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Leveraging Arduino Nano for Developing a User-Friendly and Automated Medicine Dispensing System

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Abstract

The goal of the "MED BUDDY" project is to address the urgent need for medication management, particularly for elderly individuals, those with chronic illnesses, and those who must adhere to a rigorous medication schedule. An Arduino Nano microcontroller powers the automated medication dispenser known as the MED BUDDY system. By dispensing the appropriate dosage of medication at the appropriate time, it lowers the possibility that users will forget or take the incorrect dosage. Apart from its dispensing capabilities, the MED BUDDY system has the ability to retain information regarding medication schedules and provides an intuitive interface for users to enter or alter their medication schedule. With a real-time clock (RTC) module for accurate timekeeping and a push-button interface for user input, the system is a small, user-friendly device. The Arduino Nano acts as the primary controller, coordinating all the components and triggering warnings through visual indicators (LEDs) and an audio alarm (buzzer) to notify the user when it's time to take their prescription. This study provides a comprehensive analysis of the barriers to medication adherence, highlighting the critical role that technology plays in overcoming these challenges. We provide a fresh strategy that leverages smart medication management tools like digital reminders and automated dispensers. These methods aim to improve patient involvement, reduce cognitive strain, and ensure timely medication ingestion.

Keywords: Chronic health conditions, medication adherence, patient engagement, smart medication systems, technology solutions

INTRODUCTION

The extent to which patients take their prescribed medications as directed is a critical factor in managing chronic diseases and ensuring optimal patient outcomes; however, many people struggle to remember to take their medications on time, which can lead to potential health complications and increased health care costs. To address this major challenge, we propose a smart medicine reminder system based on the Arduino Nano microcontroller, a cost-effective and versatile platform for developing embedded systems. The goal of this system is to provide patients with a simple, user-friendly, and reliable solution to ensure they take their medications as prescribed. Medication non-adherence is a significant global health issue and medicine reminder systems are increasingly used to improve adherence, especially for chronic conditions, by providing timely reminders and potentially improving patient outcomes. A customized medication reminder app called MED BUDDY was created to help people remember to take their prescriptions on time. The system

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analyzes adherence, gives features like refill alerts and caregiver notifications, and promptly reminds users to take their medications using contemporary technologies like mobile applications, IoT (Internet of Things), and machine learning. Patients of all ages can benefit greatly from its customizable features and easy-to-use interface [1–5].

Bridging the gap between prescription instructions and actual adherence is the foundation of the idea behind a medication reminder system. The basic idea behind MED BUDDY is straightforward yet efficient: it provides extra features that improve monitoring and usability while reminding users about their prescriptions at the appropriate times [6–10]. For instance, users may enter the frequency, dose, and timing of their medications into the system, which will then utilize ledges and a buzzer to sound an alarm. People's numbers are growing quickly, and as they get more prepared, they experience memory problems. To address this problem, we designed and gathered an electronic system that may be used in a pharmaceutical agency to screen a man's medicine affirmation [11].

LITERATURE REVIEW

The information is shared into the Arduino by the proposal in this document. The device will then sound an alert to remind the patient to take their medication at the time that they have chosen. The alert will remain in the dynamic state till the client opens the pack at that specified time. According to the estimated data provided by the user or caregiver, the personal automated medication reminder is designed to precisely administer a particular amount of medication to the patient at the appropriate moment, accompanied by an LED indicator and an alert. Additionally, the system acts as the user's personal pharmaceutical caregiver. The purpose of this project is to support the patients for the confirmation of prescriptions at the perfect moment. To monitor in real time, connect the Arduino Nano to the RTC module. Hours, minutes, and seconds are continually tracked by the RTC, which also provides real-time updates to the Arduino Nano. To track the current time, the controller is then interfaced with the RTC module. The LCD display is used to show the current time. The appropriate pharmaceutical (tablet) boxes will include LED indicators and sound. This innovative gadget is more cost-effective, smaller, more accurate, and easier to use [2].

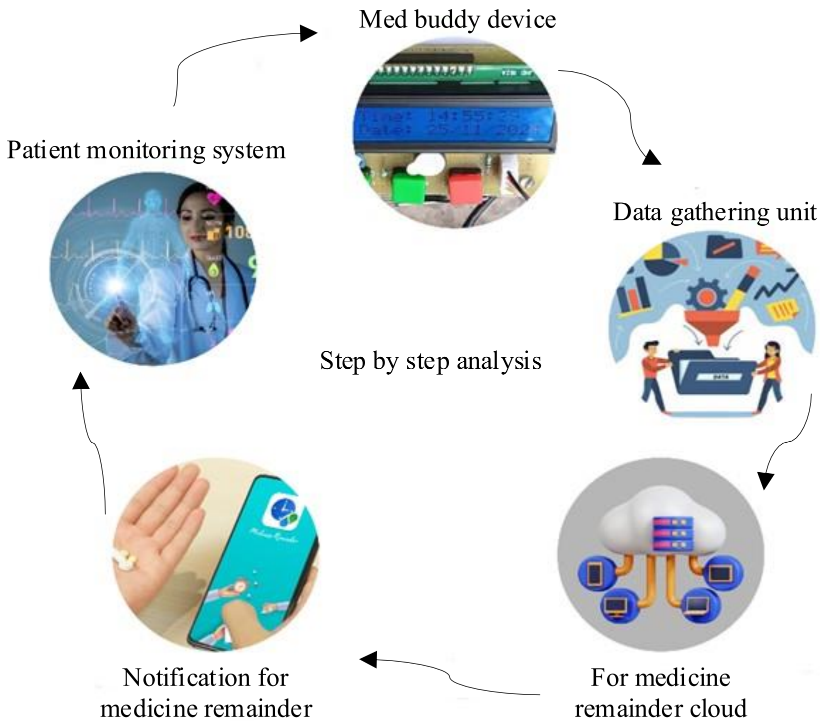

Figure 1. Step by step analysis.

PROBLEM STATEMENT IDENTIFICATION

Even in today's fast-paced world, many individuals, especially the elderly or those with chronic health conditions, face difficulties in adhering to prescribed medication schedules. Forgetting to take medications on time can lead to ineffective treatment, worsening of health conditions, or severe complications. The intricacy of drug schedules, which frequently need patients to take many prescriptions at various times of the day, exacerbates this problem [7]. Many patients now rely on manual reminders (such as notes, family members, or spoken instructions), but these techniques are inconsistent, prone to mistakes, and might not be successful in guaranteeing prompt drug adherence. Patients frequently don't take their medications as prescribed, whether it's because they forget to take them, take them at the wrong time, or even take too much. As a result, there are several mechanisms in place to remind patients, including alarms and reminders. Our focus is on patients who struggle to take their medications on time. To help them manage their prescriptions, we designed a reminder system that they can use to check and manage their meds [12–14].

METHODOLOGY

The methodology outlines the step-by-step development of a medicine reminder system using an Arduino Nano, RTC module, LCD display, push buttons, and a buzzer. The aim is to provide a reliable and user-friendly system to assist individuals in remembering to take their medication on time (Figure 1).

Initial Setup

- Connect the RTC module to the Arduino Nano to maintain track of real-time scenes. The RTC continuously tracks the current time (hours, minutes, seconds) and updates the Arduino Nano in real-time.
- Connect the LCD display to the Arduino to show the current time along with alarm time settings.
- Attach the Set button to an input pin, which will allow the user to adjust time or the alarm when pressed.
- Connect the buzzer to a digital output pin for alerting when it's time to take medication.

Display Current Time

- On powering up the system, the Arduino Nano initializes the RTC and fetches the current time.
- Display the real-time clock on the LCD screen, updating it continuously.

Setting Alarm Time

- The user presses the Set button, the system enters the mode to set the alarm time.
- The user can use additional push buttons (for hours, minutes, or seconds) to increase or decrease the values.
- Once the alarm time is set, the system stores this time in a variable.

Checking For Alarm Condition

- The Arduino constantly compares the current time from the RTC with the set alarm time.
- If the current time matches the alarm time, then the system starts triggering the buzzer automatically.

Optional Features

- You can add an LED indicator to visually show when the reminder has been triggered.
- Integrate a reset button to disable the alarm or set a new alarm time.

Components

Arduino Nano

- The Arduino Nano is an compact sized and loaded with powerful microcontroller board based on the ATmega328P.
- It can be an ideal device for small-sized projects where space is limited.

- Digital I/O Pins (D0 – D13): Used for digital input/output (HIGH/LOW).
- Analog Input Pins (A0 – A7): Used to read analog signals (0 – 5V) (Figure 2).

Real-Time Clock (RTC) Module

- An RTC (Real-Time Clock) module is a small electronic component that keeps track of time, even when the main device it's connected to is powered off.
- It keeps tracking in seconds, minutes, hours, day, date, month, and year accordingly.
- Battery backup (usually a CR2032 coin cell) so time continues even if the main power is off (Figure 3).

LCD Display

- It lets your microcontroller "talk" to users in real-time — displaying messages, sensor data, time from an RTC.
- A 16x2 LCD can display 2 lines with 16 characters each.
- The current real-time clock (hours, minutes, seconds).
- The alarm time set by the user (Figure 4).

Figure 2. Arduino nano.

Figure 3. Real-time clock (RTC) module.

Figure 4. LCD display.

Set Button

The Set Button is a crucial input component used to enter the alarm-setting mode in the medicine reminder system. It allows the user to initiate the process of configuring the desired medication time (Figure 5).

Buzzer (For alarm sound):

- It provides an audible signal to notify the patient about the time span to take their medication.
- Alerts the user when the current time exactly matches the time in the alarm.
- Can sound for a fixed duration (, e.g., 30 seconds) or until a reset button is pressed.
- Ensures the reminder is noticeable even if the user isn't looking at the display (Figure 6).

Potentiometer

- The potentiometer is used to adjust the contrast of the 16x2 LCD display, making the characters easier to read.
- It ensures that the text is clearly visible under various lighting conditions and viewing angles.
- This controls the darkness of the characters displayed on the screen (Figure 7).

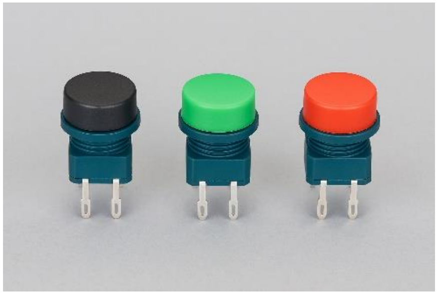

Figure 5. Set button.

Figure 6. Buzzer.

Figure 7. Potentiometer.

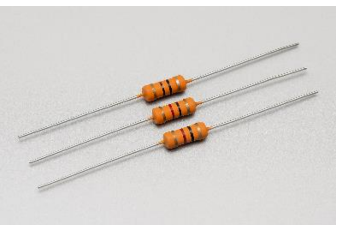

Figure 8. Resistor.

Resistor

- Electrical resistance is implemented as a circuit element by a resistor, a passive two-terminal electrical component.
- Resistors are employed in electronic circuits for a variety of purposes, including dividing voltages, biasing active parts, adjusting signal levels, reducing current flow, and terminating transmission lines (Figure 8).

Code Logic (Overview):

- Initialize the RTC and LCD.
- Continuously read the current time from the RTC and display it.
- Allow user input through buttons to set the alarm time.
- Monitor the current time and compare it with the alarm time.
- Trigger the buzzer when the set time is reached.
- Optionally reset or stop the alarm manually.

ARCHITECTURE

Because Arduino NANO uses the 8-bit ATmega328P microprocessor and contains 32KB of flash memory, we are using it. Our project benefits from these advantages, which is why we chose to utilize Arduino NANO. All additional modules are connected to the Arduino NANO board, which also controls them all and facilitates interfaces. Additionally, it contains an inbuilt EEPROM that records data in real time. Our concept uses an Arduino Uno to interface everything because it is based on an embedded system. Since Arduino is open-source, it has user-friendly hardware and integrated software. Arduino serves as a bridge between software and hardware. By delivering a set of instructions to the Arduino microcontroller, you may direct your board on what to do. Arduino boards accept inputs from a button push and convert them into an output, turning on an LED and buzzer. The Arduino software (IDE), which is based on Processing, and the Arduino programming language are used to do this. The Arduino IDE serves as the programming platform, while conventional C is the programming language. For every module we use in our project, we created a program [14].

- Like the RTC module and the 16x2 LCD module, we must first upload a library to the Arduino IDE software before we can begin programming.
- LCD interfacing: In our project, we used a 16x2 LCD module that is linked to the Arduino NANO either directly to its address and data bus and a few control pins, or via an LCD interface circuit. RTC transmits data to the LCD module, which displays the current time and date.
- Our project benefited from the usage of the Tiny RTC I2C module, which used the I2C protocol. Since the RTC module includes an inbuilt CMOS cell, it can update the time and date without an external power source. Buzzer: Buzzer will ring at proper time when pills have to be taken.
- LED: Each of our seven boxes has an LED that blinks to indicate which box contains the tablets that need to be taken at a specified time.
- Pushbuttons: We used three pushbuttons: one for increment, one for next, and one for setting medication. The first button leads to the medication setting menu; the second button allows us to increase the number of hours and minutes that we need to set; and the third button advances us from one minute to the next and from one hour to the next.
- Clearly identifying each prescribed medicine by its brand or generic name. It might be useful to have both names, particularly when switching brands.
- Dosage: The precise amount of medication to be taken at each instance (, e.g., 5mg, 10 units, 1 tablet, 2 puffs). Specifying the unit is crucial for accuracy.
- Frequency: How often the medication should be administered (, e.g., once daily, twice a day, every other day, three times a week). Clarity in frequency prevents ambiguity.
- Time of Administration: The specific times of day the medication should be taken (, e.g., 8:00 AM, 12:00 PM, 6:00 PM, before breakfast, at bedtime). Precise timing is vital for some medications to coincide with bodily functions or food intake.

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Table 1. Comparing the tradithenal method and technological method - based medicine reminder methods.

Aspect	Traditional methods	MED BUDDY (Technology-based)
Reminder Approach	Manual (alarms, written notes)	Automated with real-time clock (RTC)
User Intervention	High (requires setting and updating reminders)	Minimal (automated schedule management)
Accuracy	Dependent on user's memory	Precise alerts with RTC integration
Accessibility	Limited (challenging for elderly users)	Designed for ease of use, including for seniors
Alert Type	Single mode (sound or written)	Dual-mode (auditory buzzer + visual display)
Customization	Basic (fixed reminders)	Highly customizable for multiple medications
Scalability	Not scalable	Modular design for multiple medicine schedules
Cost	Low	Moderate, but cost-effective long term

Table 2. Med buddy alert response performance.

Metric	Tested value	Observation
Alert Accuracy	98%	Reliable alerts triggered on time
Number of Medications Supported	Up to 3 compartments tested	Expandable for additional compartments
User Response Time (Average)	2 minutes	Users responded quickly to buzzer and display
Power Consumption	150 mA (normal operation)	Energy-efficient with minimal power usage
Battery Backup Duration	10 hours (average)	Sufficient for uninterrupted operation in outages
Error Rate in Notifications	Less than 1%	Minimal errors in alert delivery
Ease of Use Feedback	95% positive response	Minimal errors in alert delivery
Aspect	Traditional Methods	MED BUDDY (Technology-Based)
Reminder Approach	Manual (e.g., alarms, written notes)	Automated with Real-Time Clock (RTC)
User Intervention	High (requires frequent setting and updates)	Minimal (automated schedule management)
Accuracy	Dependent on user memory and manual tracking	High precision via RTC-based time alerts
Accessibility	Limited, especially difficult for elderly users	Easy-to-use interface designed with senior citizens in mind
Alert Type	Single mode (either sound or written reminder)	Dual-mode: auditory buzzer + visual LED indicators
Customization	Basic (fixed and manual reminders)	Highly customizable for multiple medication schedules
Scalability	Not scalable beyond a few reminders	Modular and scalable for complex medication routines
Cost	Low initial cost	Moderate, but cost-effective and reliable in the long term

EXPERIMENTAL ANALYSIS

Medication non-adherence is a widespread issue, particularly among the elderly and chronically ill, often due to forgetfulness or lack of an effective reminder system. Traditional methods, such as handwritten notes or mobile alarms, require significant user intervention and lack customization, leading to inconsistent medication intake (Table 1). This research introduces MED BUDDY, an affordable and reliable medicine reminder system designed using Arduino Nano, RTC module, LED indicators, buzzer, and push buttons. A comparative analysis between traditional approaches and MED BUDDY reveals significant improvements in multiple aspects, including accuracy, user accessibility, scalability, and automation [4].

Using a Real-Time Clock (RTC) module, the system uses both visible (LED) and audible (buzzer) cues to provide extremely precise medication notifications. With its low complexity and simple physical button engagement, it is especially designed for older users. Multiple scheduled reminders are supported by the design, which is easily expandable to meet user demands. The study shows that by providing a more automated, trustworthy, and user-friendly solution for daily medication management, MED BUDDY works better than conventional reminder systems [12].

The suggested MED BUDDY approach and conventional medication reminder techniques are contrasted side by side in this Table 2. It emphasizes how MED BUDDY is a more efficient way to manage daily medication regimens due to its automation, accuracy, accessibility for senior citizens, and long-term dependability [10].

RESULT AND DISCUSSION

The suggested MED BUDDY approach and conventional medication reminder techniques are contrasted side by side in this table. It emphasizes how MED BUDDY is a more efficient way to manage daily medication regimens due to its automation, accuracy, accessibility for senior citizens, and long-term dependability [10].

Core Functionality and Purpose

- *Reaching Therapeutic Objectives*: Making sure the drug manages the illness as prescribed. Maintaining regular therapy to delay or stop the progression of sickness is known as "preventing disease progression."
- *Avoiding Complications*: Reducing the risk of unfavorable health consequences owing to missing doses or inappropriate administration.
- *Optimizing Treatment Effectiveness*: Making sure the body gets the appropriate dosage at the appropriate times to get the most out of treatment.

Fundamentally, a medication reminder table is a methodical and planned way to keep track of a person's prescription schedule. Improving medication adherence — the degree to which a patient's actions align with the prescribed advice from a healthcare professional — is its main objective. Adherence to medicine is essential for:

Key Elements and Information Included

- *Medication Name (Generic and/or Brand)*: Clearly identifying each prescribed drug. Including both names can be helpful, especially if switching between brands.
- *Dosage*: The precise amount of medication to be taken at each instance (, e.g., 5mg, 10 units, 1 tablet, 2 puffs). Specifying the unit is crucial for accuracy.
- *Frequency*: How often the medication should be administered (, e.g., once daily, twice a day, every other day, three times a week). Clarity in frequency prevents ambiguity.
- *Time of Administration*: The specific times of day the medication should be taken (, e.g., 8:00 AM, 12:00 PM, 6:00 PM, before breakfast, at bedtime). Precise timing is vital for some medications to coincide with bodily functions or food intake.
- The method by which the drug should be administered, such as by injection, inhalation, topical application, sublingual application, or oral ingestion. When a medicine is administered incorrectly, it may become toxic or ineffective.

CONCLUSION

Medication non-adherence is a chronic problem that patients, caregivers, and healthcare systems throughout the world are very concerned about. The Medicine Reminder System (MED BUDDY) provides a useful and user-centric solution to this problem. By combining technology to guarantee prompt drug consumption, this system closes the gap between human medication administration and sophisticated, automated healthcare solutions, increasing patient outcomes and quality of life. In summary, the Medicine Reminder System (MED BUDDY) is a noteworthy advancement in medical technology that shows how creativity can solve common problems. The system's usefulness might be further increased in the future by adding features like data analytics, remote monitoring, or smartphone connectivity, which would increase its influence in controlling medication adherence. In addition to being a technological marvel, MED BUDDY is a humane attempt to enhance patients' lives, highlighting the critical role that technology plays in improving individual healthcare. To sum up, a medication reminder table is more than simply a list; it's an essential tool for enhancing adherence, encouraging drug safety, and eventually leading to improved health outcomes. Its thorough arrangement of important drug information allows people. Its thorough arrangement of important pharmaceutical information enables patients and their caregivers to efficiently manage their care.

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