

The Smart Pill Management System for Elderly Patients was designed and implemented using an Arduino Nano microcontroller as the primary processing unit. Arduino IDE (Version 1.8.xx/2.x) was used for program development, code uploading, and debugging. The system interfaced with multiple hardware modules including LEDs, a buzzer, an LCD Display, a Real Time Clock (RTC) module (DS3231), and a GSM module (SIM800L) to provide automatic reminders and remote

notifications. Circuit design was modeled using Proteus and Tinkercad for simulation and verification before hardware assembly. All programming was performed in embedded C/C++ using the Arduino framework.

Hardware Component Specifications

Arduino Nano: Central controller for scheduling, alerts, and communication.

16x2 LCD Display: Shows medicine time messages and status.

LED Indicators: Represent morning, afternoon, and evening dosage times.

Buzzer: Provides audible alerts for medication reminders.

GSM Module (SIM800L/SIM900): Sends SMS notifications to caregivers for missed doses.

Push Button: Allows users to confirm medicine intake.

Power Supply: Provides stable DC power to the system. SIM Card: Enables SMS messaging.

2. System Functional Architecture

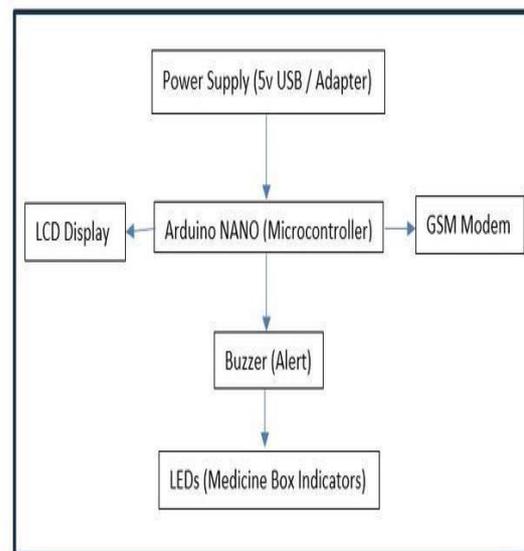


Fig 1: Block Diagram of SPMS

The architecture of the Smart Pill Management System for Elderly Patients is designed to provide an efficient and automated way to manage medication schedules. It typically consists of hardware and software components that work together to ensure timely medication intake. The hardware part includes a microcontroller (like Arduino), pill storage unit, sensors, display, and alert modules such as buzzer or LED indicators. The software part handles data processing, scheduling, and communication, often integrated with a mobile application or cloud platform for remote monitoring. This layered architecture enables the system to store pills, dispense them at the right time, notify the patient, and send updates to caregivers or doctors, ensuring safety,

accuracy, and convenience in medication management.

Working

The smart pill management system operates by combining electronic hardware, sensors, and software to ensure timely and accurate medication intake for elderly patients. The system is programmed with the patient's medication schedule, including dosage and timing. At the scheduled time, the device alerts the patient through sound, light, or mobile notifications. It then dispenses the correct dose of medication automatically or prompts the user to take it manually. Sensors can detect whether the pill has been taken, and this information is recorded and transmitted to caregivers or family members through a connected app or network. If a dose is missed, the system sends reminders or alerts to ensure adherence. This automated process improves medication compliance, reduces errors, and enhances patient safety. The basic concept of a Smart Pill Management System is to provide an automated and reliable solution to help elderly patients take their medicines correctly and on time. It combines electronic pill dispensers, sensors, reminders, and mobile applications to organize medication schedules, dispense the right dose at the right time, and alert patients or caregivers if a dose is missed. This system reduces the risk of missed doses, overdosing, or confusion and improves medication adherence, ensuring better health management for elderly individuals.

Result

The Smart Pill Management System was tested under different conditions to evaluate its performance:

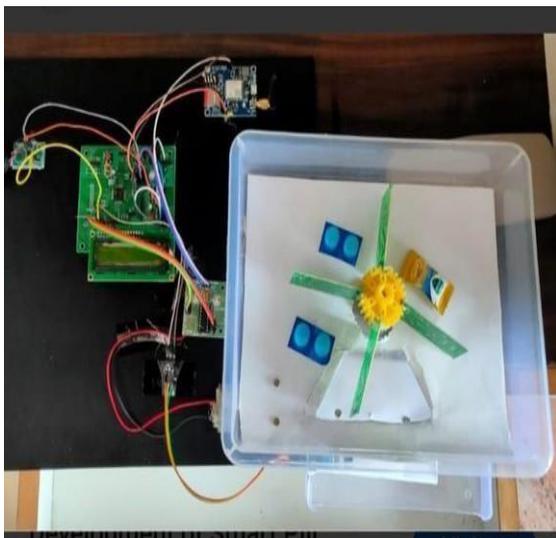


Fig 2: Visual Representation of SPMP

- **Reminder Accuracy:** LED, buzzer, and LCD alerts triggered at exact scheduled times. Visual and audio indicators were clearly noticeable for elderly users.
- **User Acknowledgment:** Button press successfully stopped the buzzer and turned off the LED. LCD displayed "Dose Taken" confirming the action.
- **Missed Dose Detection** If no action was detected during the alert period, the system categorized the dose as missed. GSM module consistently sent SMS alerts such as: "Alert: Evening dose missed."
- **Reliability:** LCD messages were clear and readable. GSM alerts were delivered within 4–7 seconds depending on network strength. System operated stably with a 12V power supply.
- **Observed Limitations:** Absence of an RTC module may cause time drift. GSM-Dependent systems require strong network coverage. User must manually press the button to confirm dose intake. Overall, the system performed reliably and demonstrated real-world usability for elderly medication reminders.

Discussion

The Smart Pill Management System developed in this project demonstrates the potential of low cost embedded solutions to improve medication adherence among elderly patients. Medication non-compliance is a common problem due to forgetfulness, complex schedules, and declining cognitive abilities. The system effectively addresses these issues by providing visual (LEDs), auditory (buzzer), and text-based (LCD and GSM alerts) reminders at the appropriate times.

The integration of an Arduino Nano as the central controller ensures reliable operation with minimal power consumption. The use of separate LEDs for morning, afternoon, and evening dosage slots simplifies user interaction, making the system understandable even for elderly users with limited technological experience. The inclusion of a GSM module extends the system's capability by sending SMS alerts to caregivers or family members. This feature enhances safety, allowing remote monitoring and reducing the chances of missed dose.

Conclusion

The Smart Medicine Reminder System successfully addresses the critical need for timely medication adherence, especially for elderly and chronic patients. By integrating an Arduino Nano with LEDs, a buzzer, an LCD display, and a GSM

modem, the system provides effective multi-sensory alerts to remind users to take their medicines on schedule. The inclusion of a user acknowledgment button and SMS alerts ensures both the patient and caregiver are informed, helping to reduce missed doses and improve overall health outcomes. The system's modular design and low-cost components make it accessible and scalable for various healthcare settings. While there are limitations such as dependency on user input and GSM network availability, the project lays a strong foundation for future enhancements, including realtime clock integration, automated dispensing, and IoT connectivity. In conclusion, this project demonstrates a practical and reliable approach to medication management, promoting better healthcare compliance and supporting patients' well-being. The system's design is modular and scalable. Additional compartments, sensors, or advanced connectivity options such as IoT platforms can be integrated to improve automation and data recording. However, the current prototype still has limitations. For example, it relies on manual placement of pills in the compartments and does not include sensors to verify whether the patient actually took the medicine. Additionally, while GSM connectivity is effective, it could be affected by network availability in rural or remote areas.

Despite these limitations, the system achieves its primary goal—supporting elderly patients in maintaining their medication routine. The combination of timely alerts and remote notifications results in a practical solution that can be deployed in homes, old-age care centers, and hospitals. Overall, the project provides a strong foundation for future developments in smart healthcare devices aimed at improving the quality of life for elderly individuals.

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