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Smart Medicine Reminder for Elderly

[1]Prof.Leena Pimple, [2]Aishwarya Adhav, [3]Dipti Kodape, [4]Vaishnavi Gour, [5]Neha Belkhade

[1,2,3,4,5]Department of Computer Engineering, Suryodaya College of Engineering and Technology, Nagpur, Maharashtra, India

[1]sulbhewar.leena@gmail.com, [2]adhavaishwarya230@gmail.com, [3]diptikodape7@gmail.com, [4]vaishnavigour54321@gmail.com, [5]nehabelkhade3@gmail.com

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ABSTRACT

Ensuring timely medication intake is a critical aspect of elderly healthcare, as missed or incorrect doses can lead to serious medical complications, reduced treatment effectiveness, and increased hospitalization. Elderly individuals often experience memory decline, multiple chronic conditions, and complex medication schedules, making adherence to prescribed therapies difficult. This paper proposes a Smart Medicine Reminder System that automates medication scheduling and reminder generation to support independent living among older adults. Medication schedules are stored in the system memory, and the controller continuously monitors the current time against predefined reminder schedules. At the scheduled time, the device activates audible and visual notifications displaying the required medication information. The alert remains active until the user acknowledges medicine intake through a confirmation button. The proposed system provides a reliable, low-cost, and user-friendly solution for medication management, enhancing treatment adherence, improving patient safety, and reducing caregiver burden through timely monitoring and notification.

1. INTRODUCTION

The growing proportion of elderly people worldwide has increased the need for reliable technologies that support long-term healthcare and medication management. Many older adults live with chronic illnesses such as diabetes, hypertension, cardiovascular diseases, and arthritis, requiring multiple medications to be taken at specific intervals. Adhering to these treatment schedules is essential for effective disease management; however, factors including age-related memory decline, cognitive impairment, visual limitations, and polypharmacy often make consistent medication intake difficult.

Medication non-adherence is a major concern because it can reduce treatment effectiveness, increase the likelihood of disease progression, and result in preventable hospital admissions. Conventional approaches, including paper-based

medication charts, pill organizers, alarm clocks, and reminders from family members, provide only basic support. These methods generally cannot determine whether a patient has actually taken the prescribed medicine and often rely on continuous caregiver involvement, limiting their effectiveness for individuals who live independently. The advancement of embedded systems and Internet of Things (IoT) technologies has enabled the development of intelligent medication management solutions that automate reminder generation and improve treatment compliance. These systems combine microcontrollers with timing, communication, and display modules to deliver medication alerts, record user responses, and notify caregivers when scheduled doses are missed. Such automation enhances patient safety while reducing the burden on caregivers.

This research proposes a Smart Medicine Reminder System specifically designed to assist elderly users in following prescribed medication schedules. The proposed device integrates a microcontroller with a Real-Time Clock (RTC) module, LCD display, buzzer, user confirmation button, and GSM or Wi-Fi communication module. The controller continuously monitors the current time and compares it with the stored medication schedule. Whenever a scheduled dose is due, the system generates audible and visual notifications indicating the medicine details. After medication intake, the user acknowledges the reminder through a confirmation button. If no acknowledgement is received within the specified time, the system automatically identifies the event as a missed dose and sends a notification to the caregiver for timely follow-up.

The proposed system focuses simplicity, affordability, reliability, and ease of operation, making it appropriate for home healthcare and assisted-living environments. By encouraging timely medication intake, reducing missed doses, and facilitating remote caregiver support, the system aims to improve medication adherence, enhance patient safety, and promote independent living among elderly individuals.

2. Literature Review

A study presented at the IEEE International Conference on Computer Engineering and Systems (ICCES 2024) proposed a Raspberry Pi-based automated reminder pill box for elderly users. The system utilized an RTC module, infrared sensors, and GSM communication to provide accurate medication reminders, medication tracking, and caregiver notifications. Although the solution offered advanced functionality, its reliance on Raspberry Pi increased hardware complexity, implementation cost, and power consumption compared with simpler microcontroller-based designs.

Researchers at the IEEE World Conference (WCONF 2024) introduced an IoT-based real-time medicine reminder and dispenser that integrates cloud computing with an automated pill dispensing mechanism. The proposed system enables remote monitoring by caregivers and supports automatic medicine dispensing, thereby improving medication adherence. However, its performance depends heavily on continuous Internet connectivity, which may limit its applicability in rural or low-network environments.

Chanane et al. (2023) proposed a medication notification application based on human-centered design principles that employs multi-channel reminders to enhance medication adherence. Their findings demonstrated that reminder acknowledgment and multiple notification channels significantly improve user engagement and compliance with prescribed medication schedules. Nevertheless, the study focused primarily on software-based solutions and did not incorporate embedded hardware for automated medication management.

Shaveet et al. (2023) developed memorAIs, an Optical Character Recognition (OCR)-based medication reminder system capable of extracting prescription information from medicine labels and automatically generating personalized reminders. The proposed approach simplifies reminder configuration and reduces manual data entry. However, its effectiveness depends on image quality and the accuracy of text recognition, which may affect system reliability in practical applications.

3. Research Gap

Although recent studies have significantly improved medication reminder technologies, several limitations rema in:

- Most existing systems provide reminders but cannot reliably confirm that the medicine has actually been taken.
- Many IoT-based solutions depend on continuous Internet connectivity, limiting their usefulness in low-network environments.
- Advanced smart pill dispensers often require expensive hardware, making them less affordable for home use.
- Several systems emphasize either hardware or software alone instead of providing an integrated, low-cost solution with caregiver notifications.
- Limited real-world evaluation has been reported for elderly users with multiple chronic conditions and complex medication schedules

4. METHODOLOGY

A .System Overview

The proposed Smart Medicine Reminder System is designed to improve medication adherence among elderly users through automated reminders and caregiver notifications. The system integrates a microcontroller, Real-Time Clock (RTC) module, LCD display, buzzer, push button, and GSM or Wi-Fi communication module . The RTC maintains accurate time, while the microcontroller continuously compares the current time with the predefined medication schedule stored in memory. When a scheduled time is reached, the system activates audible and visual alerts. The reminder remains active until the user confirms medication intake. If no confirmation is received within a predefined time interval, the system automatically sends a notification to the caregiver and updates the medication log.

B. System Workflow

The operation of the proposed system consists of the following sequential steps:

System Initialization:

- Power is supplied to the microcontroller.
- The RTC, LCD, buzzer, communication module, and push button are initialized.
- The stored medication schedule is loaded into memory.

Real-Time Monitoring:

- The RTC continuously provides the current date and time.
- The microcontroller compares the current time with the scheduled medication timings.

Medication Reminder Generation:

- When the scheduled time matches the current time, the buzzer is activated.
- The LCD displays the medicine name, dosage, and scheduled time. The reminder remains active until user interaction.

User Confirmation:

- The user acknowledges medication intake by pressing the confirmation button.
- The system records the successful completion of the scheduled dose.
- The alarm is stopped and the system resumes monitoring.

Missed Dose Detection:

- If no confirmation is received within the specified timeout period, the system marks the dose as missed.
- A notification is transmitted to the caregiver through GSM the caregiver through GSM or Wi-Fi.
- The event is logged for future reference.

Continuous Operation:

- The system updates the next medication schedule.
- The monitoring process continues automatically for all programmed medication timings.

C. Algorithm

Algorithm: Smart Medicine Reminder
Input: Medication schedule (time, medicine name, dosage)
Output: Timely reminder, confirmation status, caregiver notification

1. Start.
2. Initialize the microcontroller, RTC, LCD, buzzer, and communication module.
3. Load the medication schedule.
4. Read the current time from the RTC.
5. Compare the current time with each scheduled medication time.
6. If a match is found:
   - Activate the buzzer.
   - Display medication details on the LCD.
7. Wait for user confirmation.
8. If confirmation is received:
   - Stop the alarm.
   - Record successful medication intake.
9. Otherwise:
- Mark the dose as missed.
- Send an alert to the caregiver through GSM or Wi-Fi.
10. Update the next medication schedule.
11. Repeat Steps 4–10 continuously.
12. End.

D. Advantages of the Proposed Methodology

1. Ensures accurate medication reminders using the RTC module.
2. Reduces missed medication doses through persistent reminder alert.
3. Enables caregiver intervention when medication is not acknowledged.
4. Supports multiplemedication schedules throughout the day.
5. Employs low-cost hardware suitable for home healthcare applications.
6. Simple user interface suitable for elderly individuals with limited technical experience.

5. SYSTEM ARCHITECTURE

A. System Architecture

The proposed Smart Medicine Reminder System is designed using a microcontroller-based embedded

platform that combines timing, display, alert, and communication modules to assist elderly users in taking their medicines on time. The Real-Time Clock (RTC) module continuously provides the current date and time, while the medication details, including the medicine name, dosage, and scheduled reminder time, are stored in the microcontroller's memory.

During operation, the microcontroller continuously checks the current time against the saved medication schedule. When a scheduled reminder time is reached, the system activates the buzzer and LED and displays the medicine name, dosage, and reminder message on the LCD screen. The user confirms that the medicine has been taken by pressing the confirmation button. If the confirmation button is pressed within the specified time, the reminder is stopped and the medication is recorded as successfully taken. If no confirmation is received before the time limit expires, the system treats the medication as a missed dose and automatically sends an alert to the caregiver using the GSM or Wi-Fi communication module. After processing the event, the system updates the schedule and continues monitoring the remaining medication timings without requiring further user intervention.

B. .Block Diagram

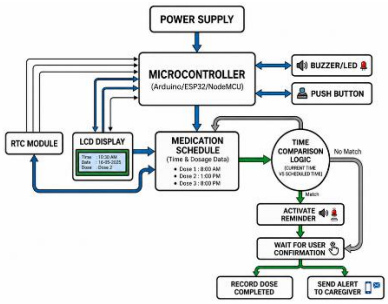

Figure 1: Block Diagram of the Microcontroller-Based Medication Reminder System

C. Working Principle

1. The system initializes all hardware modules after power-up.
2. The RTC provides the current date and time continuously.
3. The controller compares the current time with the stored medication schedul.
4. At the scheduled time, the LCD displays medicine details and the buzzer and LED generate reminder alerts.
5. The user confirms medication intake using the push button.
6. If confirmation is received, the reminder is stopped and the event is recorded.
7. If no confirmation is received within the timeout period, the caregiver is notified through GSM or Wi-Fi.
8. The system automatically proceeds to monitor the next scheduled medication cycle.

6. Experimental Results and Performance Analysis

A. Experimental Setup

The Smart Medicine Reminder System prototype was implemented using a microcontroller, RTC module, LCD display, buzzer, push button, and GSM/Wi-Fi communication module. The system was evaluated under different medication schedules to verify reminder accuracy, user acknowledgement, and caregiver notification functionality.

B. Performance Evaluation

Table 2: Experimental Results

Parameter	Test Description	Observed Value*
Reminder Accuracy	Correct reminder generation	98.0% (49/50trials)
RTC Time Error	Time deviation	±85 s / 24 hrs
LCD Display Response	Display update time	120 ms
Buzzer Activation Time	Delay after scheduled time	< 200 ms
Caregiver Notification Delay	GSM/Wi-Fi alert time	2.3 s (Wi-Fi) /5.1 s (GSM)
User Confirmation Detection	Button response	45 ms
System Uptime	Continuous operation	168 hrs (7 days uninterrupted)

C. Functional Testing

Table 3: Functional Test Cases

Test Case	Expected Result	Status
System Power ON	Hardware initializes correctly	Pass
RTC Synchronization	Correct time displayed	Pass
Scheduled Reminder	Alarm activates on time	Pass
LCD Display	Medicine details displayed	Pass
User Confirmation	Alarm stops after button press	Pass
Missed Dose	Caregiver alert sent	Pass
Next Schedule	System resumes monitoring	Pass

D. Comparative Analysis

Table 4: Comparison with Existing Systems

Feature	Traditional Alarm	Smart Pill Box	Proposed System
Time-Based Reminder	✓	✓	✓
RTC Accuracy	✗	✓	✓
LCD Display	✗	✓	✓
Audible Alert	✓	✓	✓
User Confirmation	✗	Limited	✓
Caregiver Notification	✗	Limited	✓
Multiple Medicine Scheduling	Limited	✓	✓
Low Cost	✓	✗	✓
Suitable for Elderly Users	Moderate	Moderate	High

7. ADVANTAGES

The proposed Smart Medicine Reminder System offers several benefits for elderly healthcare and medication management: Improves medication adherence by providing timely and accurate reminders. Reduces the risk of missed doses and incorrect medication intake. Supports independent living by minimizing dependence on caregivers for routine medication reminders. Provides audible and visual alerts, making the system suitable for users with mild hearing or visual impairments. Sends caregiver notifications through GSM or Wi-Fi when medication is not acknowledged within the specified time. Supports multiple medication schedules using the Real-Time Clock (RTC) module. Employs a low-cost embedded architecture suitable for home healthcare applications. Features a simple and user-friendly interface that can be easily operated by elderly individuals.

8. DISADVANTAGES

The system depends on a continuous power supply or battery backup for uninterrupted operation. GSM or Wi-Fi notification features require network availability for successful message transmission. Initial configuration of medication schedules may require assistance from caregivers or family members. Elderly users may occasionally forget to acknowledge reminders, resulting in false missed-dose notifications. The current system reminds users but does not automatically dispense medication.

- Regular maintenance of hardware components may be necessary to ensure re liable long-term operation.

9. APPLICATIONS

The Smart Medicine Reminder System can be deployed in various healthcare environments, including: Home-based healthcare for elderly individuals living independently. Hospitals for automated medication reminder support. Nursing homes and ass is ted-living facilities for continuous medication management. Rehabilitation centers where patients require scheduled medication. Healthcare monitoring systems for individuals with chronic diseases such as diabetes, hypertension, and cardiovascular disorders. Support systems for patients with mild cognitive impairment or memory-re la ted conditions. Community healthcare programs that promote safe and cons is tent medication adherence.

CONCLUSION

Ensuring that elderly patients take their medications on time is essential for effective treatment but remains a persistent challenge. This work presents a Smart Medicine Reminder System that combines low-cost hardware components to provide scheduled medication reminders and improve adherence. The system utilizes a microcontroller, Real-Time Clock (RTC), LCD display, buzzer, and GSM or Wi-Fi communication module to generate medication alerts and record user confirmation after each scheduled dose. If a patient does not acknowledge the reminder within the specified time, the system sends a notification to a caregiver, allowing timely follow-up and reducing the likelihood of missed medication. The proposed design is practical, economical, and easy to implement, making it suitable for home healthcare and elderly assistance applications. The developed system demonstrates that affordable embedded technology can enhance medication management while supporting independent living. Future improvements may focus on integrating cloud-based data storage, mobile applications, wearable health sensors, and intelligent scheduling techniques to further increase system functionality and user convenience.

Future Scope

The Smart Medicine Reminder System can be extended in several ways to improve its functionality, usability, and healthcare impact. Possible future enhancements include:
Incorporating an automated pill dispensing unit to deliver the correct medication at the scheduled time without manual intervention. Developing a dedicated Android and iOS mobile application that enables caregivers and family members to monitor medication schedules remotely. Implementing cloud-based data storage to ecurely maintain medication records and support long-term adherence tracking. Providing multilingual voice assistance to make the system more accessible and user-friendly for elderly individuals with visual or literacy limitations. Applying Artificial Intelligence

(AI) algorithms to analyze medication patterns, predict missed doses, and generate personalized reminder schedules. Integrating wearable health monitoring devices to collect physiological parameters such as heart rate, blood pressure, body temperature, and blood oxygen levels for comprehensive patient monitoring. Strengthening data security through encrypted communication, secure authentication, and protected medical record management to ensure patient privacy. Conducting extensive real-world clinical studies involving elderly participants to evaluate system performance, usability, reliability, and its effectiveness in improving medication adherence.

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