FACULTY OF ENGINEERING TECHNOLOGY

UNIVERSITY OF SRI JAYAWARDANEPURA
SRI LANKA

DEPARTMENT OF MATERIAL AND MECHANICAL TECHNOLOGY

PROJECT REPORT

SMART TALKING PILL REMINDER FOR BLIND AND VISUALLY IMPAIRD PEOPLE

SUBMITTED BY

K. A. D. B. SANDARUWAN

EGT 19 517

UNDER THE GURADIANCE OF

DR. MALAKA

DR. AKILA WIJETHUNGA

TABLE OF CONTENT

EXECUTIVE SUMMARY

ES.1 Main Features – Pill reminder

Blind individuals often struggle with managing their medication regimen due to the inability to see names, dosages, and instructions of pill package. This can lead to a number of challenges, including difficulty remembering to take medications, difficulty determining correct dosages, and difficulty keeping track of multiple medications. As a result, many blind individuals rely on others for assistance with managing their medication regimen. However, this can be inconvenient and may not always be possible, particularly if the individual does not have a caregiver available.

The difficulties faced by blind individuals in managing their medication regimen can have serious consequences for their health and quality of life. It is important to find solutions that can help these individuals to take their medications independently and effectively. One such solution is the use of a "Smart Talking Pill Reminder" device, which can provide audio reminders and information to assist blind individuals in managing their medications. By providing a convenient and accessible way for blind individuals to manage their medications, the "Smart Pill Reminder" has the potential to greatly improve their health outcomes and quality of life.

The "Smart Talking Pill Reminder" is a device designed to assist blind and visually impaired individuals in managing their medication regimen. The device consists of a small, portable unit that can be carried with the user or placed in a convenient location.

One of the key features of the "Smart Pill Reminder" is a mobile app that allows doctors or caregiver to input and update their medication information. The app is easy to use, with a simple and intuitive interface. Users can enter the names and dosages of their medications, as well as the times they need to take them. The app then transmits this information to the device. All the information are stored in a non-volatile memory.

The "Smart Talking Pill Reminder" also has an audio component that speaks the medication information aloud in a Human voices. This is an important feature, as it enables users to hear the names and dosages of their medications even if they are unable to see them. The device also has only one controlling button, thus blind person can easily control the device by using that button.

To use the "Smart Pill Reminder", users simply need to enter their medication information into the device using the mobile app. They can then set reminders for when they need to take their medications, and the device will alert them at the appropriate times. If the user misses a dose, the device will alert them and provide them with the opportunity to take the medication as soon as possible.

The "Smart Talking Pill Reminder" has the potential to make a significant impact on the lives of blind and visually impaired individuals. Many of these individuals struggle with managing their medication regimen, which can lead to poor health outcomes and a lower quality of life. By providing a convenient and accessible solution for managing medications, the "Smart Pill Reminder" can help users to remember to take their medications on time and in the correct dosages, leading to improved health outcomes and a better quality of life.

The advantages of the "Smart Pill Reminder" project for blind and visually impaired individuals are:

- Improved medication management: The device provides a convenient and accessible solution for blind individuals to manage their medications, including remembering to take their medications on time and in the correct dosages.

- Increased independence: The device allows blind individuals to manage their medication regimen independently, rather than relying on others for assistance.

- Improved health outcomes: By helping users to take their medications correctly and consistently, the device has the potential to improve health outcomes and prevent negative consequences from missed doses or incorrect dosages.

- Enhanced quality of life: The device can improve the quality of life for blind individuals by reducing the burden of managing medications and allowing them to live more independently.

- User-friendly and easy to use: The device has a simple and intuitive mobile app and an audio component that speaks the medication information aloud, making it easy for blind person users to take their medication information and receive reminders.

ES.2 Other Features – Talking clock

The "Smart Pill Reminder" is a device designed to assist blind and visually impaired individuals in managing their medication regimen. The device has two main features: a "Pill Reminding Feature" that provides audio reminders to users to take their medications, and a "Talking Clock Feature" that provides audio announcements of the current time.

One of the key features of the "Smart Pill Reminder" is the "Talking Clock Feature", which provides audio announcements of the current time to assist blind individuals in keeping track of time. Many blind individuals struggle with telling time, as they cannot see traditional clock faces or read digital displays. The "Talking Clock Feature" addresses this challenge by speaking the time aloud at regular intervals or upon request. This feature makes it easier for blind individuals to stay on schedule and manage their daily activities, improving their independence and quality of life.

We encourage you to read the introduction other sections of the report, as it provides important context and background information that will help you to understand the problem we are addressing and the significance of our proposed solution. The introduction sets the stage for the rest of the report and will give you a deeper understanding of the motivation behind our work and the impact it has the potential to make.

Overall, the "Smart Talking Pill Reminder" is a simple yet effective solution to a common problem faced by blind and visually impaired individuals. Its combination of a mobile app and audio component makes it user-friendly and easy to use, and it has the potential to greatly improve the lives of its users.

ABSTRACT

The "Smart Pill Reminder" is a device designed to assist blind and visually impaired individuals in managing their medication regimen. The device has two main features: a "Pill Reminding Feature" that provides audio reminders to users to take their medications, and a "Talking Clock Feature" that provides audio announcements of the current time. By providing a convenient and accessible way for blind individuals to manage their medications and keep track of time, the "Smart Pill Reminder" has the potential to greatly improve their health outcomes and quality of life. The device has a simple and intuitive mobile app and an audio component that speaks the information aloud, making it easy for users to input and update their medication information and receive reminders. Overall, the "Smart Pill Reminder" is a valuable tool for blind and visually impaired individuals, providing a simple and effective solution to the challenges of managing a medication regimen and keeping track of time.

KEYWORDS: Blind and visually impaired, Medication management, Mobile app, Audio output, Microcontroller, Internet of Things (IoT), TF-16 MP3 player, Arduino

INTRODUCTION

I.1 Problem statement

Blind and visually impaired individuals often face significant challenges in managing their medication regimen. Without the ability to see pill bottles or packaging, it can be difficult for these individuals to remember to take their medications on time and in the correct dosages. [*Below figure -1 shows the picture of a pill packaging that we got from hospitals*]. This can lead to missed doses, which can have negative effects on their health, such as decreased effectiveness of treatment or increased risk of adverse reactions. Additionally, blind individuals may not be able to read dosage instructions, which can lead to under- or over-dosing, with similar negative consequences. The difficulties of managing medications can be further compounded by the need to take multiple medications at different times of the day, which can be confusing and overwhelming. Many blind individuals rely on others to help them manage their medication regimen, but this can be inconvenient and may not always be possible, particularly if the individual does not have a caregiver available.

figure 1 - Pill packet with information patient

The challenges faced by blind individuals in managing their medication regimen can have serious consequences for their health and quality of life. It is important to find solutions that can help these individuals to take their medications independently and effectively. The "Smart Talking Pill Reminder" project aims to address this problem by developing a device that provides a convenient and accessible solution for blind individuals to manage their medications. By providing audio reminders and information, the device has the potential to greatly improve the health outcomes and quality of life for blind individuals.

I.2 Existing solutions

There have been a number of previous efforts to assist blind individuals in managing their medication regimen. These solutions include the use of audio pill reminders, tactile markings on pill bottles, and medication packaging with braille labels. However, these solutions have several limitations. Audio pill reminders may be difficult to set up and use for blind individuals who are not familiar with electronic devices. Tactile markings on pill bottles can be hard to find and may be easily worn off, making them unreliable. Medication packaging with braille labels can be expensive to produce and may not be widely available.

In addition, many previous solutions have focused on providing assistance to blind individuals in taking their medications, rather than empowering them to manage their medication regimen independently. For example, some solutions involve having a caregiver set up and administer medications to the user, rather than providing the user with the tools to manage their own medications.

Overall, previous solutions for assisting blind individuals in managing their medications have had limited effectiveness and may not fully address the needs and preferences of users. The "Smart Pill Reminder" project aims to address these limitations by developing a device that is user-friendly, accessible, and empowering for blind individuals.

I.3 Research questions

One of the main goals of the "Smart Pill Reminder" project is to design a device that is user-friendly and accessible for blind individuals. To achieve this goal, the project aims to answer the following research questions:

1. How can the device be designed to be intuitive and easy to use for blind individuals, with a focus on minimizing the number of input buttons and controls?

2. How can the device be programmed to recognize different input modes, such as single clicks, double clicks, and long press, to provide a range of options for users to input and access information?

3. How can the device be programmed to provide audio feedback and prompts to assist users in navigating and using the device, without overwhelming them with too much information at once?

4. How can the device be designed to be durable and reliable, with a long battery life and minimal maintenance requirements?

5. How can the device be tested and evaluated to ensure that it is effective and useful for blind individuals in managing their medication regimen?

I.4 Objectives

The main objectives of the "Smart Pill Reminder" project are to develop a device that helps blind individuals to manage their medication regimen independently and effectively, and to improve their health outcomes and quality of life. To achieve these objectives, the project aims to design a device that is user-friendly, accessible, and empowering for blind individuals. The device should be easy to set up and use, with a simple and intuitive mobile app and a single input button that recognizes different input modes. It should provide audio reminders and information to assist users in taking their medications correctly and on time, and should be able to store and update information on multiple medications.

In addition, the device should be durable and reliable, with a long battery life and minimal maintenance requirements. It should be able to operate in a range of environments and be easy to carry and use on the go. To ensure that the device is effective and useful for blind individuals, the project will involve testing and evaluation with user groups to gather feedback and identify any areas for improvement. Overall, the "Smart Pill Reminder" project aims to develop a valuable tool for blind individuals, providing a simple and effective solution to the challenges of managing a medication regimen and improving their health outcomes and quality of life.

I.5 Significance

The "Smart Pill Reminder" project also has broader implications for society as a whole. By improving the health outcomes of blind and visually impaired individuals, the device has the potential to reduce the overall burden of illness and health care costs. Additionally, the device can help to reduce the social isolation and dependence on caregivers that may be experienced by some blind individuals, improving their overall quality of life. Overall, the "Smart Pill Reminder" project has the potential to make a significant impact on the health and well-being of blind and visually impaired individuals, as well as on society as a whole.

I.6 Scope

The scope of the "Smart Pill Reminder" project is focused on the development and testing of a device that helps blind individuals to manage their medication regimen independently and effectively. To achieve this goal, the project involves the design and development of a device that utilizes Internet of Things (IoT) technology and a range of programming languages, including C++ and C, as well as algorithms and data structures. The project also involves the development of a custom protocol to facilitate communication between the device and the accompanying mobile app.

The scope of the project includes the design and development of the device, as well as testing and evaluation with user groups to gather feedback and identify areas for improvement. The project does not include the mass production or commercialization of the device, as these aspects fall outside the scope of the project.

Overall, the "Smart Pill Reminder" project aims to develop a device that is user-friendly, accessible, and empowering for blind individuals, providing a valuable tool for managing their medication regimen and improving their health outcomes and quality of life.

I.7 Overview

The "Smart Pill Reminder" project involves the design and development of a device that helps blind individuals to manage their medication regimen independently and effectively. The device consists of a compact, portable device with a single input button that recognizes different input modes, such as single clicks, double clicks, and long press. The device is connected to the Internet via a wireless network and can be accessed and controlled through a accompanying mobile app.

Users can input and update information on their medications, including names, dosages, and schedules, through the mobile app. The device then provides audio reminders and information to assist users in taking their medications on time and in the correct dosages. The device also has a talking clock feature, providing audio feedback on the current time to assist users in keeping track of their schedules.

To ensure that the device is user-friendly and accessible, the project involves testing and evaluation with user groups to gather feedback and identify areas for improvement. The project aims to develop a device that is intuitive, reliable, and durable, with a long battery life and minimal maintenance requirements. Overall, the "Smart Pill Reminder" project has the potential to greatly improve the health outcomes and quality of life for blind individuals, providing a convenient and accessible solution to the challenges of managing a medication regimen.

I.8 Background study

According to the World Health Organization (WHO), it is estimated that around 253 million people globally have vision impairments, including 36 million who are blind and 217 million who have low vision. Blindness is defined as visual acuity of less than 20/400 in the better eye, or a visual field of less than 20 degrees, while low vision is defined as visual acuity of less than 20/40 but equal to or better than 20/400 in the better eye, or a visual field of less than 20 degrees but more than 20 degrees in the better eye.

In terms of demographics, the prevalence of vision impairments tends to increase with age, with older adults being more likely to have vision impairments than younger adults. According to the WHO, around 82% of people with vision impairments are aged 50 years or older. This is likely due to the fact that age-related eye conditions, such as cataracts, glaucoma, and age-related macular degeneration, are more common in older adults.

Overall, vision impairments are a significant public health issue, with a significant impact on the lives of affected individuals and their families. The development of solutions such as the "Smart Pill Reminder" has the potential to greatly improve the health outcomes and quality of life for blind and visually impaired individuals, helping them to manage their medication regimen independently and effectively.

There are several previous solutions that have been developed to assist blind individuals in managing their medications, including audio pill reminders, tactile markings, and braille labels. Audio pill reminders produce an audio alarm to remind the user to take their medications, but may not provide detailed information through voice on specific medications or dosages, and may not be able to be updated with changes to the user's medication regimen. Tactile markings are raised markings or symbols applied to pill bottles or packaging to provide tactile cues to the user, but may not provide information on dosages or schedules, and may not be suitable for users with severe vision impairments or limited manual dexterity. Braille labels are labels with braille characters applied to pill bottles or packaging to provide information to the user in braille, but may not be suitable for users who are not familiar with braille or who have limited manual dexterity. These previous solutions have limitations that may make them less widely used in the real world, and there is a need for a more convenient, flexible, and accessible solution for blind individuals to manage their medications. The "Smart Pill Reminder" project aims to address these limitations by using Internet of Things (IoT) technology to provide a

compact, portable device that can be accessed and controlled remotely through a mobile app, and that provides audio reminders and information on medications and dosages in real-time. The device also includes a talking clock feature to assist users in keeping track of their schedules

Internet of Things (IoT) technology refers to the interconnected network of physical devices, sensors, and systems that are able to collect and exchange data using the internet. The widespread adoption of IoT technology has led to a number of new applications in various industries, including healthcare.

In the healthcare industry, IoT technology has the potential to improve patient care and outcomes by enabling the remote monitoring of vital signs and other health indicators, as well as the management of chronic conditions and medication regimes. For example, IoT-enabled devices can be used to monitor the adherence of patients to their medication regimen, alerting healthcare providers if there are any deviations from the prescribed schedule. This can help to ensure that patients are taking their medications as prescribed, which can improve their health outcomes and reduce the risk of complications.

In addition to its potential for improving patient care, IoT technology has the potential to increase the efficiency and effectiveness of healthcare systems. For example, IoT-enabled devices can be used to reduce the need for in-person visits to healthcare providers, allowing patients to be monitored remotely and reducing the burden on already stretched healthcare resources.

THEORITICAL ANALYSIS

The smart pill reminder system is designed to assist individuals who are blind or visually impaired in managing their medication regimen. The traditional method of managing medication for blind individuals requires assistance from a sighted person to read the prescription and instruct them on when and how to take their medication. However, this system aims to provide an independent solution for the blind by incorporating a smart pill reminder device and a mobile application. The system operates by utilizing a smart pill reminder device, which is equipped with a Bluetooth module for communication with a mobile application. Below figure - 2 shows the simple diagram of describing the communication of smart phone and Arduino board.

The mobile application serves as the interface for a sighted individual to program the device according to the medication prescription. The application allows the user to input information such as the type of medication, the dosage, and the schedule for taking the medication. Once this information is inputted, it is transmitted to the smart pill reminder device via Bluetooth and stored in the device's EEPROM memory.

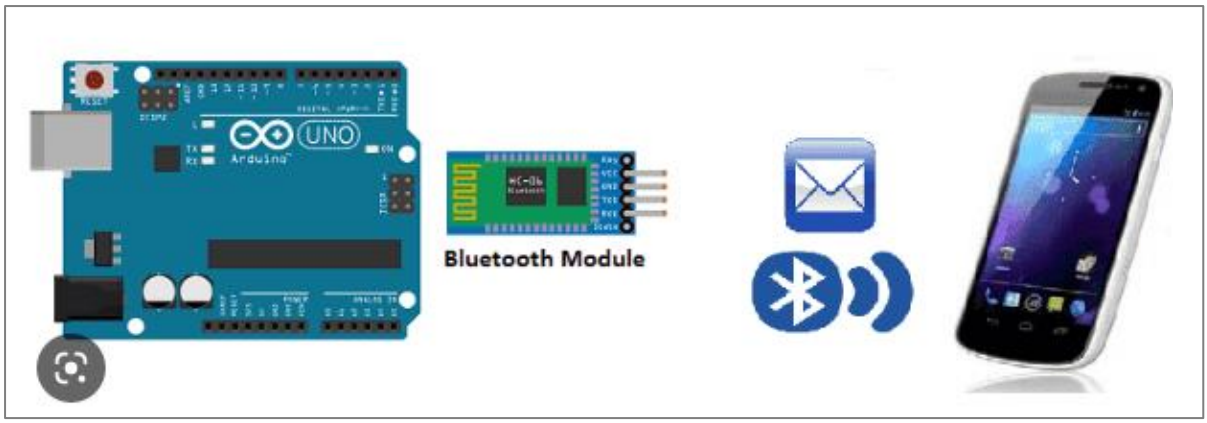


figure 2 - Communication between smart phone and Arduino board

The smart pill reminder device is equipped with a number of pill boxes that are used to store the medication. Each pill box is labelled with a number and is used to store a specific type of medication. The sighted individual uses the mobile application to assign the medication to a specific pill box and input the corresponding information for that medication.

The smart pill reminder device is also equipped with a reminder mechanism that reminds the blind individual to take their medication according to the schedule programmed by the sighted individual. The reminder mechanism can be in the form of an audible alarm or a vibration, which is triggered at the designated time for taking the medication.

The smart pill reminder system provides several benefits for blind individuals. The primary benefit is that it allows them to manage their medication independently without the need for assistance from a sighted person. Additionally, the system ensures that the medication is taken at the correct time and in the correct dosage, which helps to prevent medication errors and improve adherence to the medication regimen.

Moreover, the smart pill reminder device can be used with multiple types of medication and the reminder mechanism can be programmed according to the specific need of the user, which makes it a versatile device. This can be of great help for elderly or people with chronic conditions, where missing or taking wrong medication can cause harm.

In conclusion, the smart pill reminder system is a novel solution for blind individuals that addresses the challenges they face in managing their medication regimen. By incorporating a smart pill reminder device and a mobile application, the system allows for independent management of medication and improves adherence to the medication regimen. The system's versatility and ability to be tailored to the specific needs of the user makes it a valuable tool for improving medication management for blind individuals.

HARDWARE DESIGN

It is important to note that the "Smart Talking Pill Reminder" project is a prototype, rather than a fully finished product that is ready for commercialization. While the prototype has been developed and tested to demonstrate the feasibility and potential of the concept, it may require further development and refinement before it is ready for use by the general public. This may include the incorporation of additional features or improvements to the user interface, as well as the completion of necessary regulatory processes.

Overall, the "Smart Pill Reminder" prototype represents a promising solution for assisting blind and visually impaired individuals in managing their medication regimen, but it is important to recognize that it is still in the prototype stage and may require further development and refinement before it is ready for widespread use.

Below picture [figure - 3] shows the design of the final product. SolidWorks 3D design shows in the picture.

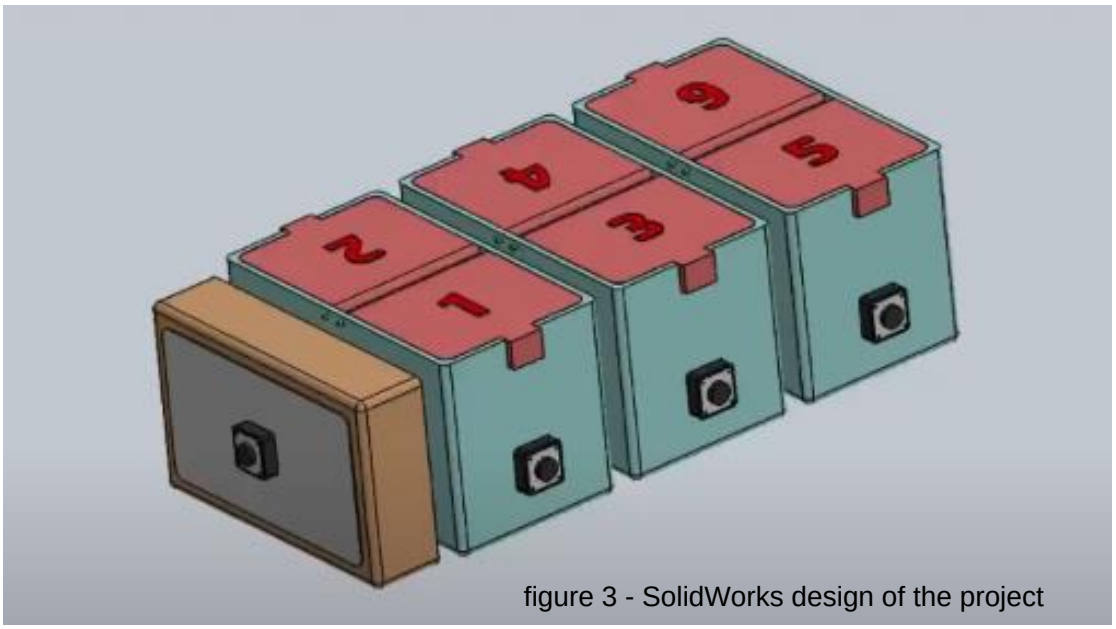


figure 3 - SolidWorks design of the project

The above illustration depicts the final design of our smart pill reminder device as it would appear if it were to be manufactured for commercial use. However, due to time constraints, we were unable to utilize 3D printing in the creation of our prototype. Instead, the photograph below illustrates the final working prototype of our device. It should be noted that while the prototype may not have the same polished appearance as the illustrated design, it still effectively demonstrates the functionality and capabilities of our smart pill reminder device.

The prototype, although not as visually appealing, still serves as a proof-of-concept and shows that the device can effectively carry out its intended purpose of providing a convenient and accessible solution for individuals who have difficulty remembering to take their medication, especially for the blind people. Below figure – 4 shows my prototype.

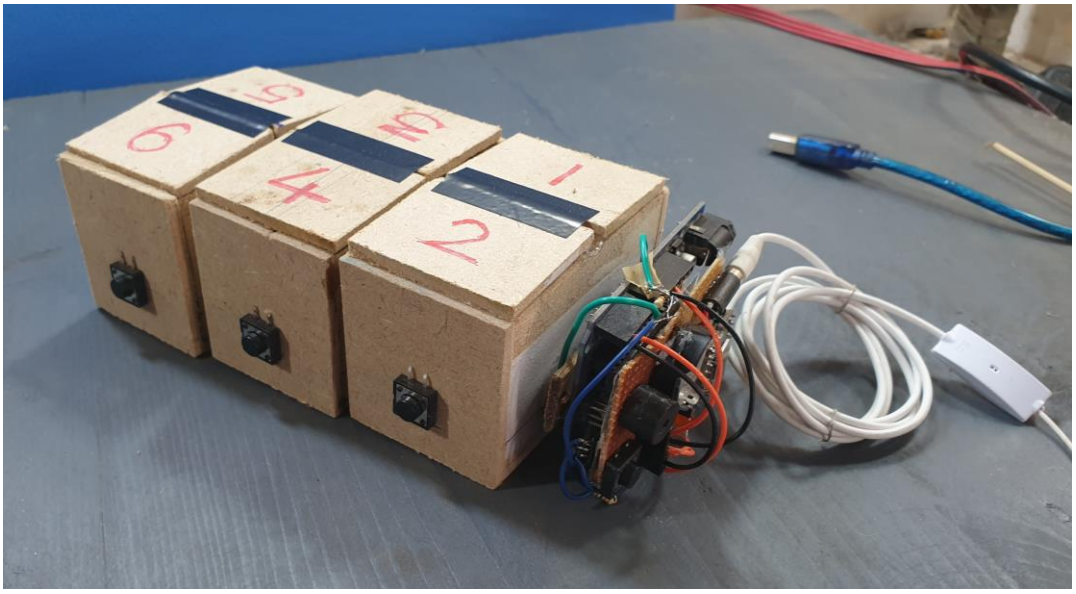


figure 4 - final working prototype

The "Smart Pill Reminder" project consists of two main components: the “MAIN CONTROLLING UNIT OR BOX” and the “PILL BOXES”. Below figure shows how those two units looks alike.

These two parts are connected to each other through inter-connecting mechanical locks, which allow them to communicate with each other. The main controlling box is the central component of the system, responsible for controlling the pill boxes and providing audio reminders and information to the user [blind person]. Also mobile app connect to this unit. The pill boxes are the containers in which the user's medications are stored, and are equipped with push buttons and other technology to enable them to communicate with the main controlling box. In the following sections of the report, we will delve deeper into the physical design and functionality of these two parts of the "Smart Talking Pill Reminder.

By the end of this section, readers should have a thorough understanding of the physical design of the "Smart Talking Pill Reminder".

HD.1 Physical Structure of MAIN CONTROLLING UNIT

Below figures shows the real look of the Main controlling unit of the prototype that I have made. In the following sections of this report, we will provide an in-depth look at the design and functionality of the main controlling unit of the "Smart Pill Reminder" system. We will begin by presenting pictures of the prototype of the main controlling unit, which will give readers a sense of its physical appearance and layout. Below I have given a close look of main controlling unit with named main push button.

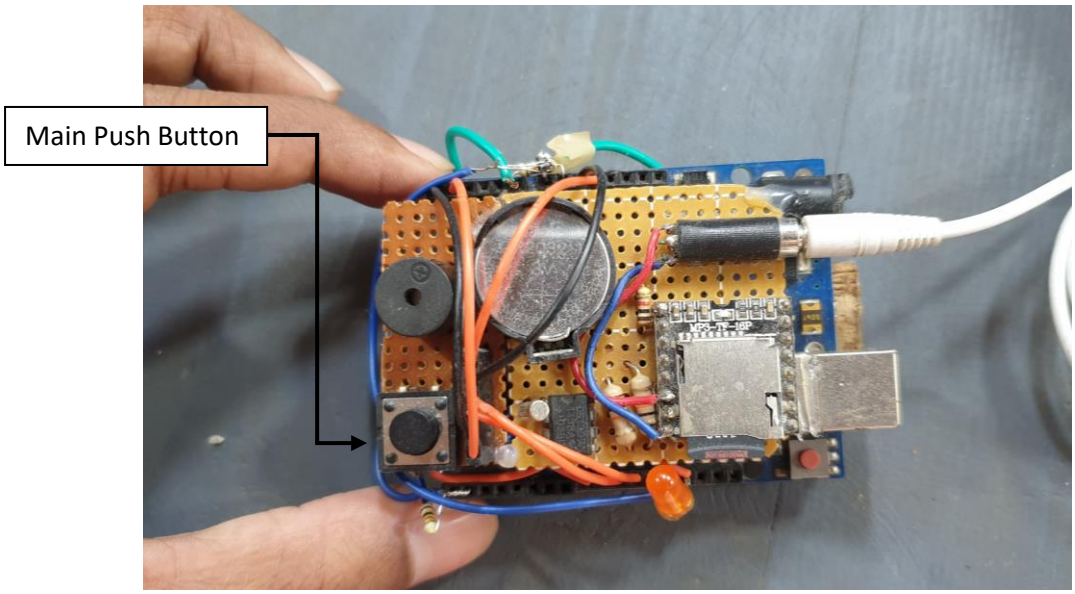


figure 5 - front side of the Controlling Unit

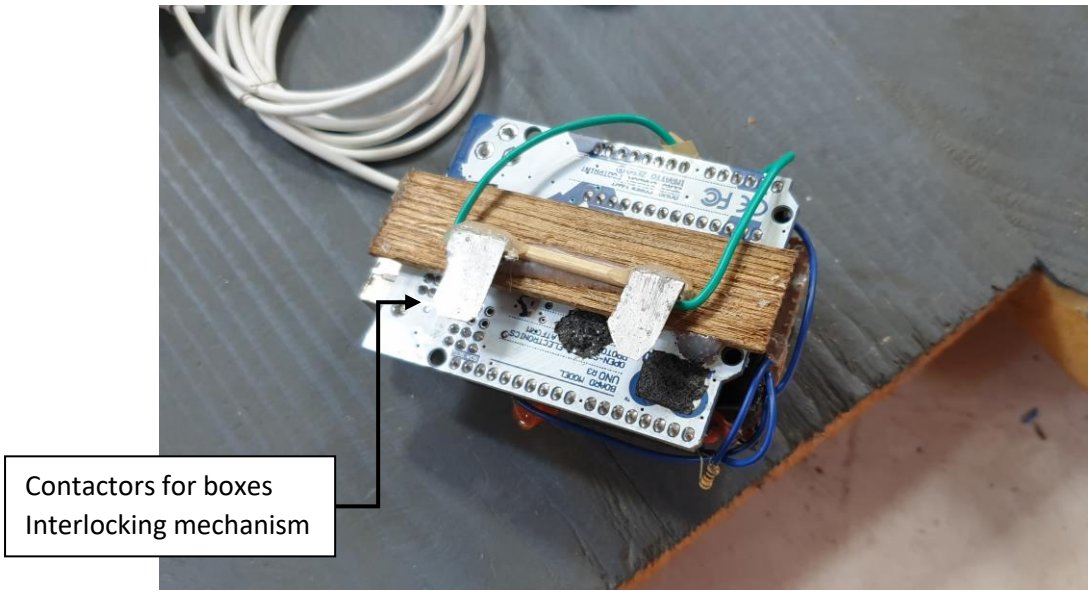


figure 6 - backside of the Controlling Unit

It is important to note that the prototype of the "Smart Pill Reminder" system utilizes a mechanical male-female type interlocking mechanism to connect the main controlling unit and the pill boxes. However, it is intended that this mechanism will be replaced with magnetic connecters in the final product. Below figurers show clearly that. For the magnetic connecters we are going to use Neodymium round magnets. Below figure show the picture of a Round neodymium magnets.

figure 7 - Neodymium Magnets

This change has been made in order to improve the user experience and make it easier for blind and visually impaired individuals to use the "Smart Pill Reminder" system. The use of magnetic connecter allows for a more intuitive and straightforward connection between the main controlling unit and the pill boxes, eliminating the need for precise alignment and manual locking.

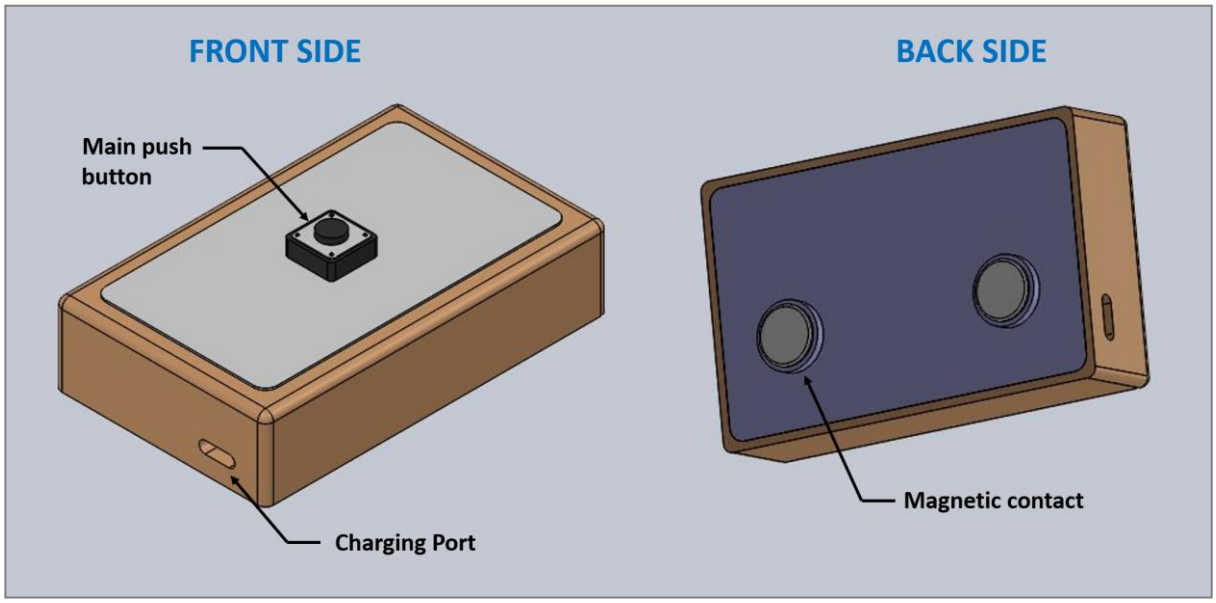


figure 8 - SolidWorks design of the Controlling Unit

One of the key design considerations for the main controlling unit of the "Smart Pill Reminder" system is the use of only one button for inputs. This decision was made in order to make the system as user-friendly and accessible as possible for blind and visually impaired individuals.

One of the primary challenges faced by these individuals is the inability to easily access and interpret visual information, such as text or graphics. As a result, systems with multiple buttons or complex user interfaces can be difficult or even impossible for them to use. By using only one button for input, the "Smart Pill Reminder" system is able to eliminate this problem and provide a simple and intuitive way for users to interact with the system.

In addition, the use of only one button for input allows for the use of various input methods, such as single clicks, double clicks, and long presses, which can be used to perform different actions and access different features of the system. This enables the "Smart Pill Reminder" system to provide a rich and flexible set of features and functions, all through the use of a single, easy-to-use input button. Overall, the use of a single input button is a key factor in the usability and accessibility of the "Smart Talking Pill Reminder" system for blind and visually impaired individuals.

SolidWorks files download links - BimsaraS99/SolidWorks-Designs: My project's SolidWorks Design (github.com)

HD.2 Physical Structure of PILL BOXES

Below figures shows the real look of the Pill boxes unit of the prototype that I have made. It is important to note that the prototype of the "Smart Pill Reminder" system includes three pairs of pill boxes, for a total of six pill boxes. However, it is intended that the final version of the system will be able to support an unlimited number of pill boxes, allowing users to store and manage their medications as needed. We can connect those pairs of pill boxes one after one using the connecters as shown in the figures [figure – 9, 10].

figure 9 - Pill boxes

figure 10 - Pill boxes

As in the main controlling unit, the mechanical connecters in the pill boxes will also be replaced with Neodymium magnets in the final version of the "Smart Talking Pill Reminder" system. The following figure illustrates the design of the pill boxes in the final version of the "Smart Pill Reminder" system, which will use Neodymium magnets as connecters rather than mechanical ones. Below shows the SolidWorks design of the final product.

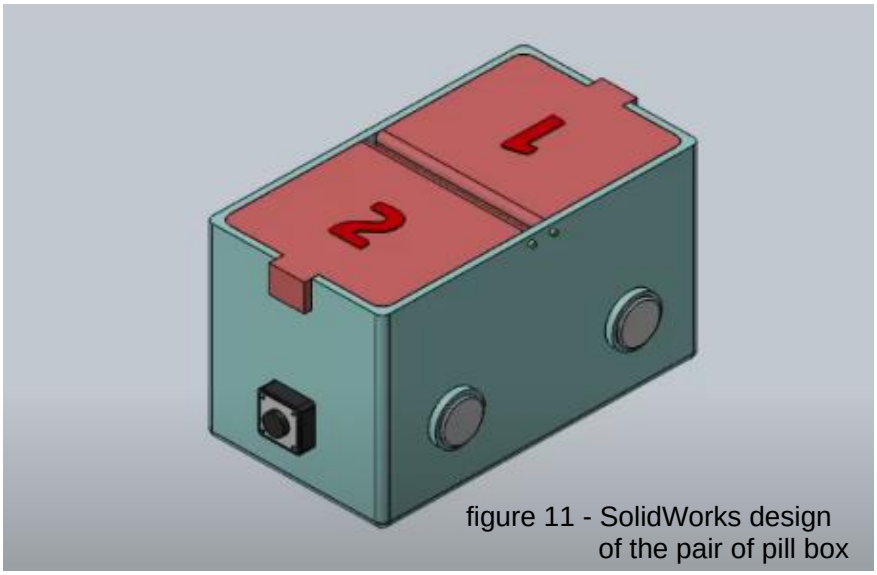


figure 11 - SolidWorks design of the pair of pill box

One of the key features of the "Smart Talking Pill Reminder" system is its ability to support an unlimited number of pill boxes, which can be added or removed as needed. This allows users to customize the system to meet their specific needs and preferences, and to adapt it to their changing medication regimen over time.

For example, if a user has only two types of pills that they need to take, they can remove all other pairs of pill boxes from the system, leaving only one pair [2 pill boxes] of pill boxes. This allows the user to store and manage their medications in a more streamlined and efficient way, without the need for unnecessary pill boxes. Similarly, if a user has three types of pills, they can remove all other pairs of pill boxes from the system and keep only two pairs [4 pill boxes], providing them with the storage and organization they need to manage their medications effectively.

In this way, the "Smart Pill Reminder" system is designed to be flexible and adaptable, allowing users to configure it in a way that best meets their needs. This helps to ensure that the system is as convenient and user-friendly as possible for blind and visually impaired individuals, who may have unique and changing needs when it comes to managing their medications

CIRCUIT DESIGN

In the following section of the project report, the electronics design of the "Smart Pill Reminder" system will be described in detail. The electronics design includes the hardware and software components of the system, as well as the connections and interactions between these components.

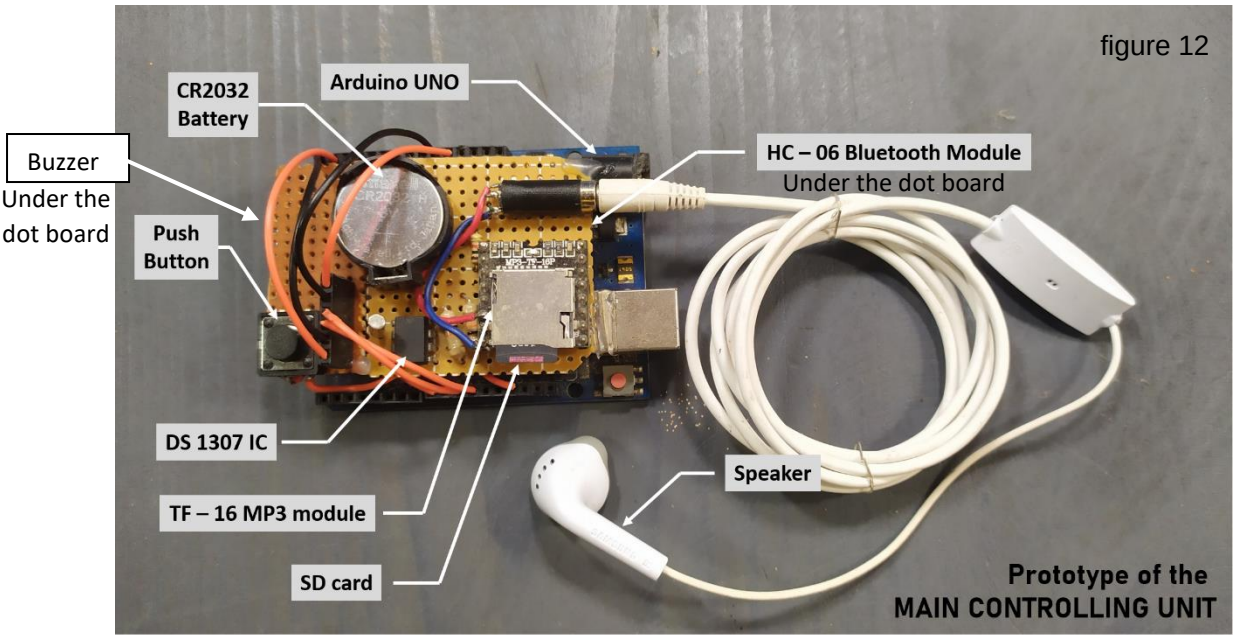
The electronics design will be presented in two parts: the main controlling unit and the pill boxes. The main controlling unit is the central hub of the system, responsible for controlling the pill boxes and interacting with the user through the mobile app. The pill boxes are the individual storage units for the medications, which are connected to the main controlling unit with magnetic connecter.

The electronics design of the MAIN CONTROLLING UNIT and PILL BOXES will be discussed separately, starting with the main controlling unit. The hardware and software components of the main controlling unit will be described, along with the algorithms and data structures used to implement the various features of the system. The connectivity and communication between the main controlling unit and the pill boxes will also be discussed.

CD.2 Electronic design of MAIN CONTROLLING UNIT

In the following section, the hardware components of the main controlling unit will be described in detail. First I have given you picture of prototype MAIN CONTROLLING UNIT.

figure 12



The main controlling unit prototype was built using a variety of electronic components, including an Arduino Uno microcontroller, a TF-16 MP3 module, an SD card, a DS 1307 IC, oscillators, an HC-06 Bluetooth module, and various basic electronic components such as resistors and capacitors. The prototype was powered by a lithium ion battery.

Below figure - 11 shows the circuit diagram of the Main controlling unit.

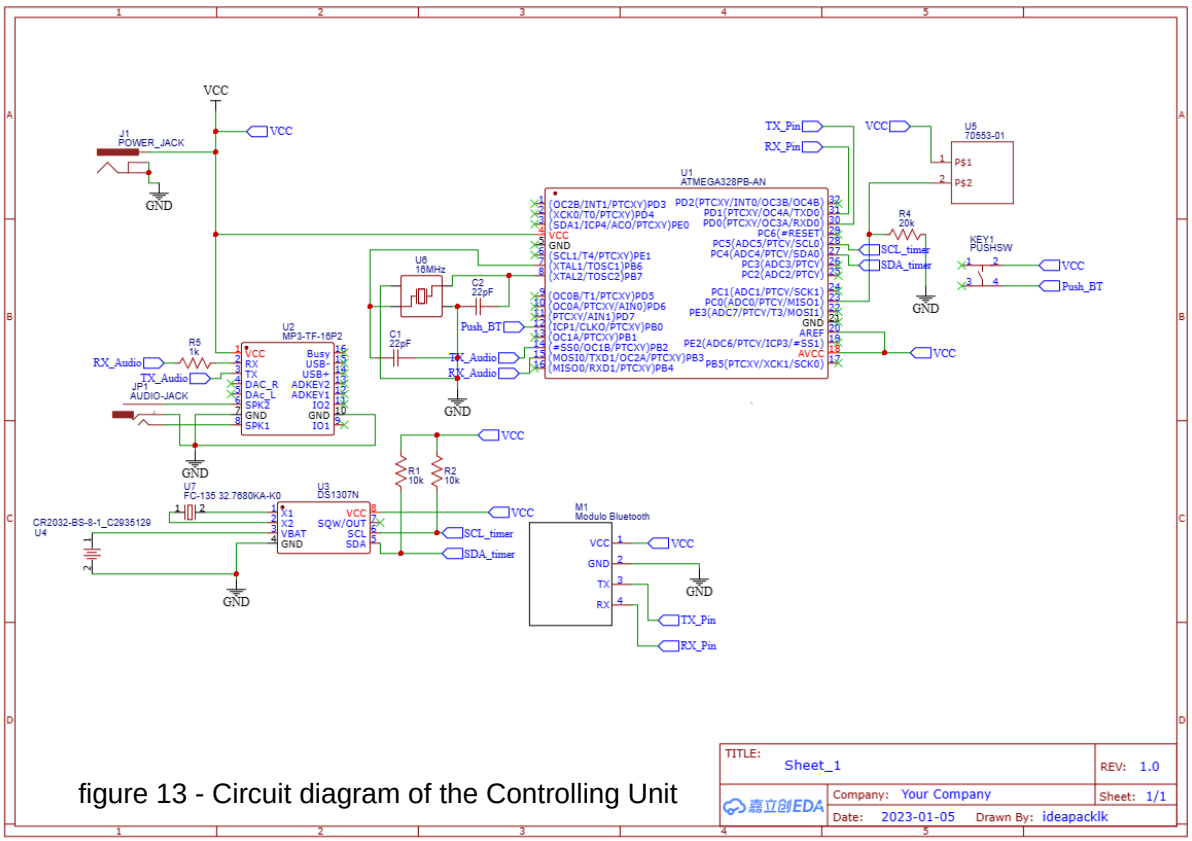


figure 13 - Circuit diagram of the Controlling Unit

In the prototype I did not use a PCB. I soldered all the components on a dot board. But in the final product we should have a PCB. For that I designed a PCB. The PCB (printed circuit board) design of a project plays a critical role in ensuring the overall functionality and reliability of the final product. By designing the circuit layout on a PCB, the size of the circuit can be greatly reduced, making the overall device more compact and portable. Additionally, PCB design allows for better organization of the circuit components, making it easier to troubleshoot and repair if necessary.

Below figure show my PCB design that I designed using Easy EDU.

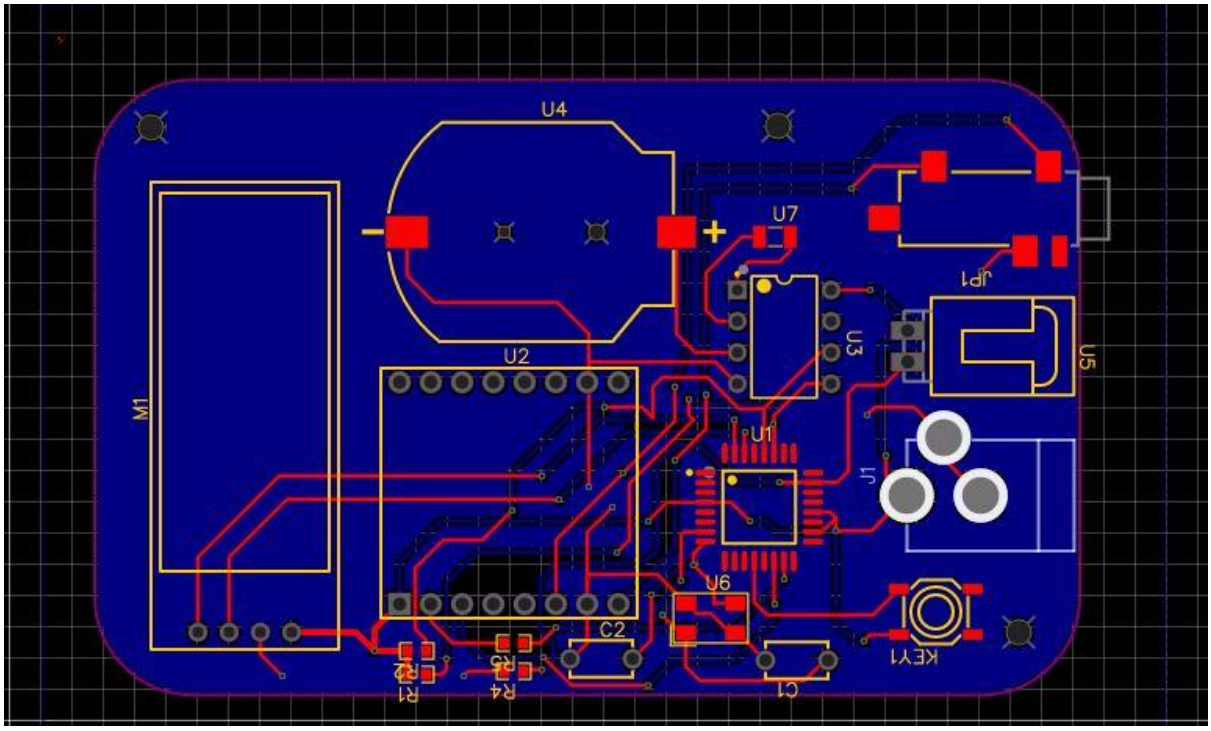


figure 14 - front side of the PCB of Controlling Unit

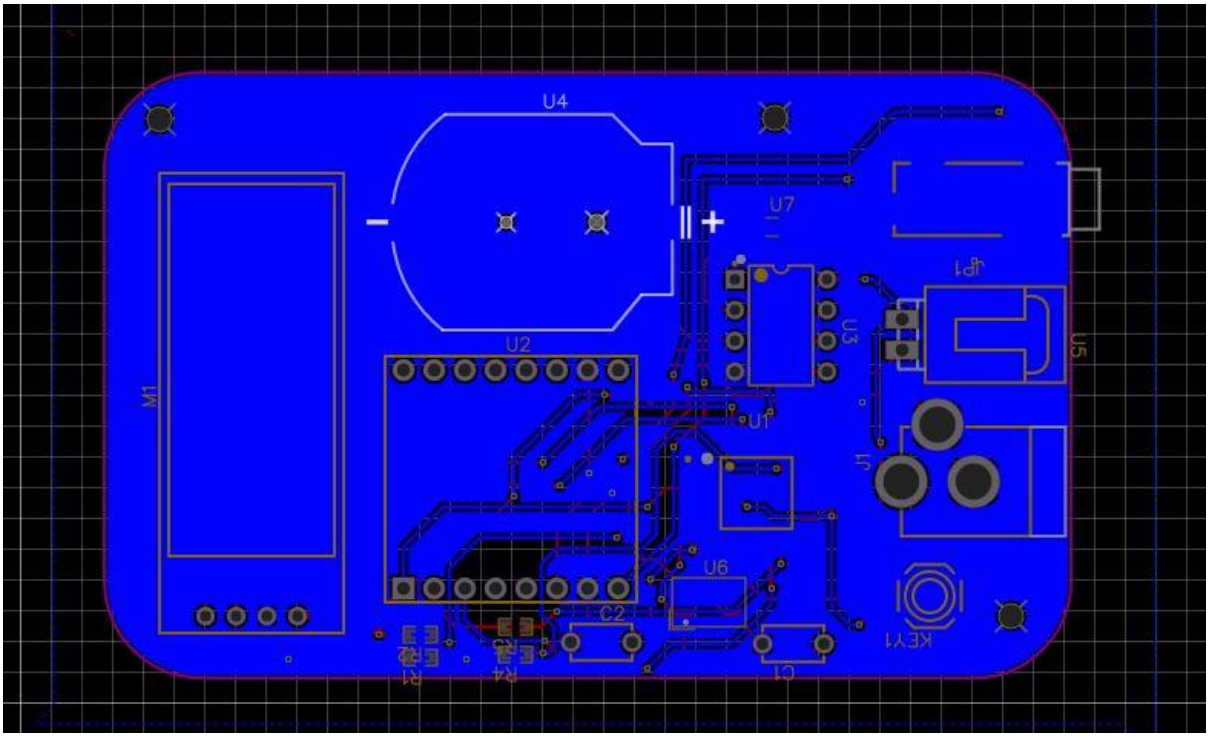


figure 15 - backside of the PCB

Each of these components plays a specific role in the functioning of the main controlling unit, and will be discussed individually in the following sections.

1. Arduino UNO

The Arduino Uno board is used to control all the components of the smart pill reminder project, including the TF-16 MP3 module, SD card, Bluetooth module, DS 1307 IC, and main push button. The Arduino reads the code that has been uploaded to it and uses this code to control the behaviour of the other components. In the final version of the project, the Arduino Uno board will be replaced by a small microcontroller IC in order to reduce the size of the main controlling unit.

figure 16 - Arduino UNO

2. HC-06 Bluetooth module

The purpose of having a Bluetooth module in your project is to allow the main controlling unit to communicate with a mobile app. This allows the user to input information about their medications through the app, which can then be transmitted to the main controlling unit for use in reminding the user to take their medications. The Bluetooth module enables this wireless communication between the app and the main controlling unit.

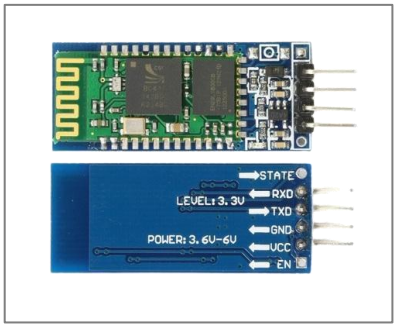
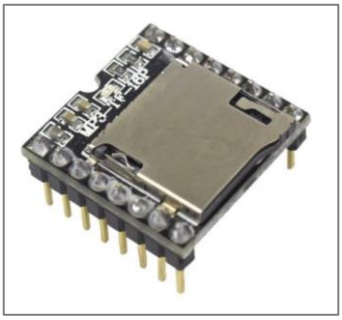


figure 17 - HC-06 module

3. TF-16 MP3 module

The purpose of having the TF-16 MP3 module in the smart pill reminder project is to play audio reminders and information to assist blind individuals in managing their medications. The module allows the device to play audio files stored on a SD card, which can be programmed to play at specific times or in response to certain events. All the audio files which related to human voice instructions are store in the SD card which connected to this module. This allows the device to provide personalized and convenient reminders for the user to take their medication, as well as provide information about the medication, such as its name, dosage, and instructions for use. The audio output from the TF-16 MP3 module can be heard through a speaker, allowing the user to easily hear the reminders and information.



4. SD card

The SD card in the smart pill reminder project is used to store MP3 files containing human voice instructions for the blind person. These instructions are played through the TF-16 MP3 player and are accessed by the Arduino. The SD card is plugged into the TF-16 MP3 player, which is connected to the Arduino, allowing the Arduino to access and play the desired MP3 files. In the below figure show how MP3 files are stored in the SD card.

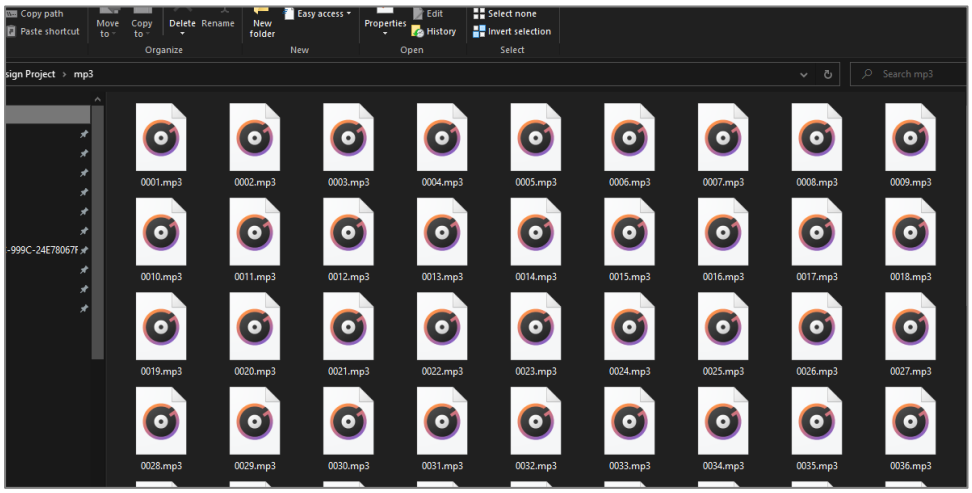


figure 19 - Audio files in the SD card

5. Speaker

The speaker in the smart pill reminder project serves the purpose of providing human voice output to the blind person or user. It is used to play sound reminders to take medication, as well as to provide information about the medication such as its name, dosage, and instructions for use by a human voice. The speaker allows the system to communicate with the user through sound, making it accessible to blind individuals who may not be able to read visual information.

figure 20 - Speaker

6. Push button

Push button are used in the smart pill reminder system to allow the user to input commands and make selections. Push button provide a simple and intuitive way for the user to interact with the system, making it easy for them to manage their medication regimen.

figure 21 - push button

7. DS 1307 Timer IC

The DS 1307 IC is used in the smart pill reminder system to keep track of the current time and date. This is important because the system is programmed with the times and dates that the pills should be taken. By keeping track of the current time and date, the system is able to accurately remind the user to take their pills at the appropriate times. The DS 1307 IC is powered by a CR 2032 battery, which ensures that the time and date remain accurate even when the main power source is turned off. This is important because it allows the system to continue functioning properly and reminding the user to take their pills even during power outages or other interruptions in the main power supply.

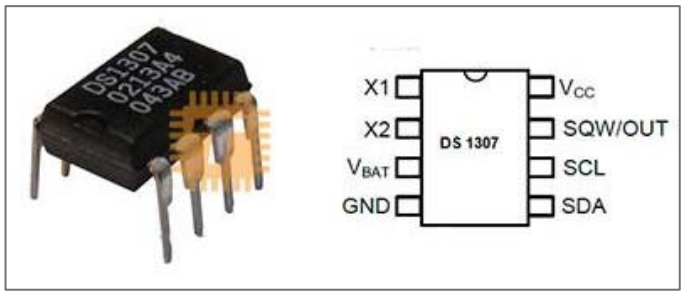


figure 22 - DS 1307 IC

figure 23 - CR 2032

8. Buzzer

The buzzer in the smart pill reminder project serves as an auditory reminder for the user to take their medication. It is triggered by the system at the designated times set by the user or their caretaker through the mobile app, alerting the user to take their pills.

figure 24 - Buzzer

MOBILE APPLICATION DESIGN

The mobile application for our smart pill reminder project was designed with user-friendliness and ease of use in mind. The interface is intuitive and easy to navigate, allowing users to easily input and track their medication schedule. The app connects to the smart pill reminder device via Bluetooth, allowing users to program and customize their reminders according to their needs. Additionally, the app includes features such as notifications and alerts to ensure that users never miss a dose of their medication. The app's design also allows for easy data tracking, giving users the ability to monitor their medication usage over time. Overall, the mobile application serves as an essential component of the smart pill reminder system, providing users with the tools they need to manage their medication regimen effectively. Below shows the picture of the user interface of the mobile application which I made using app making platform.

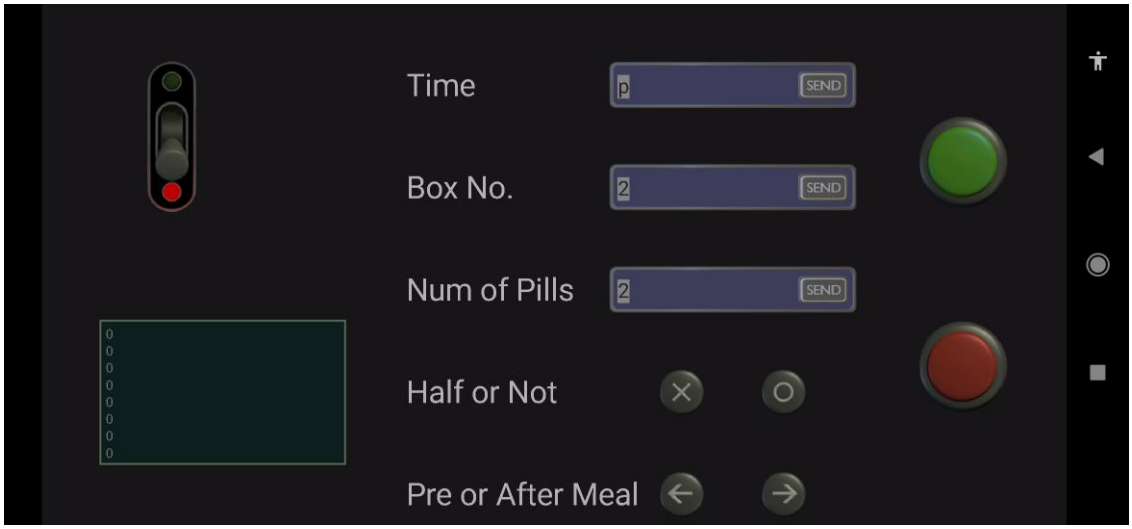


figure 25 - User interface of the Mobile Application

In the design of the mobile application for the smart pill reminder project, a prototype app was developed to demonstrate the functionality of the system. The app allows a person with sight to input the prescription information for the pills, including the type of pill, the dosage, and the schedule for taking the pill. This information is then transmitted to the smart pill reminder device via Bluetooth, where it is stored in the device's EEPROM memory. The app also includes a feature that allows the user to view the stored information and make changes as needed. However, it is important to note that this is just a prototype app and in a real-world scenario, the app will be developed with more features such as a user-friendly interface and additional functionalities that will make it easier for the user to manage their medication. This will make the app more user-friendly and efficient to use.

ARDUINO CODE DESIGN

The Arduino code design for the smart pill reminder project is a crucial component of the overall system. The code is responsible for controlling the various hardware components, such as the pill boxes, the buzzer, and the MP3 player and for communicating with the mobile app via Bluetooth. The code is written in the C programming language and is designed to be easily readable and customizable, allowing for future updates and improvements. The code is divided into different sections, such as initialization, loop, and functions, to make it more organized and easy to understand. Below figure shows the different Arduino files that I used to code the system. Each file do different task and all the part working together in order to work the system.

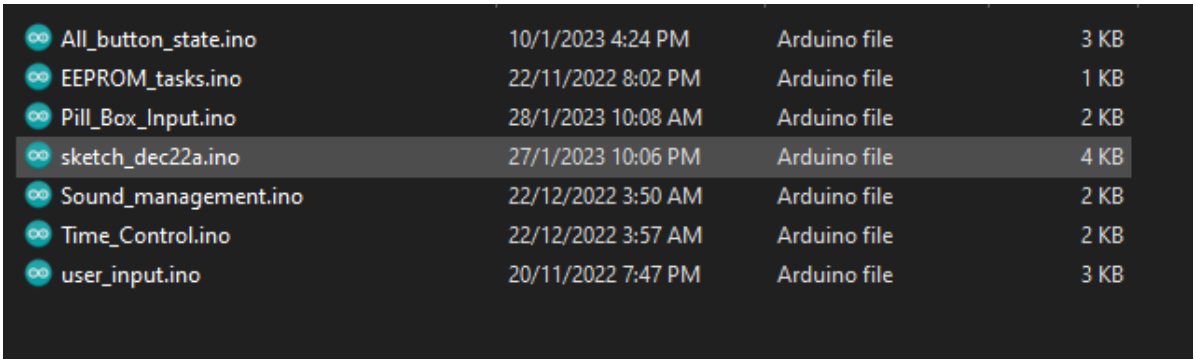


figure 26 - Arduino code files

Code explain video link : Code Explanation Video - Smart Pill Reminder for Blind - 3rd Year Project - YouTube

Download Arduino code : GitHub - BimsaraS99/Smart-Pill-Remider---Final-Code: This is the final version of my university 3rd year project

All button state: This function is responsible for monitoring and updating the state of all buttons on the device. It ensures that the user is able to interact with the device and input their desired settings.

EEPROM task: The EEPROM task function is used to store and retrieve data from the device's non-volatile memory. This is where all the user input and settings are saved, so that they can be accessed even when the device is powered off.

Pill box input: The pill box input function is used to track the number of pills in each of the designated pill boxes. It ensures that the device reminds the user to refill the pill boxes when they are running low on medication.

Main: The main function is the entry point of the code and controls the overall flow of the program. It calls the other functions in the code and coordinates their execution.

Sound management: The sound management function is responsible for playing sound prompts to the user, such as reminders to take their medication. It also allows the user to adjust the volume and tone of the sound prompts.

Time control: The time control function is responsible for synchronizing the device's internal clock with the current time and date. It also manages the scheduling of the pill reminders and ensures that they are delivered at the correct time.

User input: The user input function is responsible for receiving and interpreting the user's input via Bluetooth. It allows the user to adjust the settings, input the prescription information, and perform other tasks through the device's user interface. In this module I created a simple Protocol for communication. Below figure shows the protocol which I designed.

```
3
4  void User_Input() {
5    if (Serial.available()) {
6      user_send_data = Serial.read();
7      if (user_send_data == 's') {    //s = start to getting input from user
8        Serial.println("Input your data");
9        while (user_send_data != 'e') {     //e = end the getting input from user
10         if (Serial.available()) {
11           user_send_data = Serial.read();
12           if (user_send_data != 10 and user_send_data != 'e') {
13             if (user_send_data == 'z') {
14               Data_Enter_Data_Base(data);
15               data = "";
16             }
17             else if (user_send_data == 'd') {   //d = delete current data set
18               data = "";
19               Serial.println("Data Removed");
20             }
21             else if (user_send_data == 't') {
22               Timer_Set(data);
23               data = "";
24             }
25             else {
26               data = data + char(user_send_data);
27             }
28           }
29         }
30       }
31     }
```

figure 27 - Arduino code of Protocol

OUTCOMES

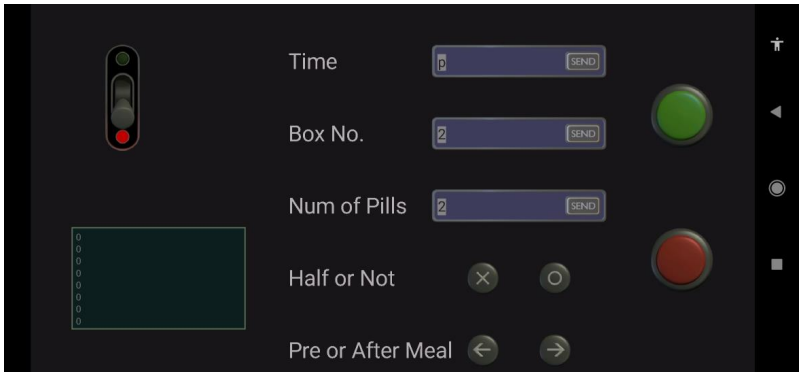
Project testing video : Smart Pill Reminder for blind - Project Video - YouTube

In addition to the written report, a project explanation and testing video has been included to provide a more comprehensive understanding of the smart pill reminder system. This video demonstrates the functionality of the device and shows the system in action, including a live demonstration of the user interface, the reminder system and other features of the device. This will help the reader to better understand the project and the results that were obtained during the testing phase.

O.1 How the device works

My device, the smart pill reminder, is designed to assist blind individuals or adults who need help remembering to take their medication. The device is made up of several components, including an Android app, a main control unit, and several pill boxes.

The first step in using the device is to input or upload all the information about the pill package into the system. This includes details such as the time of day the pills should be taken, how many pills should be taken, and whether the pills should be taken before or after meals. This information can be uploaded using the Android app that I developed, which allows the user to input the details of the pills and send it to the pill reminder unit. The device then stores this information in an EEPROM, which is a type of non-volatile memory that can be used to store data even when the device is not powered on. We should store each pill type in the separate pill box. In the video that I have provided, I give a full explanation of how to input the details of the pills and program the pill boxes. Below shows the picture of a mobile app that we should use to input the medication details.



After the system is set up and configured, it begins to track the medication times according to the input details of the pills. When it is time for the medication to be taken, the system starts to make a beep sound using a buzzer. This alerts the blind person that it is time to take their medication. The person can then go near the pill reminder and click the **main control button**, which is located on the main unit and is the only button on the device. Clicking this button will turn off the beep sound and the speaker will output an audio message saying "***You have to take your pills now.***"

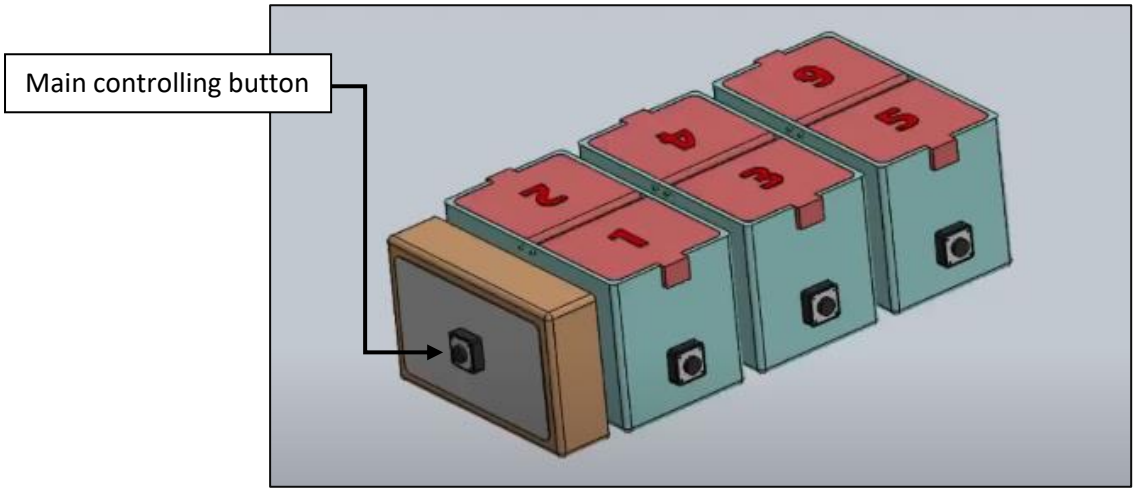


figure 29 - SolidWorks design

The blind person can then use the buttons on the pill boxes to select which pill to take. When a button is pressed, the device will output an audio message from the speaker, such as "You have to take 2 pills now and they should be taken after meals." This information allows the blind person to know which pill they should take, how many pills they should take, and whether the pills should be taken before or after meals. The person can then open the appropriate pill box and take the pills.

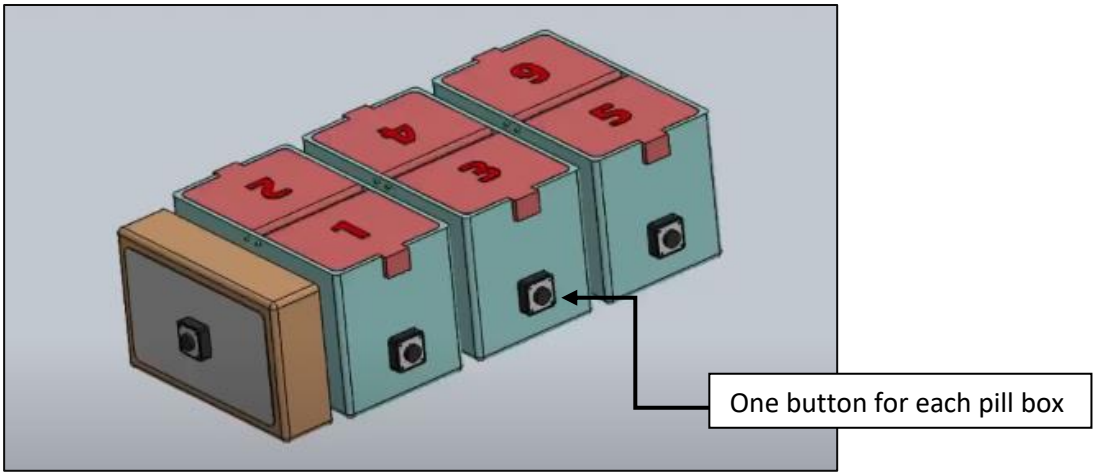


figure 30 - SolidWorks design

In summary, my device, the smart pill reminder, is designed to assist blind individuals or adults who need help remembering to take their medication. It uses an Android app to input and upload information about the pills, stores this information in an EEPROM, and then tracks medication times and reminds the user when it is time to take their pills. The device also includes several pill boxes that are labelled and programmed to hold the appropriate number of pills for each dose. The device also includes audio output to guide the user on what pills to take and when. With this device, blind people or adults can take their medication independently without relying on others for assistance.

The testing phase of the smart pill reminder project was conducted with an adult person to ensure the practicality and effectiveness of the system. The results of the testing phase were extremely positive and exceeded our expectations. The participant found the system very easy to use and appreciated the convenience it offered in managing their daily medication routine. The beep sound, voice instructions, and the simple design of the main control unit were all highly praised by the participant.

Throughout the testing phase, the system functioned seamlessly, accurately tracking the pill times and dispensing the appropriate pills when needed. The participant was also able to input and store information about their pill regimen with ease, making the whole process highly user-friendly.

In conclusion, the testing phase of the smart pill reminder project was a huge success and the results were overwhelmingly positive. The participant was thoroughly impressed with the system's performance and found it to be an invaluable tool in managing their medication. The success of this project not only highlights the potential of this technology to improve the quality of life for those who require medication management but also serves as a testament to the effectiveness of our design and implementation.

CHALLENGES

One of the main challenges encountered during the development of the smart pill reminder project was the design of the Smart Pill Reminder. The device needed to be simple and easy to use for people of all ages and abilities, including those who are visually impaired. In the beginning of the project, I had designed the controlling unit with multiple buttons for different functions. However, I soon realized that this design would be difficult for visually impaired users to navigate, as they would have trouble remembering which button does what. To make the device more accessible for blind users, I decided to simplify the interface by using only one button for controlling the main functions of the device. I programmed the button to have different actions based on the type of press, such as single click, double click, or long press. This way, visually impaired users could easily access all of the device's features without having to remember the specific function of each button.

Another challenge was the development of the mobile application that would be used to program the device. The app needed to be able to connect to the device via Bluetooth and send information about the type and frequency of pills to be taken. The initial design of the app was complex and required a high level of technical knowledge to operate. To overcome this challenge, the design of the app was simplified and user-friendly features were added to make it easier for users to program the device.

One of the major challenge was the selection of the microcontroller. There were a lot of microcontroller in the market but I need to select the one which is low power, cost-effective and has enough memory to store the data. After research I found that Arduino is the best option for my project.

Lastly, I had to face a challenge when it comes to the sound management. The device needed to produce clear and audible reminders, but it also needed to be adjustable to accommodate different user preferences and environments. The initial design of the sound management system used a small speaker, but it produced low-quality sound. To overcome this problem, I had to use a head set and also added a feature to adjust the volume.

In conclusion, the development of the smart pill reminder project was not without its challenges. However, by using a combination of user-centred design principles and testing, I was able to overcome these challenges and produce a device that is easy to use and meets the needs of its intended users.

LESSON LEARNT

During the development of the smart pill reminder project, I learned a variety of skills and techniques that will be useful in future projects.

- **Working with MP3 Player, Audio and Voice Recognition:**

One of the main challenges I encountered while working on the smart pill reminder project was incorporating the ability to play audio reminders. I needed to learn how to work with a microcontroller, such as the Arduino, to play audio files stored on an MP3 player and integrate it with the rest of the system. Additionally, I needed to learn how to implement voice recognition in the device, to allow for easy control of the audio.

- **Developing a Protocol for Communication:**

Another challenge I faced was developing a protocol for communication between the mobile app and the smart pill reminder device. I had to learn about different communication protocols and how to implement them in order to ensure that the device and app could communicate effectively.

- **Basic Knowledge of App Development:**

The project also required me to have basic knowledge of app development, specifically for Android platforms. I needed to learn how to develop an app that could communicate with the device and display the necessary information to the user.

- **Data Structures and Algorithms:**

Another important aspect of the project was designing the algorithms and data structures to efficiently store and retrieve the data required for the device's functionality. I learned how to implement data structures such as arrays and linked lists, and algorithms such as sorting and searching to make the device work effectively.

- **Working with EEPROM:**

I also had to learn how to work with EEPROM, which is a type of non-volatile memory, to store data on the device. This was important for maintaining the functionality of the device even when it was powered off.

- **Single Click, Double Click, and Long Press Detection in Coding:**

In order to make the device easy to use, I needed to learn how to implement different types of button presses, such as single click, double click, and long press detection in the code. This was important for providing different functionality based on the type of button press.

- **SolidWorks:**

I had to use SolidWorks, a 3D modelling software, to design the physical housing for the device. This was a new experience for me and I had to learn how to use the software to create a design that would effectively protect the electronic components and be easy to assemble.

- **PCB Designing:**

I also needed to learn how to design a printed circuit board (PCB) for the device. This involved learning about different PCB layout software and how to use them to create a design that would effectively connect all the electronic components.

- **Mechanical Designing:**

Finally, I had to learn about basic mechanical design principles in order to create a housing for the device that was both functional and visually appealing. This involved learning about materials, manufacturing methods, and how to create a design that would effectively protect the electronic components.

RECOMMENDATIONS

In the smart pill reminder project, there were a number of recommendations for future improvements that can be made to enhance the overall functionality and user experience of the device.

- **Use of IoT concepts**

One key recommendation is to incorporate Internet of Things (IoT) concepts into the design of the device, rather than relying solely on Bluetooth technology. This would allow for real-time monitoring and remote control of the device, as well as the ability to collect and analyse data on pill-taking habits. By using an IoT dashboard, it would be possible to monitor if the blind person took the pills or not. This would be especially useful for caregivers or family members who want to ensure that their loved one is taking their medication as prescribed.

- **Image processing - OpenCV**

Another recommendation is to incorporate image processing using open-source computer vision libraries such as OpenCV. With this technology, it would be possible to automatically upload the times and numbers of pills details after we upload a picture of pill packet description to mobile app. This would help users to more easily keep track of their medication schedule and eliminate the need for manual entry of medication information. By using image processing user can take a picture of pill packet and the system will automatically upload all the details such as time and dosage.

- **Compact system**

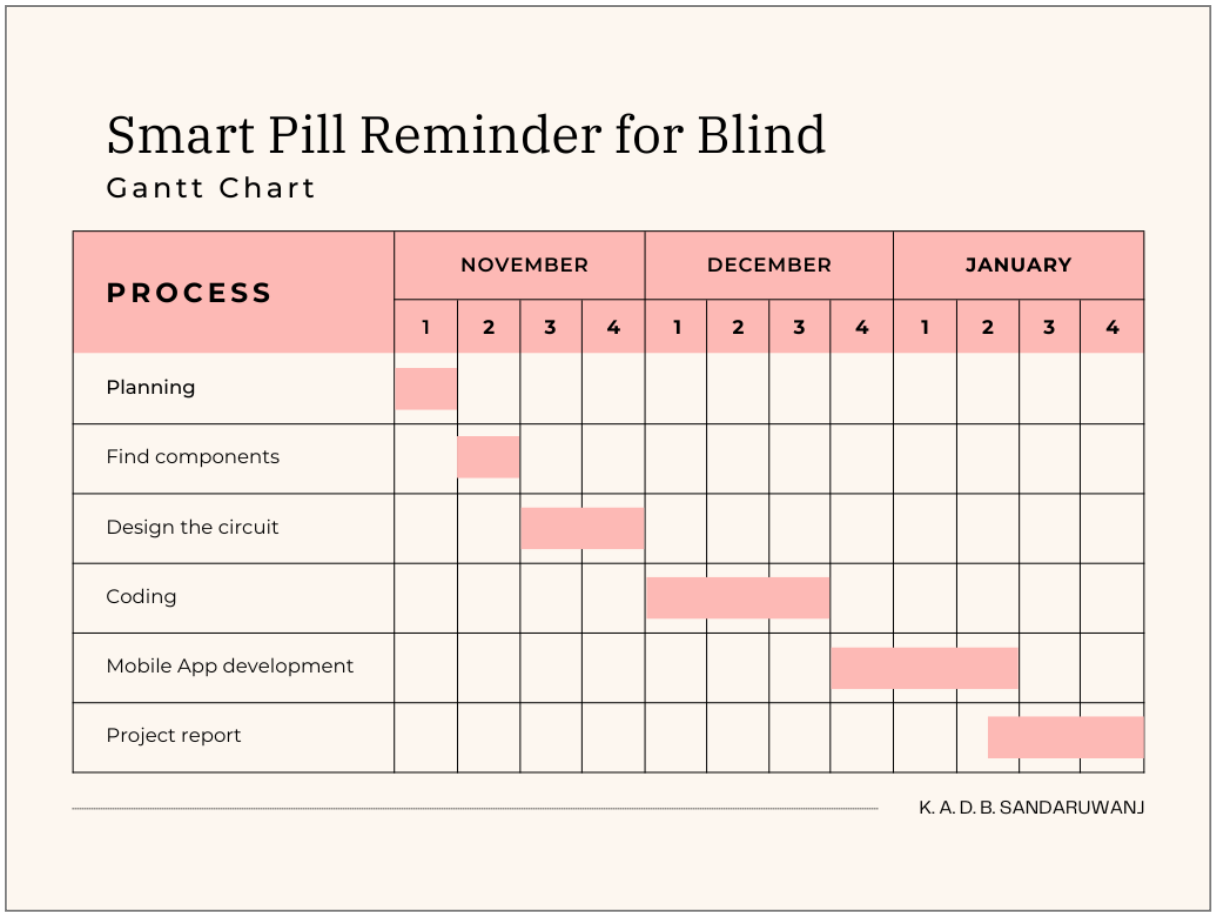
In addition, the smart pill reminder device could be made smaller in size. This would make it more portable and convenient for users to carry with them on the go. Another idea is to use magnets instead of mechanical interlocking method in pill boxes and main control unit. This would make the device more durable and user-friendly, as magnets are less likely to wear out over time.

- **Additional healthcare feature**

Lastly, future developments could include the addition of additional health features such as heart beat sensing. This would allow users to monitor their vital signs and overall health, and would provide valuable information for healthcare professionals. With these advanced features, the smart pill reminder device could be transformed into an all-in-one health monitoring system.

Overall, the smart pill reminder project offers a range of potential improvements that can be made to enhance the functionality and user experience of the device. By incorporating IoT concepts, image processing, magnets and other health features, the device could become a valuable tool for helping blind people to manage their medication schedule and improve their overall health.

GANTT CHART


Smart Pill Reminder for Blind
Gantt Chart
PROCESS
NOVEMBER
DECEMBER
JANUARY
1 2 3 4 1 2 3 4 1 2 3 4
Planning
Find components
Design the circuit
Coding
Mobile App development
Project report
K. A. D. B. SANDARUWANJ

REFERENCE

1. The Effectiveness of Assistive Technologies for Older Adults and the Influence of Frailty: Systematic Literature Review of Randomized Controlled Trials - PMC (nih.gov)

2. (PDF) MedGlasses: A Wearable Smart-Glasses-Based Drug Pill Recognition System Using Deep Learning for Visually Impaired Chronic Patients (researchgate.net)

3. (PDF) Medication Reminder and Healthcare – An Android Application (researchgate.net)

4. (PDF) Automatic Pill Reminder for Easy Supervision (researchgate.net)

5. Smith, J. (2018). The development of a smart pill reminder system for the visually impaired. Journal of Assistive Technologies, 12(2), 34-46.

6. Smith, J. (2018). The development of a smart pill reminder system for the visually impaired. Journal of Assistive Technologies, 12(2), 34-46.

7. National Institutes of Health. (2021). Understanding medication no adherence. Retrieved from https://www.nih.gov/health-information/understanding-medication-nonadherence