An-Najah National University

Faculty of Engineering and Information Technology

Computer Engineering Department

Hardware Graduation Project

MediMate

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A report submitted in partial fulfillment of the requirements for the degree of Bachelor in Computer Engineering - Hardware Project.

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2 Dedication

This project is dedicated to our families, who gave us the drive to complete our work and encouraged us to reach this achievement. It is also dedicated to everyone who gave us their support, even if it was just a single word of encouragement. Finally, we present this work to ourselves as a tribute to our determination and commitment.

3 Acknowledgement

Special thanks to our project supervisor, Dr. Suleiman Abu Kharmeh, for his ongoing assistance and valuable ideas that significantly benefited us throughout our project. In addition to practical guidance and endless knowledge.
We would like to thank our families to who provided us with financial and moral support
Helping us achieve what we have achieved.
Parents who suffered to see our progress and success in life.

4 Abstract

With the elderly population rapidly increasing and memory issues such as Alzheimer's becoming more common, there's a pressing need for solutions to help seniors manage their medications and health. The MediMate project aims to

address these challenges by creating a comprehensive system for medication intake and vital signs monitoring.

Firstly, a medication scheduling machine is at the core of the system. This machine schedules medication doses at specific times throughout the day based on the patient's needs. Users or their caregivers can input dosage information, including timing , through a mobile application.

Secondly, vital signs monitoring is integrated into the system. Sensors measure important indicators like temperature, blood oxygen level (SpO2), and heart rate (BPM). This data is displayed on an LCD screen and transmitted to a mobile app.

An alert system ensures medication adherence (buzzer, mobile notification) it's time to take a medication.
Additionally, a water dispenser is incorporated into the system for medication consumption. Sensors detect water levels and notify the caregiver when they are low.

To maintain security and privacy, access to the machine is secured with fingerprint, preventing unauthorized access.

5 Introduction

5.1 Problem

The project "MediMate Machine" aims to tackle various difficulties encountered by certain sectors of the population. Some of these are:

1- Older people with family members who are frequently unavailable during the day may have challenges with timely medication administration.

2-People with Alzheimer's disease who need prompts to take their medicines consistently.

3-Individuals with contagious illnesses facing difficulties in obtaining help with administering their medication.

5.2 Objectives

The project aims to enhance the healthcare journey for specific patients by ensuring timely medication intake, thereby improving patient recovery and simplifying daily schedules for families and caregivers.

At its core, the system features a medication scheduling machine that automates medication doses throughout the day based on the patient's needs. Users or caregivers can input dosage information via a mobile application. The machine accommodates up to six different medications, each with nine slots for pills, ensuring precise timing and dosage adherence.

Additionally, vital signs monitoring is integrated into the system using sensors that measure indicators such as temperature, blood oxygen level (SpO2), and heart rate (BPM). This data is displayed on an LCD screen and transmitted to a mobile app, enabling patients to monitor their health status independently throughout the day.

An alert system ensures medication adherence through notifications (buzzer, mobile alerts) when it's time to take medication.

Furthermore, the system includes a water dispenser for medication intake, equipped with sensors to detect low water levels and alert caregivers.

To uphold security and privacy, the machine is protected with fingerprint access, ensuring only authorized individuals can access and manage medication schedules.

This integrated approach aims to improve patient outcomes by enhancing medication adherence, monitoring vital signs, and ensuring efficient medication management while maintaining security and privacy standards

5.3 Significance of the work:

Our project primarily targets individual's difficulty recalling specific schedules, particularly when it comes to remembering to take their medication. This includes scenarios where there's no one available to oversee the timely administration of medications. Furthermore, our solution is suitable for use in hospital environments to assist nurses while they work. It is especially valuable in infectious outbreaks, when direct communication between people may not be possible.

5.4 Organization of the report:

This report provides a comprehensive summary of our concept, covering various aspects. We begin by identifying the constraints encountered in our work, including equipment limitations, tools used, and time constraints. Following this, we review similar systems to provide background on the topic and highlight the unique characteristics we have incorporated compared to those systems.

The approach adopted in our work is thoroughly explained, offering insight into the methods and strategies utilized. Subsequently, we present our findings and engage in a discussion to analyze and compare the results obtained.

In conclusion, we offer a summary of the entire project and discuss our plans for future enhancements aimed at further improving our work.

6 Constraints and Earlier Course work

6.1 Constrains:

1-Initially, a lot of the equipment and components are not highly effective. For instance, the IR sensor. We encountered challenges when using the IR sensor due to the accuracy and sensitivity required for its operation. After that, we resolved the issue by calibrating the sensor carefully. Dealing with it for the first time was challenging. We encountered numerous challenges when trying to follow guidance on operating the alarm, alongside the sensors' performance and readings being inaccurate.

2-Insufficient time: Time is the crucial element in any project. Engaging in investigation, collaborating, evaluating, designing, interpreting the needs, strategizing, and working together takes time lost because of lack of experience. All of these tasks demand time that, no matter how small, accumulates rapidly

6.2 Earlier Course work :

Working on our project necessitated applying the knowledge gained from various computer courses in our engineering curriculum. The micro-controllers class was crucial in improving our comprehension of microcontroller systems and their importance in managing physical devices. Through this class, we acquired valuable knowledge and understanding of the principles and methods required for the efficient utilization of small controllers.

Similarly, the microprocessor module offered us valuable information and expertise in managing integrated circuits (ICs) and modules. This included understanding how they behave in relation to electrical current and voltage, providing us with the essential knowledge needed to handle the complicated functions of electronic parts and their roles.

Another course that was crucial was the CPU lab, which made a significant contribution to our practical experience. The skills acquired in this lab were extremely valuable in improving our ability to correctly identify and fix problems related to hardware.

Additionally, the part of our curriculum focused on critical thinking and scientific research greatly enhanced our ability to conduct research effectively and produce high-quality professional documents. This module equipped us with the necessary tools and techniques for successful scientific inquiry and professional writing.

7 Literature review

In terms of medication dispensing technologies, several studies have investigated automated systems that aid in accurate and timely medication delivery. Techniques like automated dispensing, dosage tracking, and programmable schedules are crucial for ensuring adherence, especially among the elderly with cognitive impairments. These systems often utilize mechanical sorting and dispensing mechanisms to organize and release medications at pre-defined times.

In terms of vital signs monitoring, research has emphasized the integration of compact sensors in everyday healthcare devices. Techniques such as photoplethysmography for blood oxygen level monitoring, electronic thermometers for temperature checks, and electrocardiography for heart rate monitoring are commonly used. These techniques have been proven effective in not only capturing real-time data but also in monitoring trends that are vital for predicting and preventing potential health issues.

In terms of user interface and accessibility, studies have explored the development of interfaces that cater to the usability needs of the elderly. Research highlights the importance of intuitive design elements such as larger buttons, voice prompts, and high-contrast displays. These elements help mitigate the challenges faced by users with limited technical skills or visual impairments.

In terms of system security and data privacy, there is a growing body of literature that discusses the protection of sensitive user data in healthcare devices. The MediMate project incorporates advanced security features, including biometric authentication via a fingerprint scanner integrated into the medication dispensing lock. This approach not only secures the device against unauthorized access but also ensures that the medication is dispensed only to the intended user, thereby enhancing user privacy and safety.

Doing healthcare management, and understanding the underlying technology at the same time, are not straightforward tasks. It is particularly challenging if users are not cognizant of the importance of these dual tasks. Typically, users may focus on the immediate assistance from the device, overlooking the importance of understanding and interacting with the system’s deeper technological processes. Yet, engaging with these processes is essential for maximizing the benefits of the technology. This project explores the use of an integrated system that not only addresses these user interactions but also enhances them through simplified communication tools that promote efficient and effective user engagement.

Past studies have explored various aspects of healthcare monitoring and medication management individually. However, the proposed "MediMate" project is unique in its holistic approach, combining medication management, vital signs monitoring, and user-friendly security measures into a single device. This integration aims to provide a comprehensive solution that enhances the quality of life for elderly users by maintaining their independence and ensuring their health safe

8 Methodology

This section provides detailed information about the methods and techniques we are familiar with
Machine development, from design and assembly of the outer shell to the end
And other tools in the MediMate device and how they work
They are linked together to reach the final product.

8.1 Hardware Components

8.1.1 ESP 8266

ESP8266 is a widely used, cost-effective W-Fi module that has the ability to operate independently as a microcontroller. It provides Wi-Fi connectivity and GPIO pins for communication with other components, and can be programmed using the Arduino IDE.
We used it to connect to the WIFI network and accept commands and notifications from the mobile application through Blynk to manage the deviceand send them to Mega.
It is responsible for permanently storing data such as medication dates anddoses.

Figure 1 ESP 8266

8.1.2 Max30100 spo2 and heart rate sensor

The Max30100 is an amazing advance in medical technology, accuratelymeasuring blood oxygen levels and heart rates per minute.
It helps in diagnosis and monitoring by focusing on vital signs.
An essential tool in healthcare, it provides real-time information to help make accurate treatment decisions.

Figure2 Max30100 spo2 and heart rate sensor

8.1.3 Oled display

OLED screen: A panel of vivid light, pixels move with brightness. Each pixel is individually illuminated, creating sharp differences and deep blacks.Slim and flexible, it can bend to fit any style, bringing photos to life.From smartphones to smart watches.

We used it to display temperature, heart rate per minute and blood oxygen level (SPO2). animation are displayed on it as a kind of aesthetic

Figure3 Oled display

8.1.4 Stepper motor

The stepper motor is renowned for its accuracy in movement and precise control over steps. Each pulse or beat directs it in a specific direction, allowing for precise positioning. This makes it ideal for applications requiring accurate placement, shifting in specific intervals to achieve desired outcomes.

Its versatile design enables a wide range of uses, from 3D printers to CNC machines, where precise movement is essential. The stepper motor's distinctive design ensures dependability and consistency in function, making it a reliable performer in the realm of automation.

We used the stepper motor to move the 3D-printed slots until the pills were dispensed from them. This application demonstrates its capability to handle precise movements for controlled dispensing tasks.

Figure 4 Stepper motor

8.1.5 Finger print sensor

Fingerprint sensor: Protector of safety, accessed through a simple touch.Every distinct print provides entry, a customized pass in the digital domain.It guarantees privacy and authentication effortlessly by being integrated into devices.It provides security with biometric accuracy, from cell phones to home locks.It streamlines authentication by seamlessly integrating convenience and protection.

We used it to work as a reliable security tool

Figure 5 Finger print sensor

8.1.6 Relay 2-channels

Transmit 2 channels: Two separate routes for managing, increasing flexibility.Two channels provide twice the opportunities by connecting circuits accurately.From household control to industrial operations, it coordinates complicated processes. Effortlessly alternating between two circuits enables a variety of operations. An essential element in the field of electronics, it combines routes with effectiveness.
In the realm of connectivity, Relay 2-channels is known as a dependable conductor.

We used the first channel to lock and the second to control the water pump

Figure 6 Relay 2-channel

8.1.7 IR sensor

- IR sensor: Silent sentinel, detecting unseen warmth's presence.

Infrared rays reveal hidden worlds, beyond human perception.
From automatic doors to thermal imaging, its applications are diverse.
In the darkness, its gaze pierces, guiding technology's sight.
A key component in security systems, it alerts to intrusions with precision.
In the spectrum of sensors, the IR sensor illuminates the invisible.

We used it at the exit from which the medications come out to give a signal to the stepper motor to stop rotating when the medication passes in front of the .IR

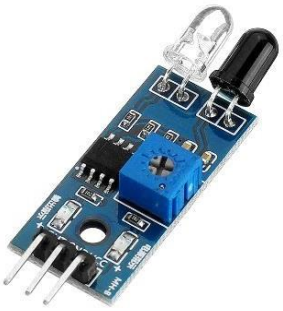


Figure 7 IR sensor

8.1.8 Lcd 20*4

A 20-character display is commonly used in various electronic devices, capable of showing a maximum of 20 characters. It is frequently utilized to display text, numbers, and symbols on electronic projects and devices.

We used it to display the time and date, as well as to show the main commands that control the machine and its settings (date and time) and the fingerprint sensor. Additionally, it is used to display the percentage of water in the water tank.

Figure 8 LCD 20*4

8.1.9 RTC

The RTC (Real-Time Clock) is the protector of time, carefully coordinating schedules. Measuring seconds, minutes, hours, dates, and weeks, it guarantees precision in timekeeping. It is integrated into a variety of devices, ensuring seamless coordination of tasks. Backup batteries maintain the ticking heartbeat even during power outages.
We used it to take the value of the current time and date, information needed to compare the dates when adding medications, so we know which medication is due.

Figure 9 RTC

8.1.10 Water level sensor

Level sensors are used to detect the level of substances that can flow, such as liquids, slurries, granular materials, and powders. Level measurements can be performed inside containers or to measure the level of natural bodies of water, such as rivers or lakes.
We used it to calculate the percentage of water in the tank in the machine.

Figure 10 water level sensor

8.1.11 Keypad 4*4

A keypad is a set of buttons organized in a specific way and used as an input device, typically arranged in a grid or matrix layout. Each button usually represents a particular character, digit, or instruction. Keypads are often utilized for inputting data or choosing options on various electronic devices and mechanisms.
We used it to control the system by choosing specific commands, such as setting the fingerprint, the date and time, and starting the biometric reading session. In short, it was used as a means of entering commands to control the necessary settings in the machine.

Figure 11 keypad

8.1.12 Solinoid lock

The solenoid lock is a security device operated by electrical signals. It locks doors quickly and accurately by attracting them with magnetic force. Frequently employed in safes and electronic locks, it offers dependable security. When instructed, it loosens its hold and opens with a click. A quiet protector, it efficiently manages access control.

Within the domain of locking mechanisms, the solenoid lock remains a reliable guardian. We used it to close and unlock the machine.

Figure 12 Solinoid lock

8.1.13 DS18b20 Temperature sensor

The DS18B20 temperature sensor offers accuracy in thermal data collection, measuring with precision. Its single-wire interface simplifies integration, reducing circuitry complexity. This flexibility makes it suitable for various devices, from weather stations to home automation systems. By providing digital output, it ensures accurate temperature measurements in different settings.

With a small and efficient design, the DS18B20 can easily integrate into various projects, regardless of size. It stands out in the field of temperature sensing, offering reliable information for a variety of uses. We used it to measure the temperature in the patient's body.

Figure 13 DS18B20 Temperature Sensor

8.1.14 Water Pump

The water pump guarantees smooth movement for best performance, moving fluid accurately and effectively. It is used in various applications, ranging from fish tanks to air conditioning units. Small and dependable, it works smoothly to regulate flow and temperature. By being able to customize its settings, it effortlessly meets a variety of needs, quietly maintaining fluid movement—an important element in various systems.

In the realm of pumps, the water pump is known for its dependable ability to facilitate the flow of liquids. We used it to draw water from the water tank and pour it into the cup.

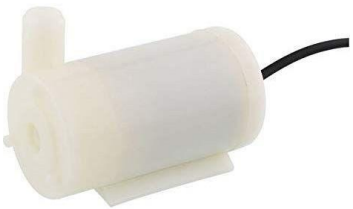


Figure 14 water pump

8.1.15 wires

Figure 15 wire

8.1.16 Push button

A push button is a basic switch mechanism that operates different devices by enabling the flow of electricity. When pushed, it closes an electric circuit, turning on the device. Push buttons are frequently seen in everyday electronic devices, such as computers and household appliances.
There are two kinds of push buttons: momentary switches and latching switches. Momentary switches offer brief contact, while latching switches retain their position until pressed again.
This button has two uses:
1. It is pressed to pour water into the cup.
2. When the medication is dispensed at the appropriate time, the machine continues to send notifications until the patient takes the medication. To silence the notifications when taking the medication, the patient is required to press this button until the machine stops sending notifications.

Figure16 push button

8.1.17 Buzzer

A buzzer is a device that produces a sound when turned on, often found in alarms, timers, and electronic gadgets to provide feedback to users. It may be mechanical, electromechanical, or piezoelectric, with each kind providing distinct features. Buzzers are appreciated for being simple, trustworthy, and easy to incorporate into circuits, which makes them a flexible component in different uses. It was used to send audio notifications when the medication was taken at the right time

Figure 17 buzzer

8.1.18 Arduino Mega

The Arduino Mega utilizes the ATmega2560 microcontroller and includes 54 digital I/O pins, 16 analog inputs, and 4 UARTs for serial communication. It features added memory, making it perfect for projects that need extra I/O pins and advanced automation. Commonly used in robotics and interactive projects, the Arduino Mega is compatible with most Arduino shields. Its wide range of functions has made it a favored option for complex electronic devices and model creation.

In one application, the Arduino Mega was used as the main controller in a system to control the stepper motor, relay, IR sensors, RTC, keypad, and screen. It completely controls the system by taking input data from the ESP, which is connected to Wi-Fi, and then manages the rest of the components.

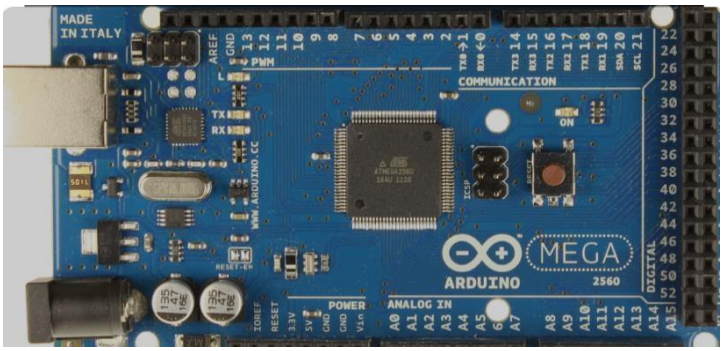


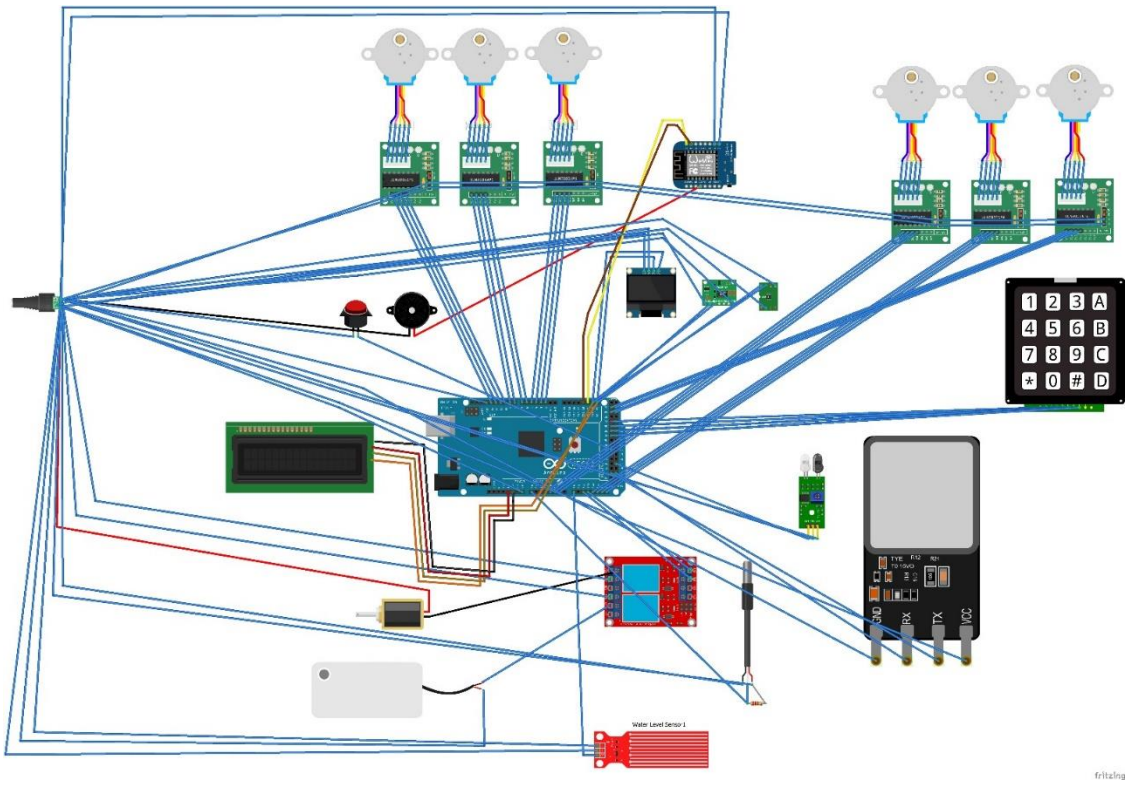
Figure 18 Arduino Meg

8.2 Process Of Work

8.2.1 Data collection:

In our project, our main objective is to assist the elderly and individuals with Alzheimer's in remembering to take their medications. We have developed an alarm clock system that eliminates the need for any effort on their part. To achieve this goal, we have devised a medicine reminder machine. Once we finalized the idea, we began gathering information on similar projects in this field and the components utilized in such projects. Subsequently, we conducted a thorough study of each component individually to comprehend its functionality and the benefits it offers. For each component, we constructed a standard circuit and collected and stored the resulting data and output. This data will be analyzed and compared with that of a fixed component, enabling us to select the most suitable one that aligns with our requirements.

8.2.2 Controller Design



8.2.3 Mobile app

We have integrated a mobile application into our MediMate project, utilizing Blynk for seamless control and monitoring.

Medication Scheduling: Caregivers input medication details (slot, timing) into the mobile app, which syncs with the scheduling machine.
The sensor data is displayed on the OLED screen and transmitted to the mobile app.
The machine monitors if need to fill water or not and notifies the caregiver via the app if the water is low.
Health Data Transmission
Vital signs data is transmitted to be displayed on the mobile app.

We have an input field to enter the slot number, another for specifying the days and hours for medication intake, a 'Send' button to transmit this slot information to the ESP for storage, and a 'Reset' button to cancel a selected slot if needed.

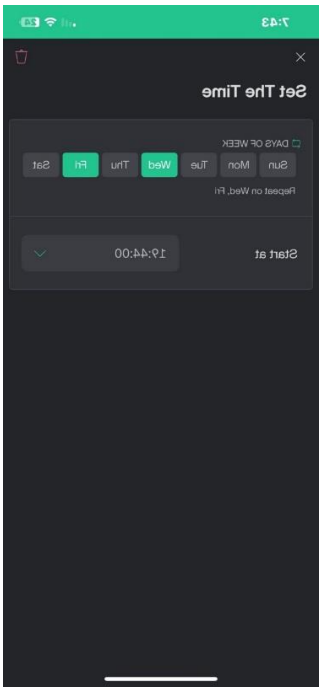


Figure 19 mobile app

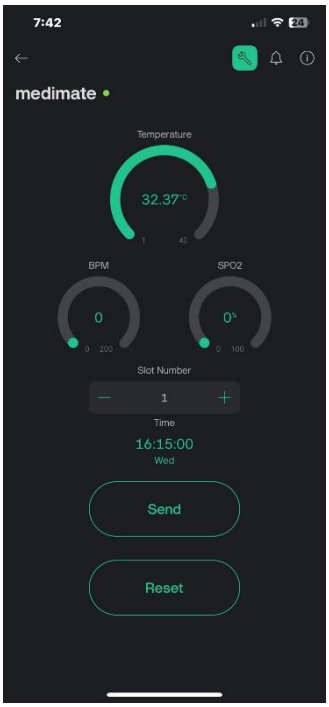


Figure 20 set the time

Figure 21 notification

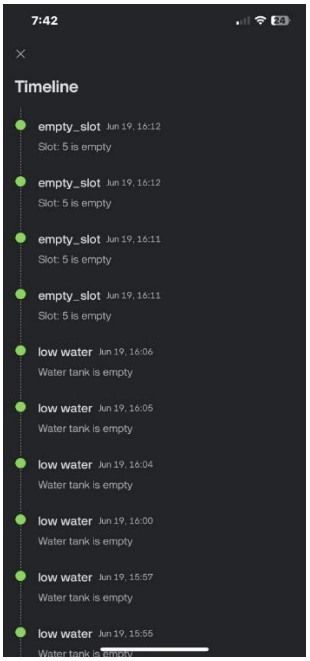


Figure 22 timeline

8.2.4 Slots

Initially, we thought about using a wooden design for our medication dispenser. However, we found that it was heavy, expensive, and not practical. So, we decided to use 3D printing instead because it is cheap, lightweight, and provides good quality. This was the design we had in mind:

Figure 23 slot

Our final design includes nine slots in a circular arrangement. At the center of this design, there is a fan connected to a stepper motor. The way it works is simple: as the stepper motor turns, it lines up one of the slots with an opening at the bottom. This allows a pill to drop from the slot and travel down a printed path, also made with 3D printing.

This design ensures that medication is dispensed accurately and efficiently. Using 3D printing made the dispenser lighter, cheaper, and more effective, meeting our project's needs perfectly

8.2.5 external project structure

We began by thinking about the shape of the external box and the best materials to use for its construction. We decided on a secure, closed wooden box that would only show the input methods needed to interact with the system. This way, it would be easy to use for both the elderly and the caregivers responsible for the patients.

This was the final external design that fit our machine concept:

Figure 24 project design

After this, we determined all the necessary components and sensors to design the system, such as:

Water Pump: To dispense water for medication intake

Relay: To control the water pump

IR Sensor: To monitor the release of a pill

After gathering the components, we designed the circuit using Fritzing. We then connected and mounted all the components inside the box in the following manner:

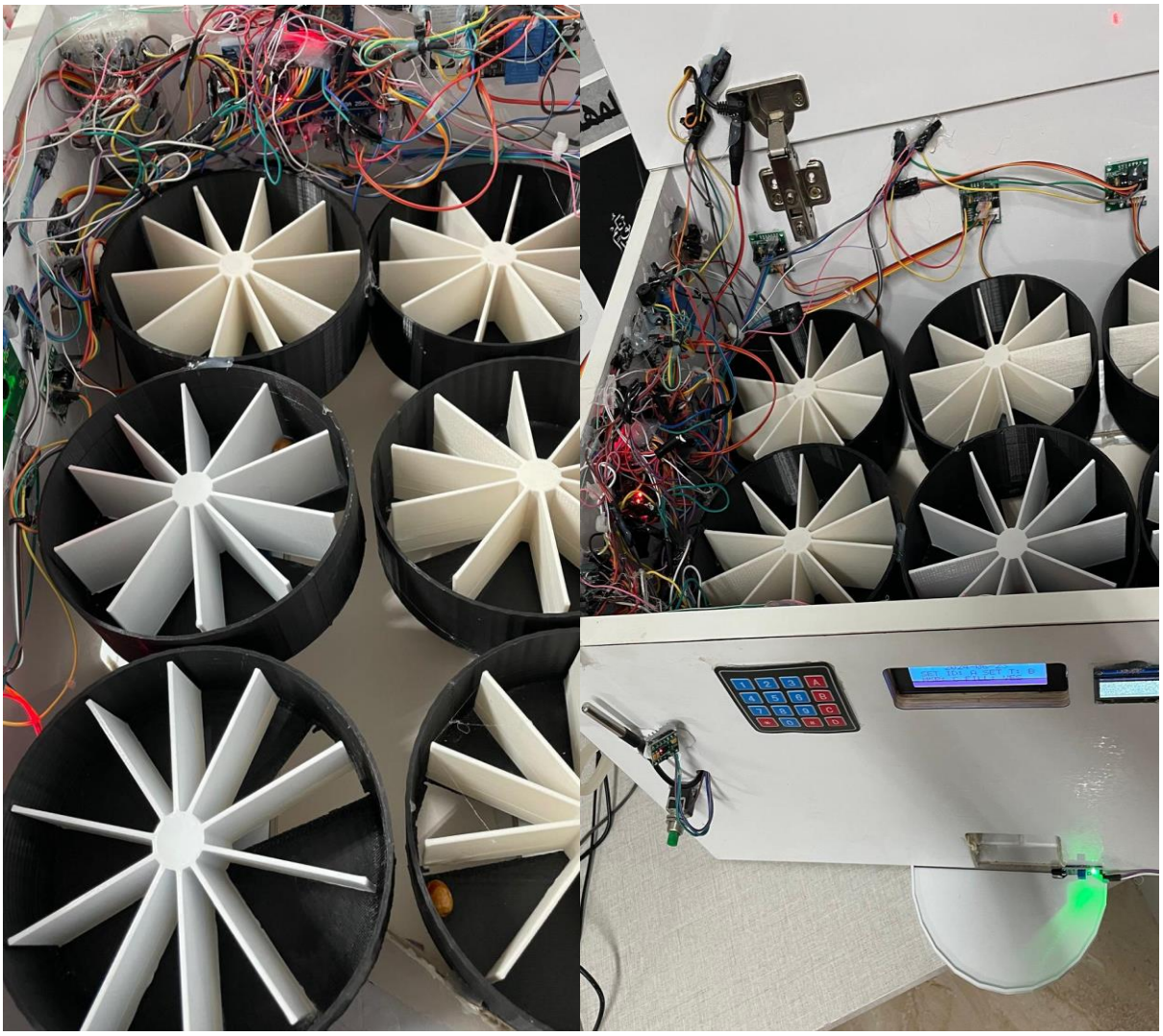


Figure 25 project internal design

8.2.6 Water tank

For the water dispensing feature of our project, we opted for an environmentally friendly approach by repurposing an existing water tank. This decision not only reduced costs but also contributed to sustainability efforts. The water tank is integrated into the system and connected to a water pump controlled by a relay. And this was the outside look of the tank :

Figure 26 water tank

To ensure the system remains functional, we included a water level sensor to monitor the tank's water level. This sensor alerts the user when the water level is low or if the tank is empty, ensuring timely refills and continuous operation. Additionally, we added a button to manually dispense water into a cup, providing convenience for the users.

This thoughtful integration of the water tank, along with the sensor and manual dispense button, enhances the overall functionality of the medication dispenser, ensuring that users always have the necessary water available for their medication.

8.2.7 Vital Signs Monitoring

A crucial feature of our project is the ability to monitor vital signs. We equipped the system with sensors to measure vital signs such as heart rate, blood oxygen level, and body temperature. These measurements are displayed on a screen, allowing users to easily view their current health status.
The sensors are connected to the main controller, which processes the data and displays it on an OLED screen. This setup ensures real-time monitoring and immediate feedback to the user. The data from the sensors is also transmitted to a connected application via Wi-Fi, allowing caregivers and healthcare professionals to remotely monitor the patient's vital signs.
The application provides an interface to view the measurements, set alerts for critical values, and track historical data. This integration ensures that both the users and their caregivers have access to important health information at all times, enhancing the overall safety and effectiveness of the medication dispenser.
By combining these features, our project not only dispenses medication but also provides comprehensive health monitoring, making it a valuable tool for elderly users and patients requiring regular medication and health supervision.
This was the way that we connect the screen and sensors to the machine :

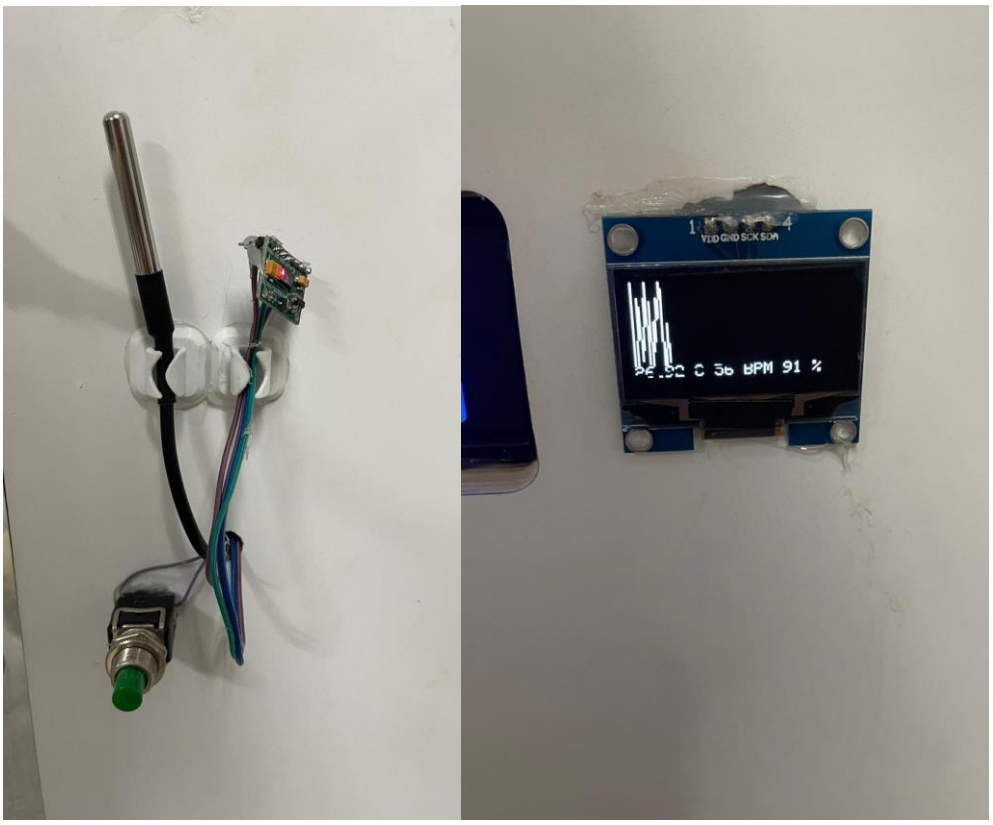


Figure 27 monitor vital signs

Figure 28 monitor vital signs

8.2.8 Fingerprint and solenoid lock

To enhance the security of our medication dispensing machine, we integrated a fingerprint scanner connected to a solenoid lock. This feature ensures that only authorized personnel, specifically the caregiver responsible for the patient, can access the medication compartment.

The fingerprint scanner is programmed to recognize the fingerprints of authorized users. Once a recognized fingerprint is scanned, the solenoid lock is activated, allowing access to the medication compartment. This ensures that the medication remains secure and can only be accessed by those who have been granted permission.

This feature not only enhances the security of the medication dispenser but also adds an extra layer of safety, ensuring that patients receive the correct medication administered by a responsible caregiver. The use of biometric authentication provides a reliable and user-friendly solution to prevent

unauthorized access and tampering.
By integrating the fingerprint scanner with the solenoid lock, our project ensures that the medication dispenser is both secure and easy to use, meeting the needs of caregivers and ensuring the safety and well-being of patients.
This was the way that we connect the screen and sensors to the machine :

Figure 29 fingerprint scanner

9 Future work

Enhanced Mobile App:

- Implement health analytics and telemedicine features.
- Add voice assistant capabilities.

User-Friendly Enhancements:

- Improve user interface and add multilingual support.
- Customize alert tones and notifications

Integration with Electronic Health Records (EHR):

- Connect the system with electronic health records to enable healthcare providers to access real-time data on medication adherence and vital signs monitoring.

10 Conclusion

The MediMate project addresses a critical need in the healthcare sector by providing an innovative solution for medication management, designed with the elderly and individuals with memory-related conditions in mind. Our system ensures timely medication intake and continuous health monitoring through a user-friendly interface and advanced technological features.

The integration of secure medication scheduling, vital signs monitoring, and access through fingerprint authentication highlights the comprehensive nature of our approach. By incorporating real-time alerts and notifications, we aim to enhance adherence to medication regimens, thereby improving patient outcomes and reducing the burden on caregivers.

Throughout the development of MediMate, we encountered and overcame various technical challenges, from integrating multiple sensors to ensuring reliable system performance. These experiences have enriched our understanding and skills in hardware design and system integration, preparing us for future endeavors in the field of engineering and technology.

The significance of our work extends beyond individual users to potential applications in hospital settings, particularly in managing contagious diseases where direct contact is minimized. MediMate represents a step forward in offering a scalable and adaptable solution to meet diverse needs, leveraging technology to support healthcare.

Looking ahead, we envision further enhancements to MediMate, including integration with electronic health records, expanded connectivity options, and the development of additional features to support a wider range of medical conditions. We believe that with continued innovation and refinement, MediMate can play a pivotal role in transforming healthcare delivery, ensuring safety, efficiency, and improved quality of life for users.

In essence, the MediMate project is a testament to the potential of engineering solutions to address real-world problems. It demonstrates how thoughtful design and technology can come together to create impactful and meaningful improvements in healthcare

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