Palestine Polytechnic University

College of information and technology Computer Engineering

Department of Computer System Engineering

Smart Watch For Elderly Using Microcontroller

Team :

Inam Hazem Maraqa

Tasnim Yousef Al-Karaki

Rawand Iyad Yasin

Supervisor :

Eng. Elayan Abu Gharbyeh

Palestine

2021

Acknowledgment

First of all, praise be to God "Allah" Almighty and thank him for his blessings throughout our work on our project to give us strength and knowledge and help us succeed in this project. We are extremely grateful to those whom the pleasure of Allah is in the pleasure of them our parents for their love, prayers, caring and sacrifices for educating and preparing us for our future. We know the thanks are not enough and there are not enough words to describe how thankful we are to them.

We would like to express our deepest gratitude to our graduation project supervisor Dr. Elayan Abu-Gharbyeh for his patience and guidance and help in the project. Moreover, it is our duty to thank Dr. Wael Takrouri to help us and provide assistance when needed. We would like to thank Eng. Ayman Wazwaz for all the useful information that was provided . Special thanks to all the family members of the university staff and the educational unit for the efforts they made to provide us with all useful information and the interesting lectures they presented which had great benefit for all of us.

At the end , we would like to thank all the people who helped, supported and encouraged us to successfully finish the graduation project whether they were in the university or in the life.

Abstract :

Elderly are the blessing of our lives, and our precious treasure that provides us with experience, advice, and sincere supplications from the heart, but sometimes some sons are unable to give their elderly family members enough time due to the pressures of daily life, work concerns, studies, and family responsibilities. Where the elderly need care and attention significantly.

Our project seeks to design a smart watch for elderly person. The system helps to monitor an elderly person, without the need for the care provider to be near him all the time. In this system, care provider will be able to monitor the vital signs (heart rate , temperature and blood oxygen level) of elderly person remotely through a heart rate and temperature sensor , and GPS to determine the location . Also the chance of survival for an elderly person in case of any medical emergency happens is better because it gives an alert if there's a emergency situation, and sends information to his care provider through the mit app inventor mobile application , where the application is the link between elderly person , and care provider.

Care providers will have the freedom to practice their life normally, without the need to be near the elderly permanently or worry excessively about them, because this system allows you to monitor elderly person permanently and send information to the care provider mobile through the application

Table of Contents :

List of Figures:

List of Tables:

Chapter 1: Introduction

1.1 Overview

The smart watch for elderly is a system designed to monitor elderly, especially outdoors. This system enables the care provider to monitor the vital signs (heart rate, temperature, and blood oxygen level) , location, and the emergency situations of the elderly person remotely through a mobile application, without the need for the care provider to be near him all the time.

1.2 Motivation and Importance

The need for this system was due to suffer most elderly from major and minor health issues which affect their routine life, and that may cause anxiety problems for care providers because the inability of care providers to be around them all the time due to their daily concerns. In this system, care provider will be able to monitor the vital signs (heart rate, temperature, and blood oxygen level), location of elderly person remotely. Also the chance of survival for an elderly person in case of any medical emergency happens is better because it gives an alert if there's an emergency situation, and sends information to the care provider through the mobile application to save the elderly person life.

1.3 System Objectives

The main objectives of this system are:

- The system will be able to monitor vital signs (heart rate, temperature, and blood oxygen level) for elderly person.
- The system will be able to monitor location for elderly person.
- The system will be able to send these information to a mobile application.
- In emergency cases when the elderly feels tired and need a medical help, he will be able to press the emergency button, and an alert will be sent to the mobile application, advance to that a sound alarm is issued so that nearby people can help the elderly person.
- In other emergency situations, when the vital signs not in the expected range an alert will be sent to the mobile application.

1.4 Problem Statement:

In this section, we're going to talk about problem analysis, a list of requirements, expected results, and definitions.

1.4.1 Problem analysis

Care providers have anxiety problems on the elderly people, where some of them suffer from major and minor health issues which affect their routine life. It is also one of the problems they face that they don't know the location of their elderly person or what is his health state. Therefore, In order to take care of the elderly suffering from such diseases it is necessary to track their health status by regularly checking their vital signs, without the need for the care provider to be available all the time, as a solution, our system provides remote monitoring of the health status of the elderly.

1.4.2 List of requirements

The system requirements can be summarized as:

1. Design a suitable watch for the elderly.
2. Collect all data
3. The system must always update the status periodically and send the data to the mobile application.
4. Create a phone application in a simple and easy where the care provider can deal with.
5. When linking the watch and the application on the care provider mobile, the information must be received for the elderly person correctly.
6. High accuracy in location and sensors.

1.4.3 Expected Results

Expect to build an integrated system with the following specifications:

1. A simple, low-cost watch used to monitor elderly.
2. The system must be able to monitor vital signs heart rate, temperature, and blood oxygen level for elderly person.
3. The system will be able to monitor location for elderly person.
4. The system must be able to deal with emergency situations.
5. The system will be able to send these information to a mobile application.

1.5 Short description of the system

This system works as follows:

This system will measure the elderly vital signs heart rate, temperature, and blood oxygen level using a sensors connected to the microcontroller that will do the previous operations, a GPS is used to determine location . Also a button and a piezo sounder connected to the microcontroller to use in the emergency situation, since the elderly can press the button to send an alert to the care taker and a sound alarm is issued so that nearby people can help the elderly person. In addition, the watch can be turned off and on through a switch.

All these data will be sent via the Internet to a mobile application so that the user care taker can see all the data.

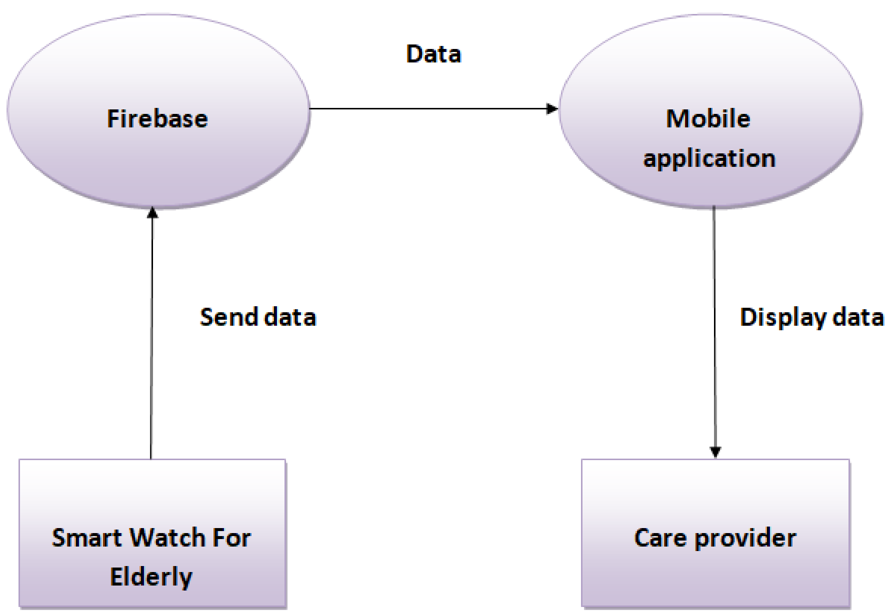

Figure 1.1 : Context Diagram of smart watch for elderly

1.6 Overview of the rest of the report

The rest of the report is organized as follows: Chapter 2 presents a theoretical background of the project, a description of the hardware and software components is discussed in addition to the system specification and design constraints. Chapter 3 detailed design, block diagrams, flowcharts. Chapter 4 contains an introduction to the software and the platform used for project programming. Chapter 5 contains the expected results and validation for the project. The last chapter contains a conclusion about our work, then we have a summary, references.

Chapter 2 : Background

2.1 Overview

This chapter introduces a theoretical background of the system, some descriptions of the hardware and software components used in the system. Specifications of the design system and constraints are discussed too.

2.2 Theoretical background

The main idea of the project is to design a watch for the elderly using ESP32 . Based on the Arduino programming language and c/c++ environment.

To achieve the goals of our project we need several components. At the beginning Sensors are used to measure signs in the body of an elderly person, and then sent to ESP32, and then ESP32 will send it to the application that will display those signs. To achieve the measurement of body temperature, we need an infrared sensor . The MLX90614 is a Contactless Infrared (IR) Digital Temperature Sensor that can be used to measure the temperature of a particular object ranging from -20°C…120°C . The sensor uses IR rays to measure the temperature of the object without any physical contact . It has a range of around 1cm.[1]

The MLX90614 provides two methods of output: PWM and SMBus (i.e. TWI, I2C). Both these outputs are easy and simple to use with many micro controllers. The 10-bit PWM output provides a resolution of 0.14°C, while the I2C interface has a resolution of 0.02°C. MLX90614 offers a standard accuracy of ±0.5˚C around room temperatures. A special version for medical applications exists offering an accuracy of ±0.2˚C in a limited temperature range around the human body temperature. The normal temperature range varies according to the area of the body in which it is measured, where the mean forehead, wrist, and tympanic measurements were 35.6±1.2 °C, 35.7±0.8 °C, and 36.6±0.6 °C respectively. [2][3]

It also uses an optical sensor MAX30100 to measure the heart rate and oxygen levels in the blood based on what is known as photo plethysmography. This technology is based on a very simple fact: blood is red because it reflects red and absorbs green. The Smart Watch uses red LED lights paired with photosensitive photodiodes to detect the amount of blood flowing through the wrist at any given moment. When the heart beats, blood flows to the wrist, and the red color is more absorbed. While less between each heartbeat and the other. The sensor can calculate the number of times your heartbeat per minute by flashing LED lights hundreds of times every second, thus calculating your heart rate. The optical heart rate sensor supports a range of 30 to 210 beats per minute. In addition, this sensor is designed to measure the percentage of oxygen in the red blood cells that carry oxygen from your lungs to the rest of your body using red LED lights that are reflected on the wrist.[4].

A normal heart rate for seniors is between 60 and 100 beats per minute. According to the American Heart Association, the estimated target heart rate numbers for adults ages 45-70 are:

45 years: 88 to 149 beats per minute

50 years: 85 to 145 beats per minute

55 years: 83 to 140 beats per minute

60 years: 80 to 136 beats per minute

65 years: 78 to 132 beats per minute

70 years: 75 to 128 beats per minute.[5]

A normal oxygen saturation level is 97-100% but older adults typically have lower levels than younger adults, so a normal oxygen level for elderly adults may be about 95%, which is acceptable.[6]

NEO-6M GPS Module that can track up to satellites and identifies locations anywhere in the world. It may serve as a great launch pad for anyone looking to get into the world of GPS. They are low power (suitable for battery powered devices), inexpensive, easy to interface with. GPS receivers actually work by figuring out how far they are from a number of satellites. They are pre-programmed to know where the GPS satellites are at any given time.The satellites transmit information about their position and the current time in the form of radio signals towards the Earth. These signals identify the satellites and tell the receiver where they are located. The receiver then calculates how far away each satellite is by figuring out how long it took for the signals to arrive. Once it has information on how far away at least three satellites are and where they are in space, it can pinpoint your location on Earth. This process is known as Trilateration.

NEO-6M GPS Module can track up to 22 satellites on 50 channels and achieves the industry's highest level of sensitivity i.e. -161 dB tracking, while consuming only 45mA supply current. Unlike other GPS modules, it can do up to 5 location updates a second with 2.5m Horizontal position accuracy. The u-blox 6 positioning engine also boasts a Time-To-First-Fix (TTFF) of under 1 second.[7]

2.3 Literature review

In this section we will talk about some projects similar to the idea of our project:

- **Child monitoring system:**

  A system that works to monitor children through the design of bracelets that the child puts on his hand and provides the system (location, acoustic sensors) and all this information is stored and sent to the application on the mobile phone of parents , where the application is also designed to provide parents with a login system , and the application is the link between school and parents.[8]

- **Remote health monitoring of elderly through wearable sensors :**

  A system which enables continuous monitoring for elderly people's health in real-time to prevent chronic diseases, thus preventing hospitalization that burden the healthcare systems and costs. This project presents a framework which utilizes a smart-phone app and Wearable Sensors for Smart Healthcare Monitoring System (SW-SHMS) for elderly people. The system accumulates patient's physiological data via wearable sensors (i.e., pulse, oxygen etc.) of elderly people in real-time. The data is transmitted to a data repository, where it will be stored and checked for any abnormality. Thus, any detection of disorder in a patient's vitals will be reported to the patient's doctors and/or hospital in real-time to act on quickly and prevent a number of problems, such as a sudden heart attack. Technologies are capable of providing patients physiological data from their locations to physicians anywhere in real-time, therefore, enabling remote remediation. For example, data such as blood oxygen saturation, heart-rate, and blood pressure can be measured via wearable devices and transmitted from patients locations to their doctors in real-time. This enables doctors and patients to communicate remotely. [9]

In this system sensors are worn on different parts of the body as shown in figure 2.1 , but in our system sensors are placed in a watch shape around the wrist which make it easy to put on and take off unlike the other system.

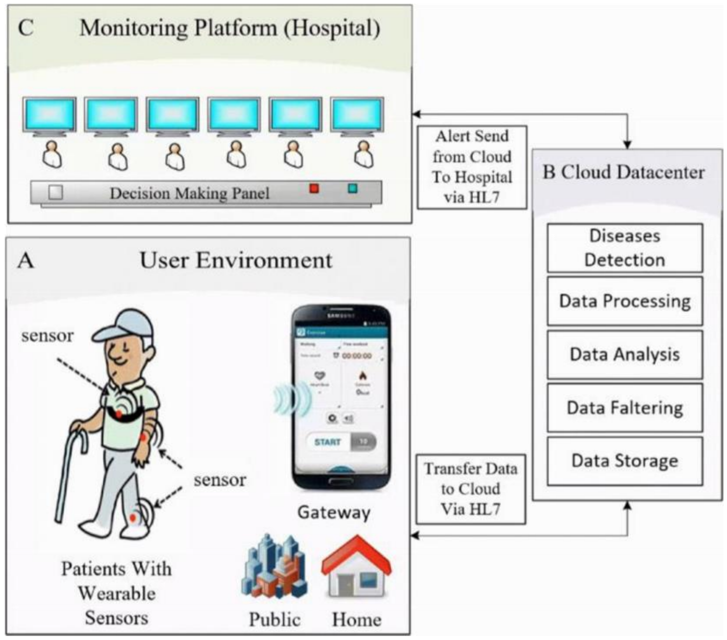

Figure 2.1 : Remote health monitoring of elderly through wearable sensors[9]

2.4 Technologies to be used in the project

This subsection illustrates the main technologies to be used in this project and what tasks they do.

- **Arduino programming language**

  Is an open-source computer programming language based on the wiring development platform, the Arduino IDE is based upon the Processing IDE, and it is available in several operating systems, which give us a programing editor with integrated libraries support and a way to easily compile and load our Arduino programs to a board connected to the computer. This language is a framework built on top of C++, the main difference from c/c++ is that you wrap all your code into two main functions, any Arduino program must provide at least two main functions . [10]

- **Google Firebase:**

Firebase is a platform developed by Google for creating mobile and web applications , firebase's first product was the Firebase Realtime Database, an API that synchronizes application data across iOS, Android, and Web devices, and stores it on Firebase's cloud. The product assists software developers in building real-time, collaborative applications.

The Firebase SDK supports programming in C++, Java, JavaScript, JavaScript/Node.js, Objective-C, and Swift. Angular, Backbone, Ember and React are supported through bindings to the database. Google added a number of helper libraries: FirebaseUI, Geofire, Firebase Queue, FirebaseJobDispatcher , Firebase also supports importing large JSON data sets and integration with Elastic Search. [11]

Firebase Realtime Database Security Rules determine who has read and write access to your database, how your data is structured, and what indexes exist. These rules live on the Firebase servers and are enforced automatically at all times. Every read and write request will only be completed if your rules allow it. By default, your rules do not allow anyone access to your database. This is to protect your database from abuse until you have time to customize your rules or set up authentication. The Firebase Realtime Database provides a full set of tools for managing the security of your app. These tools make it easy to authenticate your users, enforce user permissions, and validate inputs.[12]

- **MIT App Inventor**

MIT App Inventor is an intuitive, visual programming environment that allows everyone even children to build fully functional apps for smartphones and tablets. Those new to MIT App Inventor can have a simple first app up and running in less than 30 minutes. And what's more, our blocks-based tool facilitates the creation of complex, high-impact apps in significantly less time than traditional programming environments. The MIT App Inventor project seeks to democratize software development by empowering all people, especially young people, to move from technology consumption to technology creation. A small team of CSAIL staff and students, led by Professor Hal Abelson, forms the nucleus of an international movement of inventors. In addition to leading educational outreach around MIT App Inventor and conducting research on its impacts, this core team maintains the free online app development environment that serves more than 6 million registered users. Blocks-based coding programs inspire intellectual and creative empowerment. [13]

2.5 Hardware System Components:

This section describes all hardware used in my project , it presents figure for each one with short description about its work principle and why it is used in the system :

1. **NodeMCU ESP32**

The ESP32 is a dual-core 160MHz to 240MHz CPU, whereas the ESP8266 is a single-core processor that runs at 80MHz. These modules come with GPIOs that support various protocols like SPI, I2C, UART, ADC, DAC, and PWM. The best part is that these boards come with wireless networking included, which makes them apart from other microcontrollers like the arduino. This means that you can easily control and monitor devices remotely via Wi-Fi or Bluetooth for a very low price.[14]

We will program this controller to deal with the data coming from the connected sensors and send it to the application for display to the care provider.

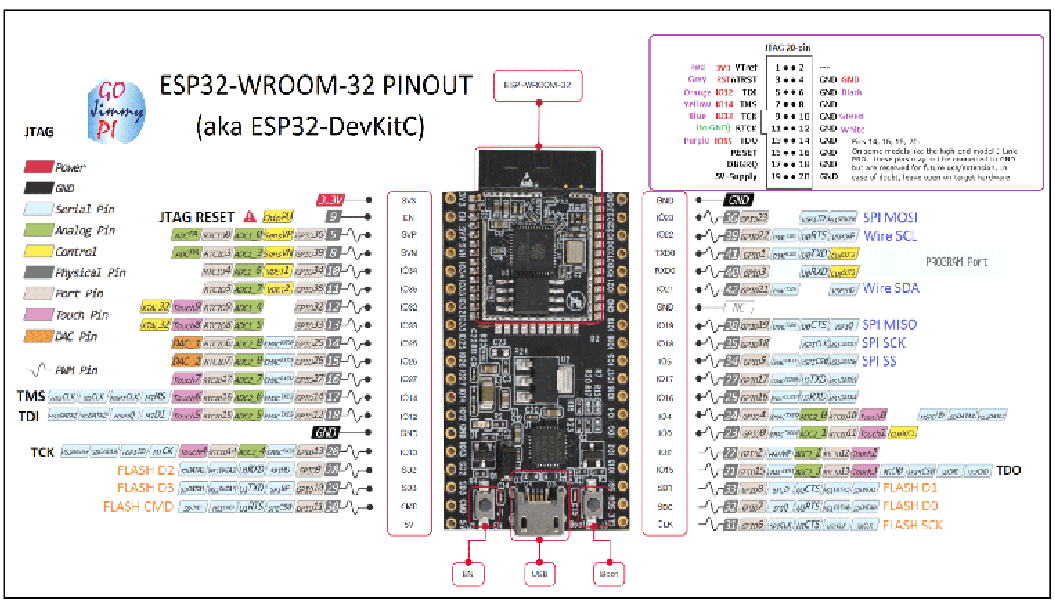

Figure 2.2 : Functions of ESP32 pins[15]

2. NEO 6M GPS Module

This is a complete GPS module that is based on the NEO 6M GPS. This unit uses the latest technology to give the best possible positioning information and includes a larger built-in 25 x 25mm active GPS antenna with a UART TTL socket. A battery is also included so that you can obtain a GPS lock faster. This is an updated GPS module that can be used with Ardupilot mega v2. This GPS module gives the best possible position information ,allowing for better performance with your Ardupilot or other Multirotor control platform.

The GPS module has serial TTL output, it has four pins: TX, RX, VCC, and GND. You can download the u-centre software for configuring the GPS and changing the settings and much more. It is really good software.[16]

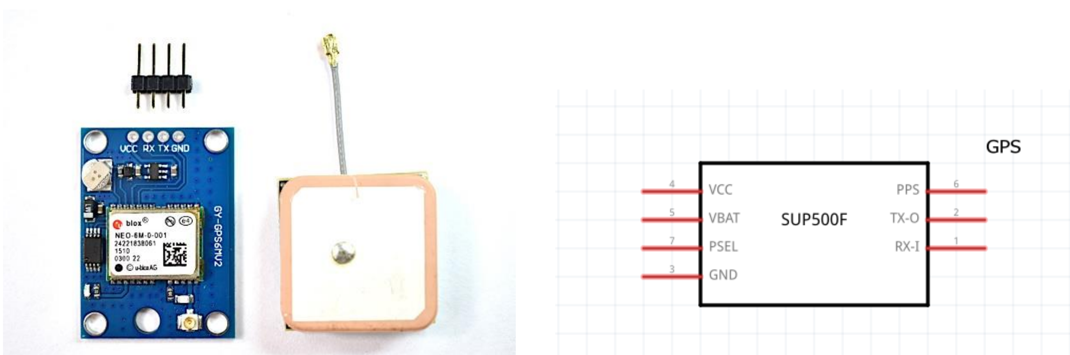

Figure 2.3 : NEO 6M GPS Module[17]

3. Temperature Sensor (MLX90614)

Temperature Sensor Specifications Operating Voltage: 3.6V to 5V (available in 3V and 5V version) Supply Current: 1.5mA Object Temperature Range: -70° C to 382.2°C Ambient Temperature Range: -40° C to 125°C Accuracy: 0.02°C Field of View: 80° Distance between object and sensor It has a range of around 1cm. [18]

Table 2.1 : Functions of temperature sensor pins[18]

Pin No.	Pin Name	Description
1	Vdd (Power supply)	Vdd can be used to power the sensor, typically using 5V
2	Ground	The metal can also act as ground
3	SDA – Serial Data	Serial data pin used for I2C Communication
4	SCL – Serial Clock	Serial Clock Pin used for I2C Communication

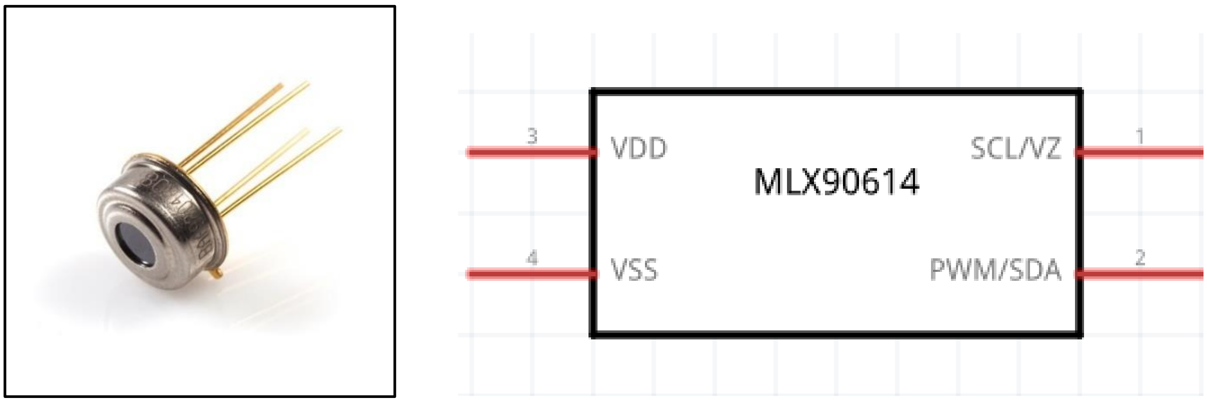

Figure 2.4 : Temperature Sensor MLX90614 [19]

4. Heart-Rate and Pulse Oximeter Sensor (MAX30100)

The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.[20]

Specification:

- Operating Voltage - 1.8V to 3.3V
- Weight (gm) - 2
- Input Current - 20mA
- Integrated Ambient Light Cancellation
- High Sample Rate Capability

- Fast Data Output Capability
- Dimensions – 8*6*4 cm

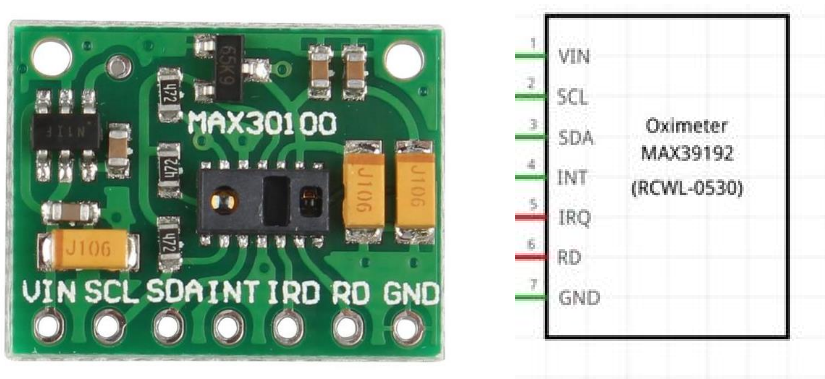

Figure 2.5 : Heart-Rate and Pulse Oximeter Sensor (MAX30100) [21]

5. Power Bank

Power banks are used for providing portable power to charge battery powered items like mobile phones and other similar items that have a USB interface: they can charge via USB. Ranging in size from slim, pocket-sized devices up to larger, higher-capacity Power Banks. The industry standard cell used within the Power Bank commonly output 3.7 Volts. This voltage has to be boosted up to 5 Volts via the Power Bank's internal circuitry as this is the standard voltage of a USB interface. [22]

Figure 2.6 : Power Bank [23]

6. Piezo sounder

piezo buzzer is a type of electronic device that’s used to produce a tone, alarm or sound. It’s lightweight with a simple construction, and it’s typically a low-cost product. Yet at the same time, depending on the piezo ceramic buzzer specifications, it’s also reliable and can be constructed in a wide range of sizes that work across varying frequencies to produce different sound outputs.[24]

Buzzer Features and Specifications :

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

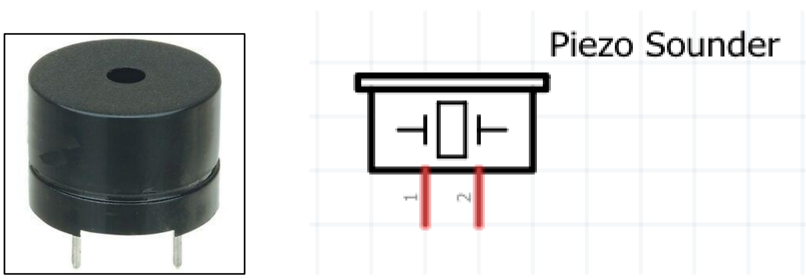

Figure 2.7 : Piezo Sounder [25]

7. Button :

Button switch is a type which consists of a simple electric mechanism or air switch mechanism to turn something on or off. [25]

Table 2.2 : Push Button Specification

Usage	On/Of
Material/Body	Plastic
Current Rating	5 A
Voltage	24 V
Operating Frequency	50 Hz

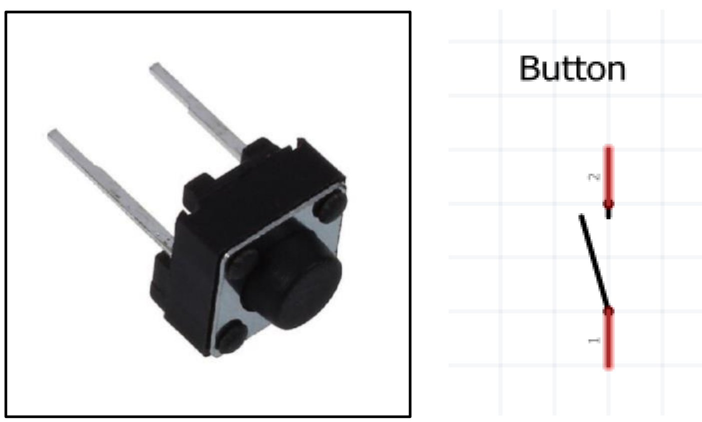

Figure 2.8 : Push Button[27]

2.6 Design alternatives.

This subsection illustrates the alternative for NodeMCU ESP32 and explains why we don't use it. Wemos microcontroller was selected as the microcontroller used in the project in the introduction . But in the introduction discussion it was objected by the Judgement committee and requested to change it to another microcontroller because of its size .

So, Wemos was replaced with Arduino Nano, which is characterized by its small and appropriate size for the project , but it does not support the Internet, so an esp12f was also used to transfer the data to the database using the Internet .

But after working on it for almost a period of two and a half months, we faced many problems in sending the data to the database using the esp21f and In addition to that, the size is not appropriate for the two pieces together to be placed as a watch around the wrist of an elderly person . So the Nano Arduino and esp21f were replaced with a esp32 , as it supports the Internet and is more appropriate to use for the project instead of using two pieces to perform the task of one piece.

Table 2.3 shows the main difference in specifications for ESP32 and Arduino Nano .

Table 2.3 : ESP32 VS. Arduino Nano

FEATURE	ESP32 NodeMCU	Arduino nano
Price	$11	$29.50
Processor	ESP32	Atmega328P
Clock speed	80 MHz / 160 MHz	16 MHz
Digital I/O Pins	36	14
Analog Input Pins	15	6
WIFI	yes	no
Ethernet MAC Interface	Yes	no
Bluetooth	yes	no

All ESP8266 variants have an ESP8266EX core processor and a Tensilica L106 32- bit microcontroller unit. This is a low cost, high performance, low power consumption, easy to program, wireless SoC(System-On-Chip). Table 2.4 shows the main difference in specifications for ESP8266 and ESP32.[27]

Table 2.4 : ESP2866 VS. ESP32

	ESP8266	**ESP32**
MCU	Xtensa Single-core 32-bit L106	Xtensa Dual-Core 32-bit LX6 with 600 DMIPS
Typical Frequency	80 MHz	160 MHz
802.11 b/g/n Wi-Fi	HT20	HT40
Hardware /Software PWM	None / 8 channels	None / 16 channels
SPI/I2C/I2S/UART	2/1/2/2	4/2/2/2

2.4 Design constraints.

1. Permanent need for the internet.
2. GPS works best outdoors

Chapter 3 : Design

3.1 Overview

The following section has a description of the system, detailed design, and necessary information about the design.

3.2 Detailed description of the system

The system was designed to monitor the elderly person remotely . A Heart-Rate and Pulse Oximeter sensor has been used to measure elderly heart-rate and blood oxygen level , and ESP32 microcontroller will receive the data, then transfer to the DB then send it to the care taker through a mobile app , Its also the same way for the temperature sensor , so the care taker will be able to monitor the elderly heart rate, blood oxygen level and temperature .

GPS tracks the current location for the elderly person, and ESP32 microcontroller will receive the data from GPS,then send the it to DB then to the care taker through a mobile app.

Emergency button is used by the elderly person to report that there is an emergency situation, and ESP32 microcontroller will receive that, the piezo sounder will turn on, and an alert will be send to the care provider through the mobile application. In addition, In emergency cases when the sensor readings are not within the accepted range, also an alert will be sent to the care taker through the mobile application.

In addition, the watch can be turned on and off through a switch the elderly can use it .

3.3 System diagrams

In this subsection, three diagrams are represented for the understanding of the project concepts and design.

3.3.1 System block diagram

Figure 3.1 is the general block diagram of the project. As illustrated below, after the smart watch turned on through the on/off switch the sensors when the system is activated will collect the necessary data and send it to the ESP32. After the ESP32 gets it, it will examine this data , then send it to the firebase to send it to the care provider . But if the data obtained from the sensors is not within the expected range of the elderly, in addition to send it to the care provider an alert will send also.

The location of the elderly will be monitored and sent to the care provider . And In the emergency cases, such as the elderly getting very tired and need an emergency help, he can inform the care provider and the people around him by pressing the emergency button, so an alert is sent to the care taker and sound alert in the system .

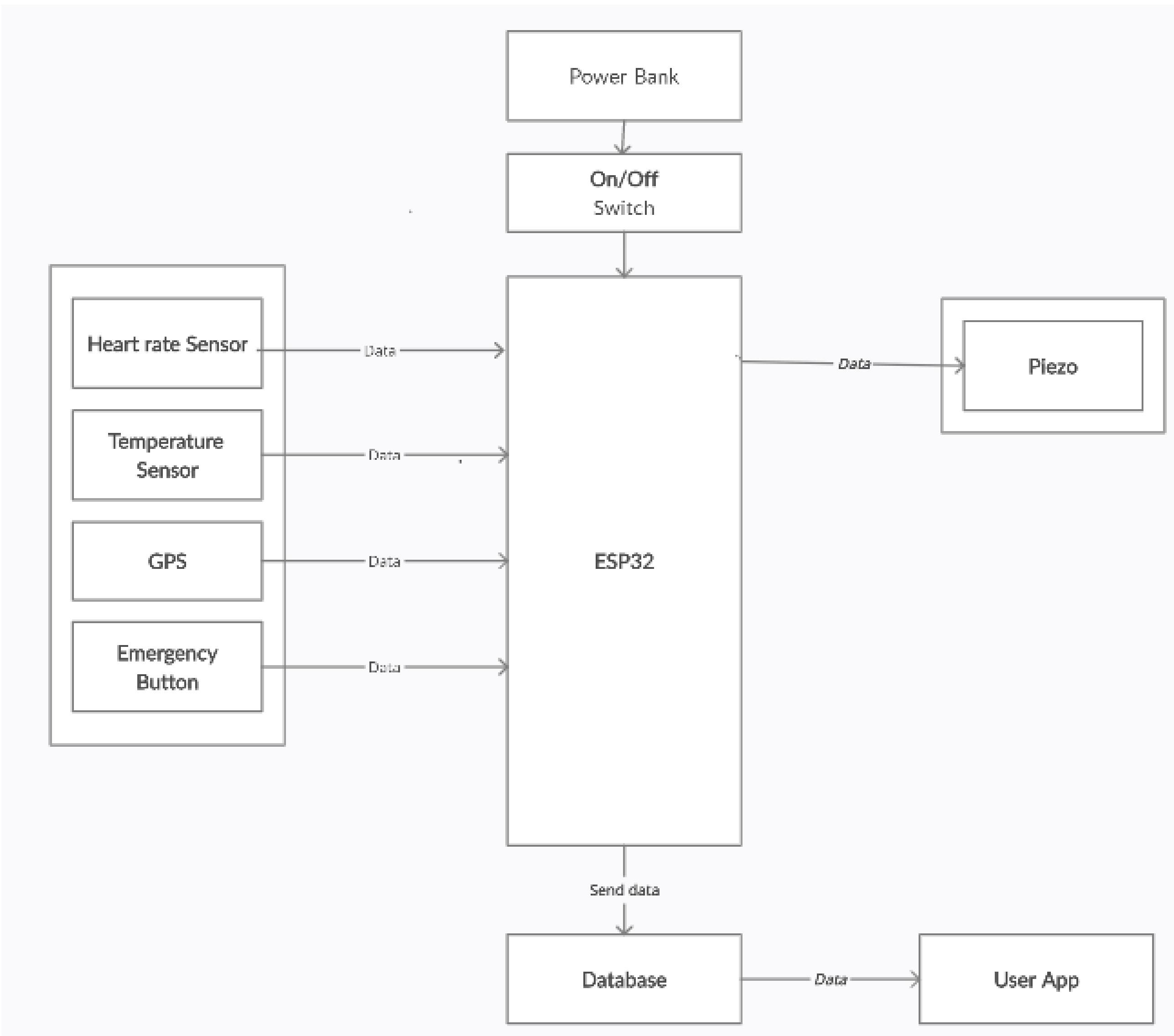

Figure 3.1 : General block diagram of smart water watch

3.3.2 Schematic diagram

Figure 3.2 describes the system elements and how they are connected.

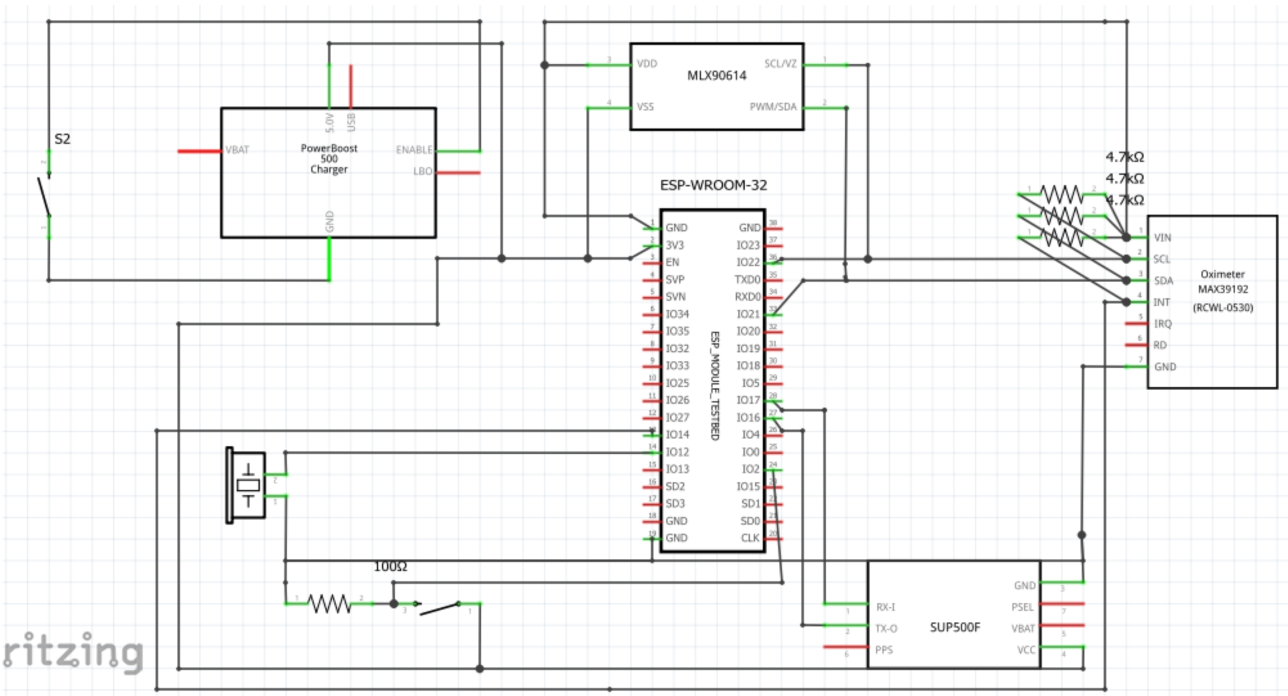

Figure 3.2: Schematic diagram of smart water watch

1. **ESP32:** The main component in the system, which will be linked to the other components. Represent the inlet and outlet of the signals and information. It will also send the data to the firebase to display on the care provider mobile application.
2. **On/Off Switch** : Its used to turn on or off the smart watch.
3. power bank : It is used to provide the system with the energy needed to make it work with 5 volt.
4. **Temperature Sensor** : It has been used to measure elderly temperature, and ESP32 will receive the temperature sensor reading, which is an analogy data format , then sent it to the firebase to display it to care provider mobile Application.

5. **Heart-Rate and Pulse Oximeter Sensor** : It been used to measure elderly heart rate and blood oxygen level. ESP32 will receive the sensor analog data readings, then sent it to google firebase to display it to care provider mobile Application.
6. **GPS**: Its used to tracks the current location for the elderly person , and ESP32 will receive the data from GPS and sent it to google firebase to display it to care provider mobile Application.
7. **Emergency Button** : Its is used by the elderly person to report that there is an emergency situation. ESP32 will receive that and the piezo sounder will turn on, then an alert will be sent to the mobile Application.

3.4 Flow charts

This diagram shows the flowchart of the system:

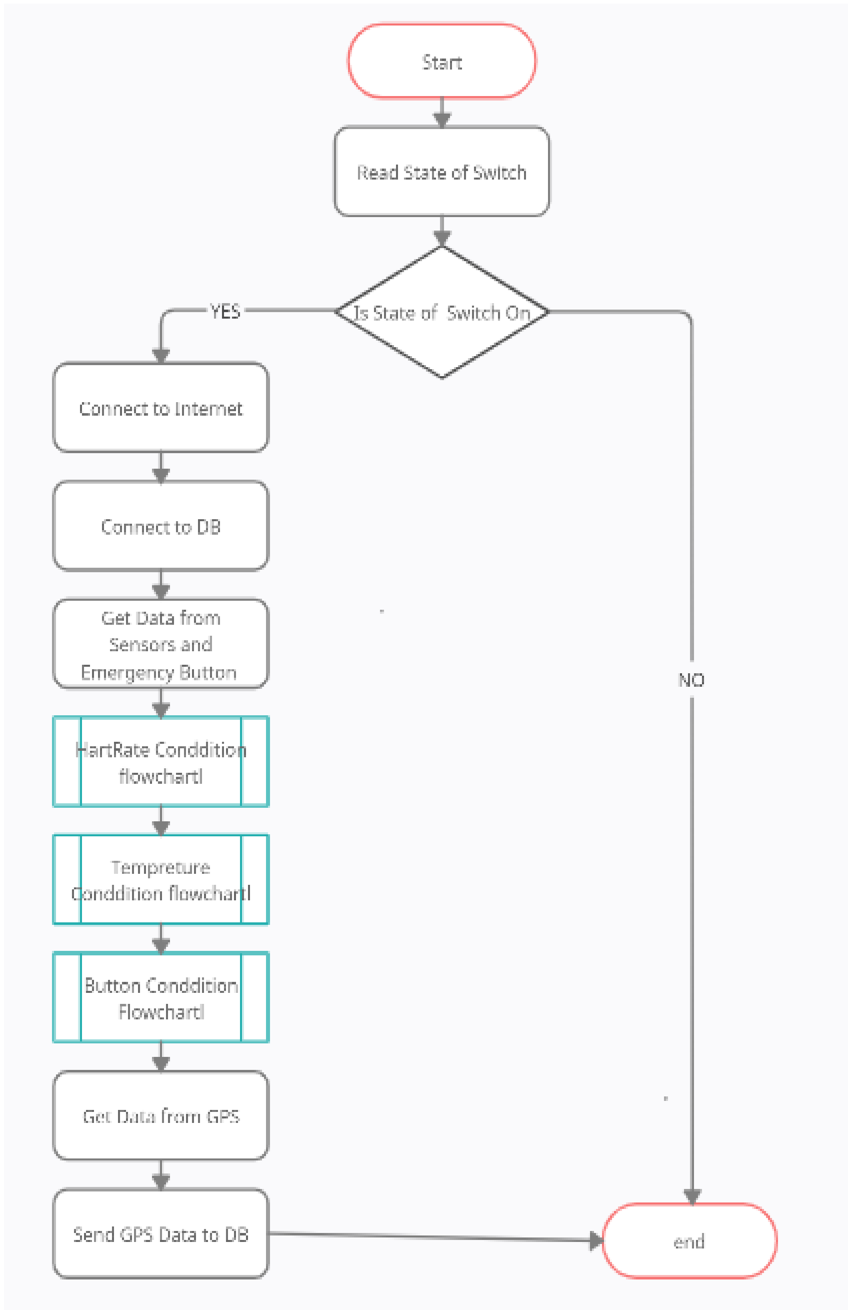

Figure 3.3: Flowchart of smart watch system

This diagram shows the flowchart of the heart rate condition:

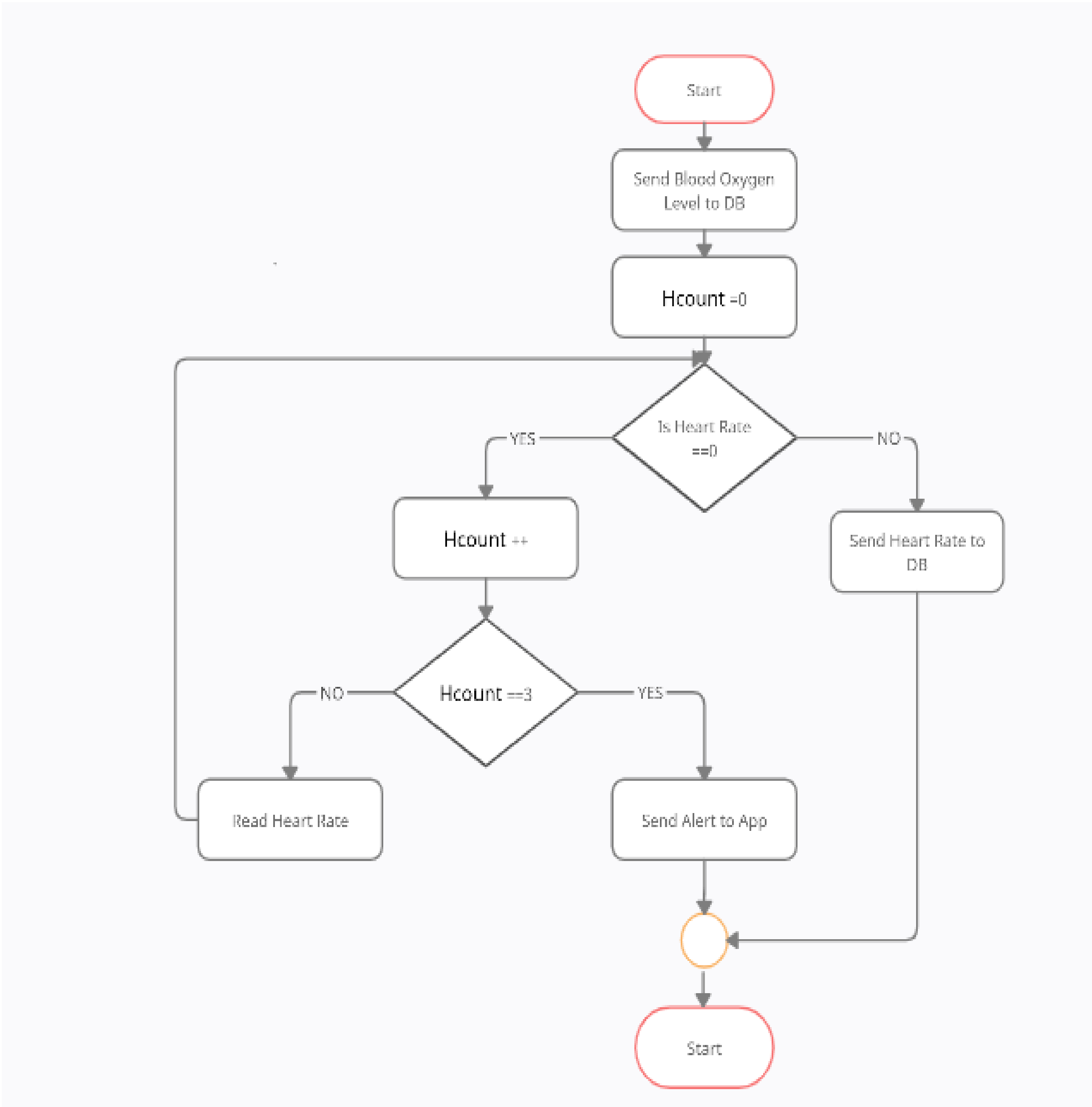

Figure 3.4: Flowchart of heart rate condition

This diagram shows the flowchart of the temperature condition:

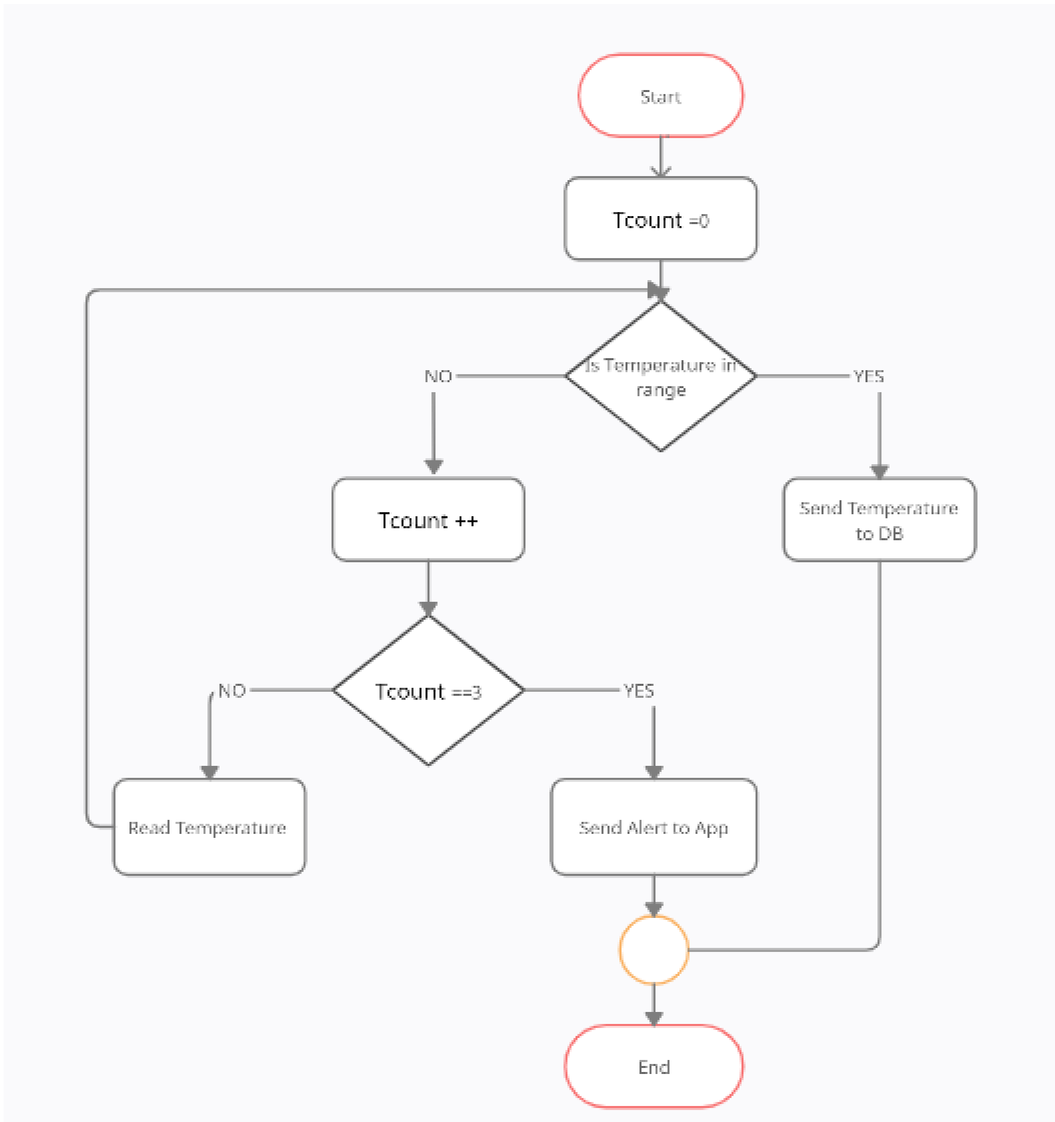

Figure 3.5: Flowchart of temperature condition

This diagram shows the flowchart of the emergency button condition:

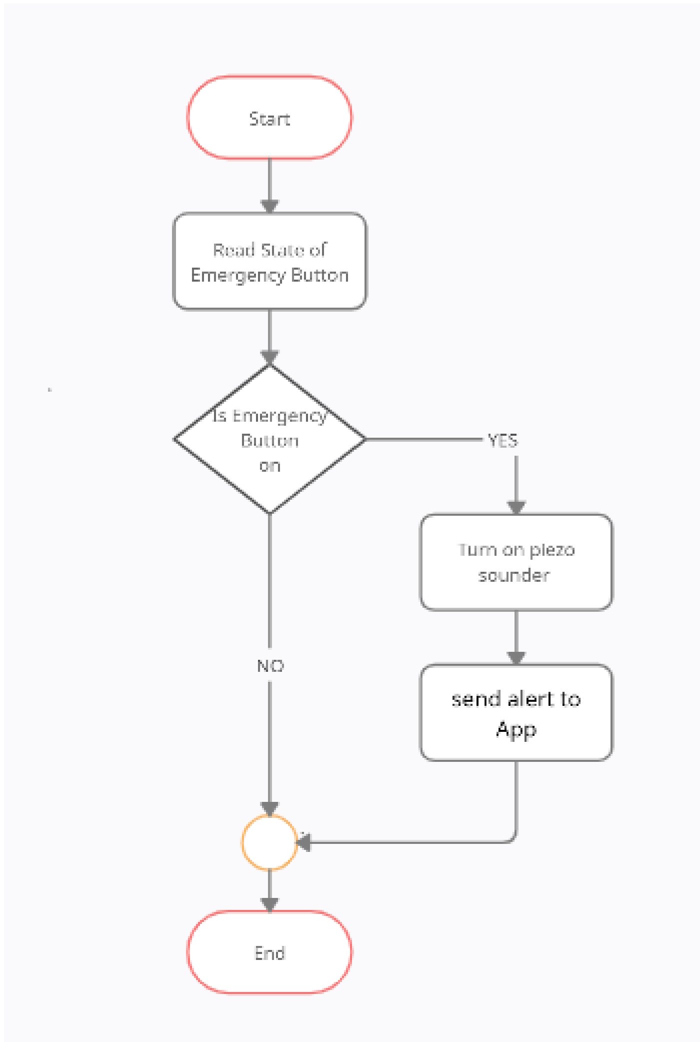

Figure 3.6: Flowchart of emergency button condition

3.5 Pseudocode of the system

The following subsections have a description of the pseudocode used in the system:

```
get data from switch
while switch state is on
    connect to internet
    connect to database
    get data from sensors and emergency button
    send blood oxygen level to DB to display in the Application
    Hcount = 0
    if heart rate == 0
        Hcount ++
        if count == 3
            send alert to Application
        else
        get data from heart rate sensor
    else
        send heart rate to DB to display in the Application
    Tcount = 0
    if temperature in range
        send temperature to DB to display in the Application
      else
      Tcount ++
      if count == 3
          send alert to App
      if emergency button in on
         turn on piezo sounder
         send alert to App
    get data from GPS
    send GPS data to DB
```

3.6 Detailed design

- **Temperature Sensor (mlx90614) with ESP32**

  Figure 3.7 shows how the temperature sensor connected to the ESP32. This sensor was used to measure elderly temperature , and ESP32 will receive the temperature sensor readings .

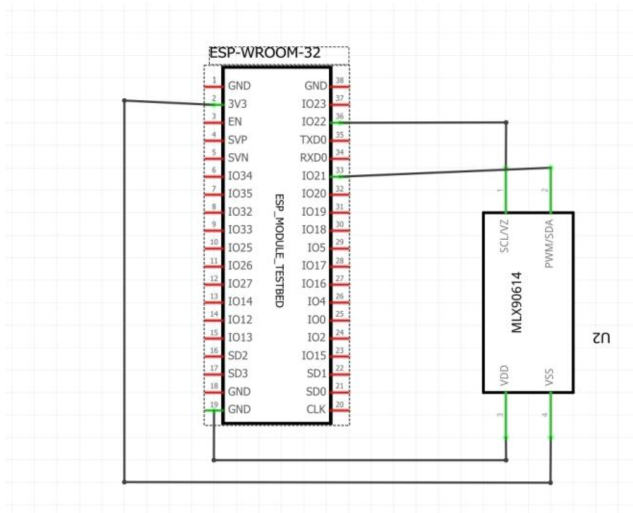

Figure 3.7: Temperature Sensor (mlx90614) with ESP32

- **NEO 6M GPS Module with ESP32**

  Figure 3.8 shows how the GPS connected to the ESP32. GPS tracks the current location for the elderly person, andESP32 will receive the data from GPS.

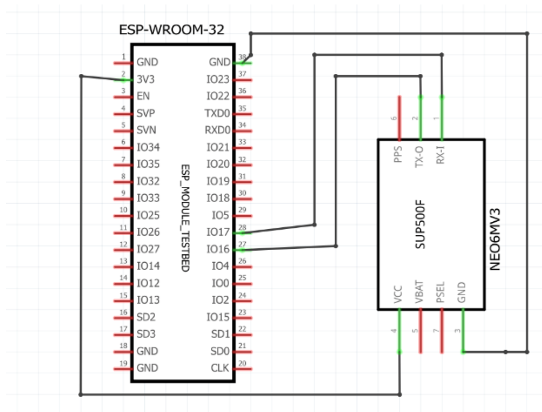

Figure 3.8: NEO 6M GPS Module with ESP32

- **Heart-Rate and Pulse Oximeter Sensor (MAX30100) with ESP32**

Figure 3.9 shows how the heart rate and pulse oximeter sensor connected to the ESP32 and a 4.7 KOhms was used .This sensor has been used to measure elderly heart-rate and blood oxygen level. ESP32 will receive the heart rate and pulse oximeter sensor readings.

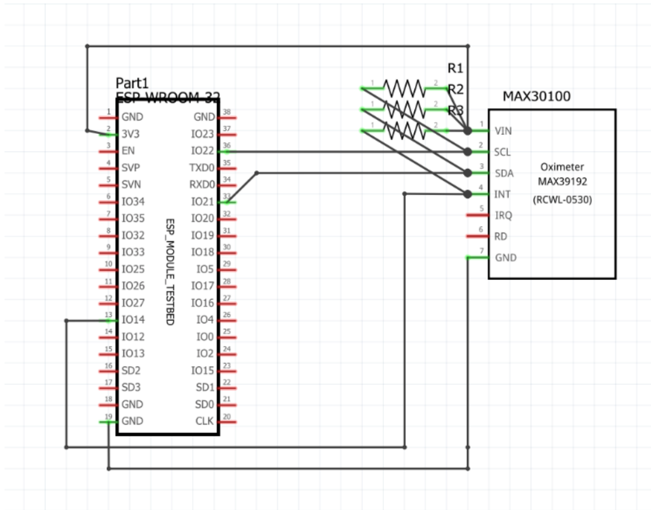

Figure3.9: Heart-Rate and Pulse Oximeter Sensor (MAX30100)with ESP32

- **Piezo sounder with ESP32**

Figure 3.10 shows how the Piezo sounder connected to the ESP32 . Piezo sounder is used to alert people who is near elderly person when he is in danger.

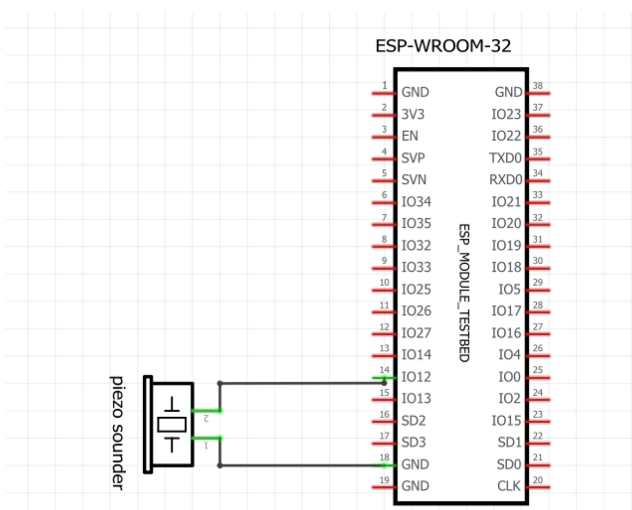

Figure 3.10: Piezo sounder with ESP32

- **Emergency Button with ESP32**

Figure 3.11shows how the emergency button connected to the ESP32 . Emergency button is used by the elderly person to report that there is an emergency situation. ESP32 will receive that.

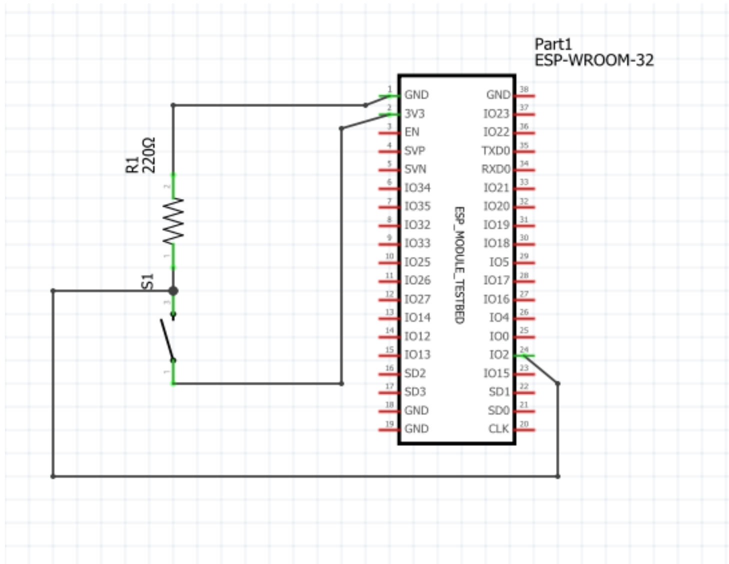

Figure 3.11 : Emergency Button with ESP32

Chapter Four : System Implementation, System Testing, and Discussion

4.1 Overview

This chapter introduces a description of the implementation, implementation issues, implementation challenges, description of the method used to validate the system, validation results include an analysis and discussion about the result and recommendations based on the result.

4.2 Description of the implementation

Was purchased the necessary components for the project, and the plastic container that will be placed around the wrist using a wristband.

- Assembled ESP32 with the GPS and piezo sounder in the container.
- The wires needed to connect the ESP32 to the rest of the sensors were taken out through holes in the side of the container.
- Heart-Rate and Pulse Oximeter Sensor was connected to the ESP32, and it was placed under the container so that it was touching the wrist.
- Temperature Sensor was connected to the ESP32 , and it was placed under the container, inside a certain hole that accommodates it, so that it is close to the wrist, not touching it.
- The button was connected to the ESP32 and placed on the side of the container.
- The system was supplied with power through connect a power bank, where the power bank was connected with a switch then with ESP32, and the power bank was placed above the container.

Figure 4.1 shows an illustration image of how the watch is placed around the wrist of the elderly. So that the sensors are close to the skin and on the opposite side of the smart watch the power bank ..

Figure 4.1 : An illustration image of the smart watch

4.3 Validation result

4.3.1 Hardware testing

The hardware components were welded and assembled in a container on a wristband. The figures below show how the smart watch was assembled. Figure 4.2 show the container and the wrist band of the smart watch.

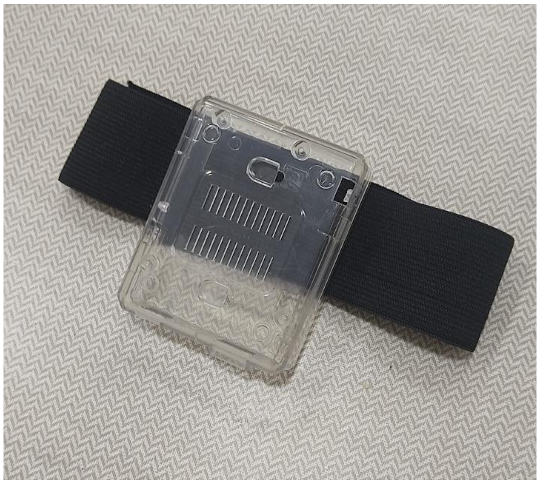

Figure 4.2: Container and the wristband for the smart watch

Figure 4.3 shows the components of the system on the stripboard

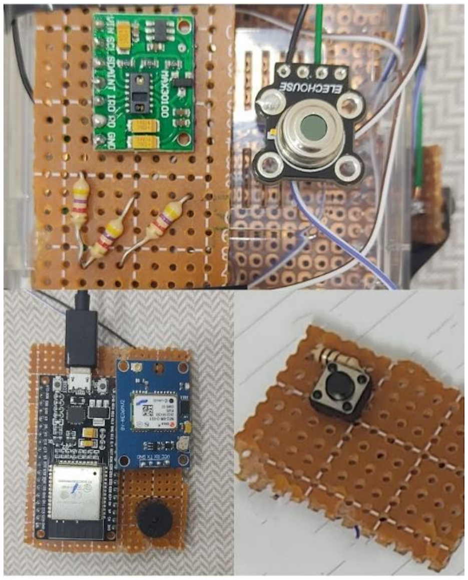

Figure 4.3 : Components of the system on the stripboard

Figure 4.4 shows the container and the wrist band contain the ESP32 , GPS and piezo sounder and the button on the container side. Also all needed wires to connect the ESP32 to the rest of the sensors were taken out through holes in the side of the container. Also the two sensors placed under the container.

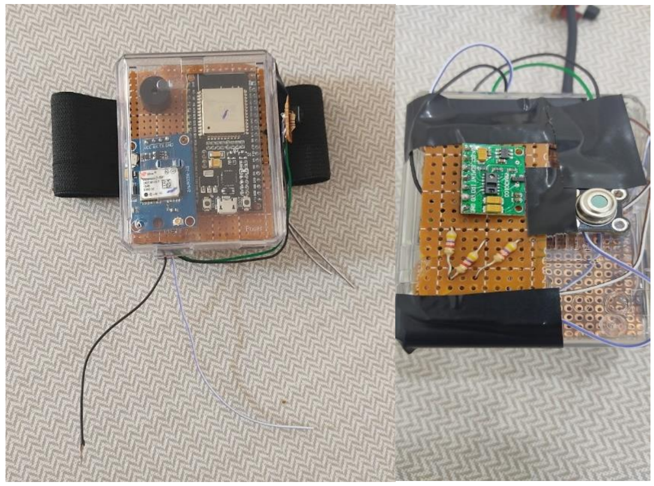

Figure 4.4 : upper and lower side of container

Figure 4.5 shows the final image of the smart watch after connect the power bank on the top of the container and connect a switch between the ESP32 and the power bank to turn the smart watch on and off.

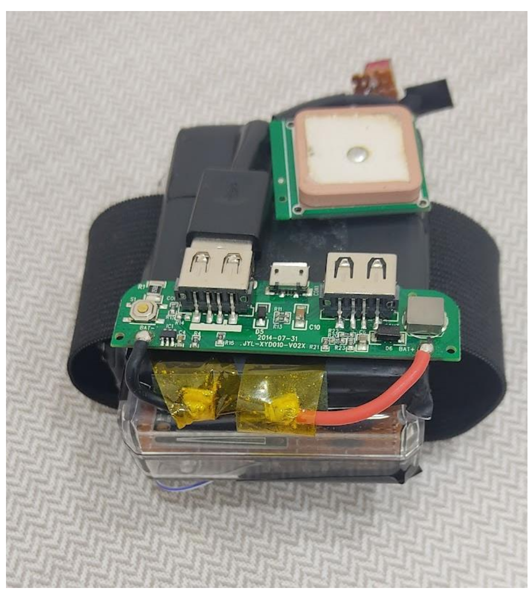

Figure 4.5 : Smart watch with power bank

The data is stored in the Database in the fields shown in the following figures on the Firebase Realtime Database website:

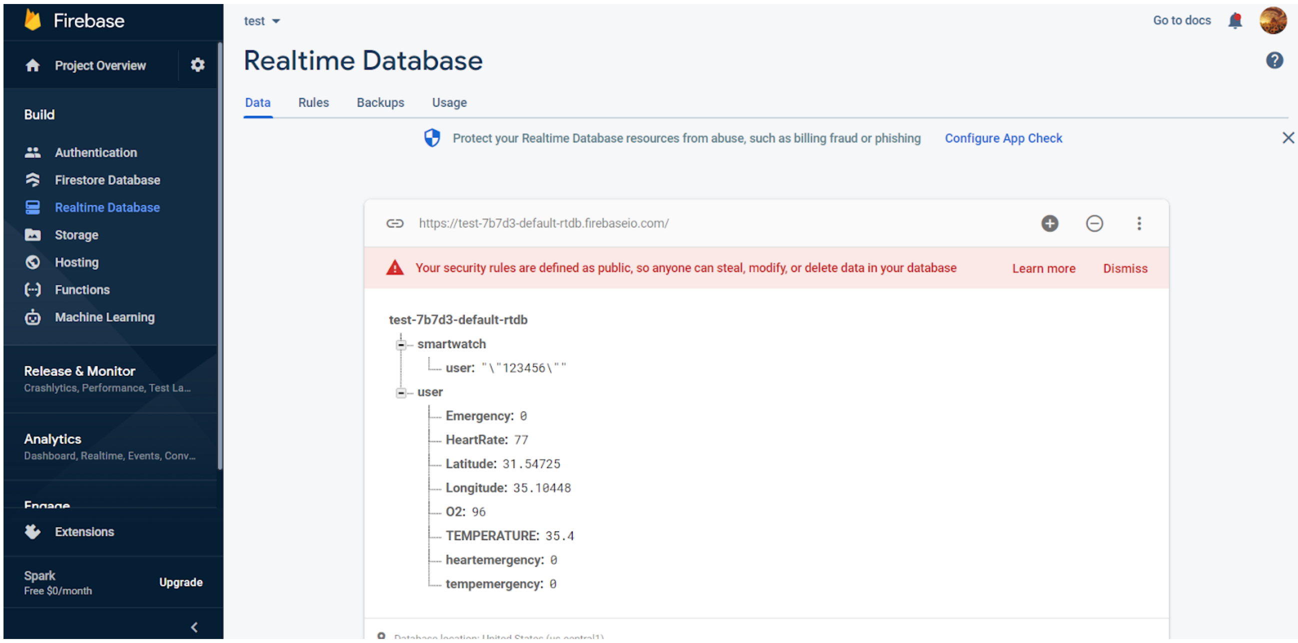

Figure 4.6 : Firebase data

4.3.2 Software testing

The system was fully checked and ensured how it worked and the results of the Testing were successful, and the following tables are a review of some of the tests that we have carried out.

Table 4.1: Unit Test

#	Case	Expected Output	Obtained Output	Pass / Fail
1	Get data from on/off switch	Get data from switch	Get data from switch successfully	pass
1	Connect to the Internet	Connect to the Internet	Connect to the Internet successfully	Pass
2	Get data from sensors and GPS and button	Get data from all sensors GPS and button	Get data successfully	Pass
4	Send data to the DB	Send data to the DB	Send data successfully	Pass
5	Turn the piezo sounder on when the button is pressed	Turn the piezo sounder on when the button is pressed	Turn the piezo sounder successfully	Pass

Table 4.2: Application Log in

#	Case	Expected Output	Obtained Output	Pass / Fail
1	The information entered is correct	successfully	successfully	Pass
2	The information entered is incorrect	Error message	Error message	Pass
3	If care provider left an essential field empty	Error message	Error message	Pass

Table 4.3: Application Sign up

#	Case	Expected Output	Obtained Output	Pass / Fail
1	The information entered is correct	successfully	successfully	Pass
2	The information entered is incorrect	Error message	Error message	Pass
3	User already exist	Error message	Error message	Pass
4	If care provider left an essential field empty	Error message	Error message	Pass

Table 4.4: Application Test

#	Case	Expected Output	Obtained Output	Pass / Fail
1	Get data from DB	Show data in home page	Show data in home page successfully	Pass
2	Show data history when click on the sensor icon	Show data in the top of home page	Show data in the top of home page successfully	Pass
3	Show map when click on the GPS icon	Show map in the top of home page	Displayed map in the top of home page	Pass
4	If the elderly press the emergency button	Show a notifier message appear on the main page, and audio alert.	Show a notifier message appear on the main page, and audio alert successfully	Pass
5	If the data is not in the expected range	Show a notifier message appear on the main page	Show a notifier message appear on the main page successfully	Pass

The app was developed using Mit App Invertor , as it is an excellent tool for implementing mobile applications, whether, for Android or iOS. The firebase real-time databases was connected with the app through entering the Firebaase Token and FireBase URL in the Mit App Inverter. When the care provider opens the application, he logs in, through entering user and its password to be checked by DB, and if he does not have an account, a new account can made from entering user and a new password to be added to the Database. With it, after registration, the care provider will be directs to the home page, which contains the heart rate , blood oxygen level, temperature and location data .

When the care provider click on the heart rate, blood oxygen level, or temperature icon, a screen appears showing the history of the readings from the moment the smart watch was turned on until the current moment, this screen contain a button to return to the main page. Also the location icon, when click on it a screen appears showing the current location for the elderly on a map, this screen contain a button to return to the main page .

when the elderly press the emergency button , a notifier message appear on the main page. In addition, the application issues an audio alert to inform the care provider of an emergency situation. In the emergency situations, when the sensor reading is not in the expected range an audio alert and a notifier message appear on the main page.

This screens shows the log in page

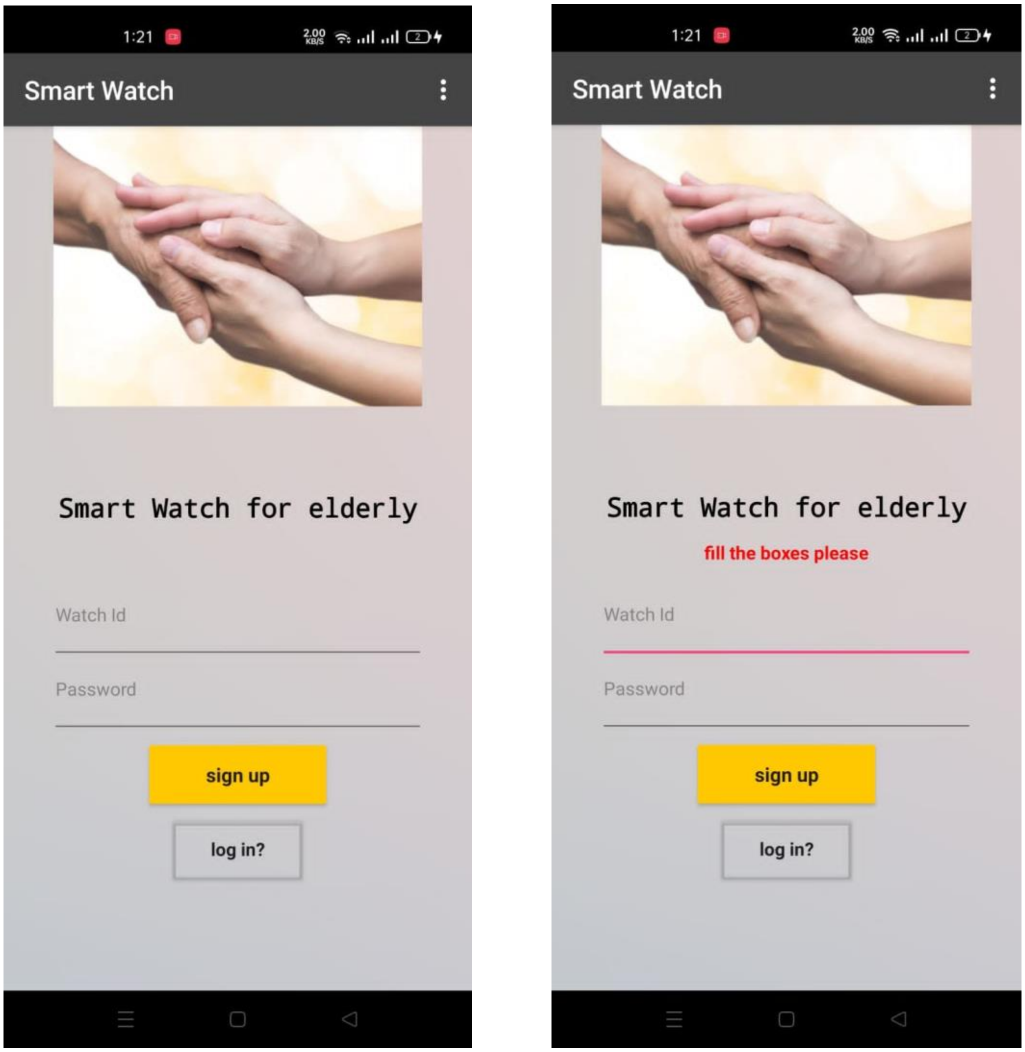

Figure 4.7 : Screenshots show the log in page

This screens shows the main page were the data will display to the care taker

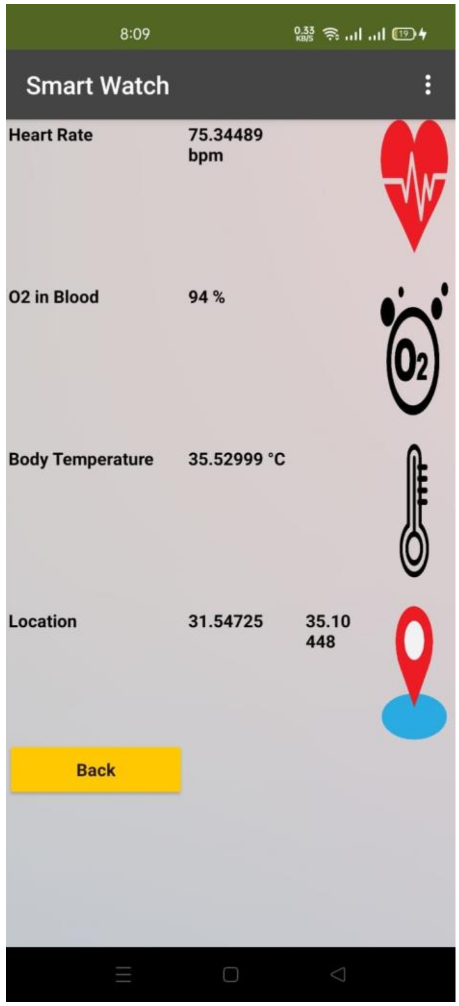

Figure 4.8 : Screenshot show the main page

This screens shows the history of the readings

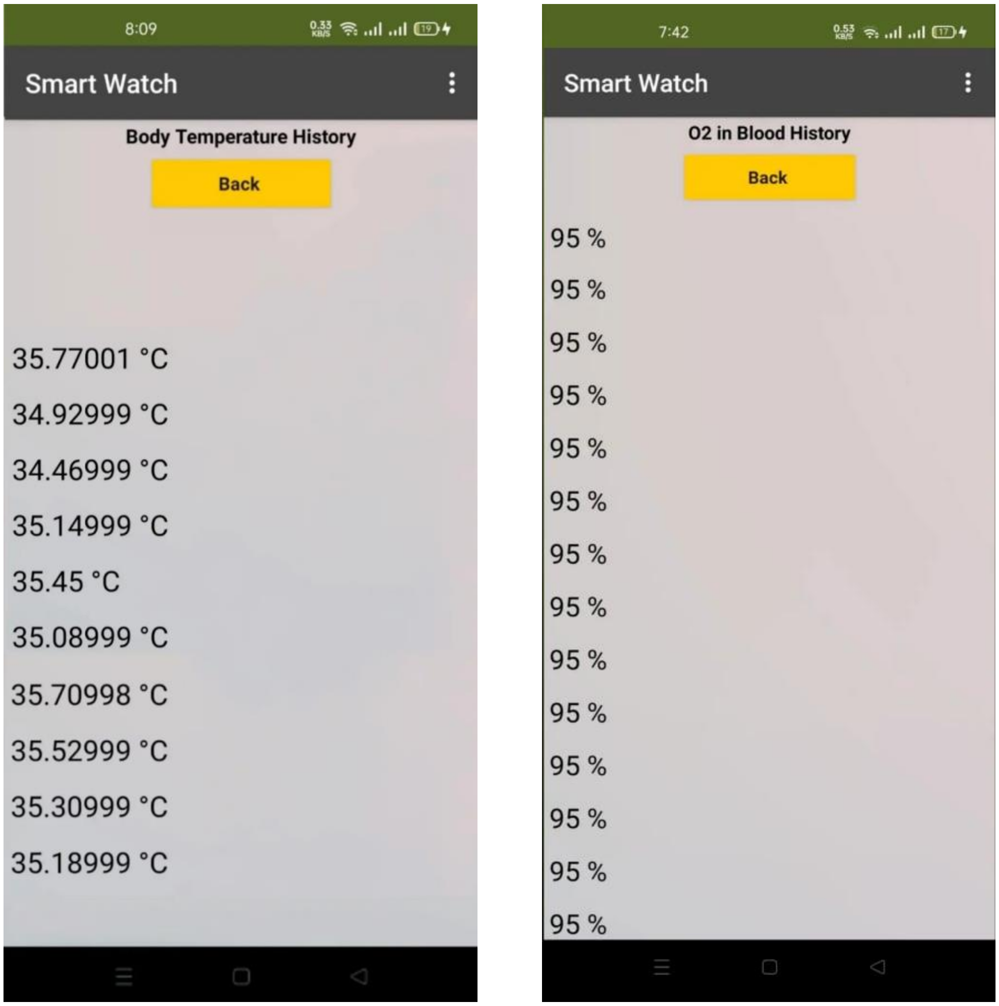

Figure 4.9 : Screenshots show history page for temperature and blood oxygen level

This screens shows the notifier message in the emergency situation

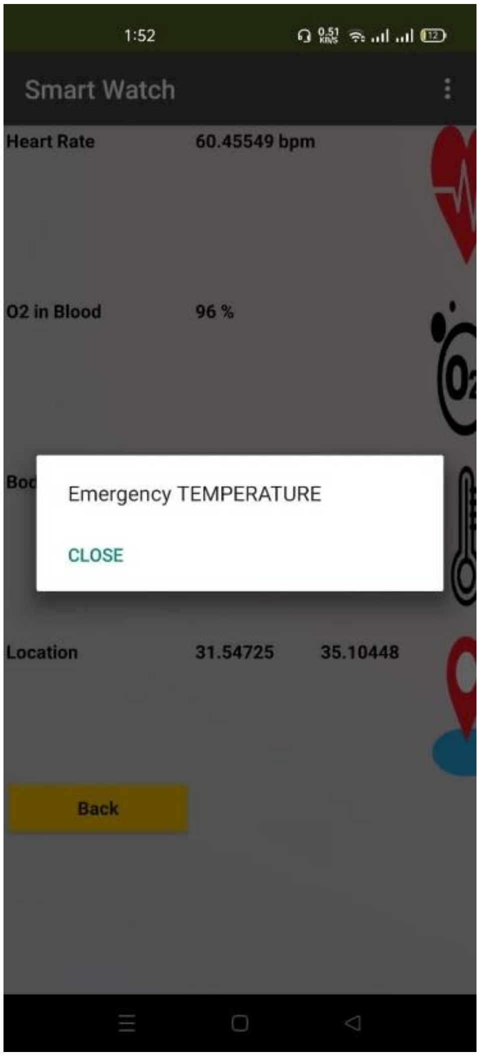

Figure 4.10 : Screenshot show notifier message

This screens shows a map with the current location for the elderly

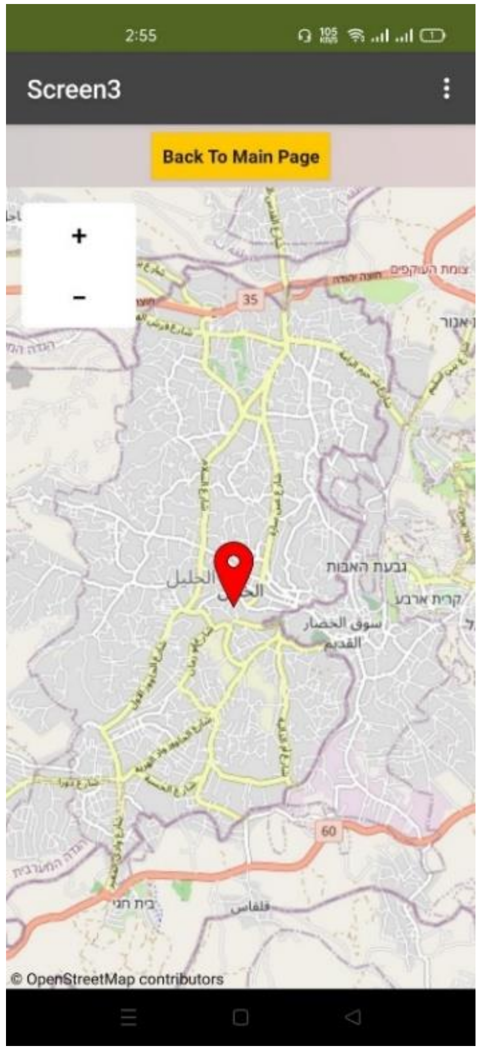

Figure 4.11 : Screenshot show the map

4.4 Implementation issues and challenges

Challenges and issues are normal, especially when one develops their first project, but solving these problems is a success. Below are the main challenges and issues that were raised during the development of the system.

- Some project components are not available at the beginning of the semester, and the procurement process for components took a lot of time.
- Some devices were damaged because of their high sensitivity, so new devices were purchased.
- Heart rate and pulse oximeter sensor (MAX30100) and temperature sensor (MLX90614) works perfectly in separate, but when combining the two sensors, MAX30100 sensor gives zeros. The solution to this problem that the MAX30100 library sets the I2C bus speed to 400kHz, so to be able to make these two sensors work together, the I2C bus speed should be changed that to 100kHz in the MAX30100 library.
- Heart rate and pulse oximeter sensor (MAX30100) works correctly, but when trying to send these readings to the firebase, it gives zero for both heart rate and blood oxygen level in the firebase. This problem cost us a long time and a lot of effort to solve, first the libraries of the firebase and max30100 sensor have been changed each one separately, but the problem wasn't solved, so the DB itself was change from firebase to Cayenne Database but also that didn't worked because the sensor still give zero values in the DB . An attempt was made to store the reading of the sensor on ESP32 using EPROM and then send it to firebase , but also that didn't work. At the end we managed to solve this problem through balancing between the sensor reading of the data and sending it to the Firebase by using some of the functions of the max30100 sensor to make the sensor read and then stop, and after a specified period of time has passed, it is restarted to read again without causing a conflict between reading from the sensor and sending it to the Firebase.

- Heart rate and pulse oximeter sensor (MAX30100) It gives values within the normal limits, but sometimes the changes in the values are fast and illogical, so we replaced the sensor with a new one, but we faced the same problem, and therefore we were not able to determine the emergency cases very accurately and also we were unable to determine a specific rate according to age due to problem with the sensor itself, as we were only able to find this sensor to measure the heart rate from the wrist and which is available in the market, as the other heart rate sensors measures heart rate from the finger and not from the wrist.

4.5 Discussion

In the beginning, there were several goals in this project to solve problem of elderly and care provider. Work has been done to achieve this through this system, which consists of two sensors, GPS, button and piezo sounder. Where these components have been programmed to achieve the requirements of this system, and after building this system and doing the necessary tests to ensure that it works in the required manner and whether it achieves the goals of its construction or not, we can say that it achieved the desired goals and that it worked as required for a simple system. As this system took the data from the sensors, GPS and button. Then the data was sent to the database correctly and displayed on the mobile application

Chapter Five : Conclusion

5.1 Overview

Tack in this part about the summary of all parts, future directions, and future work.

5.2 Conclusion

A Smart Watch can solve many of the problems facing care providers , and that may cause anxiety problems for them because the inability to be around elderly all the time due to their daily concerns . In this system, care providers can view all elderly data through the phone application and from wherever they are . This system has been built and verified to work as required to achieve the requirements of this project, and it was found that it works as required and meets the needs of this project.

5.3 Future work

In the future, we look forward to adding important features to the system, the most important of which are:

- System development for making calls and sending messages.
- Provide the system with a fall sensor so that it detects the moment the user falls to the ground to issue an audible alarm.
- Develop the system to deal directly with emergency cases and call the ambulance.

References:

[1]. components101. Available from:

https://components101.com/sensors/melexis-mlx90614-contact-less-ir-temperature-sensor

[2]. Ncbi. Available from:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8266026/

[3]. Sun Electronics. Available from**:**

https://www.sunelectronics.co.in/GY-906-MLX90614-BAA-Non-Contact-Infrared-Temperature-Sensor-Digital-Output

[4]. Apple. Available from:

https://support.apple.com/ar-sa/HT204666

[5]. Griswoldhomecare. Available from:

https://www.griswoldhomecare.com/blog/2021/september/normal-heart-rate-for-elderly-adults/

[6]. Griswoldhomecare. Available from:

https://www.griswoldhomecare.com/blog/2021/august/oxygen-levels-in-elderly-adults-when-to-be-conce/

[7]. Last Minute ENGINEERS. Available from:

https://lastminuteengineers.com/neo6m-gps-arduino-tutorial/

[8]. PPU. Available from:

https://scholar.ppu.edu/handle/123456789/2177

[9]. Springer Link. Available from:

https://link.springer.com/article/10.1007/s11042-018-7134-7?fbclid=IwAR0poYucJymMbPw2sotw0VpMWppOsKuXiCVAqPpCb-k3u8UmO9tsRtlIuKI

[10]. Flaviocopes. Available from:

https://flaviocopes.com/arduino-programming-language/

[11]. Wikipedia. Available from:

https://en.wikipedia.org/wiki/Firebase

[12]. Firebase. Available from :
https://firebase.google.com/docs/database/security

[13]. Mit App Inventor. Available from:

https://appinventor.mit.edu/about-us

[14]. Maker Advisor. Available from:

https://makeradvisor.com/esp32-vs-esp8266/

[15]. Components101. Available from:

https://components101.com/microcontrollers/esp32-devkitc

[16].IElectrony.Available from:

https://ielectrony.com/en/shop/neo-6m-gps-module/

[17]. Makers Portal.Available from:

https://makersportal.com/shop/neo-6m-gps-module

[18]. Components101. Available from:

https://components101.com/sensors/melexis-mlx90614-contact-less-ir-temperature-sensor

[19]. sparkfun. Available from:

https://www.sparkfun.com/products/9570

[20]. maxim integrated. Available from:

https://datasheets.maximintegrated.com/en/ds/MAX30100.pdf

[21]. Amazon. Available from:

https://www.amazon.in/xcluma-MAX30100-Oximetry-Sensor-Module/dp/B07CSHN2HW

[22]. Flashbay. Available from:

https://www.flashbay.com/blog/power-bank-charging

[23]. Amazon. Available from:

https://www.amazon.in/Ovista-20000mAH-Universal-Battery-Output/dp/B07P8DVVKN

[24]. americanpiezo. Available from:

https://www.americanpiezo.com/standard-products/buzzers.html

[25]. Ebay**.** Available from:

https://www.ebay.com/itm/291550728713

[26]. Herga**.** Available from:

https://www.herga.com/news-media/technical-blog-archive/what-is-a-push-button-switch-

[27]. Moderndevice. Available from:

https://moderndevice.com/product/momentary-push-button-switch/

[28]. Maker advisor. Available from:

https://makeradvisor.com/esp32-vs-esp8266/