Palestine Polytechnic University

College of Information Technology

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Smart Medical Wallet

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الإهـــــــــــداء

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بسم الله الرحمن الرحيم, والحمد والشكر لله رب العالمين, والصلاة والسلام على رسولنا الأمين,
الحمد لله الذي رزقنا العلم و وفقنا به وأعاننا على اجتياز هذه المرحلة العلمية بتفوق والنجاح.

في البداية نحب ان نشكر كل من ساعدنا وكان عونا لنا في اجتياز مسيرتنا التعليمية, وبذلك نحب أن نهدي هذا المشروع الى مشرفتنا المعلمة الفاضلة الدكتورة أمل دويك, التي كان لها الدور الأكبر في تحقيق الأهداف اللازمة في انجاز هذا المشروع, كما ونشكر المهندس وائل التكروري لمساعدته الدائمة طيلة هذه الفترة, ولا ننسى بالذكر الدكتور يوسف صلاح على تواجده معنا والنصائح القيمة التي زودنا بها.

كما ونهدي هذا الانجاز إلى عائلاتنا وأصدقائنا وكل من كان له دور في مساعدتنا وتشجيعنا حتى وصلنا لما نحن به و لما اكتسبناه من خبرات عملية وتقنية طيلة هذه الفترة.

Abstract

There are some patients who suffer from health problems that force them to take a certain medicine to help them recover. The patients may be exposed to health problems because of not taking the required medicine at the right time or taking another medicine by mistake.

This project aims to help patients take their medicines more smoothly and safely by keeping the medicines inside the medicine wallet to prevent the mixing of more than one type of medicine or mistakenly taking the wrong medicine at the wrong time. The patient is allowed to take the right medicine at the right time. The system alerts the patient with visual and audible means that help different groups of patients such as the deaf, the dumb, the blind, and the elderly to take the necessary medicine when it is due. This decreases the need for an escort who takes care of the patient. A mobile-built application is used to set up first sittings for the drawers which are also used to alert the patient or his escort if the patient doesn't take medicine on time. The system enables the user to configure the system and update settings according to the patient's case using a mobile application. There is a possibility of having one user or escort to configure the system. After testing the built prototype, the system is proven to achieve all its objectives.

Content

Chapter 1
Introduction

1.1 Overview:

This chapter introduces the motivation and objectives of the system. It presents the problem statement and describes the general idea of the project too. Finally, it discusses the system requirements.

1.2 Motivation and Importance:

The idea rises for a human need. We noticed that there are a significant number of people who forget to take medicines or who are confused about choosing the appropriate medicine.

It's very important for patients to have medicine properties to achieve good results. In contrast, some patients have problems taking the correct medicine at the correct time. Others take more than one kind of medicine which adds difficulty in following the doctor's prescriptions.

1.3 Aims and Objectives:

The main aim is to help people to take their medicine correctly on time. To achieve this aim, the following objectives should be achieved :

- Building a medicine wallet that helps organizing the medicine and storing it inside compartments
- Designing and implementing the wallet to automatically schedule medicine.
- The system enables the supervisor to ensure that the correct medicine is already taken at the correct time by sending a message.
- Create a mobile application to help setting up and using the wallet.

1.4 Problem Statement:

In most houses, there are patients who suffer from health problems that force them to take a certain medicine to help them recover. Taking the incorrect medicine can cause complications that negatively affect the patient's health, causing side effects. Some patients have difficulties choosing among medicines and others may forget to take it in time. Sometimes, medicines are mixed and this may be difficult, especially for the elderly, to distinguish among the types of medicines, according to the prescription.

The wallet solves this problem by sorting the medicine inside the drawers, then he/she will be able to take out the appropriate medicine at the correct time. The system will alert the user by an audible message and a LED to be turned on alerting the user for medicine time.

The main purpose of establishing the project is to achieve the process of organizing medicine taken by patients by scheduling their medicine with their correct times at a low cost.

1.5 System Description:

The suggested project is an automatic (smart) wallet, where the wallet can communicate with the application via a Wi-Fi network to manage medicine times, Of course the application is used to prepare the drawer the first time before placing the medicine, and then the ESP32 itself connects to the internet to obtain the time and compare it with the required time to take the pill, in addition to the presence of a sensor to determine the presence of a pill or not. A medicine wallet consisting of three rectangular drawers. Each drawer contains 3 compartments for medicine pills and 1 to throw the medicine from it and these 4 compartments arranged in a circular disk so that the medicine is placed inside them as shown in Figure 1.1, The medicine is placed manually by opening the side drawers after determining the type of medicine by a barcode reader. The disc consists of blades(it's from wood) that help move the pill into a hole so that it then falls through a tube into the package through which the patient takes the medicine as in Figure 1.2,When the medicine reaches the container, the system alerts the patient too. The system checks whether the medicine has been taken or not within a certain period.

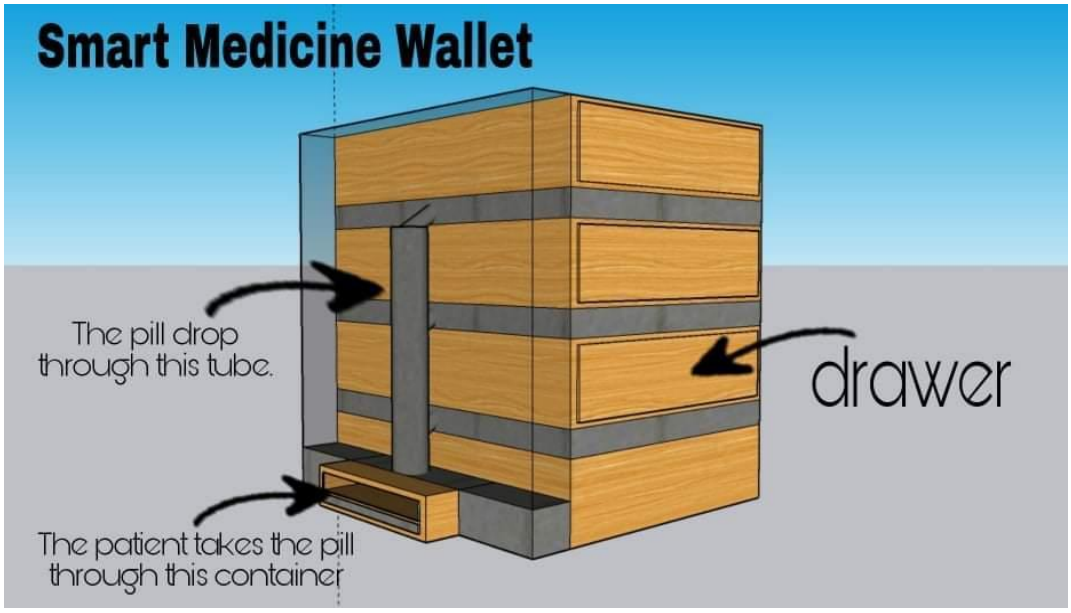


Figure 1.1: Outside View

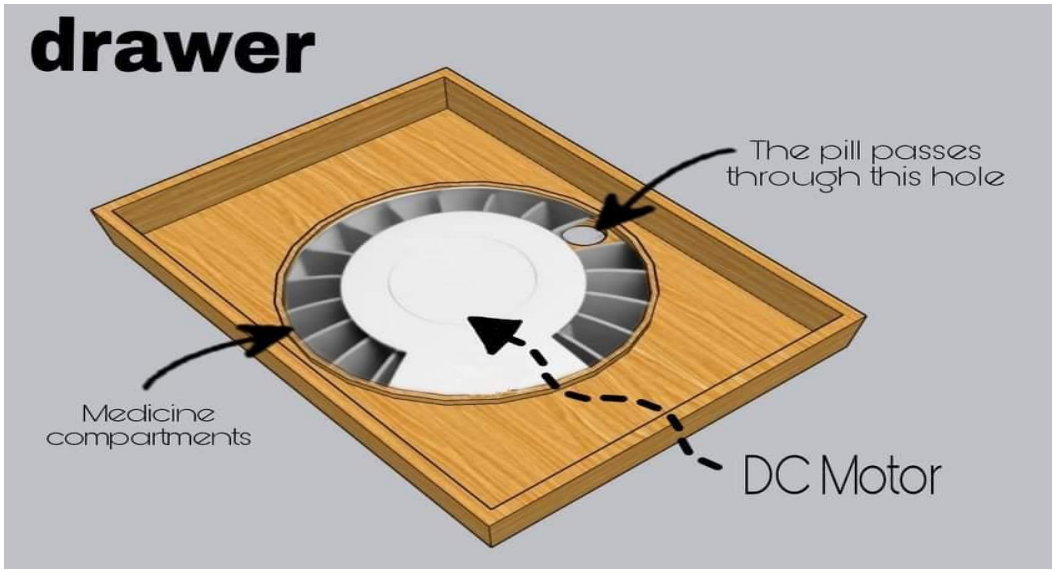


Figure 1.2: Drawer View

1.6 System Requirements:

The functional and non-functional requirements are described as follows:

1. **Functional requirements**
    - The system will be able to provide the right medicine at the right time
    - Enable the user to setup the system.

- Alert the user if he/she does not take the medicine within a specified period, and send a message or notification to relatives.
- If there is no response after the first alert, it will resend another message or notification.
- The system will provide a friendly app that can be used to setup and update the status of the system.

2. **Non-Functional requirements**
    - Accuracy: The system can identify the required medicine and deliver it at the scheduled time.
    - Cost: The system design consists of low-cost hardware components, This makes the wallet relatively affordable.
    - Efficiency: The efficiency of the system comes from adjusting the selection of the appropriate medicine with high accuracy.
    - Usability: The mechanism of the system is easy, and everyone can use it easily with very simple and short instructions.
    - Scalability: The system can be extended to contain many drawers and more types of medicine , By adding a Motor Driver and two DC Motors for each drawer.
    - Reliability: The system will alert the user, in case of system failure.
    - Maintainability: The device consists of hardware parts available in the market that can be easily replaced if something malfunctions in one of its parts.
    - Safety: Keeps the medicine inside the box away from external influences, without changing the composition of the medicine.

1.7 Expected Results:

The system is expected to give the following features:

- To develop a wallet that stores medicines inside the compartment of different drawers.
- The ability to choose the right medicine for the patient at the scheduled time.
- The ability of the system to get feedback to ensure that the medicine is taken on time.

Chapter 2
Background

2.1 Overview:

This chapter mainly displays a theoretical background about the system, some literature reviews from other projects, and the important hardware components we need.

2.2 Theoretical background:

Due to a large number of medicines and the presence of some medicines that are almost similar in shape, it has become difficult to choose the appropriate medicine among many other medicines by patients who face difficulties in knowing their medicines, especially the elderly, and those who cannot read. The number of people aged 65 or over Approximately 703 million people around the world according to the 2019 statistic, as nearly 89% of the elderly take their medicines[1]. The problem lies in not choosing the appropriate medicine and replacing it with another medicine, which causes side effects in the patient's health, knowing that the elderly are more at risk than the young to take the wrong medicines[2].

The problems resulting from taking the wrong medicine to revolve around the following[3]:

1. Weaken the immune system, increasing susceptibility to infections.
2. Feeling sick, vomiting.
3. Some muscle spasms and tremors.
4. Significantly irregular or rapid heartbeat.
5. It may cause partial effects such as kidney failure and may lead to death.

Despite the problems caused by taking the wrong medicines that could endanger the patient's health, not taking medicines regularly and forgetting to take them can also cause death. For example, the non-compliance of people who need to take blood pressure medicines increases the risk of heart attacks**[4]** .

The motivation for wallet building, in particular, is to improve medicine adherence in patients. A wallet makes it easier for patients and escorts to sort multiple medicines and choose the right medicine. It also allows escorts to monitor and use the device from anywhere. Providers can update treatment times and schedules. The patient, and can also know the time of taking the medicine by sending a notification to the phone, and it is possible to know whether the patient has taken the medicine or not through the sensor.

2.3 Literature review:

Here we will take a look at some projects and research papers that have similar ideas to our project:

1. **Smart Medicine Reminder Box [5]:**

   This project was done in SAL Institute of Technology & Engineering Research by Sanjay Bhati, Harshid Soni, Vijayrajsinh Zala, and Parth Vyas in 2017. The main goal of the project is to make a smart medicine box for patients who forget to take their medicines, where a schedule is prepared for the prescribed medicines. Informing the patient at the correct time of taking the medicine by light and sound notifications where the box continues to make a loud sound until someone takes out the medicine.

   They chose the Arduino UNO because it uses an 8-bit microcontroller and has 32KB of flash memory. In addition to the LCD, it displays the time and date through the RTC I2C module with a buzzer and seven LEDs.

   The difference between the wallet project and the medicine box project is its lack of a mobile application where times are scheduled manually using buttons on the box. In our project, we will create an application that can inform the patient by sending a notification to the phone. In the wallet project, there is an LED to warn the patient to take the medicine, and in the medicine box project there is an LED available at each tractor to determine the medicine that he should take. In the wallet project, the pill is lowered into a specific drawer. In the medicine box project, the patient must take the medicine from the medicine drawer.

2. Design of Smart Home Pharmacy[6]:

This project was done in Palestine Polytechnic University by Bayan Drabee Fatima Sbeih in 2017. The main objective of the project is to help patients, especially the elderly, to take multiple medicines that may cause forgetfulness for elderly patients, and the smart pharmacy contains a cooling system that activates automatically when the room temperature increases, and moreover, an alarm system will be activated at the time of taking each medicine and when the number of pills ends. The pharmacy has the ability to send a message to the user with the name of the medicine, the remaining quantity, and the expiration date.

They chose the Arduino MEGA 2560 in addition to the GSM Shield, which allows the Arduino board to connect to the Internet, LCD, Servo Motor, Keypad, Timer Controller, Fan, Temperature & Humidity Sensor were used.

The difference between the wallet project and Smart Home Pharmacy the wallet project does not have a cooling system, a temperature sensor, a screen to display the information, and the lack of a protection system, In our project, the drawer opens automatically when the drawer is empty or the barcode value is equal to the special drawers barcode**.**

Table 2.1: Differences between the wallet project and some projects and research papers that have similar ideas to our project

Features	**Our System**	**Smart Medicine Reminder Box**	**Design of Smart Home Pharmacy**
Microcontroller	**NodeMCU ESP32**	**Arduino UNO**	**Arduino MEGA 2560**
Barcode reading	**Yes**	**No**	**No**

Sound Alert	**Yes**	**Yes**	**Yes**
Light Alert	**Yes**	**Yes**	**Yes**
Mobile Application	**Yes**	**No**	**Yes**
Automatically eject the appropriate pill	**Yes**	**No**	**No**
Automatic opening of drawers when needed.	**Yes**	**No**	**No**

2.4 System components

2.4.1 Hardware components

In this section, we will display the main hardware components for the project and some detailed descriptions of them.

2.4.1.1 Barcode Reader

It is an electrical device used to read the barcode. All pharmaceutical products have barcodes. The barcode reader will help you identify the type of medicine by reading the barcode on the medicine box or envelope.

2.4.1.2 Microcontroller

A microprocessor is a microcomputer, which contains a processor and memory that can be programmed to perform certain functions that can be connected to the input and output modules.

Microcontrollers will allow us to control the wallet where the actuators that move the drawers will be connected, in addition to having WiFi and Bluetooth that will help us manage the wallet through the mobile application.

2.4.1.3 DC Motors with Encoder

They are devices that convert current electrical energy into mechanical energy and use the generated electricity to produce wheel motion. In our project, we need Six DC motors located in the drawer to be pulled and pushed. The rotation of the disk can be determined by it and how many pills can be dropped into the container.

2.4.4 Motor Driver

It is an IC that can operate and control DC motors and control their direction, it is used to enable DC motors to open drawers to add medicine and to rotate the disk inside the drawer to throw the pill.

2.4.1.5 Distance Sensor

Sensors are used to detect the presence of a pill in the compartment designated for taking the pill,and if there is a pill, it sends a signal to the controller .

2.4.1.6 Buzzer

The device converts electrical energy into acoustic signal energy, and can hear it from a room bandwidth. We use a Piezoelectric buzzer to alert the patient if he does not take the medicine on time.

2.4.1.7 LED

The LED works in parallel with the Buzzer to emit a light signal to alert the user to take the medicine.

2.4.2 Software Components :

2.4.2.1 Mobile Application

There are 3 types of mobile applications as shown in Table 2.2

Table 2.2: Mobile application options

	Android	IOS	Flutter
Programming Language	**Java,C,C++**	**Swift,Objective-C**	**Dart**
Source Model	**Open Source**	**Closed with open Source Component**	**Open**
Developer	**Google**	**Apple**	**Google**
Supports	**android application**	**IOS application**	**android, IOS, and web**

We chose flutter framework because it's able to run on the two operating systems android and ios and it does what we want.

2.4.2.2 Arduino IDE

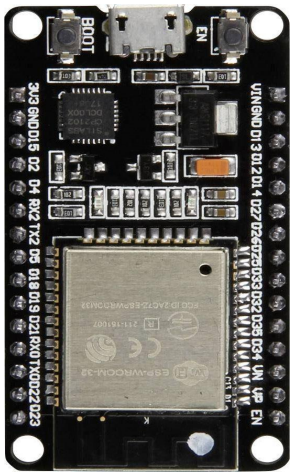
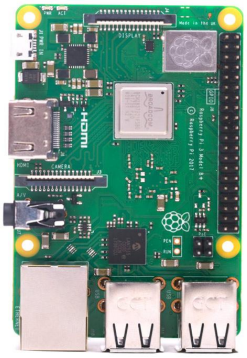
Its open-source arduino software used to write code and upload it to microcontroller ,this software can be used in ESP32 .

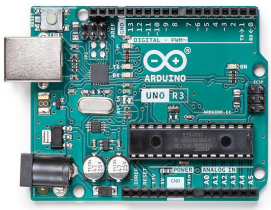
2.5 Design Options

2.5.1 Microcontroller Options:

There are 3 options as shown in Table 2.3

Table 2.3: Microcontroller Options

Type	Image	Specifications	Advantage	Disadvantage
NodeMCU ESP32 [7]		Processor: This board has 2.4 GHz Build in Modules : dual-mode WiFi and a Bluetooth wireless connection. Memory :512 KB SRAM and a 16MB memory are integrated on the microcontroller development board. Interfacing Pins: The board has 21 pins for interface connection, including I2C, SPI, UART, DAC and ADC.	Small Size. Built in WiFi and Bluetooth.	Its higher Cost.
Raspberry PI 3 [8]		Flash Memory (Operating System) : 16Gbytes SSD memory card. Internal RAM: 1Gbytes DDR2. Clock Frequency: 1.2GHz. GPU: Dual Core Videocore IV® Multimedia Co-Processor. Provides OpenGLES 2.0, hardware-accelerated Open	It has enough ram (16 Gbyte RAM) Built in Wireless and Bluetooth.	Its higher Cost.

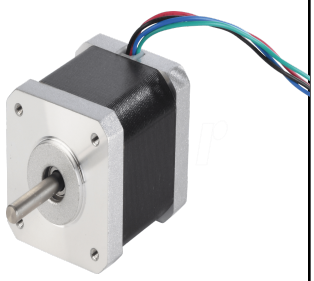
		VG, and 1080p30 H.264 high-profile decode. **Ethernet: 10/100 Ethernet.** **Wireless Connectivity: BCM43143 (802.11 b/g/n Wireless LAN and Bluetooth 4.1).**		
Arduino ATmega328P [9]		**Memory: 2 KB SRAM, 32KB FLASH,1KB EEPROM.** **Code Efficient, all 31 registers are directly connected to the arithmetic logic unit (ALU), making it 10 times faster than conventional CISC microcontrollers.**	**Low Cost.**	**Its low specifications.** **Does not have built-in WiFi and bluetooth.**

We chose NodeMCU ESP32 because it's available and it has built-in WiFi and Bluetooth, with suitable memory size , and enough interfacing pins

2.5.1 Motor Options:

Here we will use a dc motor with an L298 driver and a stepper motor with an easy driver. Table 2.4 describes two kinds of motors, to choose one of them.

Table 2.4: Motor Options

Type	DC Motor	Servo Motor	Stepper Motor
Specifications	**powered from direct current (DC) , such as batteries**	**powered from direct current (DC) , such as batteries**	**powered from direct current (DC) , such as batteries**
Structure	**constructed with brushes and a commutator, which add to the maintenance, limit the speed and usually reduce the life expectancy of brushed D.C.motors.**	**composed of three elements: the motor, the encoder and the driver. The driver has the role of comparing the position command and the encoder**	**consists primarily of two parts: a stator and a rotor. The rotor in turn is made up of three components: rotor cup 1, rotor cup 2 and a permanent magnet. The rotor is magnetized in the axial direction.**
Controllability	**The speed of a D.C. motor is controlled by varying the armature winding current.**	**The motor is controlled by delay microseconds**	**Stepper motor control provides this input train of pulses to command the motor to move to the desired position or at the desired speed.**
Image			

We chose a servo motor for opening and closing the drawer, and a stepper motor to throw the medicine bill.

2.5.2 Barcode Reader

Table 2.5 differentiates between two barcode scanners:

Table 2.5 Barcode Reader

Requirement	Laser barcode scanners	Camera scanner mobile application
Image		
The cost	**expensive**	**Depends on the price of the phone**
Efficiency	**Reads all common 1D barcodes**	**Reads all 1D and 2D barcodes**
Useability	**The device must be connected to a cable and a USB port in order for it to work**	**Works using the phone's camera Or through the camera scanner app**

Due to the ease of use of the mobile and its availability in every home, we will use the barcode reader app with a camera on the phone instead of a barcode reader to read medical products.

2.5.3 Distance Sensor

Table 2.6 differentiates between two distance sensors to choose among of them:

Table 2.6: Distance sensor Options

Type	Ultrasonic Distance Sensor HC-SR04	IR Sensor GP2Y0A51
Minimum range	**2 cm**	**2 cm**
Maximum range	**400 cm**	**15 cm**
Cost	**Low**	**Low**
Function	**Measure distances by sound waves**	**Object identification by infrared**

The project uses an infrared sensor because it is suitable for identifying objects with higher accuracy than ultrasonic sensors.

2.6 Design Constraints

Some of the design constraints are :-

1. The medicine is initially placed manually in the drawers.
2. A WiFi network must be available.
3. It is necessary to have a power source all the time.
4. The model may be heavy to hand.
5. The intended system is a prototype model.there are three drawers.each drawer has only one kind of medicine so three types of medicines are allowed, and each drawer has only three sectors hence, a maximum of three pieces of medicine at a time.

Chapter 3

System Design

3.1 Overview :

This chapter presents the detailed description of the system, general block diagram and describes the detailed design.

3.2 Detailed conceptual description of the system :

A patient or the patient's caregiver scans the medicine barcode via the smart medical wallet app, then the specific drawer will open, the caregiver manually put three pills into a specific drawer and then adds the information using a mobile app. A medicine is added to the medicine wallet in an empty drawer, and the type of medicine is determined by reading the barcode. Then the user schedules the medical appointments through the mobile application. Then, the information is stored in Firebase, the mobile application sends an alert 5 minutes before the set time for the medicine, after which the system fetches the medicine information from Firebase and then sends it to the microcontroller (ESP32) to find out the type of medicine and check the exact time as done prefilled.

The wallet consists of three drawers, inside each drawer there is a stepper motor that moves the disk in a circular motion so that the medicine drops through the tube into the container. When it is time to take the medicine, the medicine will be thrown into the container. When the medicine reaches the container, it will be recognized via an infrared sensor. Then, the patient is notified through an LED, and a buzzer sounds. When the sensor stops detecting the pill, the system stops notifying the patient.

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3.2.1 General block diagram :

The system consists of an ESP32 microcontroller which is the main part, and peripheral parts like IR Sensor, Buzzer, LED, and DC Motors. The mobile application is used to set up the system. Data is then sent to the Microcontroller, the Microcontroller is

connected to WiFi by which it can access the stored data. After that, the ESP32 will check if it is time to take medicine or not. If it is the time, it will send instructions to DC Motor using l298 to rotate at a specific angle to throw the medicine in the container. The IR sensor checks if the medicine is in the container and sends feedback to the ESP32. The ESP32 signals the LED and the Buzzer to turn on, until getting new feedback from IRSensor, As shown in figure 3.1.

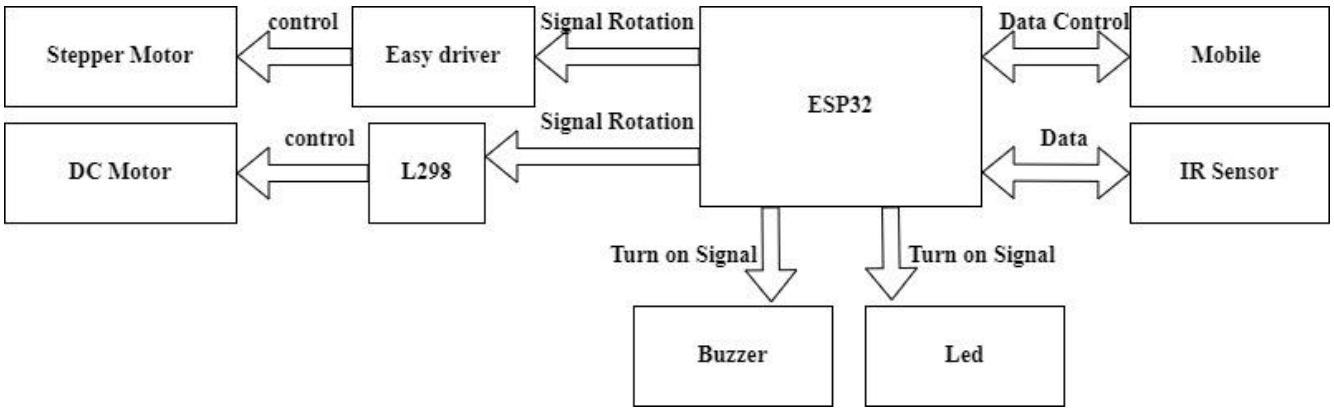

Figure 3.1: Block diagram for the medical wallet

3.3 Detailed design :

In this section we will talk about Hardware and Software design.

3.3.1 Hardware design interfaces:

3.3.1.1) IR Sensor With ESP32:

The IR sensor checks for the presence of the pill and sends the result to the microcontroller to make the appropriate decision .The schematic diagram is shown in figure 3.2:

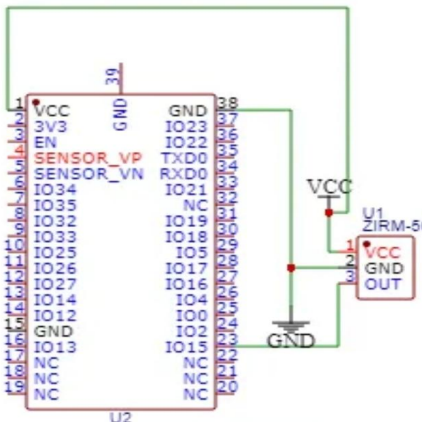

Figure 3.2: IR Sensor With ESP32

3.3.1.3) DC Motor With ESP32

There are three Dc Motors that will be put in a smart medicine Wallet. The motor rotates at a specific angle when it is time to take the medicine to drop the pill, The ESP32 and the DC motor are coordinated by the l298 driver.The schematic diagram is shown in figure 3.3:

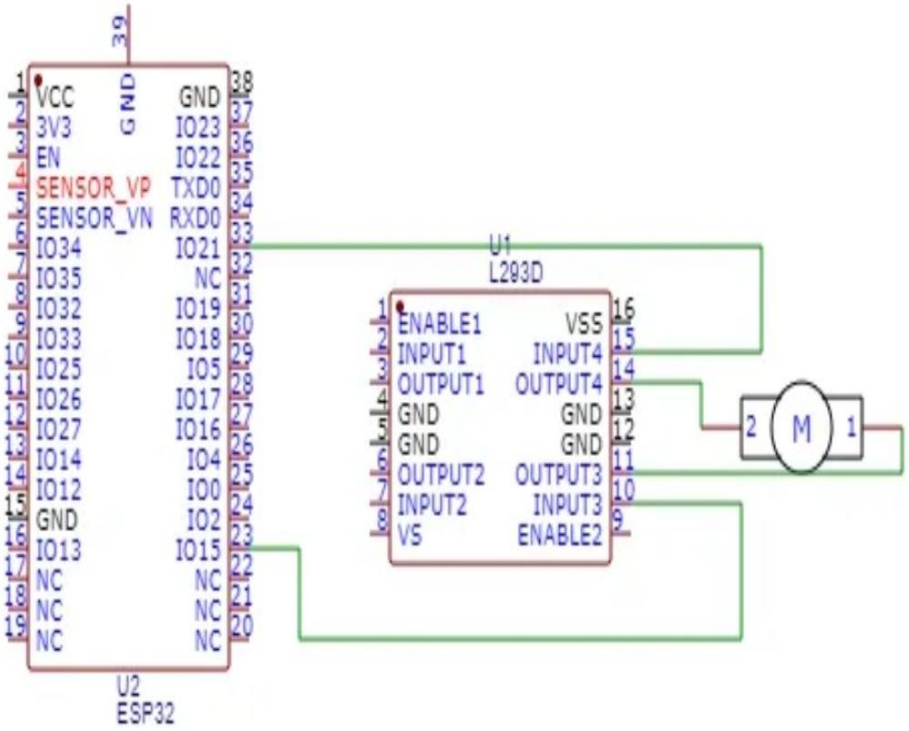

Figure 3.3: DC Motor With ESP32

3.3.1.3) LED With ESP 32

The sensor checks the value of the signal if it is HIGH or LOW, sends a high digital value to the ESP32, an activation signal is emitted to the LED by ESP32. The schematic diagram is shown in figure 3.4:

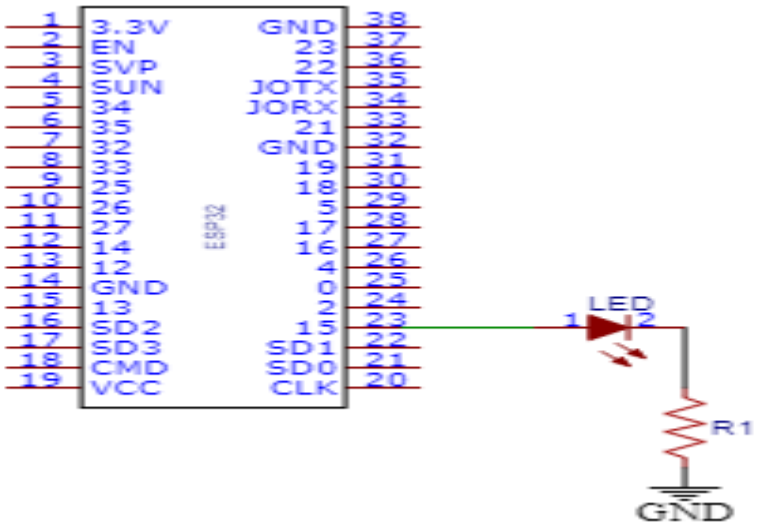

Figure 3.4: LED With ESP32

3.3.1.4) Buzzer With ESP32

When the sensor sends a high digital value to the ESP32, an activation signal is emitted to the Buzzer by ESP32 .The schematic diagram is shown in figure 3.5:

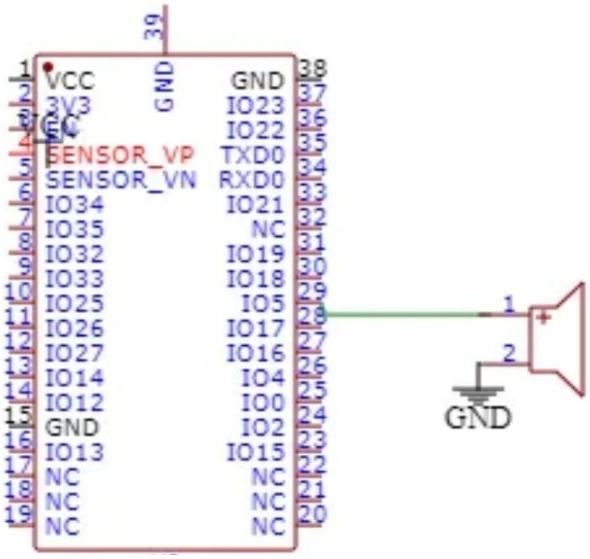

Figure 3.5: Buzzer With ESP32

3.3.1.5) Stepper Motor With ESP32

There are three stepper Motors that will be put in a smart medicine Wallet. The motor rotates at a specific angle when it is time to take the medicine to drop the pill, The ESP32 and the stepper motor are coordinated by the easy driver.The schematic diagram is shown in figure 3.6:

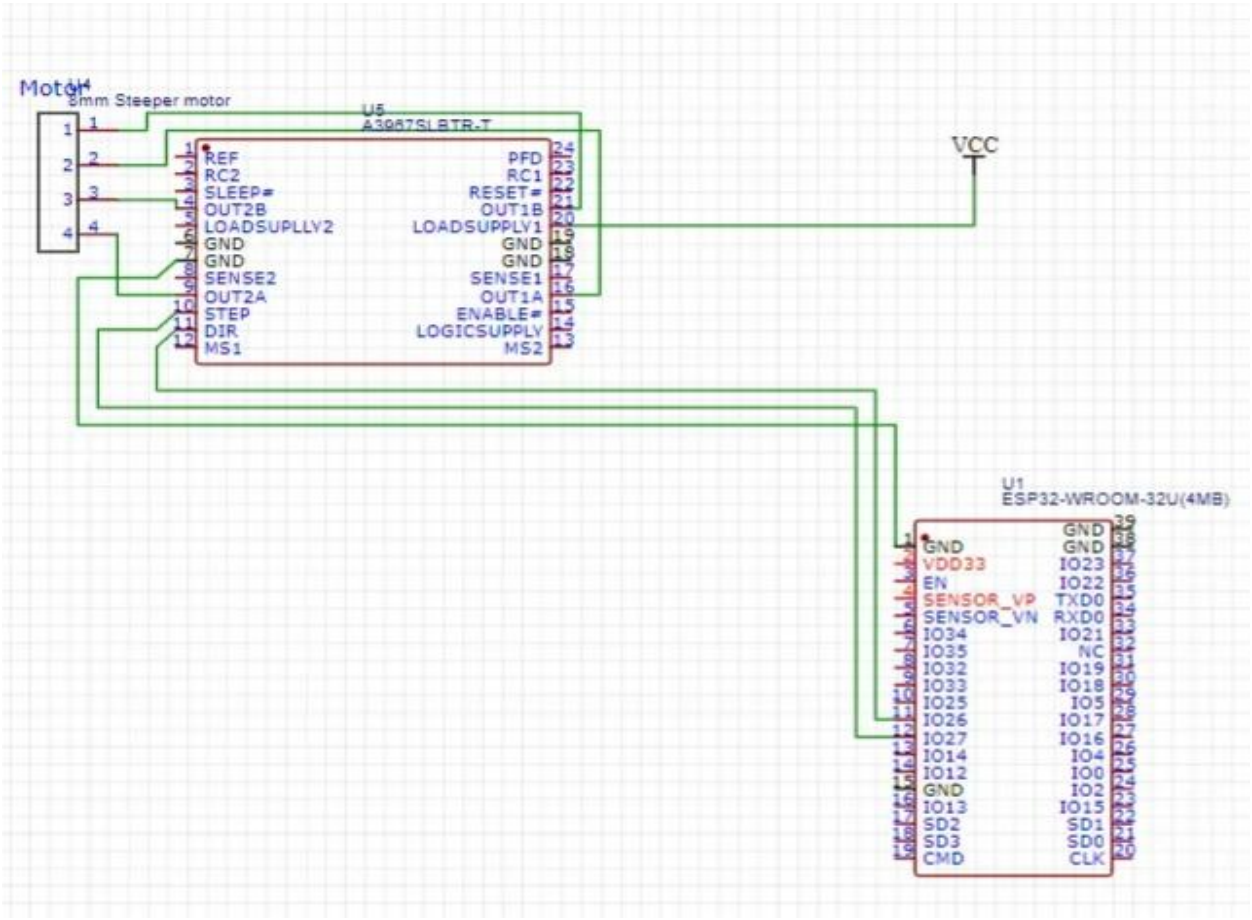

Figure 3.6: stepper Motor With ESP32

The Schematic diagram for all system in figure 3.7 shows the connection between all hardware components and explains the connection between the ESP32 and other Interfaces, The DC motors connected with l298 which connected with ESP32, IR sensor is connected immediately with the ESP32, and the LED and Buzzer is connected with the same pin:

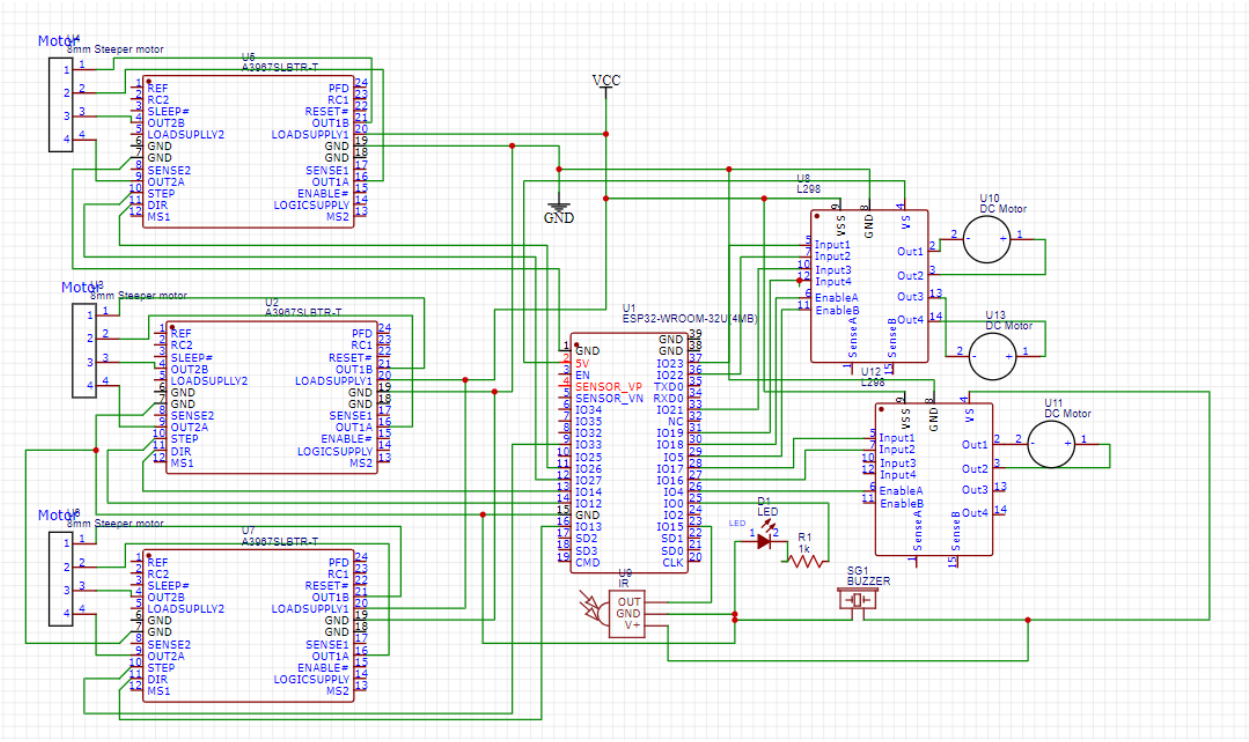

Figure 3.7: General Schematic Diagram

3.3.2 Software design:

Here we will Explain the general flowchart as shown in figure 3.7, the system checks if the mobile and ESP is connected to WiFi then it will let the user to add the medicine to the Wallet after that it checks if it is the time to take the medicine, if it's true then the stepper motor inside the drawer will rotate it in a specific angle to throw the pill to a container. When the pill arrives, the IR sensor will notice that, then the system will alarm and notify the user.

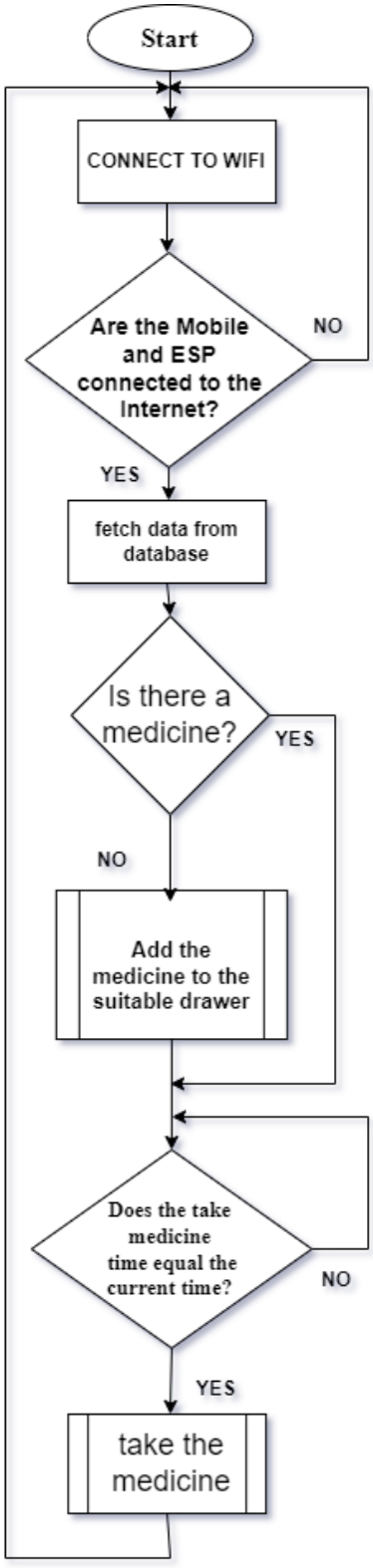

Figure 3.7 : General Flowchart

The figure 3.8, the user used barcode reader which is in the mobile app to read the barcode of the medicine and then store its information using the application , and checks if there is an empty drawer or not, if there is, it will set the barcode and medicine information for it and open it to add medicine, if not, it checks if there is a drawer has the same barcode, if there is it will open the drawer to add more pills in, else it will notify the user there is no space.

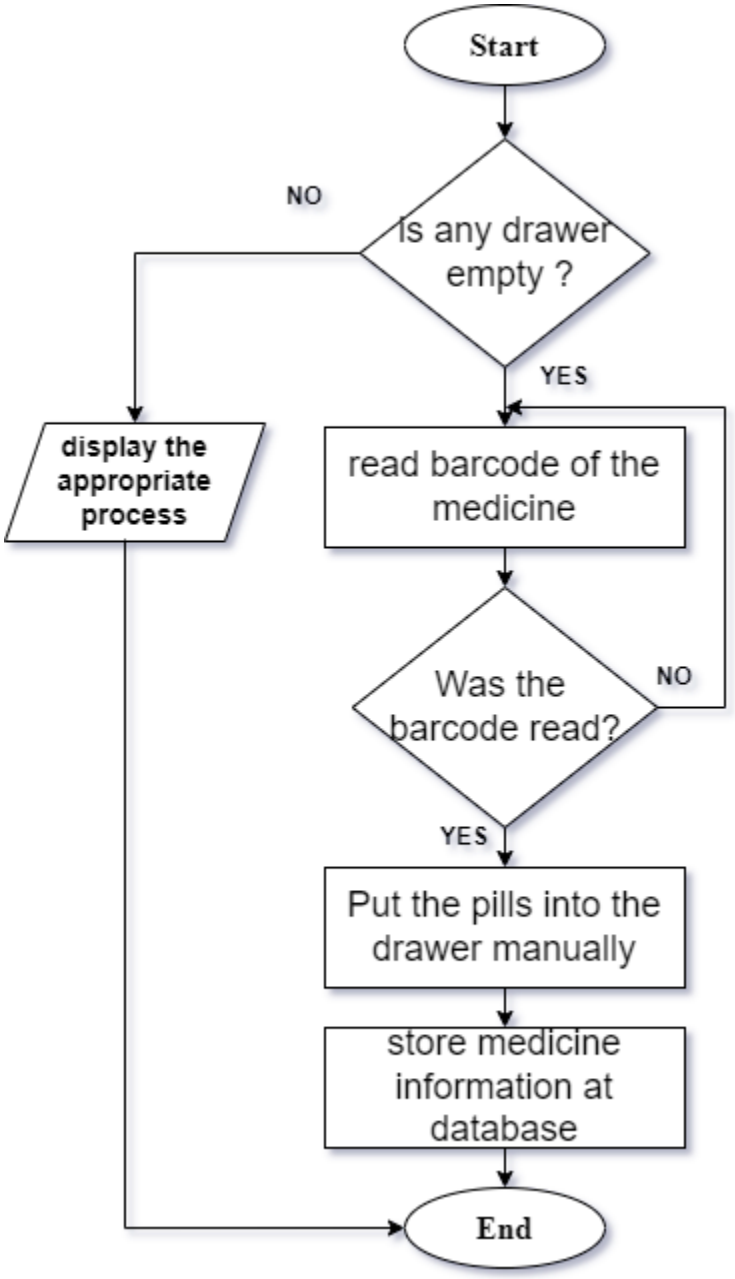

Figure 3.8 : Add the medicine to the Wallet Flowchart

When it's the time to take the medicine the microcontroller compares the barcode of the medicine with the specific drawer as shown in figure 3.9.

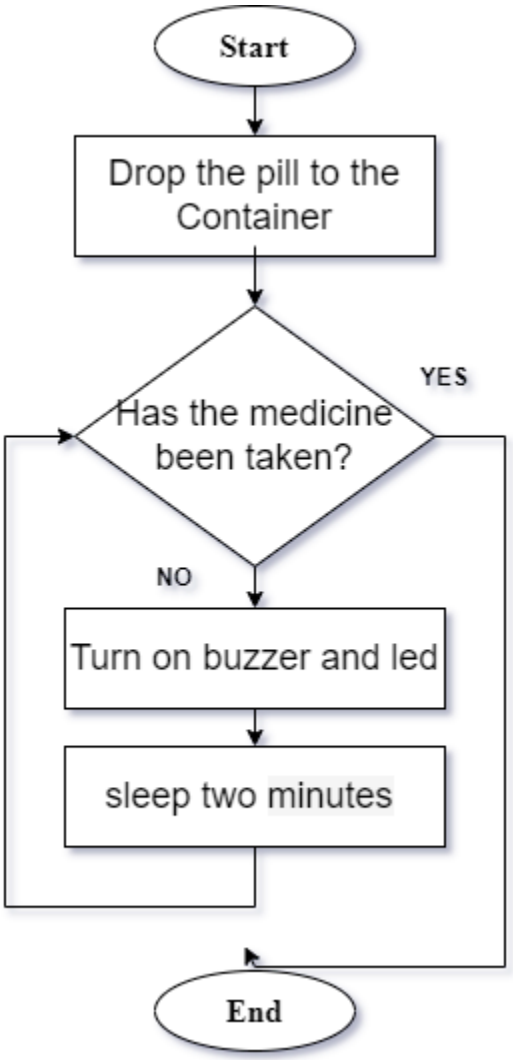

Figure 3.9 : Taking the medicine from the Wallet Flowchart

Chapter 4
System Implementation

4.1 Overview

This chapter describes and presents the implementation of the hardware and the software, such as the circuit connection, microcontroller, and the IDEs which are used to build the project codes.

4.2 Hardware Implementation:

The main component is the ESP32 microcontroller which is connected with the other system components as follows:

1. Three DC motors were connected with two l298 drivers, and then these two l298 drivers were connected to the ESP32 to open and close the three drawers.
2. The three stepper motor was connected to the three easy drivers, and then the three easy drivers were connected to the ESP32 to rotate the disc at a certain angle.
3. The IR sensor is connected to the ESP32 to scan if the medicine is in the container or not.
4. The LED and Buzzer are connected to the ESP32 to alert the patient.
5. A 12V/2A converter was used to power the system.
6. The hardware module is connected to firebase to send and receive the data .

4.3 Software Implementation:

4.3.1 Mobile app Code Implementation:

The application is developed with Flutter framework, as it is an excellent tool To implement mobile applications for either Android or IOS. We also link firebase databases in real time to the application. When the user opens the application, the program directs the user to the home page, which contains medicine data in the form of cards, each card represents the jars in which the medicine will be placed.When pressing the card, if there is no prior medication, the user will be directed to enter the medication through a pop-up window from the bottom. This window contains a button that reads the barcode of the medicine. When reading the barcode, the jars are opened automatically, and upon completion of data filling, such as the number of pills and the time required to take the medicine, the jars are closed when the add button is pressed. If there is a medicine, the user is directed to a window that contains buttons that modify the values in the

database, such as opening the jars, hanging them, or permanently deleting the medicine information.

Visual Studio Code IDE was used for mobile application programming and writing of code.
Overall code of the system composed of the following modules:

1- Homepage:

The main page consists of a title bar and the body. The body contains three cards representing the drawers in which the medicine is placed. Each card contains information about the medicine, including the name and time to take the medicine.

2- Bottom bar:

When clicking on the card, a lower bar appears through which the medicine information is entered. The bar contains a button that transfers the user to the barcode scanner and three buttons, which are morning, noon and evening,representing the date of taking the medicine.

3- Firebase:

When medicine information is entered, it is sent and stored as a key and value in the firebase.

4- Esp32 with firebase

The firebase was linked through a library into the Arduino code, which calls the medicine information from the firebase in the form of values.

4.3.2 Arduino Code Implementation:

The Arduino IDE was used to program the ESP32 microcontroller and write the code.
The code consists from these main concepts or functionalities:
1- Reading\writing data from\to the firebase.
2- Controlling the dc motor.
3- Controlling the stepper motor and rotating it in a specific direction with a specific angle.
4- Reading data from IR sensor and output data on buzzer and led.

4.4 Implementation Issues:

During the course of the project implementation, we faced many obstacles and had to take several issues to reach the most suitable design of the system and reach the best properties related to the project's aims. The following is a summary of these issues:

1. Controlling the open and close of the drawer: we used a servo motor to control the drawer but the problem is that it opens only a little centimeters, and to solve that we have used dc motors, rollers and zippers to let the drawer open.
2. The increase in temperature of the easy driver: we noticed that after a period of time the temperature increased in a strange way and to solve that we used heat sinks.
3. Controlling speed of the dc motor that opens the drawer:when we open the drawer it opens very fast and it comes out of the drawer stepper, and to solve that we control the dc speed from code.

4.5 Implementation Results :

By the end of the implementation process, the desired goals of the smart medical wallet were achieved, the Smart Medical Wallet prototype is shown in figure 4.1. The mobile application is shown in figure 4.2.

Figure 4.1.a: The front side of smw

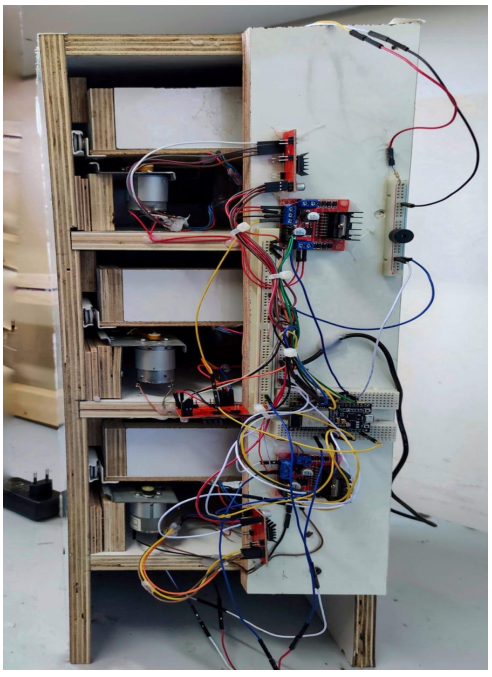

Figure 4.1.b: The back side smw

Figure 4.1: System prototype

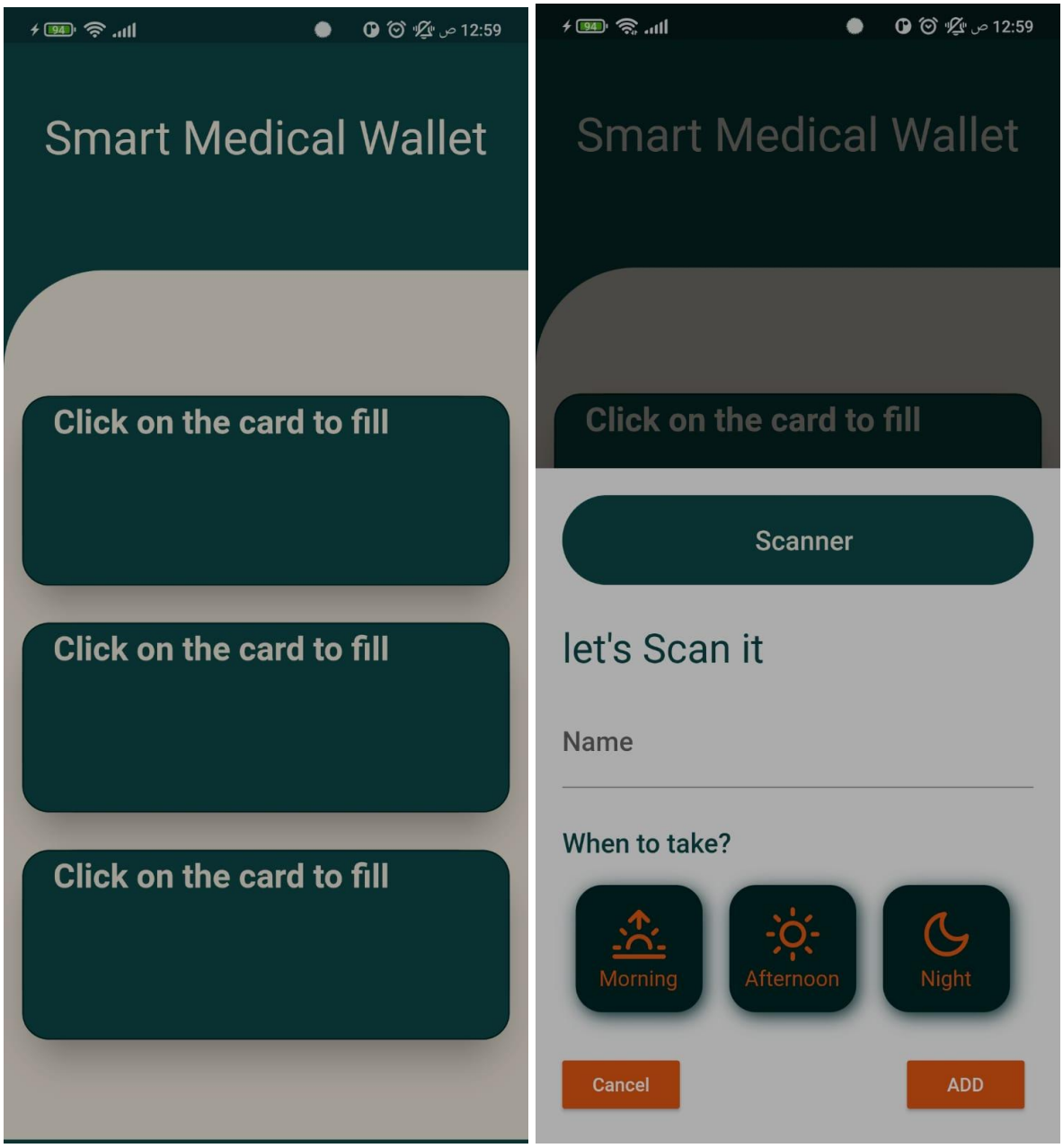

Figure 4.2: Mobile application home screen

4.6 Summary :

The system is implemented in sequential steps, starting from entering the patient's information through the application and the mechanism of work of the hardware components in the medicine wallet and making sure that they are working well.

Chapter 5
Testing and Challenges

5.1 Overview

This chapter describes the implementation of the system step by step. The methods used to validate the system, results of the testing of the system and challenges we faced.

5.2 Hardware Testing

This section discusses the testing process for the hardware components.

5.2.1 Unit testing

1. **Testing esp32:**

   We verified the ESP32 microcontroller by connecting it to a power source and writing a test code, and the ESP32 microcontroller was verified

2. **Testing ir sensor:**

   To test the ir sensor, we connected it to the microprocessor and passed an object in its range until the readings were shown on the device.

3. **Testing wifi module:**

   Connected with the firebase, and the connection between them was successful. We got this by sending data from vibers and receiving it in esp32.

4. **Testing stepper motor and esay driver :**

   We checked the Stepper motor and esay driver by connecting them to the ESP32 microcontroller and writing a test code. The operation was successful, the engine rotated at specific speeds and at different angles without any problems.

5. **Testing DC motors and L298 driver:**

   We checked the DC motor and l298 driver by connecting them to the ESP32 microcontroller and writing a test code, and the DC motor and l298 driver was verified.

6. **Testing LED and Buzzer:**

   We checked the LED and Buzzer by connecting them to the ESP32 microcontroller and writing a test code, and the LED and Buzzer were verified .

5.2.2 Integration testing

We tested the system after we connected all components as shown in figure 5.1, and it works successfully.

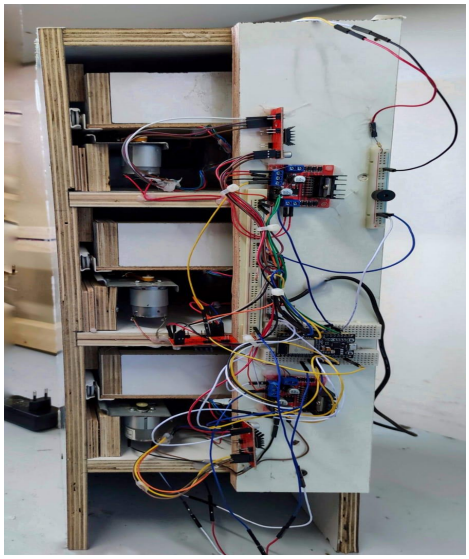

Figure 5.1

5.3 Software Testing:

This section discusses the testing for our functions in the software as shown in table 5.1

Table 5.1: System Test

	Case	Expected Output	Obtained Output	Pass/Fail
1	Rotate the disc when the time is right	Rotate the disc	Rotate the disc successfully	Pass
2	Open the drawer when read barcode	Open the drawer	Open the drawer successfully	Pass
3	Close the drawer when input the medical info	Close the drawer	Close the drawer successfully	Pass
4	Turn on the led and buzzer when ir read the data	Turn on the led and buzzer	Turn on the led and buzzer successfully	Pass

5.3.1 Test Arduino Software:

We've used the serial monitor to test the software on the Arduino. We've entered a character inside the monitor, and we got the following results:

1. If the character is o, then the drawer is opening right now.
2. If the character is c, then the drawer is closing now.
3. If the character is n, then the drawer is not opening or closing now.
4. If the character is r, then the stepper motor is rotating.

5.3.2 Test Mobile Application Software

1. **Application interface:**
   We programmed the application with the main interface and downloaded it to our own devices and it was working well.
2. **Testing Firebase:**
   We checked if there is a connection between the database and the mobile application by sending initial values from the application and storing them in the database and it worked without problems.**:**
3. **Testing barcode reader:**
   We have tried several readings from several special barcodes in medicines and it really worked.
4. **Testing open drawers by barcode:**
   We tried opening the drawer by sending the bool value to the firebase and receiving it from esp32.

Table 5.2: Unit Test

	Case	Expected Output	Obtained Output	Pass/Fail
1	Connect to the internet	Connect to the internet	Connected to the internet	Pass
2	Get current time from *ntp	Get current time from ntp	Get the time successfully	Pass
3	Get data from DB(firebase)	Get data from DB (firebase)	Get data successfully	Pass
4	Get data from sensors	Get data from IR sensor	Get data successfully	Pass
5	Get and store data From memory	Read and write data from memory	Read and write successfully	Pass
6	Send data to DB	Send data to DB	Send data successfully	Pass

***ntp : Network Time Protocol**

Chapter 6

Conclusion and Future Work

6.1 Conclusion:

The project aims to organize the process of taking the medicine to help patients reduce the harm caused by not taking medicines on time or problems caused by taking another pill by mistake. The system sends an alert to the patient when the time is due to take the pill, with the possibility of examining whether the patient took the pill on time or not. It is controlled by a mobile application that enables the patient or escort to save the medicine information in the microcontroller and then retrieves the data when it is due and alerts the patients accordingly.

6.2 Future Work:

We can enhancement the current model in different aspects, such as:

- Possibility of drawers that can accommodate a larger number of medicines.
- Add a side water tank with the medicine .
- Add suitable bottles for liquid medicines to include all types of medicines.
- Adding a scale that can calculate the weight of a pill that fits the needs of the body.
- Changing the system design or shape to make it more familiare with medicine.
- This project aims to help patients take their medicines more smoothly and safely by keeping the medicine inside the Optimizing the system, so that the physician supervising the patient can monitor the patient's medication by cloud intake and make any adjustments.

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