SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR.

Mini Project/Electronic Design Workshop Report

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"Pill Dispensing Medicine Assistant"

Submitted By

Batch: A2
Group Number: 1

Ishita Jaiswal (Roll No.-31, Sec-A)
Labdhie Bendey (Roll No.-34, Sec-A)
Ganesh Moroliya (Roll No.-102, Sec-A)
Hemant Paunikar (Roll No.-103, Sec-A)

Guide Name: Prof. Vipul S. Lande

Workshop Coordinator: Prof. T Harinkhede

Department of Electronics and Communication Engineering

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1. Introduction

Medication adherence is a critical aspect of healthcare management, particularly for individuals requiring regular doses of medication. However, remembering to take medication at the prescribed times can be challenging, leading to potential health risks. To address this issue, we present a medication assistance system implemented using an Arduino Uno microcontroller. This system aims to provide users with a reliable and user-friendly solution for managing their medication schedules effectively.

1.1 Literature Survey:

Some issues present in the existing products and design are:

- Complexity and Size:

  Existing pill-dispensing medicine assistant systems often suffer from structural complexity and large size, making them challenging to build, integrate, and use in daily life. The complexity of these systems leads to difficulties in maintenance and operation.
  The patent titled 'Pill Dispenser' invented by David Baarman and 6 others brings out a design that manages multiple medicines and doses but has extremely high structural complexity and is too bulky to be applicable and usable in daily life[2].

- Intensive Slot-Wise Feeding:

  The repetitive manual slot-wise feeding required by many of the existing products like the one shown in Figure 1.1 contributes to user-intensive operation and potential errors[6]. Users are required to individually load medicines into each slot, which can be time-consuming and can make the system prone to mistakes, especially for patients with complex medication routines.
  In the patent titled 'Portable medication Dispenser' in the name of Michel Poirier Paul and Andre Bouchard brings out a multi-pill dispenser but faces the problem of high structural complexity and user intensiveness [1].

Fig: 1.1 Manual Pill Dispenser

- High Cost:

  Affordability remains a significant problem for existing pill-dispensing medicine assistant systems, as many of these products are priced beyond the average consumer's reach. The problem lies in the high manufacturing costs associated with these systems, worsened by the need for specialized components or technologies like IoT-based mobile-connected systems. These factors contribute to the higher prices of these systems, rendering them unfeasible for many potential users.
  The pill dispenser in Fig 1.2 is an IoT-based dispenser with a very high initial cost and requires an annual subscription[5].

Fig: 1.2- IoT Based Pill Dispenser

- Lack of Potential for practical application:

  Many patents and research papers present innovative ideas for pill-dispensing medicine assistant systems. However, they often face practical challenges that make them inapplicable in real-world scenarios. These challenges may include high complexity, structural issues or feasibility constraints that restrict the conversion of ideas into functional products.

- Lack of diversity in Medication:

  Many automated or semiautomated products cannot accommodate diversity of medicines. This makes them inviable for use as general prescriptions consist of multiple medicine administration. The patents titled 'Electronic pill dispenser'[3] and 'Medication dispensing and Monitoring system'[4] are such design ideas.

The proposed pill dispensing medicine assistant system is a user-friendly and efficient solution designed to streamline medication management for patients with complex medication or limited mobility. This automated system integrates various components, including an Arduino Uno microcontroller, RTC module, OLED display, servo motor, push buttons, and a buzzer, to facilitate precise medication dispensing and timely reminders.

1.2 Features of Our Proposed Model:

- Automated Medicine Dispensing: The system automates the process of dispensing medications by utilizing a servo motor to rotate and dispense pills from designated slots. This automated dispensing mechanism ensures accurate dosage delivery and reduces the risk of medication errors.

- Customizable Alarm Settings: Users can set personalized alarm times for medication reminders using the push buttons and OLED display. The system provides flexibility for users to adjust alarm settings according to their medication schedule and preferences.

- Real-Time Display: The OLED display shows the current date and time fetched from the RTC module, providing users with up-to-date information for medication management. Additionally, the display offers feedback on alarm settings, system status, and user interactions.

- User Interaction: Patients can easily interact with the system using the push buttons to select alarms, adjust settings, or acknowledge medication reminders. This interface enhances user experience.

- Auditory Cue: When the set alarm time is reached, the system triggers a loud sound from the buzzer, alerting users to take their medication. Simultaneously, the servo motor dispenses the required pill from the designated slot, ensuring timely medication administration.

- Enhanced Medication Adherence: The automated dispensing and timely reminders provided by the system help improve medication adherence and ensure patients adhere to their prescribed treatment routines.

- User-Friendly Design: Users of all ages and abilities can utilize the system thanks to its user-friendly interface and adaptable features, which encourage independence and ease of use when managing medications.

2. Impact of Project on society and the environment

The implementation of our medicine assistance system extends beyond individual users to implement broader applications within hospital settings and home environments, particularly targeting elderly individuals who may require additional support in managing their medication routines. This expanded scope highlights the versatility and potential impact of our system in improving medication and healthcare outcomes across diverse users.

- Hospital Implementation:

In hospitals, clinics and similar settings, our medicine assistance system serves as a valuable tool for healthcare in managing and monitoring patient medication routines. By integrating of IoT and centralized monitoring system into the existing hospital infrastructure, the system facilitates efficient medication control. Additionally, the system's ability to store patient-specific medication schedules and dosage information ensures personalized care and accurate administration, minimizing the risk of adverse drug events, improving overall patient outcomes and reducing the workload on nurses.

- Enhanced Patient Safety:

By accurately dispensing medications at the correct time and dosage, the system significantly reduces the risk of medication errors such as missed doses, incorrect dosages, or incorrect medication administration. This, in turn, enhances patient safety and reduces the likelihood of adverse drug events, complications and hospitalizations.

- Home Use for Elderly Individuals:

In-home environments, our medicine assistance system provides valuable support for elderly individuals who may lack the physical and cognitive capacity to manage their medication routines independently. Due to age-related conditions and chronic illnesses among the elderly population, the need for reliable medication adherence solutions is necessary. Our system offers a user-friendly interface and intuitive operation, making it accessible and easy to use for elderly individuals with varying levels of technological knowledge. By reminding users of medication schedules, dispensing accurate dosages and providing visual and auditory cues, the system promotes medication adherence and enables elderly individuals to maintain their health and well-being at home.

The versatility of our medication assistance system makes it a valuable asset in both hospital and home settings, catering to the diverse needs of patients and caregivers both. By enhancing medication adherence, promoting patient autonomy, and facilitating efficient healthcare management, our system contributes to improved patient outcomes, reduced healthcare costs, and enhanced quality of life for individuals across different healthcare settings.

3. Block diagram and Functional description

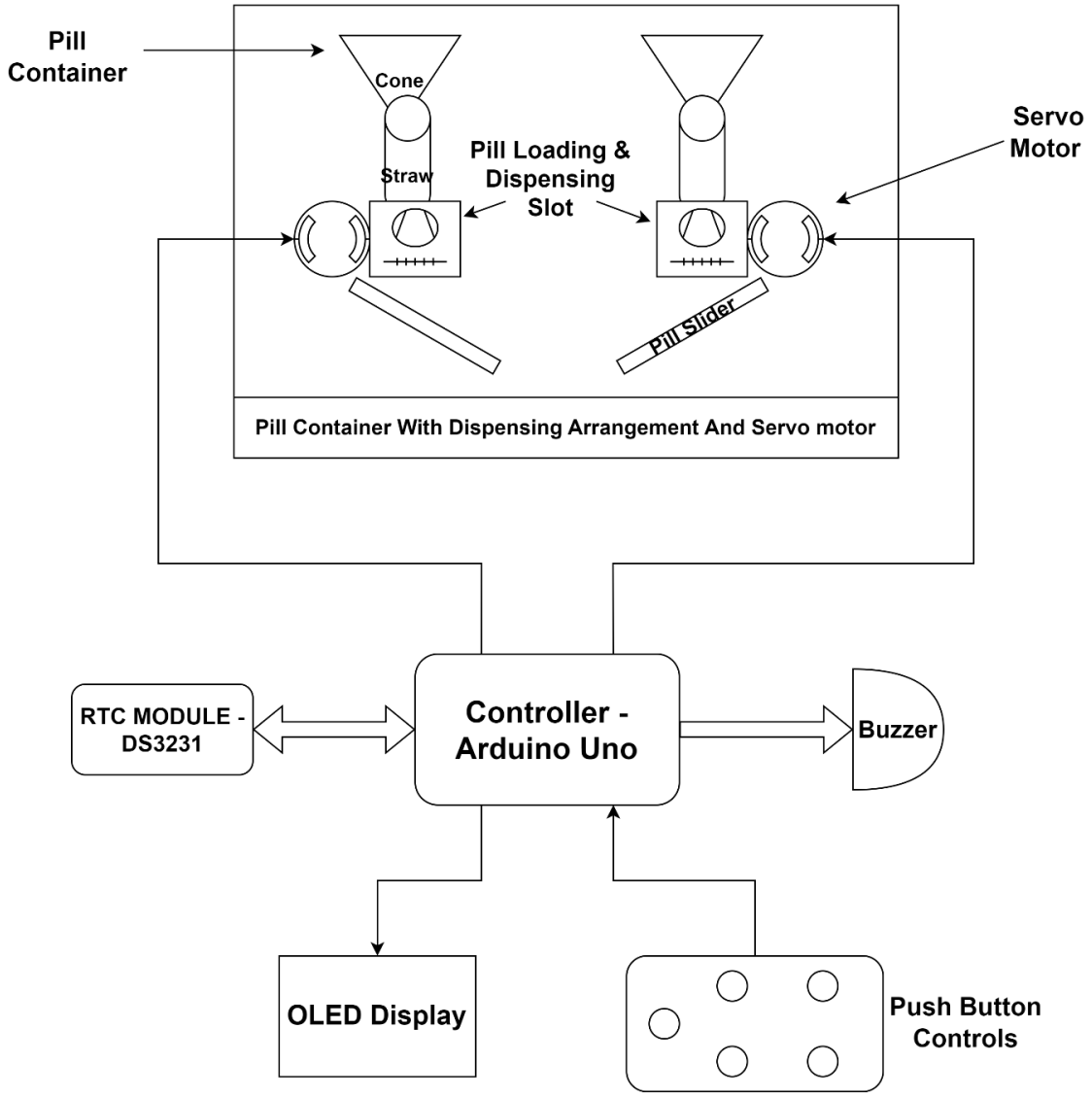

Fig: 3.1- Block Diagram of Pill Dispenser

- Arduino Uno: The Arduino Uno acts as the central controller for managing signals between various components of the pill-dispensing medicine assistant system. It coordinates the interaction between the RTC module, OLED display, push buttons, and servo motors, ensuring seamless communication and synchronization of operations. The Arduino Uno utilizes the in-built EEPROM (Electrically Erasable Programmable Read-Only Memory) to store alarm time and related data persistently, even when the system is powered off[10]. When the user sets the alarm time using the push buttons, the Arduino writes the alarm time data to the EEPROM memory. Upon system startup, the Arduino retrieves the stored alarm time from EEPROM, ensuring that the alarm settings are retained across power cycles.

- RTC Module: The DS3231 Real-Time Clock (RTC) module is integrated into the pill dispensing medicine assistant system to provide accurate timekeeping functionality. In conjunction with an OLED display, the DS3231 RTC module ensures that users have access to real-time time information. RTC module is initialized and configured to communicate with the Arduino Uno via the I2C interface . The DS3231 RTC module ensures accurate timekeeping, while the OLED display presents the current time in a user-friendly format. This feature enhances the usability of the system, allowing users to track medication schedules and adhere to prescribed treatments effectively.

- OLED Display: The OLED display shows the current time fetched from the RTC module, providing users with up-to-date time information for medication management. Users can view the set alarms for medication reminders on the OLED display, allowing them to monitor upcoming alarms and adjust settings as needed. The OLED display provides an interface for users to set alarm times and configure medication slots. Users can interact with the OLED display to adjust alarm settings, set medication schedules, and customize slot configurations for efficient medication management.

- Servo SG90: The Arduino Uno controls multiple servo motors responsible for dispensing medication. Servo motors are connected to the Arduino's digital pins using PWM (Pulse Width Modulation) signals to precisely control their rotation angle. By programming the Arduino, we adjust the servo motor's rotation to dispense the required amount of medication accurately.

- Buzzer: The buzzer is an electromechanical component that produces audible sound when an electrical signal is applied to it. In the pill-dispensing medicine assistant system, the buzzer serves the function of alerting users when the alarm time is reached, indicating that it's time to take medication.

- Dispensing Mechanism: It showcases the pill container structure, featuring a cone or funnel-like component linked to a hollow straw, which serves to guide the pills individually. The straw is carefully sized to accommodate the specific dimensions and shapes of the pills being dispensed. Directly beneath the straw, there's a slot designed for loading one pill at a time[15]. This slot is intricately connected to a servo motor, which handles both the loading and dispensing of pills through its controlled movement. When it's time to dispense a pill, the servo motor rotates the slot outward to release one pill, then smoothly returns it to its original position to load the next pill. Following the dispensing process, a pill slider ensures the pill's smooth transition to the dispatch area.

4. Circuit diagram and its description

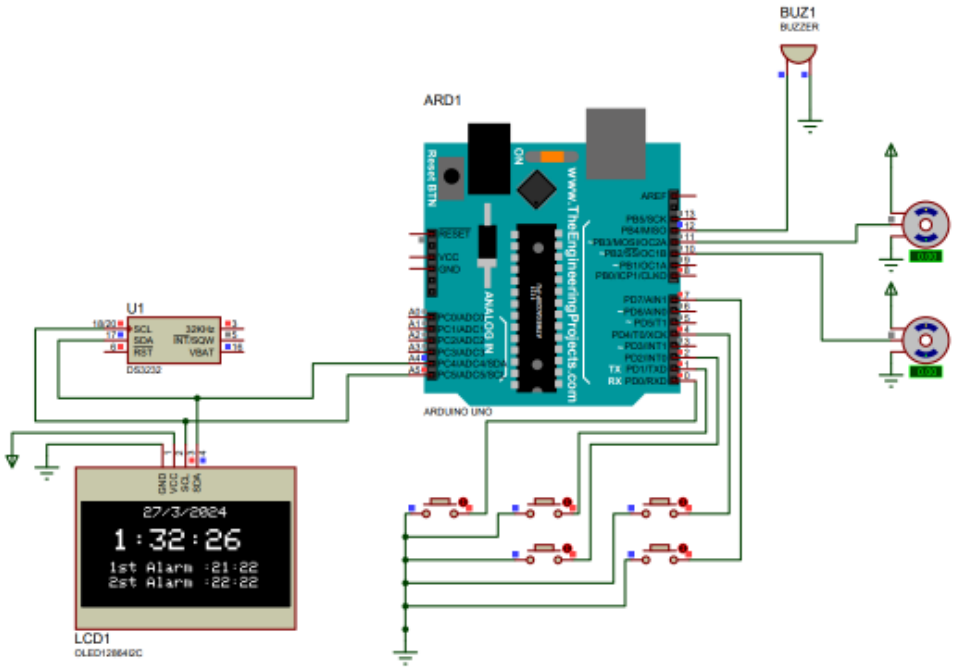

Fig: 4.1- Circuit Diagram

- Arduino Uno: The Arduino Uno is a widely-used microcontroller board renowned for its versatility, simplicity, and ease of use in electronics projects, including our pill-dispensing medicine assistant system. Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button[13]. The Arduino Uno acts as the central controller for managing signals between various components of the pill-dispensing medicine assistant system. It coordinates the interaction between the RTC module, OLED display, push buttons, and servo motors, ensuring seamless communication and synchronization of operations[11].

- RTC Module (DS3231): The DS3231 is a low-cost, low-power and extremely accurate I2C real-time clock (RTC) module. It is widely used in various electronic devices and systems to provide precise timing and calendar functions. It offers excellent timekeeping accuracy, with typical deviations of just a few seconds per month[7]. It utilizes a Temperature Compensated Crystal Oscillator to maintain accurate timekeeping over a wide temperature range[12]. It supports two programmable alarms, which can trigger at specific times or dates configured by the user.

- OLED Display: An OLED(Organic Light-Emitting Diode) display works without a backlight because it emits its own visible light. Thus, it can display deep black levels and can be thinner and lighter than a liquid crystal

display (LCD). They are a type of flat-panel display technology that utilizes organic compounds to emit light when an electric current is applied. They offer several advantages over traditional LCD displays, including higher contrast ratios, faster response times, wider viewing angles, and lower power consumption[9].

- Push Buttons: Push buttons are used to allow user interaction with the system, such as setting alarm times, acknowledging alarms, or adjusting system settings. The Arduino Uno reads the state of the push buttons connected to its digital input pins, detecting button presses and responding accordingly based on programmed logic.

- Servo Motor (SG90): The SG90 servo motor is a small and lightweight electromechanical device widely used in projects, robotics, and automation applications. It offers precise control over angular position and is commonly employed in systems requiring controlled motion. Its small size allows for easy integration into various projects and devices without adding significant bulk or weight. It operates on the principle of feedback control, where the motor's internal potentiometer provides position feedback to maintain the desired angular position accurately. The SG90 servo motor offers precise positional control, with typical angular resolutions ranging from a few degrees to less than one degree per pulse. The SG90 servo motor is typically controlled using PWM signals generated by microcontrollers or servo motor controllers[8].

5. Working of Project

The pill dispensing medicine assistant system works to achieve the aim of dispensing pills at the set alarm time. The System has a very simple initialization process after which the alarm can be set and thus medicine dispensed at that particular time slot along with the buzzer sound.

The Working of the Project is as explained below:

- Initialization of Components:

  Upon powering on, the Arduino Uno initializes all necessary components, including the RTC module, OLED display, servo motor, and push buttons. This ensures that the system is ready to perform its intended functions.

- Displaying Current Date and Time:

  The OLED display shows the current date and time fetched from the RTC module. This provides real-time information, allowing us to keep track of the current time and date.

- Alarm Selection:

  User presses the button to select between Alarm 1 and Alarm 2. This allows users to choose slot for which they want to set or modify the alarm based on their medication schedule or preferences.

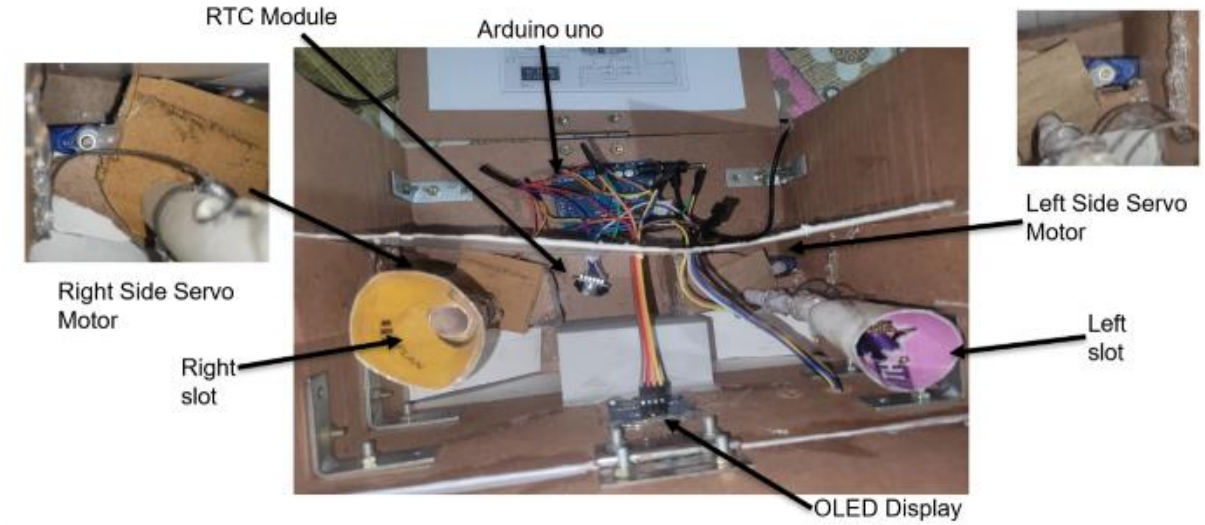

Fig:5.1- Internal Structure of the Model

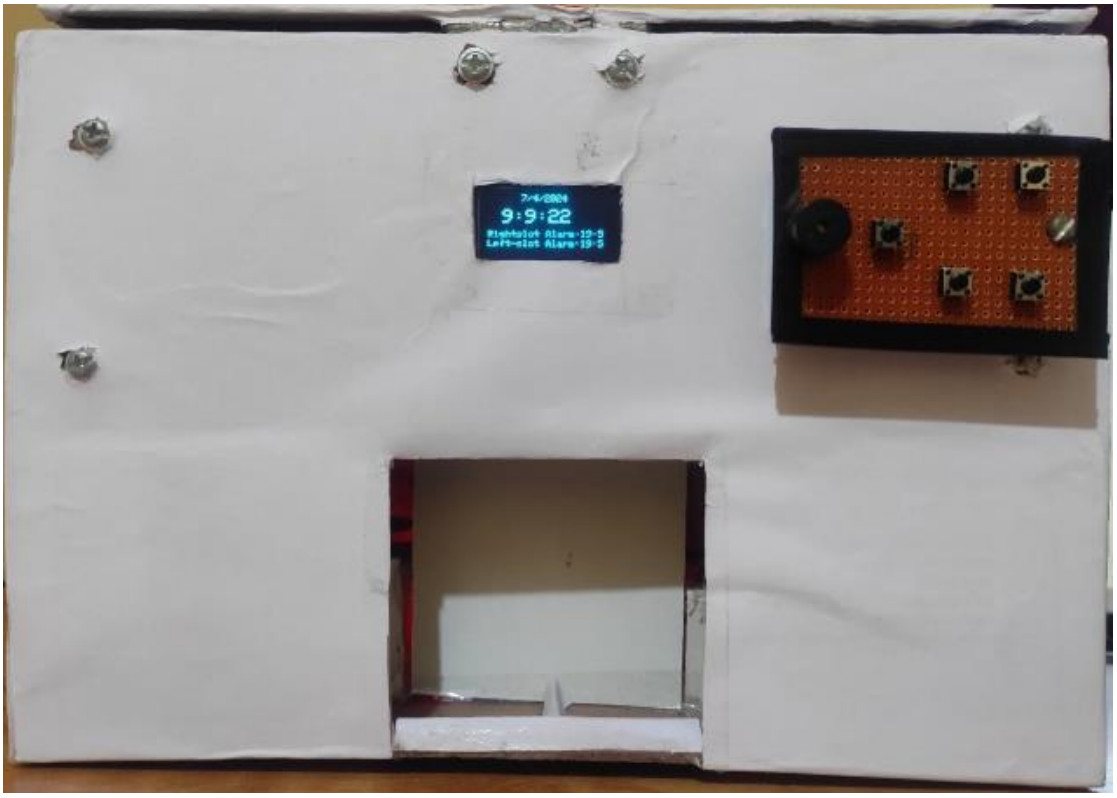

Fig: 5.2- Front View of the proposed Model

- Setting Alarm Time:

  Once the desired alarm is selected, we can increment or decrement the hour and minute values using separate buttons (UP and DOWN buttons). This enables users to customize the alarm time according to their medication schedule or specific needs.

- Triggering Alarms:

  When the current time matches the set alarm time for either Alarm 1 or Alarm 2, the alarm function is triggered. This alerts the user that it's time to take their medication by producing a loud sound using the buzzer for about 10 seconds, ensuring that they are reminded about their dose.

- Dispensing Medication:

  Simultaneously with the alarm triggering, the servo motor associated with the corresponding alarm (Alarm 1 or Alarm 2) rotates to dispense one pill. The servo motor rotation angle and duration are configured to dispense precisely one pill per activation. After dispensing the pill, the servo returns to its initial position, ready for the next dispensing cycle.

- User Interaction:

  Throughout the process, users can interact with the system using push buttons to adjust alarm settings or acknowledge the alarm. there is an instruction guide at the top of our project model shown in Fig. 5.3 which helps a lot in handling the device. This provides users with control and flexibility in managing their medication schedule and responding to alarm notifications.

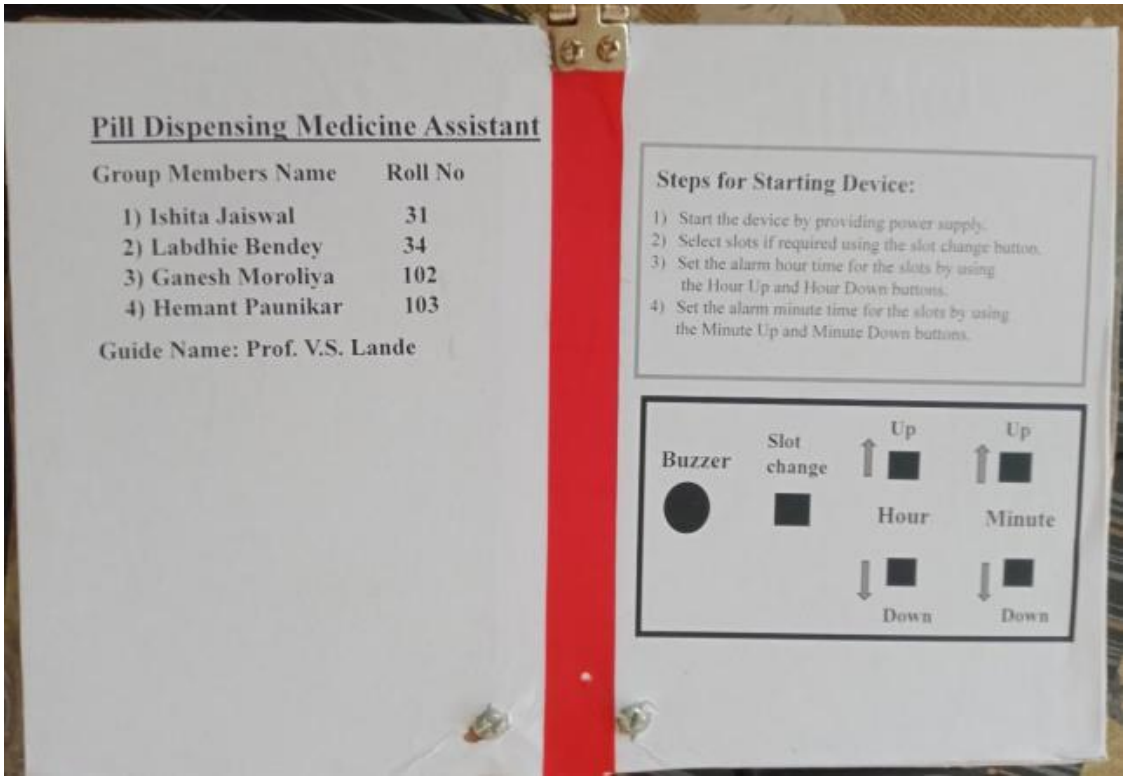

Fig:5.3- Top View of proposed Model

- Continuous Monitoring and Control:

  The main loop of the Arduino continuously monitors the current time from the RTC module and checks for any alarm time. It also attends to the user input from the push buttons to allow dynamic adjustment of alarm settings, ensuring that the system remains responsive and adaptable to users' needs.

The OLED display displays data to the user regarding the current state of the system, including alarm selection, time settings, and alarm time display. This ensures that users are informed and can easily monitor and manage the operation of the pill dispensing medicine assistant.
The system also displays a greeting message upon startup to welcome users and introduce the PILL DISPENSING MEDICINE ASSISTANT. This enhances the user experience and creates a positive interaction with the system.

6. Result and Future Scope

Advantages:

- Errorless Medicine Administration:

  Patients no longer need to remember the specific times for taking their medications. With multiple slots for dispensing, the system automatically dispenses medicines at the designated times, relieving patients of the burden of remembering complex medication schedules. By automating the dispensing process, the system ensures precise and error-free administration of medications. This reduces the risk of dosage errors, missed doses, or incorrect timing, thereby enhancing medication safety and effectiveness.

- Reduced Burden on Nurses and Caregivers:

  The system lightens the workload for nurses and caregivers by automating medicine administration tasks. With multiple slots for dispensing, caregivers no longer need to manually check each patient's medications at specific times, allowing them to focus on other aspects of patient care.

- Independence for Patients:

  Patients gain greater independence in managing their medications. With the system handling the timing and dosage of medications, patients can rely on the automated process without needing constant supervision or assistance from caregivers.

Limitations:

- Limited Capacity:

  Systems with multiple slots may have a finite capacity, restricting the number of medications that can be stored and dispensed at any given time. Patients with extensive medication regimens may require additional slots or alternative storage solutions, which could increase system complexity and cost. Setting up and configuring a system with multiple slots can be more complex compared to systems with fewer slots.

- Special storage conditions and Variety in pill sizes:

  Some medicines require special storage conditions like extremely low temperatures or a moisture-free environment. Accommodating these medicines in the system is possible only with a higher cost.

Medicines come in variable sizes hence the mechanism employed in dispensing them has to be either customizable to their size of flexible to work with all shapes and sizes of medicines.

Future Scope:

- Introducing Power Saving :

  Implementing power-saving features in the pill-dispensing medicine assistant system involves optimizing the Arduino's power usage to prolong battery life or reduce electricity consumption. This can be achieved by incorporating sleep modes or low-power standby states during periods of inactivity. When the system detects no user interaction or medication dispensing activity for a specific duration, say 1 minute, it automatically switches to a power-saving mode, temporarily shutting off non-essential components such as the display. Upon user interaction or scheduled medication dispensing, the Arduino wakes up from its low-power state to resume normal operation, thereby conserving energy without compromising system functionality.

- Multiple Slots for Medicines:

  Expanding the pill dispensing medicine assistant system to accommodate multiple medication slots offers enhanced versatility and flexibility in managing complex medications. Each slot within the dispenser can be designated for a specific medication or dosage frequency. The system's user interface can facilitate easy navigation and selection of medications from multiple slots, providing clear visuals and reminders for each medicine routine. Additionally, the system can incorporate features such as refill reminders and tracking for individual medication slots, ensuring timely refill of doses and minimizing the risk of missed doses.

- Portable by Making it Smaller and Compact:

  Improving the portability of the pill dispensing medicine assistant system involves reducing its size and weight to enhance mobility. This can be achieved by redesigning the system's hardware components to be more compact and lightweight, utilizing smaller form factors for the Arduino(designing a PCB using microcontroller ATMega328p) and dispensing mechanism. By making the system smaller and more portable, users can easily carry it with them while traveling or relocating, ensuring continuity of medication management and adherence support in various settings.

- Extension to Hospitals for Centralized Use:

  Extending the pill dispensing medicine assistant system to hospitals for centralized use involves integrating the system into existing healthcare infrastructure to support medication management in clinical settings. This can be achieved by implementing network connectivity features that enable communication between multiple dispensers and a centralized management platform. Hospital staff, including doctors and nurses, can access this platform to monitor medication adherence and remotely manage medication schedules for multiple patients. Incorporating AI algorithms into pill dispensing systems can help us personalize medication management based on individual patient data, including medication history and health conditions. AI can also help analyze patient behaviour to anticipate medication patterns and optimize treatment outcomes. Additionally, the system can facilitate seamless integration with electronic health record systems to ensure accurate documentation and continuity of care across healthcare settings.

- Dispensing Multiple Pills According to Patients' Needs:

  Expanding the functionality of the pill dispensing medicine assistant system to accommodate the dispensing of multiple pills according to patients' individual medication needs enhances customization. This feature allows the system to dispense a combination of different medications and dosages according to each patient's needs. Users or caregivers can input the details of the patient's medication into the system's interface, specifying the types and quantities of pills to be dispensed at each scheduled interval.

Result:

The implementation of the pill-dispensing medicine assistant system yielded several significant outcomes, demonstrating its effectiveness in enhancing medication management and patient care.

The pill dispensing medicine assistant system prototype was successfully developed and demonstrated functionality. The system effectively integrated components such as the Arduino Uno microcontroller, RTC module, OLED display, servo motor, push buttons, and buzzer to automate medication management tasks. The OLED display accurately presented real-time information fetched from the RTC module, facilitating easy monitoring of current time and alarm settings. Users could select between Alarm 1 and Alarm 2 and adjust hour and minute values using the push buttons for personalized medication reminders. Upon triggering the alarm, the buzzer emitted a loud sound, signaling the need for

medication intake. Simultaneously, the servo motor rotated to dispense a single pill from the designated slot, ensuring precise dosage delivery. The system's design emphasized user interaction, providing a user-friendly interface for adjusting settings and acknowledging alarms. Overall, the prototype demonstrated the potential for improving medication adherence and patient safety through automated medication management.

In conclusion, the successful development and functionality demonstration of the pill dispensing medicine assistant system prototype highlight its potential as a valuable tool for optimizing medication management. While formal testing with users was not conducted during this stage, the system's design and functionality lay the foundation for future testing and refinement. Further development efforts will focus on addressing any identified limitations and preparing the system for real-world deployment and evaluation with patient populations.

7. References/ Citations

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