MEDICINE REMINDER ALARAM CLOCK

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CERTIFICATE

This is to certify that this is the bonafide record of the application development entitled **"Medicine Reminder Alaram Clock"** submitted by **V.Rajeshwari(2211CS050115),Y.Vaishali(2211CS050117), D.Sanjana(2211CS050141**), **N.Vishwa Kalyani(2211CS050145)** B. Tech II year II semester, Department of CSE (IoT) during the year 2023-24. The results embodied in this report have not been submitted to any other university or institute for the award of any degree or diploma.

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ABSTRACT

Medicine Reminder Alarm Clock is to automatically transmit message through voice alarm based on the medication to an individual at specified time slots. It especially used for the old aged, parallelized persons, and even for uneducated persons. By leveraging an Internet of Things (IoT) framework, this system bridges the gap between personal medical supervision and patient adherence, ultimately contributing to better healthcare outcomes. It caters to both individual patients and groups, emphasizing affordability, ease of use, and reliability. The integration of alarm functionality with medication schedule of a person streamlines the process for patients by reducing the risk of missed doses and improves overall health management.

In today's fast-paced world, diseases are on the rise, and most individuals find themselves needing to take prescribed medications at specific times. However, overlooking medication schedules can lead to serious consequences. The lack of 24-hour medical supervision and the scarcity of nurses in underdeveloped countries exacerbate this problem, resulting in avoidable deaths and urgent health situations. This automatic medicine reminder system bridges the gap between medical supervision and patient adherence, ultimately contributing to better healthcare outcomes as remembering and taking medications as prescribed is crucial for maintaining health to prevent further complications.

The project involves designing and implementing a comprehensive medicine reminder alarm clock using an Arduino Uno microcontroller. The system integrates multiple components, including a DS3231 Real-Time Clock (RTC) module for accurate timekeeping, an APR33R3 voice module for voice reminders, an 8-ohm speaker for audio output, a 16x2 LCD display for visual feedback, a SIM900 GSM module for SMS notifications, and several user interface buttons. Powered by a 9V

adapter, the device is designed to ensure users adhere to their medication schedules effectively.

The primary function of the system is to alert users to take their medication at pre-set times through both audible and visual alarms. The RTC module keeps precise time, even during power outages, ensuring the alarm system's reliability. The voice module plays pre-recorded messages through the speaker, providing a clear and personalized reminder. The LCD display shows the current time and alarm information, while the GSM module sends SMS notifications as an additional reminder, enhancing adherence to medication schedules.

User interaction is facilitated through buttons that allow setting the current time, programming multiple alarms, and managing alarm responses, including snooze and stop functions. The system's software, developed using the Arduino IDE, orchestrates the interactions between components, handling time checks, alarm triggers, voice playback, SMS sending, and user input processing.

This project aims to provide a robust, user-friendly solution to assist individuals in managing their medication schedules, leveraging both audio-visual and SMS notifications to ensure timely adherence to prescribed regimens. By integrating these technologies, the medicine reminder alarm clock offers a reliable and effective tool for improving medication compliance and, consequently, health outcomes.

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1.INTRODUCTION

1.1 Problem Definition & Description

The problem is that many people often struggle to remember and adhere to their medication schedule. For individuals with multiple medications, complex dosing regimens, or memory-related conditions, it can be particularly challenging to stay on track with taking their medications at the right time.

A medicine reminder alarm clock aims to address this problem by providing timely and personalized reminders for individuals to take their medications. It functions as an alarm clock but with added features specifically designed to manage medication schedules. Medication non-adherence is a significant issue that affects health outcomes, particularly among individuals with chronic conditions or those on complex medication regimens. Many patients forget to take their medication on time, leading to suboptimal treatment outcomes, increased healthcare costs, and potential worsening of their conditions. There is a need for a reliable, user-friendly system that can remind patients to take their medication at the correct times, thereby improving adherence and overall health.

The system operates by maintaining an accurate clock through the RTC module. Users can set multiple alarms using the interface buttons, which are stored and monitored by the Arduino. When an alarm time is reached, the system triggers the APR33R3 voice module to play a pre-recorded message through the speaker, alerting the user audibly. Simultaneously, the GSM module sends an SMS reminder to a designated phone number, ensuring the user is reminded even if they are not near the device. The LCD displays the current time and alarm information, providing visual confirmation of the alarms.

This multi-faceted approach addresses the problem of medication non-adherence by offering timely, clear, and redundant reminders. By combining audio, visual, and SMS notifications, the system enhances the likelihood that users will remember to take their medication as prescribed, thereby improving health outcomes and reducing the burden of non-adherence on the healthcare system.

Features may include:

Customized Reminders: The alarm clock allows users to set multiple reminders for various medications, specifying the medication name, dosage, and frequency.

Multiple Alarms: Users can set different alarms throughout the day to remind them of different medication dosages at different times.

Dosage Tracking: The alarm clock can track the number of doses taken and provide notifications to the user if a dose is missed or delayed.

Smartphone Integration: Some alarm clocks can sync with a smartphone app, allowing users to access and manage their medication schedules more conveniently, even when they are away from home.

User-Friendly Interface: The alarm clock has an easy-to-use interface, displaying medication reminders clearly and offering simple navigation for setting up schedules and alarms.

Accurate Timekeeping: The DS3231 RTC module provides highly accurate timekeeping, ensuring the clock maintains the correct time even if power is interrupted.

Time Display: The current time is displayed on the LCD, making it easy for the user to check the time at a glance.

Multiple Alarms: Users can set multiple alarms for different times of the day, ensuring they don't miss their medication schedule.

User Input for Alarms: Dedicated buttons allow users to easily set and adjust alarm times.

Voice Playback: The APR33R3 voice module plays pre-recorded voice messages, providing a personalized reminder to take medication.

Voice Recording: Users can record custom messages for different alarms, making the reminders more effective and personal.

GSM Module Integration: The SIM900 GSM module sends SMS notifications to a predefined number, providing an additional layer of reminder.

Custom SMS Messages: The SMS messages can be customized to include specific information about the medication.

1.2 Objective of the Project

Enhancing medication adherence: By reminding users to take their medications on time, the project aims to improve adherence to prescribed treatment regimens.
Improving health outcomes: By ensuring timely medication intake, the project seeks to enhance overall health outcomes and reduce the risk of complications.
Providing convenience and peace of mind: The project aims to offer users a convenient and reliable way to manage their medication schedules, reducing the stress and worry associated with forgetting to take medications.
Increasing independence: For individuals who require assistance with medication management, the project aims to promote independence by empowering them to manage their own medication schedules.
Supporting caregivers: For caregivers responsible for managing medication schedules, the project aims to provide tools and features to streamline the process and ensure the well-being of their loved ones.

The primary objective of the medicine reminder alarm clock project is to develop a reliable and user-friendly system that assists individuals in adhering to their medication

schedules. This system aims to address the problem of medication non-adherence by providing timely and effective reminders through multiple notification channels. The specific objectives of this project include:

Ensure Accurate Timekeeping:Utilize the DS3231 RTC module to maintain precise time, even during power outages, ensuring the system always operates on the correct schedule.

Provide Clear and Personalized Reminders:Use the APR33R3 voice module and an 8-ohm speaker to play pre-recorded voice messages at scheduled times, offering audible and personalized reminders to take medication.

Enhance Usability with Visual Feedback:Implement a 16x2 LCD display to show the current time and alarm information, making it easy for users to verify the time and understand their medication schedule.

Offer Redundant Notification Channels:Integrate the SIM900 GSM module to send SMS notifications to a predefined phone number, ensuring users receive reminders even when they are not near the device.

Provide an Intuitive User Interface:Design a simple interface with buttons for setting the current time, programming alarms, and managing alarm responses (snooze and stop), making the system accessible and easy to use for all users.

Ensure Continuous Operation:Power the system reliably using a 9V power adapter, ensuring all components remain operational and the system functions without interruption.

Improve Medication Adherence:By providing timely, clear, and redundant reminders, the system aims to significantly improve users' adherence to their prescribed medication schedules, leading to better health outcomes.

Enhance User Engagement and Trust:Build a system that is dependable, easy to interact with, and customizable, fostering user trust and engagement, which are critical for long-term adherence to medication regimens.

The overarching goal of this project is to create a robust and effective medicine reminder alarm clock that leverages multiple technologies to provide comprehensive support for medication adherence. By ensuring accurate timekeeping, delivering clear and personalized reminders, offering redundant notification channels, and providing an intuitive user interface, the system aims to significantly reduce the problem of medication non-adherence and contribute to improved health outcomes for users.

1.3 Scope of the Project

The scope of a medicine reminder alarm project would typically include features such as setting reminders for medication intake, customizing reminders based on medication schedules, providing notifications/alerts, possibly integrating with a database of medications for easier setup, and ensuring user-friendly interfaces for easy interaction. It might also involve options for snoozing or dismissing reminders, and potentially integrating with wearable devices for added convenience. Additionally, considerations for data privacy and security would be essential.

Functionality: This includes the core features of the app, like setting up medication schedules, customizable alarm settings, reminders, and notifications.
User Interface (UI) and User Experience (UX): Designing an intuitive and user-friendly interface is crucial for easy navigation and interaction. UX considerations ensure that the app is efficient and enjoyable to use.

Compatibility: Ensuring that the app is compatible with various devices and operating systems (iOS, Android) expands its reach to a wider audience.

Customization: Providing options for users to customize their reminders according to their medication regimen, dosage, frequency, and specific needs.
Reminders and Notifications: Implementing reliable reminders and notifications that prompt users to take their medication on time, with options for snoozing or dismissing reminders.

Medication Tracking: Incorporating features for users to track their medication intake history, including missed doses and adherence statistics.
Data Security and Privacy: Implementing robust security measures to protect users' personal health information and ensuring compliance with relevant data protection regulations.

Additional Features: Considering additional features like medication refill reminders, doctor appointments, medication interactions, and integration with other health tracking devices or apps.
Testing and Quality Assurance: Thoroughly testing the app to identify and fix any bugs or issues, ensuring its reliability and stability.
Documentation and Support: Providing clear documentation and support resources for users to troubleshoot any problems and maximize their experience with the app.
Prototype Deployment: Developing a prototype for testing and demonstration purposes.
Maintenance Plan: Establishing a maintenance plan to ensure the device remains functional over time, including potential updates and repairs.

Unit Testing: Testing individual components (RTC, voice module, LCD, GSM module) to ensure they function correctly.
Integration Testing: Testing the interactions between components to ensure the system works as a cohesive unit.

2. SYSTEM ANALYSIS

2.1 Existing System

Medisafe: This app allows users to input their medication schedules, set reminders for each dose, and track medication adherence. It also offers features like drug interaction warnings, refill reminders, and progress reports that can be shared with healthcare providers or family members.

MyTherapy: MyTherapy offers similar features to Medisafe, including medication reminders, adherence tracking, and refill reminders. It also allows users to log other health-related activities such as measurements (e.g., blood pressure, weight) and symptoms.

Mango Health: Mango Health is another medication reminder app that emphasizes gamification to encourage medication adherence. Users earn points for taking their medication on time and can redeem rewards such as gift cards or donations to charity.

Smart Pillboxes: There are also smart pillboxes available that automatically dispense medication at scheduled times and send reminders to users' smartphones. Some models even feature connectivity to caregivers or healthcare providers for added monitoring.

Wearable Gadgets: Certain wearable devices, like smartwatches, can be programmed to deliver medication reminders through vibrations or notifications. These reminders can be synchronized with smartphone apps for added convenience.

These systems aim to improve medication adherence by providing personalized reminders and tracking tools, ultimately helping users manage their health more effectively.

2.1.1 Background & Literature Survey

Importance of Medicine Reminder Alarm Clocks:

Medication non-adherence is a pervasive issue, leading to treatment failure, increased healthcare costs, and patient morbidity and mortality. Medicine reminder alarm clocks play a crucial role in addressing this issue by providing structured and consistent reminders for medication administration. These devices are designed to notify patients

or caregivers about the specific time for medication intake, helping to establish a routine and reduce forgetfulness.

Features of Medicine Reminder Alarm Clocks:

Medicine reminder alarm clocks are equipped with various features to cater to the different needs of patients. These features may include programmable alarms, customizable reminders, multiple medication compartments, audio and visual alerts, and storage for medication information. Some devices may also have additional functionalities such as tracking medication intake history, providing dosage instructions, and integrating with smartphone applications for remote monitoring.

Effectiveness of Medicine Reminder Alarm Clocks:

Numerous studies have investigated the effectiveness of medicine reminder alarm clocks in improving medication adherence. A systematic review by Aikens et al. (2011) examined the impact of electronic reminder devices on medication adherence among individuals with chronic diseases. The study found a significant positive effect of these devices on medication adherence, with improved adherence rates ranging from 14% to 71%.

Similarly, a randomized controlled trial conducted by McKibbon et al. (2012) evaluated the efficacy of medication reminder devices in elderly patients. The study reported improved adherence rates in the intervention group compared to the control group, emphasizing the usefulness of reminder devices in this population.

In addition to improving adherence, medicine reminder alarm clocks have also shown the potential to enhance patient satisfaction and quality of life. A review by Schedlbauer et al. (2012) reported that patients using reminder devices often perceived them as helpful and felt more confident in managing their medications.

2.1.2 Limitations of Existing System

- **Medication Adherence and Health Outcomes**
    - **Study**: Osterberg, L., & Blaschke, T. (2005). Adherence to medication. *New England Journal of Medicine*, 353(5), 487-497.

- **Findings**: The study highlights the challenges and consequences of medication non-adherence, emphasizing the need for effective reminder systems to improve adherence and health outcomes.

- **Technological Solutions for Medication Adherence**

  - **Study**: Vervloet, M., et al. (2012). The effectiveness of interventions using electronic reminders to improve adherence to chronic medication: A systematic review of the literature. *Journal of the American Medical Informatics Association*, 19(5), 696-704.
  - **Findings**: The systematic review concluded that electronic reminders, such as SMS alerts and electronic pillboxes, are effective in improving medication adherence, but the effectiveness varies based on the complexity and design of the reminder system.

- **Voice Reminder Systems**

  - **Study**: Park, D., et al. (2014). Voice reminders as a way to reduce cognitive load for older adults. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 4307-4312.
  - **Findings**: The study found that voice reminders are particularly effective for older adults, as they reduce cognitive load and provide clear, understandable prompts that can be more effective than visual reminders alone.

While medicine reminder alarm clocks have proven to be effective in promoting medication adherence, there are some limitations associated with existing systems. These limitations include:

1. **Lack of customization**: Many existing medicine reminder alarm clocks have limited customization options. Patients may have varying medication schedules, dosage frequencies, and specific instructions. Therefore, a one-size-fits-all approach may not

adequately address individual needs.

2. **Limited reminder types**: Most medicine reminder alarm clocks provide audio and visual alerts as reminders. However, some individuals may benefit from alternative reminders that cater to their unique preferences, such as vibrating alarms or text messages.

3.Complexity and usability: Some medicine reminder alarm clocks can be complex to program, especially for elderly individuals or those with limited technological literacy. Complicated user interfaces may lead to frustration and hinder their effectiveness in promoting adherence.

Lack of connectivity and integration: While some medicine reminder alarm clocks offer connectivity options to smartphones or other devices, many still lack the ability to integrate with electronic health records or share medication adherence data with healthcare providers. This limits the potential for remote monitoring and intervention by healthcare professionals.

Mobility limitations: Certain medicine reminder alarm clocks are bulky or not easily portable, making it challenging for individuals who travel frequently or are always on the go to maintain adherence to their medication schedules outside of their homes.

Cost: Depending on the features and functionalities, medicine reminder alarm clocks can be relatively expensive, especially more advanced devices that offer additional capabilities. This cost may be a barrier for some patients who cannot afford such devices.

Limited feedback and tracking: While some medicine reminder alarm clocks track medication adherence history, the level of detail and feedback provided may not be sufficient for patients or healthcare providers to identify patterns or areas of improvement.

Addressing these limitations requires continual advancements in technology and user-centered design. Future systems should focus on increased customization, simplified usability, improved connectivity, enhanced portability, and affordability to maximize the benefits and impact of medicine reminder alarm clocks on medication adherence. Additionally, integrating these systems with electronic health records and involving

healthcare providers in monitoring and intervening when necessary could further enhance their effectiveness.

2.2 Proposed System

Accessibility Features: Include accessibility features such as text-to-speech for visually impaired users and easy-to-read interfaces for users with cognitive impairments.

Data Security: Implement robust security measures to protect user data, including encryption of sensitive information and secure authentication methods.

Feedback Mechanism: Allow users to provide feedback on the effectiveness of the reminder system and any improvements they would like to see.

Syncing Across Devices: Enable synchronization of medication schedules and reminders across multiple devices for users who use the system on different platforms.

Health Tracking: Optionally, integrate features for users to track their medication adherence and health progress over time, providing insights and motivation for sticking to their medication regimen.

Offline Functionality: Ensure the system has some level of offline functionality so that reminders can still be triggered even if the user temporarily loses internet connectivity

2.2.1 Advantages of Proposed System

Improved medication adherence: By receiving timely reminders for medication doses, individuals are more likely to take their medications as prescribed, leading to improved health outcomes.

Customizability: Users can easily schedule reminders for multiple medications at different times, ensuring that they never miss a dose.

Accessibility: With the proposed system, individuals can set reminders using their smartphones, making it convenient and accessible at all times.

Personalized alerts: Users can receive alerts in the form of notifications, alarms, or even text messages, allowing for personalized reminders that suit their preferences.

Peace of mind: The system provides peace of mind to users and their loved ones by ensuring they are taken care of in terms of medication management.

Prevents medication errors: By reminding individuals to take their medications, the system helps to reduce the risk of dosage errors or missed doses.

Health tracking: Some systems may offer features to track medication intake, providing users with insights into their medication adherence over time.

Increased independence: For individuals who require medication reminders, the system promotes independence by allowing them to manage their medications on their own.

User-friendly interface: The system is designed to be easy to use and intuitive, making it accessible to users of all ages and technical abilities.

Cost-effective: In the long run, the system could potentially reduce healthcare costs by preventing medication-related complications and hospitalizations due to missed doses

2.3 Software & Hardware Requirements

2.3.1 Software Requirements

User Interface: The software should have a user-friendly interface that allows users to easily set and manage medication reminders. This includes features such as a visual alarm clock display, a calendar for scheduling medication doses, and clear instructions for adding new medications.

Reminder System: The software should include a reminder system that alerts users when it is time to take their medication. This can include audible alarms, visual notifications, and customizable reminder settings (such as frequency and timing of reminders).

Alarm System: The software should have a reliable alarm system that delivers notifications in a timely manner. This can include pop-up notifications on the user's device, sound alarms, and vibration alerts for users who may be hearing-impaired.

Testing and Validation: The software should undergo rigorous testing to ensure that it functions as intended and that all features work correctly. This can include testing for usability, reliability, and accuracy of reminders.

Libraries: The software may require libraries or APIs for integrating with other systems or devices, such as electronic health records (EHR) systems or wearable health trackers. These libraries can help enhance the functionality of the medication reminder software.

- **Wire.h**: For I2C communication with the RTC module.
- **RTClib.h**: For interfacing with the DS3231 RTC module.
- **LiquidCrystal.h**: For controlling the LCD display.
- **SoftwareSerial.h**: For serial communication with the SIM900 GSM module.

2.3.2 Hardware Requirements

Mobile device: Users will need a mobile device, such as a smartphone or tablet, to download and use the medication reminder application.

APR33R3: The APR33R3 is a high-quality, low-cost voice recording and playback module widely used in various applications, including medicine reminder alarm clocks. Here's an overview of how the APR33R3 module can be integrated into a medicine reminder alarm clock:

Features of APR33R3

- **Single-chip Voice Recording & Playback**: It can store multiple voice messages.
- **Non-volatile Memory**: Retains the recorded messages even after power loss.
- **Sampling Rate**: Adjustable sampling rate for different audio quality needs.
- **Playback Control**: Simple playback control using buttons or microcontrollers.

Steps for Integration

1. **Recording Messages**:
    - Record the message using the built-in microphone or an external one.
    - Save the message to the non-volatile memory of the APR33R3.
2. **Playback Messages**:
    - At the scheduled time, the microcontroller sends a playback signal to the APR33R3 module.

- The APR33R3 module plays the pre-recorded message through the speaker.

9V Power Adaptor: Ensure it provides stable 9V DC output.

Using a 9V power adaptor for your medicine reminder alarm clock project with the APR33R3 module requires careful attention to voltage regulation and current requirements. Here's a step-by-step guide to ensuring proper power managent

Internet connection: A stable internet connection is necessary for accessing and updating medication schedules, receiving notifications, and syncing data with cloud storage.

SIM900 GSM Module: For sending and receiving SMS.

Using a SIM900 GSM module in a medicine reminder alarm clock can add significant value by enabling SMS reminders for taking medication. Below is an outline of how you could integrate the SIM900 GSM module into such a project.

- **GSM Setup**: Initialize the SIM900 module to send and receive SMS.
- **Alarm Logic**: Program the logic to check the current time against the set reminder times.
- **SMS Sending Logic**: Write functions to send SMS reminders using the SIM900 module.

Battery life: The mobile device should have a sufficient battery life to ensure that users receive medication reminders throughout the day without running out of power.

Accessibility features: The device should have accessibility features such as screen readers, voice commands, or larger fonts for users with visual or hearing impairments.

Data storage capacity: Sufficient storage capacity on the device is needed to store application data, medication schedules, and reminders.

Compatibility with accessories: If users prefer additional accessories, such as smartwatches or Bluetooth devices, the mobile device should be compatible with these accessories for enhanced functionality.

Built-in sensors: Some mobile devices may have built-in sensors, such as heart rate monitors or activity trackers, that can be integrated with the medication reminder alarm clock system for additional health monitoring capabilities..

- **Arduino Uno**
  - **Specification**: Microcontroller based on the ATmega328P.
  - **Function**: Acts as the main controller for the project.
- **RTC Module (DS3231)**
  - **Specification**: Real-Time Clock with a battery backup to keep track of time.
  - **Function**: Provides accurate timekeeping.
- **APR33R3 Voice Module**
  - **Specification**: 8/16/32 voice message recording and playback IC.
  - **Function**: Plays pre-recorded voice messages as reminders.
- **8 Ohm Speaker**
  - **Specification**: 0.5W to 1W power rating.
  - **Function**: Outputs the audio from the APR33R3 voice module.
- **LCD Base Board (16x2 LCD)**
  - **Specification**: 16 columns by 2 rows alphanumeric display.
  - **Function**: Displays the current time and alarm information.
- **SIM900 GSM Module**
  - **Specification**: Quad-band GSM/GPRS module.
  - **Function**: Sends SMS notifications.

- **9V Power Adapter**

  - **Specification**: 9V DC output.
  - **Function**: Powers the Arduino and other components.

2.4 Feasibility Study

2.4.1 Technical Feasibility

The proposed medicine reminder alarm clock project is technically feasible due to the availability and compatibility of the selected components with the Arduino Uno microcontroller. The DS3231 RTC module provides reliable and accurate timekeeping essential for scheduling alarms, and its integration with the Arduino through the I2C interface is straightforward. The APR33R3 voice module, paired with an 8-ohm speaker, is capable of recording and playing back clear voice reminders, and it interfaces easily with the Arduino via digital I/O pins. The 16x2 LCD display, commonly used in Arduino projects, will provide real-time visual feedback on time and alarm settings, and it connects seamlessly through standard libraries. The SIM900 GSM module is well-documented for use with Arduino, allowing the system to send SMS notifications reliably. Arduino's digital input capabilities. Powering the system with a 9V adapter is feasible, given the low power requirements of the Arduino and associated components. Overall, the integration of these components is well within the capabilities of the Arduino platform, supported by extensive libraries and community resources, ensuring that the project can be successfully implemented and maintained.

Alarm clock functionality: The device must have a reliable alarm clock feature that can be set to go off at specific times to remind the user to take their medication.

Programmable reminders: The device should allow users to program multiple medication reminders throughout the day, with the ability to set different times for each reminder.

Customizable alerts: The device should offer customizable alert options, such as

different tones or vibrations, to ensure that the reminders are noticed by the user.

Integration with smartphone apps: Many modern medication reminder alarm clocks can be connected to smartphone apps for additional features, such as tracking medication adherence, setting up refill reminders, and providing medication information.

Battery life: The device should have a long battery life to ensure that the reminders are consistently delivered, even when the device is not plugged in.

Durability: The device should be durable and able to withstand daily use, as well as be portable for users who may need to travel with it.

2.4.2 Robustness & Reliability

Build quality: The alarm clock should be made of durable materials that can withstand everyday wear and tear. It should be able to withstand accidental drops and bumps without malfunctioning.

Alarm settings: The alarm clock should have multiple alarm settings to accommodate different medication schedules. It should be able to set multiple alarms throughout the day to remind the user to take their medication at the right time.

Battery life: A reliable medicine reminder alarm clock should have a long battery life to ensure it doesn't run out of power when needed the most. It should also have a low battery indicator to alert the user when the battery needs to be replaced.

Loud and clear alarm: The alarm should be loud enough to be heard even in noisy environments. It should also have clear and easy-to-understand sounds to ensure the user doesn't miss their medication reminder.

Easy to use: The alarm clock should have a user-friendly interface that is easy to navigate. It should be easy to set the alarm, adjust settings, and turn it on and off.

2.4.3 Economic Feasibility

Market Demand: Conduct market research to understand the demand for such a product. Identify the target market, their needs, and preferences. Are there enough people who would benefit from a medicine reminder alarm clock to support its production and sales.

Production Costs: Calculate the costs involved in designing, manufacturing, and assembling the alarm clock with medicine reminder functionality. Consider components, labor, technology, and any additional features that may increase production costs.

Pricing Strategy: Determine the optimal pricing strategy for the medicine reminder alarm clock. Consider the production costs, target market's willingness to pay, and competitors' prices. Pricing the product competitively yet profitably is essential for economic feasibility.

Marketing and Distribution: Estimate the costs of marketing and distributing the product. Determine the most effective channels to reach potential customers and establish brand awareness. Consider how these costs will impact the overall feasibility of the product.

Return on Investment (ROI): Calculate the potential return on investment for the medicine reminder alarm clock. Determine the break-even point and forecast sales to assess the profitability of the product over time.

Regulatory Compliance: Ensure that the product complies with any regulatory requirements related to healthcare devices and alarms. Non-compliance could result in additional costs or barriers to market entry.

Competition: Analyze the competitive landscape, including existing medicine reminder devices and alarm clocks. Identify unique selling points and differentiation strategies to stand out in the market.

3. ARCHITECTURAL DESIGN

3.1 Modules Design

3.1.1 Data Pre-processing

Data pre-processing is an important step in developing a medicine reminder alarm clock application. Here are some key steps that may be involved in the data pre-processing phase:

Data collection: Gather relevant data such as medication details, dosage information,

patient preferences, and schedule data to be used in the reminder alarm clock application.

Data cleaning: Clean the collected data to ensure consistency and accuracy. This may involve removing duplicate entries, correcting errors, and filling in missing information.

Data normalization: Normalize the data to a standard format for easier processing. This may involve converting data into a common unit of measurement or categorizing data into predefined categories.

Data formatting: Format the data in a way that is easily readable and digestible by the reminder alarm clock application. This may involve organizing the data into structured tables or lists.

Data integration: Integrate the collected and cleaned data into the reminder alarm clock application to ensure that all necessary information is available for setting up medication reminders.

Data validation: Validate the data to ensure that it meets the requirements and constraints of the reminder alarm clock application. This may involve cross-checking data against predefined rules or requirements.

3.1.2 Feature Extraction & Selection

Feature extraction and selection for a medicine reminder alarm clock would involve identifying and selecting relevant data points that are useful for reminding users to take their medication. Some possible features to consider include:

Medication schedule: The alarm clock should be able to store and track the user's medication schedule, including the time and frequency of doses.

User preferences: Users may have specific preferences for how they prefer to be reminded to take their medication, such as sound, vibration, or visual alerts.

Medication information: The alarm clock could store information about the user's medications, including the name, dosage, and instructions for taking them.

Reminders and notifications: The alarm clock could provide reminders and notifications to the user when it is time to take their medication.

User feedback: The alarm clock could allow users to provide feedback on how well they are adhering to their medication schedule, which could help improve its effectiveness.

3.1.3 Number of Modules as per analysis

Based on an analysis of a medicine reminder alarm clock, the number of modules required for such a device can vary depending on its functionality and features. Some of the key modules that may be needed for a medicine reminder alarm clock include:

RTC Module

- **Function**: Accurate timekeeping and time management.
- **Components**: DS3231 RTC module.
- **Responsibilities**:
    - Maintain current time.
    - Provide time data to the Arduino for alarm checking.
    - Handle time synchronization even during power outages.

2. Voice Module

- **Function**: Recording and playback of voice messages.
- **Components**: APR33R3 voice module, 8-ohm speaker.
- **Responsibilities**:
    - Store pre-recorded voice messages.
    - Play voice messages at scheduled alarm times.

3. Display Module

- **Function**: Display time and alarm information.
- **Components**: 16x2 LCD display.
- **Responsibilities**:
    - Show the current time.

- Display upcoming alarms.
- Provide user feedback for system interactions.

4. GSM Module

- **Function**: Sending SMS notifications.
- **Components**: SIM900 GSM module.
- **Responsibilities**:
  - Send SMS reminders to a predefined phone number at alarm times.
  - Ensure GSM communication is reliable and efficient.

5. User Interface Module

- **Function**: Allow user interaction with the system.
- **Components**: Push buttons.
- **Responsibilities**:
  - Set current time.
  - Program and manage alarms.
  - Provide snooze and stop functionalities.

6. Power Management Module

- **Function**: Power the system components.
- **Components**: 9V power adapter.
- **Responsibilities**:
  - Provide stable power supply to the Arduino and other components.
  - Ensure continuous operation of the system.

7. Central Control Module

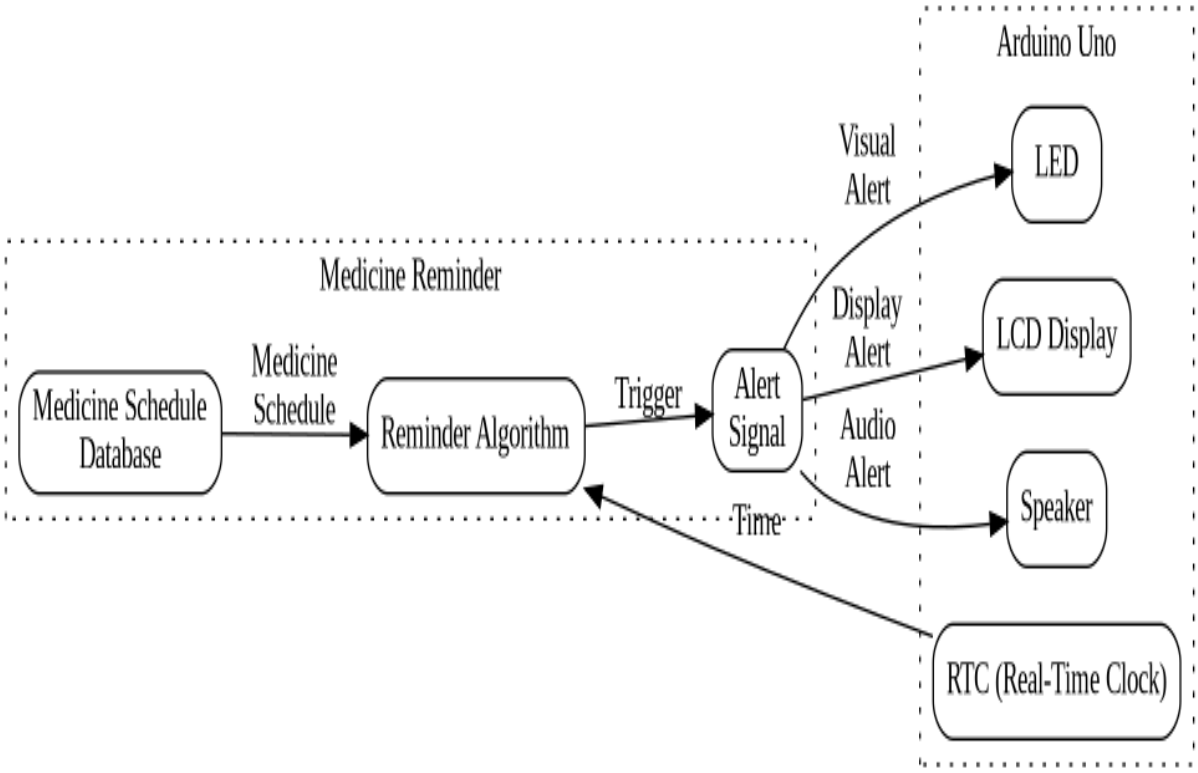
- **Function**: Coordinate all operations of the system.
- **Components**: Arduino Uno.

- **Responsibilities**:
    - Integrate and control all other modules.
    - Execute the main program logic.
    - Handle time-based checks and alarm triggers.
    - Manage user inputs and system responses.

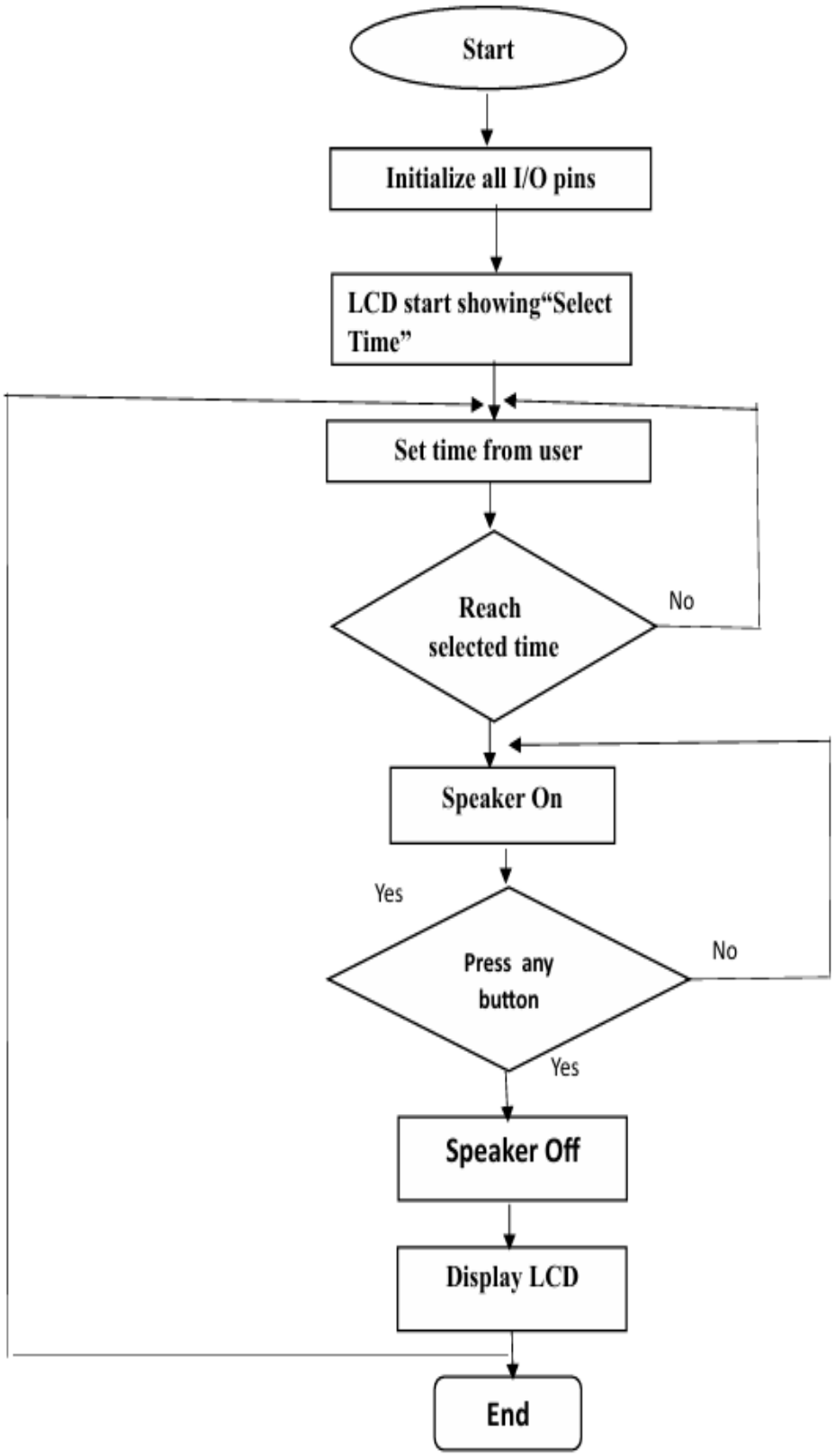
By dividing the project into these modules, each component and functionality can be developed, tested, and maintained independently, ensuring a modular and scalable design. This modular approach also facilitates easier troubleshooting and potential future enhancements.

3.2 Project Architecture

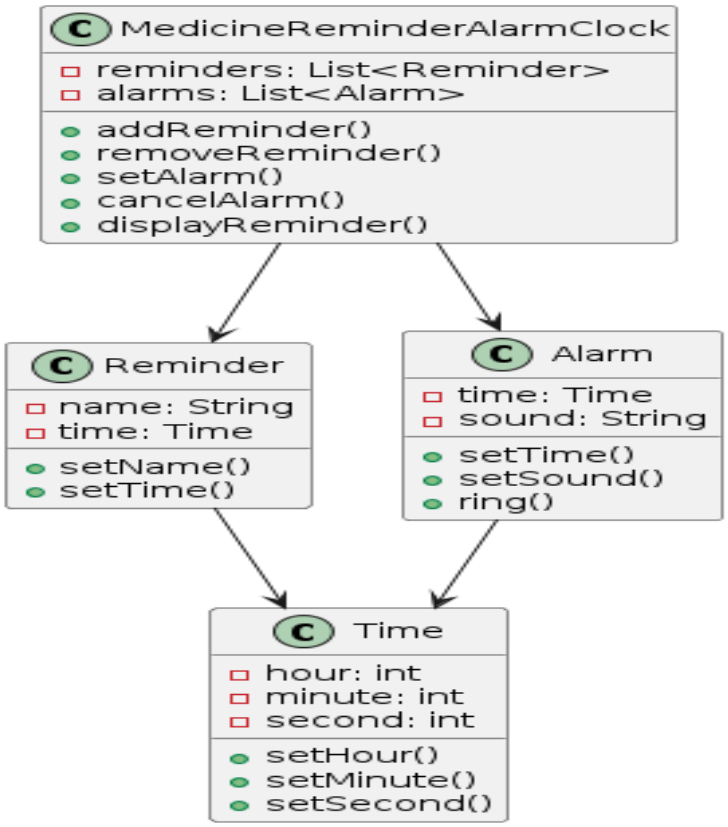
3.2.1 Complete Architecture



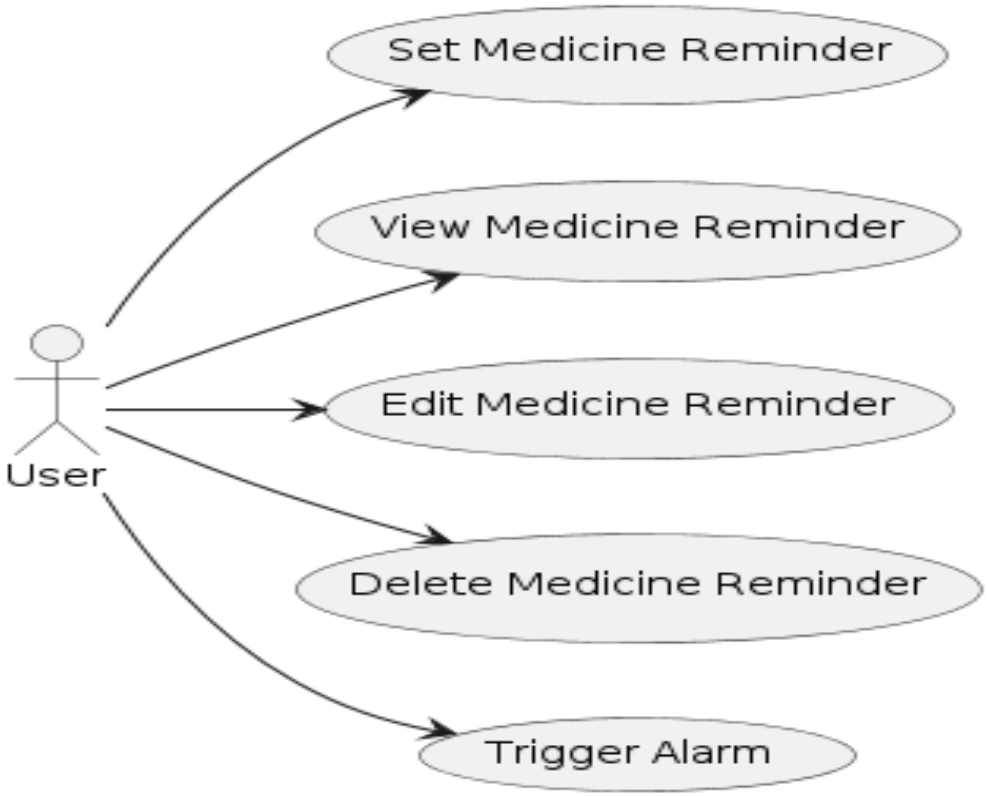
3.2.2 Data Flow & Process Flow Diagram



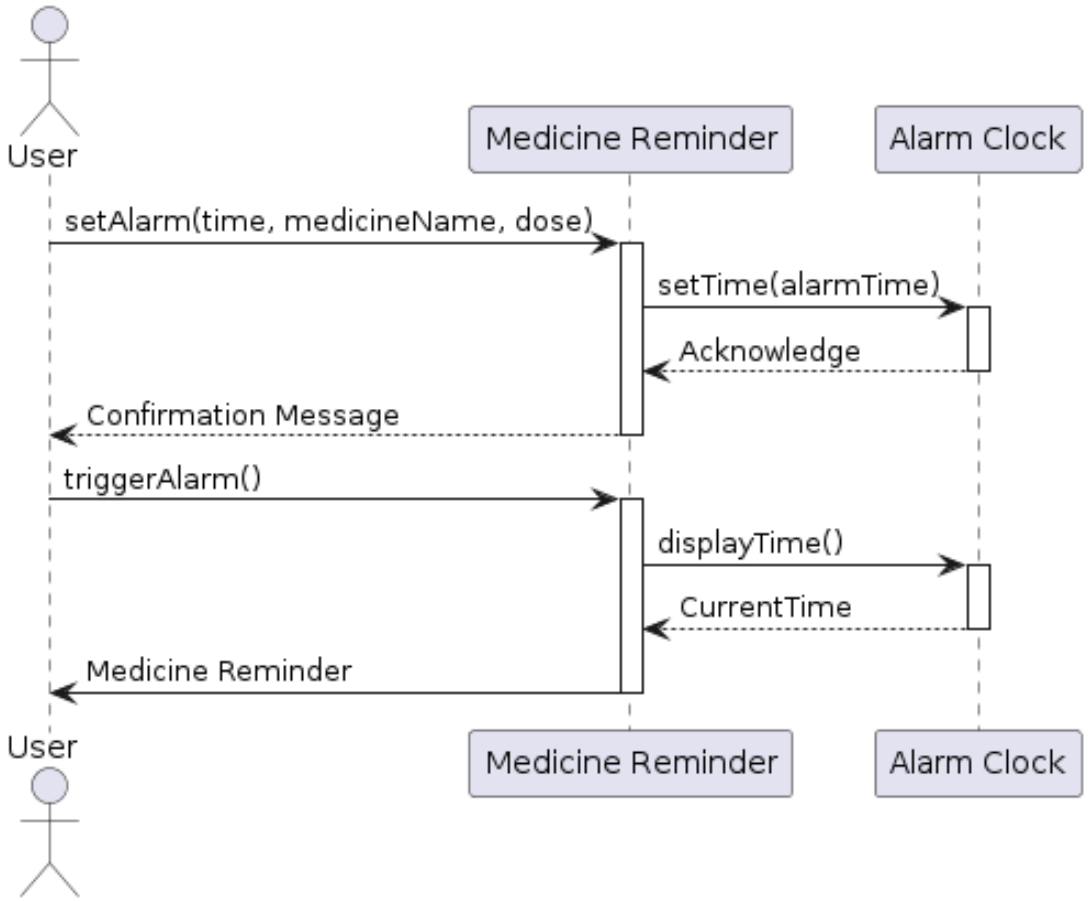
3.2.3 Class Diagram



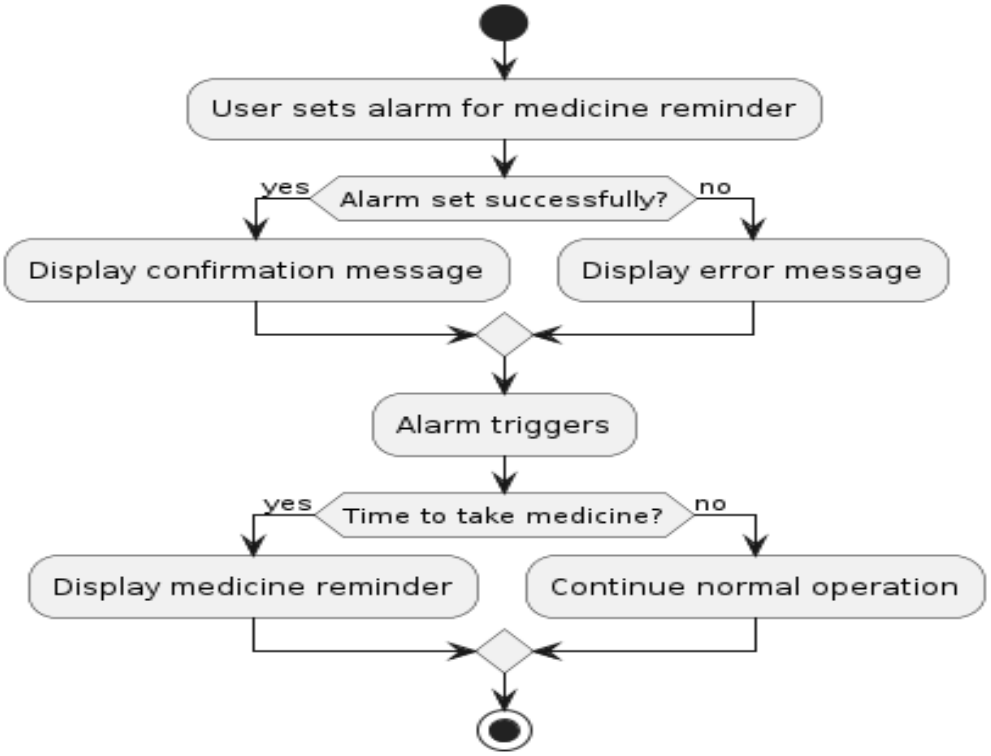
3.2.4 Usecase Diagram



3.2.5 Sequence Diagram



3.2.6 Activity Diagram



4. Implementation & Testing

4.1 Coding

```
#include <SoftwareSerial.h>
SoftwareSerial gsm(2,3);/// GSM MODEM Tx 2 and Rx to 3
#include <LiquidCrystal.h>
LiquidCrystal lcd(A0,A1,A2,A3,A4,A5);
#define voice1 4
#define voice2 5
#define voice3 6
#define voice4 7
#define led 13
int m=0,i=0;
void SendSMS(String Data){     ////send a message///
  gsm.print("AT+CMGF=1\r");    //Because we want to send the SMS in
text mode
  delay(1000);
  gsm.print("AT+CMGS=\"+918465903782\"\r");    //Start sending msg
to this number //
  //to be sent to the number specified.
  //Replace this number with the target mobile number.
  delay(1000);
  gsm.print(Data);
  gsm.print("\r");   //The text for the message
  delay(1000);
  gsm.write(0x1A);  //Equivalent to sending Ctrl+Z
}
void setup() {
  gsm.begin(9600);
  lcd.begin(16, 2);
  lcd.setCursor(0,0); lcd.print("MEDICINE");
  lcd.setCursor(0,1); lcd.print("REMAINDER");
  pinMode(voice1,OUTPUT);
```

```
  pinMode(voice2,OUTPUT);
  pinMode(voice3,OUTPUT);
  pinMode(voice4,OUTPUT);
  digitalWrite(voice1,HIGH);
  digitalWrite(voice2,HIGH);
  digitalWrite(voice3,HIGH);
  digitalWrite(voice4,HIGH);
  Serial.begin(9600);
  delay(3000);
  lcd.clear();
}
void(* resetFunc) (void) = 0;

void off(){
  digitalWrite(voice1,HIGH);
  digitalWrite(voice2,HIGH);
  digitalWrite(voice3,HIGH);
  digitalWrite(voice4,HIGH);
}

void Voice1(){
  digitalWrite(voice1,LOW);
  digitalWrite(voice2,HIGH);
  digitalWrite(voice3,HIGH);
  digitalWrite(voice4,HIGH);
}

void Voice2(){
  digitalWrite(voice1,HIGH);
  digitalWrite(voice2,LOW);
```

```
  digitalWrite(voice3,HIGH);
  digitalWrite(voice4,HIGH);
}

void Voice3(){
  digitalWrite(voice1,HIGH);
  digitalWrite(voice2,HIGH);
  digitalWrite(voice3,LOW);
  digitalWrite(voice4,HIGH);
}

void Voice4(){
  digitalWrite(voice1,HIGH);
  digitalWrite(voice2,HIGH);
  digitalWrite(voice3,HIGH);
  digitalWrite(voice4,LOW);
}
void loop() {
  off();
  lcd.clear();
  lcd.setCursor(0,0); lcd.print("PLZ TAKE");   // PRINT DATA ON
LINE 1
  lcd.setCursor(1,1); lcd.print("CROSIN TABLET"); // PRINT DATA ON
LINE 2
  SendSMS("MEDICINE REMAINDER : PLZ TAKE CROSIN TABLET");  // SMS
ALERT
  Voice1();
  delay(2000);
  off();
  delay(6000); // timer 1
```

```
  lcd.clear();
  lcd.setCursor(0,0); lcd.print("PLZ TAKE");   // PRINT DATA ON
LINE 1
  lcd.setCursor(1,1); lcd.print("BP TABLET"); // PRINT DATA ON LINE
2
  SendSMS("MEDICINE REMAINDER : PLZ TAKE BP TABLET");  // SMS ALERT
  Voice2();
  delay(2000);
  off();
  delay(9000); // timer 2
  lcd.clear();
  lcd.setCursor(0,0); lcd.print("PLZ TAKE");   // PRINT DATA ON
LINE 1
  lcd.setCursor(1,1); lcd.print("CALCIUM TABLET"); // PRINT DATA ON
LINE 2
  SendSMS("MEDICINE REMAINDER : PLZ TAKE CALCIUM TABLET");  // SMS
ALERT
  Voice3();
  delay(2000);
  off();
  delay(9000); delay(3000); // timer 3
  lcd.clear();
  lcd.setCursor(0,0); lcd.print("PLZ TAKE");   // PRINT DATA ON
LINE 1
  lcd.setCursor(1,1); lcd.print("VITAMIN TABLET"); // PRINT DATA ON
LINE 2
  SendSMS("MEDICINE REMAINDER : PLZ TAKE VITAMIN TABLET");  // SMS
ALERT
  Voice4();
  delay(2000);
```

```
  off();
  delay(9000); delay(2000); // timer 3
}
```

4.2 Execution Flow

1. Initialization

- **Setup Microcontroller**: Initialize the Arduino Uno and set up serial communication for debugging.
- **Initialize RTC Module**: Communicate with the RTC module to get the current time.
- **Initialize APR33R3 Voice Module**: Setup the voice module for playback.
- **Initialize LCD Display**: Setup the LCD display for showing time and alarms.
- **Initialize SIM900 GSM Module**: Setup the GSM module for sending SMS notifications.
- **Setup Buttons**: Initialize buttons for setting the time and alarms.

2. Set Current Time

- **Check RTC**: Read the current time from the RTC module.
- **User Input**: Allow the user to set the current time if needed using buttons.
- **Update RTC**: Update the RTC module with the new time if it was changed.

3. Set Alarms

- **User Input**: Allow the user to set multiple alarms using buttons.
- **Store Alarms**: Save the set alarms in the microcontroller's memory.

4. Voice Recording/Playback Setup

- **Record Messages**: Record medicine reminder messages using the APR33R3 module.
- **Store Messages**: Store these messages in different memory locations on the APR33R3 module.
- **Playback Test**: Optionally test playback to ensure correct messages are recorded.

5. Main Loop

- **Read Time**: Continuously read the current time from the RTC module.
- **Check Alarms**: Compare the current time with the set alarm times.
- **Trigger Alarm**:
  - **Play Message**: If the current time matches an alarm time, use the APR33R3 to play the corresponding voice message.
  - **Send SMS**: Use the SIM900 module to send an SMS notification.
- **Update Display**: Continuously update the display with the current time and any active alarms.

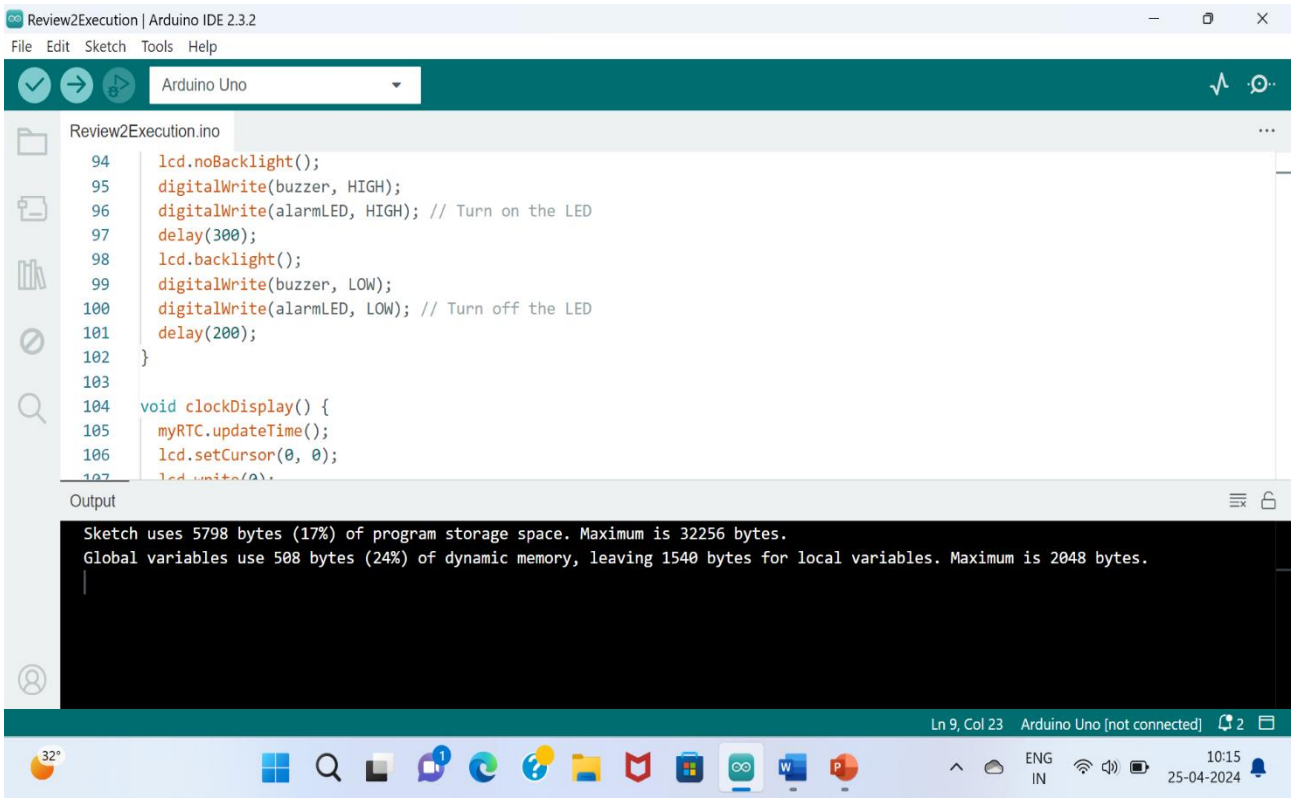
6. Alarm Handling

- **Alarm Playback**: Ensure the alarm playback loop is non-blocking to allow for real-time operation.
- **Snooze Functionality**: Implement snooze functionality, allowing the user to delay the alarm for a few minutes.
- **Stop Alarm**: Allow the user to stop the alarm completely.

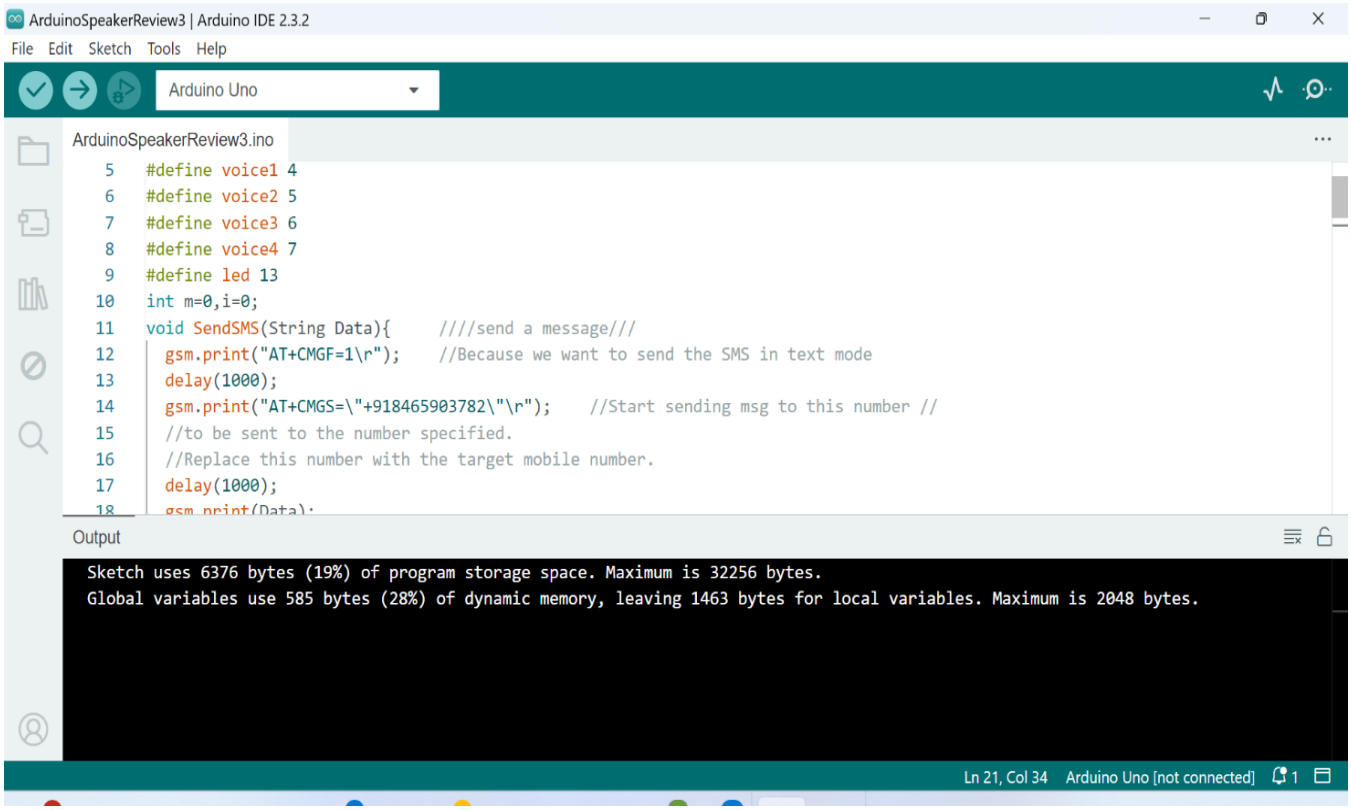
5.1 Testing & Results

5.1 Resulting Screens

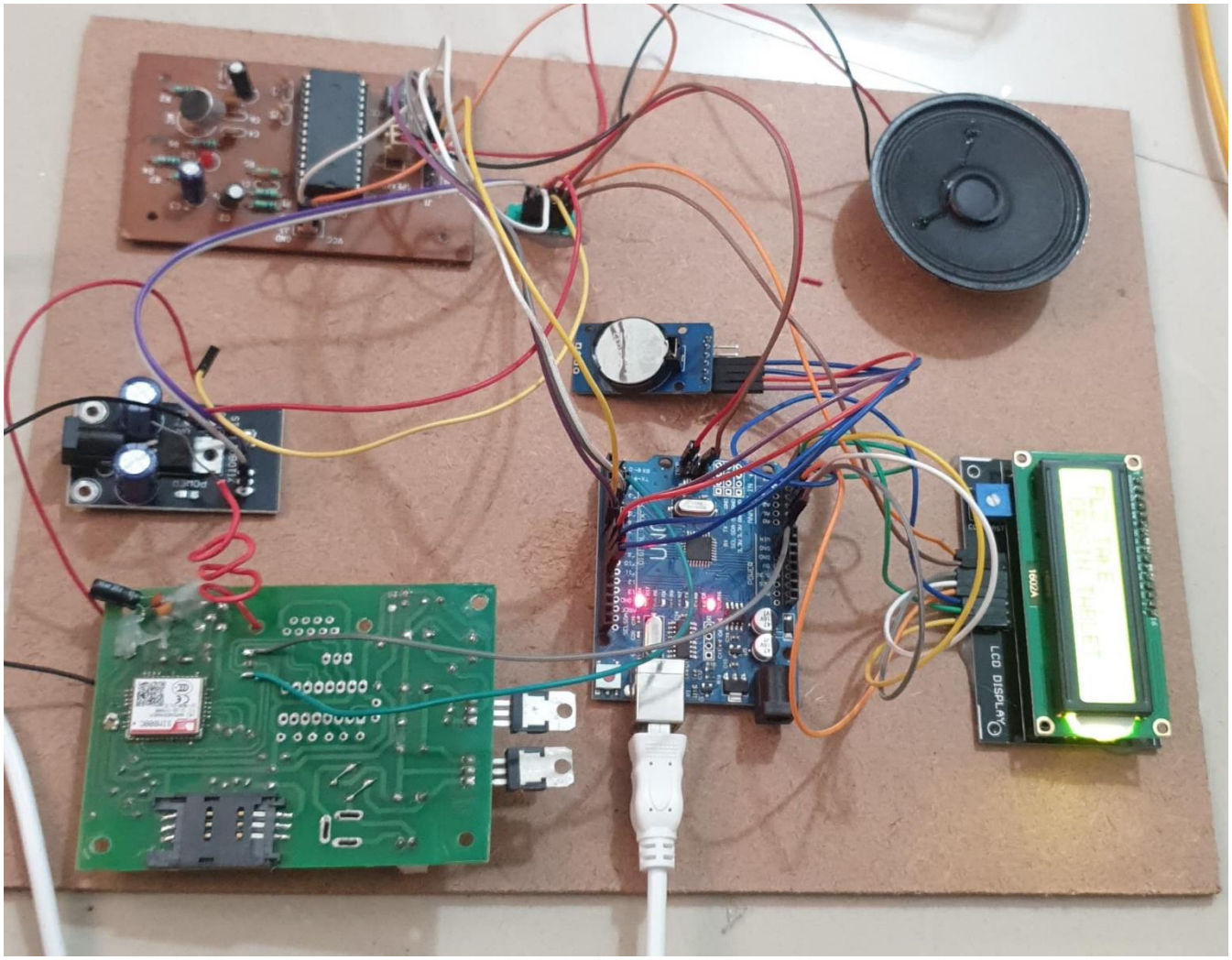
Test Case1:


Review2Execution | Arduino IDE 2.3.2
File Edit Sketch Tools Help
Arduino Uno
Review2Execution.ino
lcd.noBacklight();
digitalWrite(buzzer, HIGH);
digitalWrite(alarmLED, HIGH); // Turn on the LED
delay(300);
lcd.backlight();
digitalWrite(buzzer, LOW);
digitalWrite(alarmLED, LOW); // Turn off the LED
delay(200);
}
void clockDisplay() {
myRTC.updateTime();
lcd.setCursor(0, 0);
Output
Sketch uses 5798 bytes (17%) of program storage space. Maximum is 32256 bytes.
Global variables use 508 bytes (24%) of dynamic memory, leaving 1540 bytes for local variables. Maximum is 2048 bytes.
Ln 9, Col 23 Arduino Uno [not connected]
ENG IN
10:15 25-04-2024

Test Case 2:


ArduinoSpeakerReview3 | Arduino IDE 2.3.2
File Edit Sketch Tools Help
Arduino Uno
ArduinoSpeakerReview3.ino
#define voice1 4
#define voice2 5
#define voice3 6
#define voice4 7
#define led 13
int m=0,i=0;
void SendSMS(String Data){ ////send a message///
gsm.print("AT+CMGF=1\r"); //Because we want to send the SMS in text mode
delay(1000);
gsm.print("AT+CMGS=\"+918465903782\"\r"); //Start sending msg to this number //
//to be sent to the number specified.
//Replace this number with the target mobile number.
delay(1000);
Output
Sketch uses 6376 bytes (19%) of program storage space. Maximum is 32256 bytes.
Global variables use 585 bytes (28%) of dynamic memory, leaving 1463 bytes for local variables. Maximum is 2048 bytes.
Ln 21, Col 34 Arduino Uno [not connected]

Result:



6.Conclusion & Future Scope

6.1 Conclusion

In conclusion, a medicine reminder alarm clock is an effective and reliable tool for prompting individuals to take their medication on time. It serves as a convenient solution for managing complex medication schedules and reducing the risk of missed doses. By incorporating this technology into their daily routine, individuals can enhance their medication adherence, improve treatment outcomes, and ultimately, maintain better overall health and well-being. The medicine reminder alarm clock is a simple yet

valuable asset for anyone looking to stay on top of their medication regimen.The proposed medicine reminder alarm clock project presents a technically feasible and comprehensive solution to the pervasive problem of medication non-adherence. By leveraging the capabilities of the Arduino Uno microcontroller, along with a carefully selected set of components including the DS3231 RTC module, APR33R3 voice module, 16x2 LCD display, SIM900 GSM module, and user interface buttons, the system offers reliable, multi-channel reminders to ensure timely medication intake.

The RTC module guarantees precise timekeeping essential for accurate alarm scheduling, while the voice module and speaker provide clear, personalized audio reminders. The LCD display enhances usability by offering real-time visual feedback, and the GSM module adds a layer of redundancy through SMS notifications, ensuring that users receive reminders even when away from the device. The user-friendly interface allows for easy setting and management of alarms, making the system accessible to a broad user base, including the elderly and those with cognitive impairments.This project not only addresses the critical issue of medication adherence but also demonstrates a modular and scalable design, facilitating future enhancements and maintenance. The extensive support and documentation available for the Arduino platform further affirm the technical feasibility of the project.

In conclusion, the medicine reminder alarm clock is a robust, user-friendly, and effective solution that integrates multiple technologies to improve health outcomes by ensuring that users adhere to their prescribed medication schedules. Through this project, we aim to significantly enhance the quality of life for individuals managing chronic conditions or complex medication regimens.

6.2 Future Scope

Integration with wearable devices: The medicine reminder alarm clock could be integrated with popular wearable devices such as smartwatches or fitness trackers to provide a more personalized and interactive experience for users. The alarm clock could

sync with the wearable device to provide timely reminders and notifications about medication schedules.

Gamification features: Adding gamification elements such as rewards, points, and badges to the medicine reminder alarm clock could help motivate users to stay on track with their medication regimen. Users could earn points for taking their medication on time and redeem them for rewards or incentives.

Cloud-based storage: A cloud-based storage system could be implemented to securely store users' medication schedules, dosage information, and preferences. This would allow users to access their medication information from any device and receive reminders even if they switch to a new device.

Virtual assistant integration: Integrating with virtual assistants such as Amazon Alexa or Google Assistant could provide users with hands-free access to medication reminders and information. Users could simply ask their virtual assistant to remind them to take their medication or inquire about their medication schedule.

Remote monitoring and notifications: The medicine reminder alarm clock could have the ability to send notifications to caregivers or healthcare providers in case of missed doses or medication non-adherence. This feature could help ensure that users are receiving the necessary support and intervention when needed.

Data analytics and insights: The alarm clock could track user behavior and adherence patterns over time to provide insights and recommendations for improving medication adherence. Users could receive personalized suggestions based on their past adherence record to help them better manage their medication regimen.

- **Cloud Integration**: Store medication schedules and user data in the cloud for seamless synchronization across multiple devices and access from anywhere.

- **Medication Dispensing**: Explore the integration of automated medication dispensing systems to further streamline medication management and adherence.

- **Mobile App Companion**: Develop a companion mobile app to complement the alarm clock, offering additional features such as medication tracking, refill reminders, and adherence analytics.

- **User Feedback Mechanism**: Implement mechanisms for gathering user feedback and usage data to continuously improve the system's effectiveness and user satisfaction.

- **Localization and Multilingual Support**: Add support for multiple languages and localization to cater to diverse user demographics and cultural preferences.

- **Enhanced User Interface**: Design a more intuitive and interactive user interface with touchscreen capabilities or graphical user interfaces (GUIs) for easier navigation and customization.

- **Integration with Electronic Health Records (EHR)**: Enable seamless integration with EHR systems to provide healthcare providers with real-time medication adherence data and insights.