Palestine Polytechnic University

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Graduation Project Name

IOT – based weather reporting system

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Acknowledgement

Thank God, as he should, for the majesty of his face and the greatness of his sultan, he is the patron of our grace, for those who have guided paradise, to the source of inexhaustible tenderness, to the candle that has caught and melted to enlighten us our way, to the most precious of our mothers. To the good heart and symbol of giving and love to our fathers, to all those who supported us, encouraged us and strengthened us with the fruit of this humble achievement. We thank our supervisor, Eng :Elayan Abu Gharbyeh, who has provided us with support and advice, and we thank all the teachers of our college and our dear university and all those who helped us, and thank God the Lord of the Worlds.

Abstract

The proposed system is a progressive solution for weather monitoring at a particular place and make the data available over the internet. The system makes use of the cutting-edge technology Internet of Things (IOT) where is described as connecting everyday objects like smart phones, internet televisions, sensors and actuators to the internet where the devices are intelligently linked together to enable new forms of communication amongst people and themselves.

The designed system measures atmospheric pressure, temperature and humidity, and the system is linked to a web page and a database and communicates with the API site to fetch the wind speed from the site of this data and send it through the MQTT, and the system takes advantage of sensors such as (DHT11 and BOSCH BMP180,relay,thermoelectric cooler TEC1-12706–40X40MM) and other electronic components to build the system.

Abbreviations

DHT11	Temperature-Humidity Sensor
TEC1-12706	Thermoelectric cooler
IoT	Internet of Things
GPIO	General Purpose Input/output
VCC	Voltage, Common Collector
GND	Ground
PC	Personal Computer
USB	Universal Serial Bus
BMP180	barometric pressure
IDE	integrated development environment
MOSI	Master out slave in
MISO	Master in slave out
RST	Reset
esp8266	*Espressif modules*
XAMPP	*cross-platform, Apache, MySQL, ،PHP and Perl*
TX	Transmit
RX	Receive
PHP	Hypertext Preprocessor

Table 1:Abbreviations

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Chapter1: Introduction

1.1. Overview of The Project

The term weather refers to the state of the atmosphere in an area as a result of fluctuations that occur in the atmosphere at a particular moment and on a daily or weekly basis. The weather may change within minutes or days. These fluctuations include wind, atmospheric pressure, temperature, humidity changes, and other changes.

Weather affects a person's life and activities in many ways. Sudden weather changes can be a nuisance to many people. So a person needs to know the weather changes continuously, and know how to deal with some tasks inside the house when the weather changes while outside the house.

1.2. Motivation

Knowing the fluctuations of the weather is one of the important things in our lives. There are many motives that encouraged us to do this project:

The main motive for building this system is to know weather fluctuations and sudden changes in wind speed, temperature and other factors related to weather changes, also one of the motives that led to the design of the system is the many people’s annoyance about not expecting the many fluctuations of the weather and prompting them to change their daily plans frequently, or their lack of knowledge of opening or closing windows when leaving the house or turn on the heating or fan ,so this system was designed to solve all the problems and complications that it suffers from people.

1.3. Importance of the project

The importance of the project What makes our project important to the individual and society is:

1. Our system provides automatic and continuous weather monitoring. It monitors the reading of the following weather elements, which are temperature, wind speed, humidity and atmospheric pressure.
2. The website shows reports of both (temperature, humidity, barometric sensor).
3. The system enables us to do some tasks inside the house during the fluctuations of the weather, such as closing the window or opening the window even if we are not inside the house.
4. The system also allows the operation of both the heating or the fan according to changes in the weather.

1.4. Objectives

This project aims to satisfy the following objectives:

1. measure the most important weather elements such as temperature, humidity, precipitation, atmospheric pressure and wind speed On the roof of a particular building.
2. Based on the resulting readings in the first point , the necessary actions should be taken ,such us, closing or opening the building windows or turn on both the heating and the fan according to changes in the weather.

1.5. Problem Statement

1.5.1 Definition

Many people face unexpected changes in the weather so that the weather can suddenly get worse or better, so it will be difficult to know what the readings of weather elements such as temperature, wind speed, precipitation, humidity and atmospheric pressure are in each period, and it will be difficult for them to take preventive measures at home If they are out of the house.

1.5.2 Problem Analysis

Weather reports and home protection from weather fluctuations are important in anyone's life. Many people face unexpected changes in the weather, such as heavy rain, increased humidity in the air, or an increase in wind speed. Most of the time, the windows of the house are not closed, so rain or dust and moisture will enter the house, Therefore, we are working to reduce these problems that many individuals suffer from, which affect their daily lives and lead to a change in their daily program.

1.5.3 List of Requirements

In this section, we will talk about functional and nonfunctional requirements**:**

❖ **Functional requirements**

1. The website shows reports of both (temperature, humidity, barometric sensor).
2. We need a Database in our project to require data processing, analytics, and storage.
3. web page should meet the following needs:
    - Show the user a list of the weather elements.
    - Control buttons for opening and closing windows and air conditioning.
    - Monitor system status and data transferred in both directions.

❖ **non-functional requirements**

- Working on a security system.
- The web page be easy to use and suitable for users.

1.5.4 Expected Results

After development of the system, the following results are expected to be achieved:

1. Through the system, you will know the readings of the weather elements, which are temperature, wind speed, atmospheric pressure, humidity and automatically and continuously.
2. This system shows reports on (temperature, humidity, barometric sensor).
3. The system has buttons, to open or close the window.
4. The system has buttons, to turn on both the heating and the fan according to changes in the weather.

1.6. Description of The System

In this project the system is weather monitoring at a particular place and make the data available over the internet. The system makes use of the cutting-edge technology Internet of Things (IoT) where is described as connecting everyday objects like smart phones, internet televisions, sensors and actuators to the internet where the devices are intelligently linked together to enable new forms of communication amongst people and themselves.

The designed system measures atmospheric pressure, temperature and humidity. The system is linked to an Android application and a database and communicates with the API site to fetch the wind speed from the site of this data and send it through the MQTT, and the system takes advantage of sensors such as DHT11 and BOSCH BMP180 and relay to open or close window and another relay connect thermoelectric cooler TEC1-12706–40X40MM to turn on the heating or fan .

1.7. Overview of The Rest of Report

The outline of the report consists of six chapters; the following is a brief description of the topics that are covered in each other next chapters:

Chapter 2: "Background", contains the theoretical background and Literature review, options (design options for hardware components and design options for software components) and design constraints.

Chapter 3: "Design", includes a detailed conceptual description of the system (HW and SW), detailed design, schematic diagrams, block diagrams, structural diagrams, and any necessary information about the design.

Chapter4:"Software", This chapter describes the implementations of the software that are used in this project, application and web page.

Chapter 5: "Validation and Discussion", This chapter describes the implementation, implementation issues, and implementation challenges. Also include description of the method used to validate the system, validation results, analysis and discussion about the results, and recommendations.

Chapter 6: "Conclusion", In this chapter gives information about conclusion and provides for more features that can be done in the future.

Chapter 2: Background

2.1. Overview:

This chapter introduces a theoretical background of the project, short description of design options that will be used in the system, discussion of the specification and design constraints and some additional information about the system.

2.2. Theoretical background:

INTERNET OF THINGS

The internet has changed all human lives in the past decade. The internet of things, or "IOT" for short, is the extension of Internet connectivity beyond computers and smartphones to a whole range of other things, processes and environments such as physical devices and everyday objects.

Embedded with electronics, Internet connectivity and other forms of hardware such as sensors, these devices can communicate and interact with others over the Internet, and can be remotely monitored and controlled [2].

IOT has its applications in a large number of areas such as consumer applications like smart homes, wearable technology and connected vehicles, commercial applications like medical and healthcare and industrial applications like manufacturing, agriculture, energy management and environmental monitoring.

In our project, making weather reports using the Internet of things is a process that includes all the activities and procedures required in measuring the elements of the atmosphere, from the beginning until it is published. This includes monitoring the weather and taking some precautions at home if necessary.

Our project focuses on improving the process of collecting weather information using special sensors, which is DH11 and Electro Peak BOSH BMP180 ,to publish it automatically using the Internet of things in reports that are renewed and published also automatically in web page . Which will enable you, in cases of bad weather such as heavy rain or an increase in wind speed, to close or open the window and turn on the heating or fan .

2.3 Literature review:

The first literature review

A scientific paper published in July 2021 entitled weather forecasting study in internet of things technology. In this scientific paper, weather forecasting is mainly used provides weather and climate information that changes "How does the climate change over time?" Weather forecasting is the use of science and technology to forecast the weather in a particular area.

To predict the weather, environmental sensors are used for measurements and are reported in real time on the cloud. The elements that are measured in this paper are temperature, forecast, humidity and wind , In the field of weather forecasting, these measurements are sent to a web server via the internet via a Wi-Fi connection, weather parameters are uploaded to the cloud and then live reports of weather information are provided.[3]

The second literature review

A scientific paper published on June 9, 2020 entitled IoT-based advanced weather monitoring system this paper finds a solution for weather monitoring at a particular place , and makes the data available over the internet.

The system uses environmental sensors to monitor environmental parameters such as wind speed, temperature and humidity, and then the data is generated in real time and stored in the cloud. In this paper, applications that take this data are used to take some necessary action[4]

The advantages of our project over previous solutions :

1. What distinguishes our project from the solution presented by the first scientific paper is that we measure atmospheric pressure and temperature, humidity and fetch the wind speed and that based on these measurements, certain measures are taken.
2. Our project is very similar to the second scientific paper but besides temperature, humidity and atmospheric pressure sensors we will be using wind speed readings as well, these readings are recorded in a server that is not in a cloud and in our project we use a web page to take these readings from the server and apply the appropriate procedure.

2.4. System design Components:

This section describes all of the hardware used in our project, it presents a figure for each one with a short description of its work principle and why it is used in the system.

2.4.1.Hardware components

2.4.1.1:Microcontroller:

During our search, we`ve encountered microcontroller alternatives options.

- **NodeMCU (esp8266):**

NodeMCU is an open-source firmware and development kit that helps you to prototype or build IoT products. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266[5].

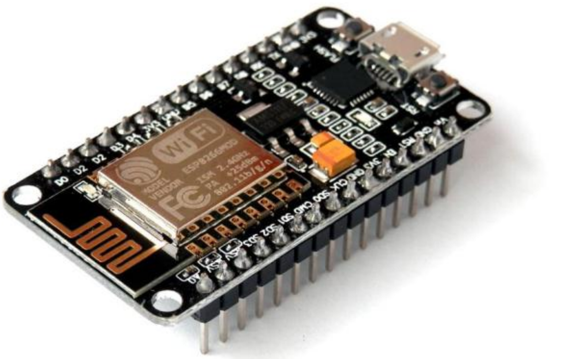


figure 1:esp8266

2.4.1.2: DHT11:

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old[7].

Technical Details:

a) Low cost
b) 3 to 5V power and I/O
c) 2.5mA max current use during conversion (while requesting data)
d) Good for 20-80% humidity readings with 5% accuracy
e) Good for 0-50°C temperature readings ±2°C accuracy
f) No more than 1 Hz sampling rate (once every second)
g) Body size 15.5mm x 12mm x 5.5mm
h) 4 pins with 0.1" spacing.

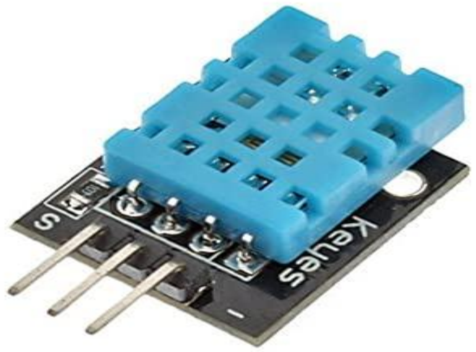


figure 2:DHT11

2.4.1.3: BMP180:

This precision sensor from Bosch is the best low-cost sensing solution for measuring barometric pressure and temperature. Because pressure changes with altitude you can also use it as an altimeter! The sensor is soldered onto a PCB with a 3.3V regulator, I2C level shifter and pull-up resistors on the I2C pins .The BMP180 is the next-generation of sensors from Bosch, and replaces the BMP085. This board is 5V compliant - a 3.3V regulator and a i2c level shifter circuit is included so you can use this sensor safely with 5V logic and power[6].

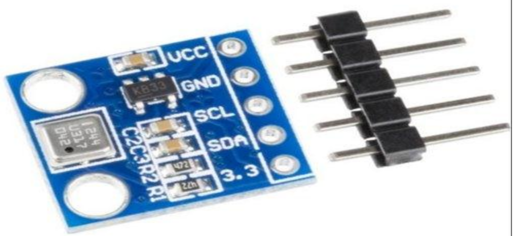


figure 3:BMP180

2.4.1.4: Relay:

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations[8].

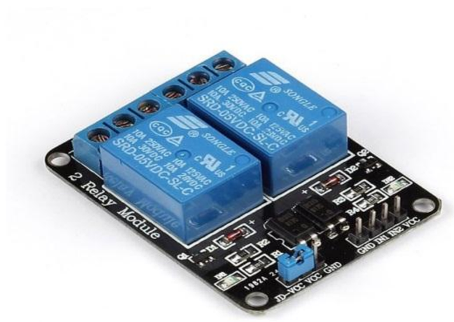


figure 4:Relay

2.4.1.5: Thermoelectric cooler TEC1-12706–40X40MM:

This is TEC1-12706 40x40mm thermoelectric cooler Peltier plate module 12V 60W Get ice cold in minutes or heat to boiling by simply reversing the polarity, used for numerous applications from CPU coolers to alternate power sources, or even for your own custom car drink warmer/cooler. Since they consist primarily of semiconductor material sandwiched between ceramic plates and have no moving parts[9].

Feature: Its work is characterized by side refrigeration and side fever. Hot and cold on both sides of the temperature difference of 68 degrees Connected to the 12-volt power supply cooling piece on both sides there will be difference in temperature, side cold side of the heat, do not long power cooler radiator, otherwise it will cause cooler internal overheating and burning.

Specification:

1. Model: TEC1-12706
2. Size: 40mm x 40mm
3. Operates from 0~15.2V and 0~6A
4. Operates Temperature: -30C to 70C
5. Max power consumption: 60W
6. These devices must be used in conjunction with a heat sink to avoid burned
7. Each device is full inspected and tested
8. Fitted with 6-inch insulated leads

Figure 5:TEC1-12706

Difference between Raspberry Pi VS Arduino VS NodeMCU:

Component	Arduino	Raspberry Pi	Node MCU
Best choose	☒	☒	✓
Developer	Arduino	Raspberry Pi Foundation	open source community
Type	Single board microcontroller	Mini computer	Single board microcontroller
Operating System	None	Linux	XTOS
CPU	Atmel, ARM, Intel	ARM Cortex	LXT106
Clock Speed	16 MHz	1.2GHz	26 MHz – 52 MHz
Memory	32KB	1-4GB	Upto 128MB
Storage	1KB	MicroSDHC Slot	4MB
Power	USB, Battery, Power Supply	USB, Power Supply	USB
Operating Voltage	5V	5V	3.3V
I/O Connectivity	SPI I2C UART GPIO	SPI DSI UART SDIOCSI GPIO	UART, GPIO
Image			

Table 2PI VS Arduino VS nodmcu

Difference between DHT11 VS DHT22:

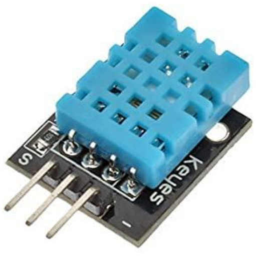
Component	**DHT11**	**DHT22**
Best choose	✓	☒
Temperature Range	-20 to 60℃	-40 to 80℃
Temperature Accuracy	±2%	±0.5%
Humidity Range	5 to 95% RH	0 to 100%RH
Humidity Accuracy	±5%	±2%
Cost	$5.90	$9.90
Image		

Table 3:DHT11 VS DHT22

2.4.2:System Software Component:

This section will provide some information about the main programs and software technologies used in our project.

Software used for hardware and sensors:

2.4.2.1: Arduino IDE:

Arduino code is written in C+ with an addition of special methods and functions. C++ is a human-readable programming language. The Arduino Integrated Development Environment (IDE) is the main text editing program used for Arduino programming. It is where you'll be typing up your code before uploading it to the board you want to program. Arduino code is referred to as sketches, It is processed and compiled to machine language, and arduino sketch code is used to program wemos microcontrollers[10].

Software used for Web page:

2.4.2.2: XAMMP:

XAMPP is a free and open-source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, Maria DB database, and interpreters for scripts written in the PHP and Perl programming languages. Since most actual web server deployments use the same components as XAMPP, it makes transitioning from a local test server to a live server possible.

2.5.2.3: Notepad++:

Notepad++ is a text and source code editor for use with Microsoft Windows. It supports tabbed editing, which allows working with multiple open files in a single window. The product's name comes from the C increment operator.

Based on the powerful editing component Scintilla, Notepad++ is written in C++ and uses pure Win32 API and STL which ensures a higher execution speed and smaller program size. By optimizing as many routines as possible without losing user friendliness.

2.5. Design constraints:

1. The system can’t send data or notifications without Wi-Fi connection so all devices must be constantly connected to Wi-Fi.
2. The web page will not run without the Internet.
3. The system must work in an ideal environment because any external influences other than weather factors will negatively affect our smart project.

CHAPTER 3: System Design

3.1 Introduction

This chapter discusses the conceptual design of the system, it shows the system requirement analysis, a block diagram of the system, schematic diagrams and hardware system design.

3.2 Detailed system description

The proposed system monitoring the weather status according the pressure, temperature, humidity and wind, by these information it will to be easy for the user to take a decision about what have to do like open the window or run the condition.

The system uses DHL11 sensor to track the temperature and humidity and BOSCH BMP180 sensor to track the pressure, these sensors will be connected will NodeMCU microcontroller to read the values and handle it to send these value to the server throw the api to be sorted in the DB and the user reach it throw the web page . The web page displays the reading of the temperature, humidity and pressure (which sended from the sensors) from the server and DB, also gets wind form external weather APIs to display for the user on the mobile.

The web page allows you to take actions and display the temperature, humidity and pressure readings, the user can open or close the window and on/off the air condition. The server take this action and store it to send it for the NodeMCU for reflect these changes on reality. You can show the functional block diagram in figure 5.

Block diagram:

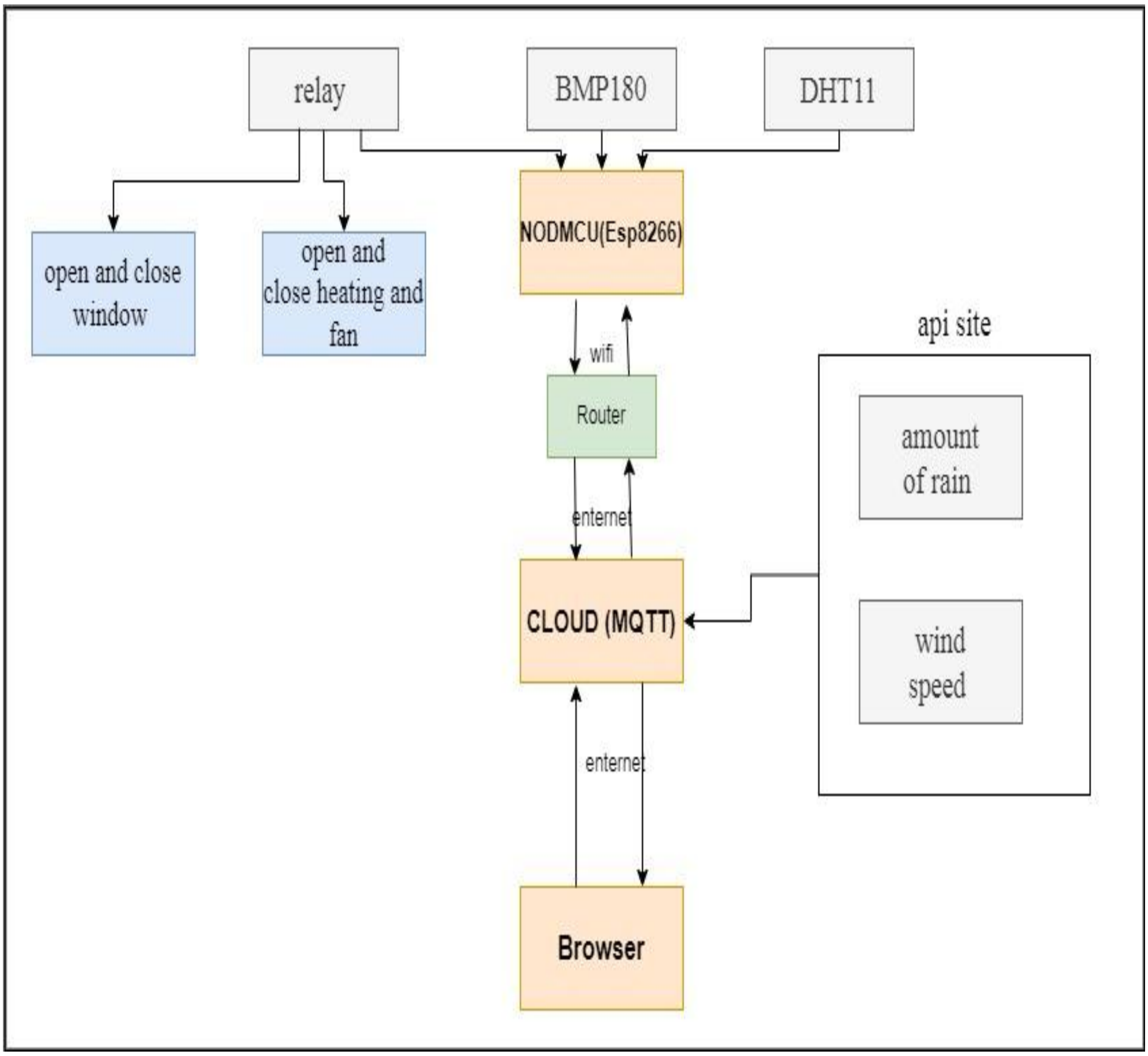


figure 6:block digram

3.3 Hardware system design

- **Esp8266 connect to DHT11:**

  In case are using the DHT11 Sensor, then connect a 4.7 KΩ Resistor between Data Pin and VIN (or 3.3V) of ESP8266.

  1. VCC: Power Supply (3V to 5.5V)
  2. DATA: D4
  3. NC: Not Connected
  4. GND: Ground

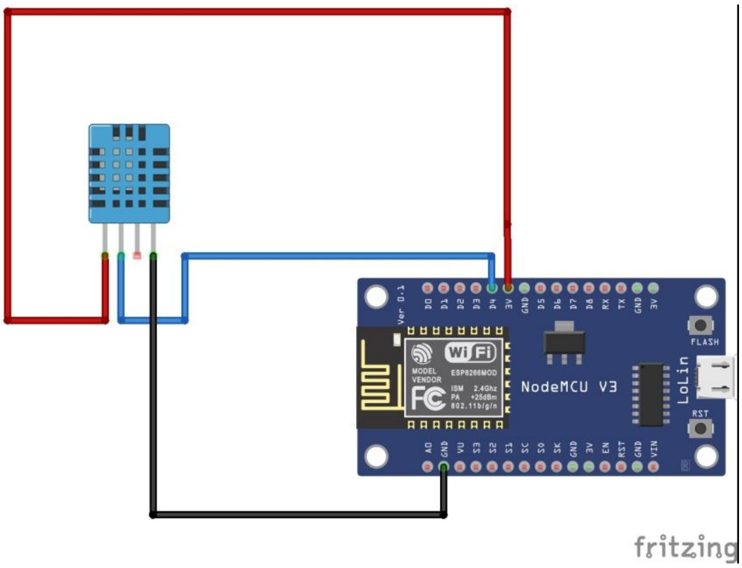


figure 7:Esp8266 connect to DHT11

- **Esp8266 connect to BMP180:**

Start by connecting the VIN pin to the 3.3V output on the NodeMCU and connect GND to ground. Now we are remaining with the pins that are used for I2C communication. Note that each Arduino Board has different I2C pins which should be connected accordingly. On the used Arduino b, the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin. They are also known as D1 (SCL) and D2 (SDA). The figure 3.3 shows how to wire BOSCH BMP180 to NodeMCU.

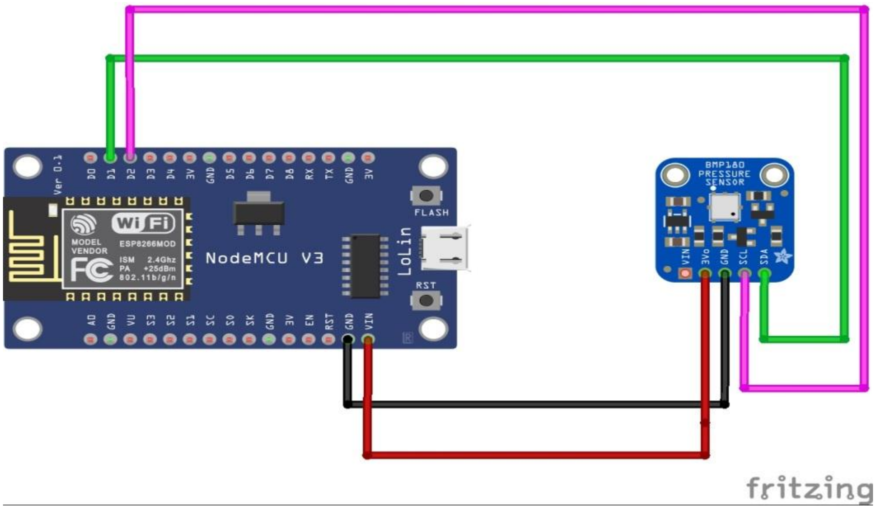


figure 8:Esp8266 connect to BMP180

- **Esp8266 connect to relay :**

Some ESP8266 pins output a 3.3V signal when the ESP8266 boots. This may be problematic if you have relays or other peripherals connected to those GPIOs. Additionally, some pins must be pulled HIGH or LOW in order to boot the ESP8266.Taking this into account, the safest ESP8266 pins to use with relays are: GPIO 5, GPIO 4, GPIO 14, GPIO 12 and GPIO 13.

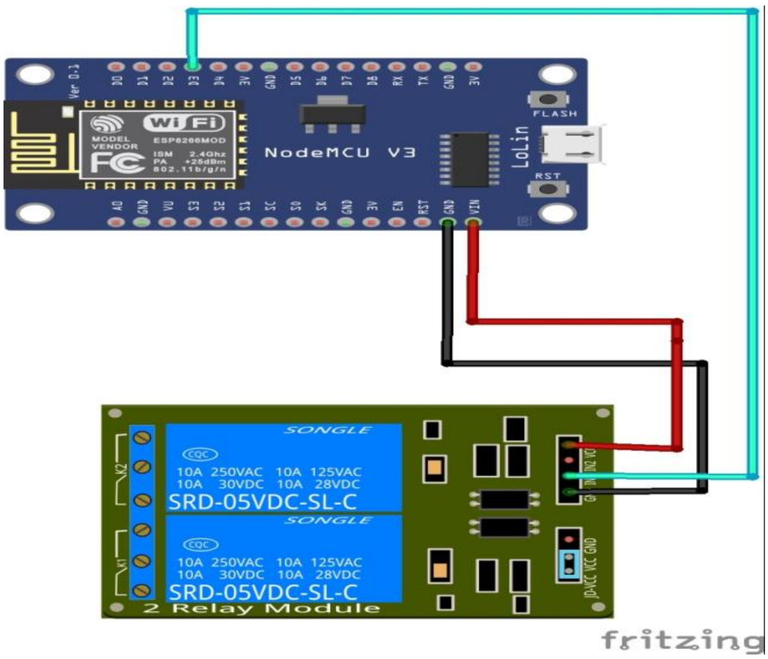


figure 9:Esp8266 connect to relay

- **relay connect to TEC1-12706:**

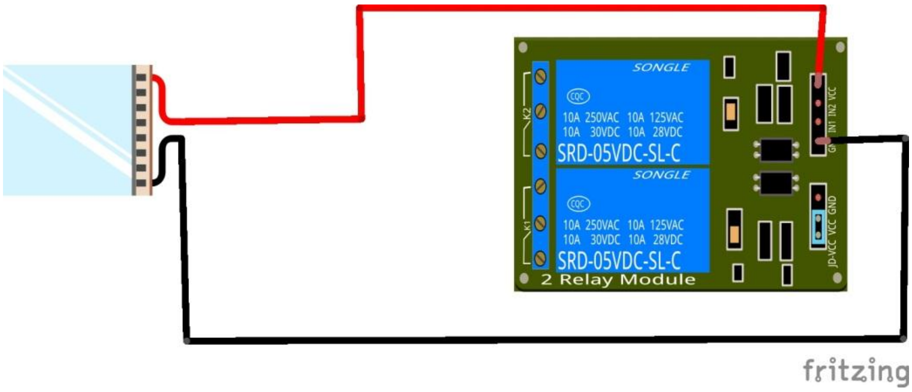


Figure 10:relay connect to TEC1-12706

- **Wiring Diagrams of weather**

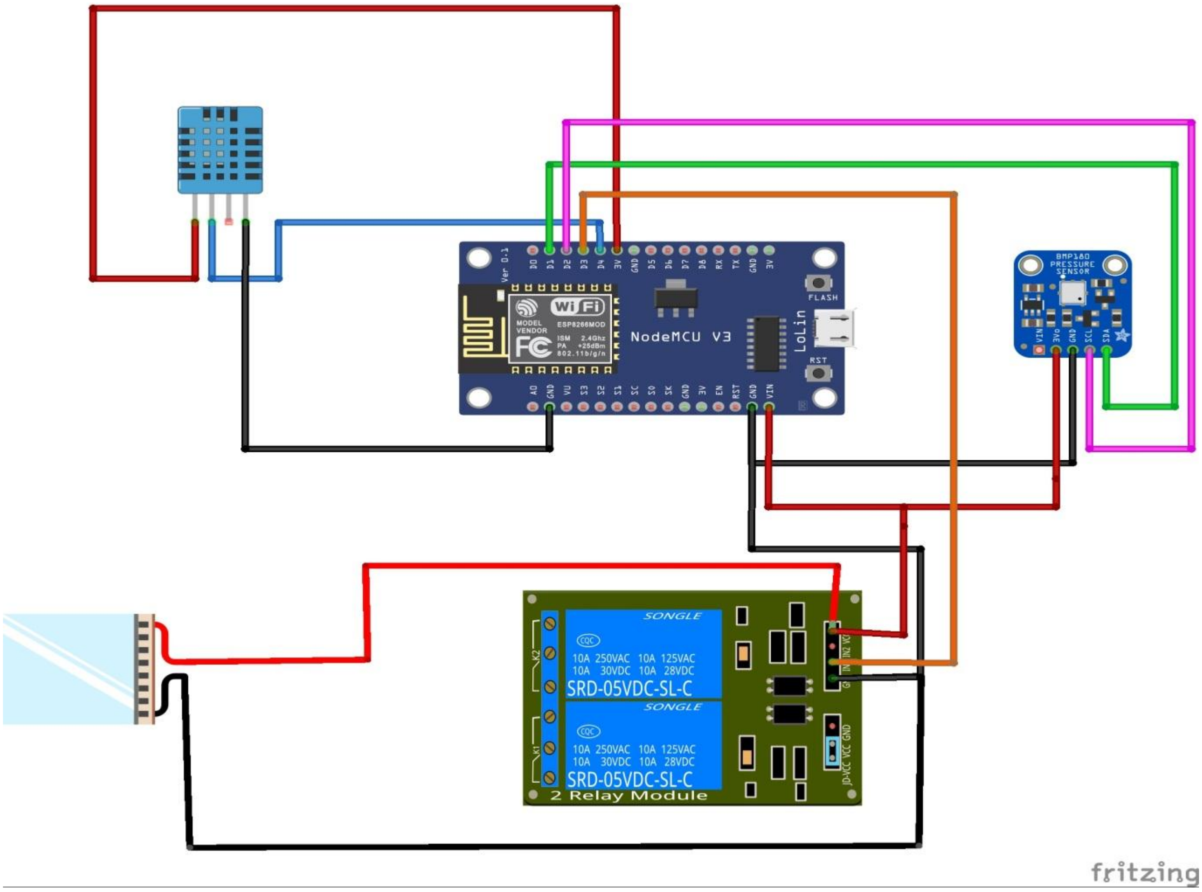


figure 11:Wiring Diagrams of weather

- ## System Schematic diagram:

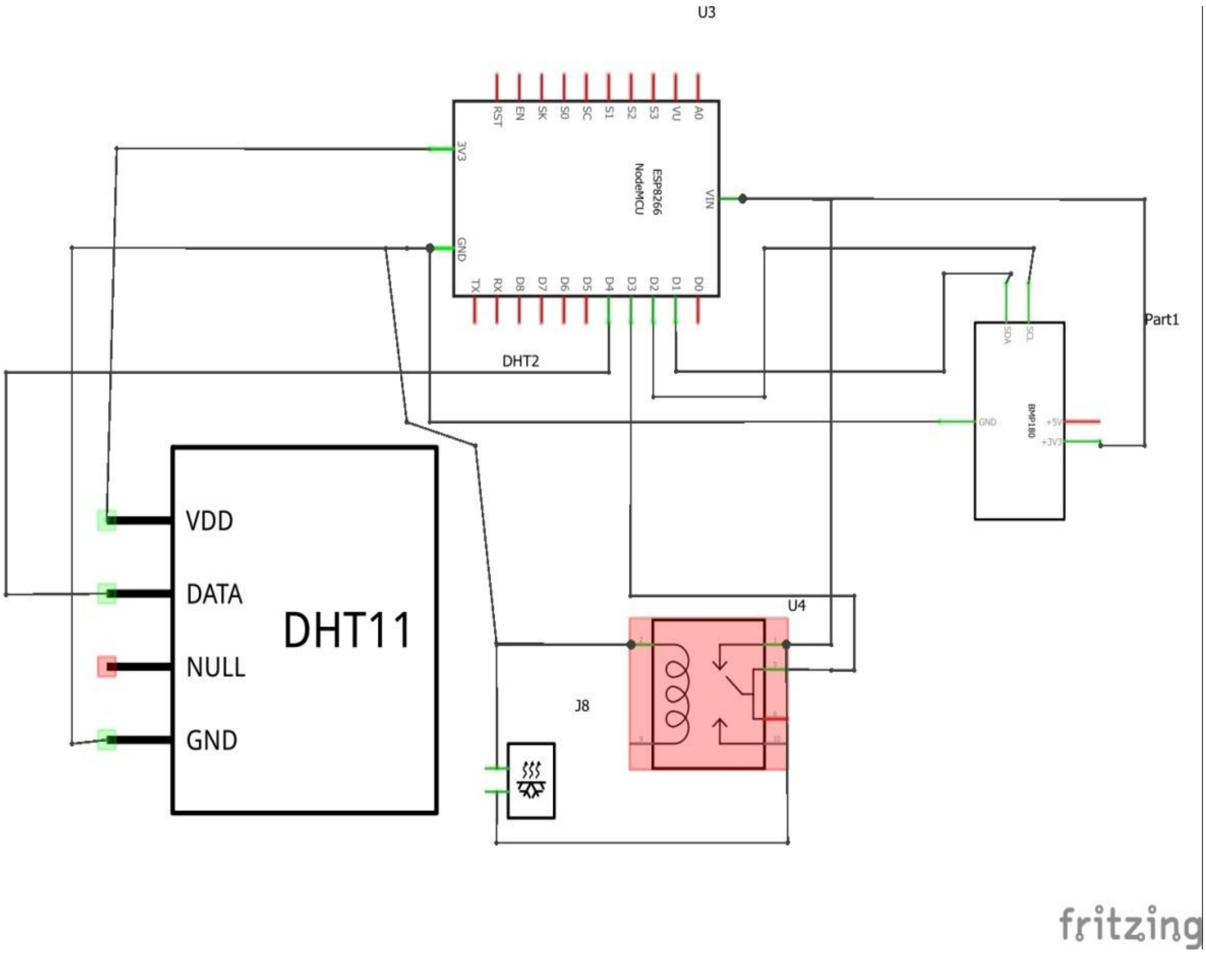


figure 12: System Schematic diagram

3.4 :Flow chart

In this figure 13, it shows how the web page that was designed works, as it includes:

1. The login page through which the user name and password are entered.
2. Verify the entries thereafter and give a warning message if the entries are wrong.
3. Enter the main page to view the live value of sensors .
4. click to choose (Humidity sensor report , user setting , MQTT setting ,Barometric sensor report ,Temperature sensor report) .
5. Exit the site.

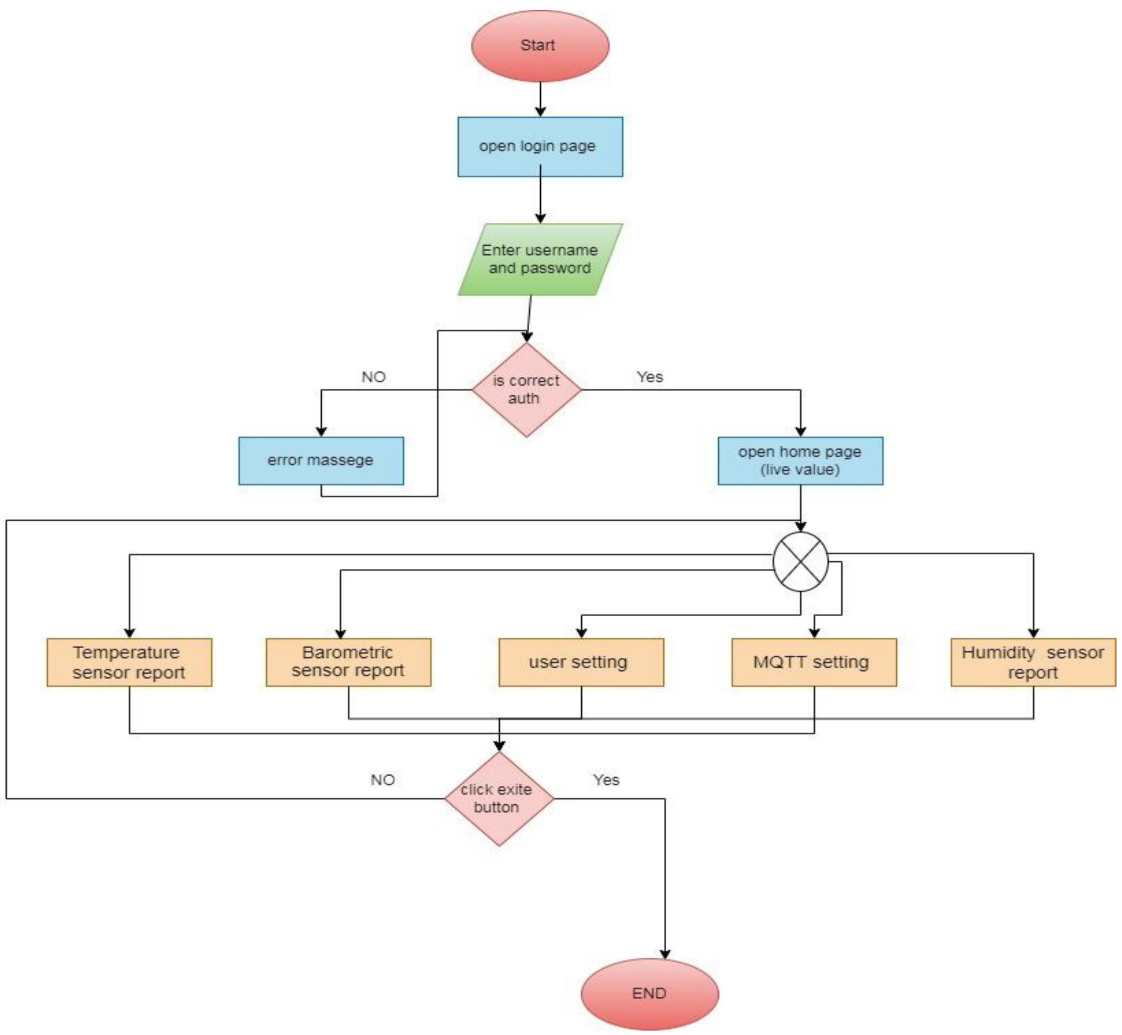


Figure 13:flow chart(web page)

In this figure 14, it shows how the hardware that was designed works, as it includes:

1. Make sure the system is power on .
2. Control (fan ,heater, window)
3. Fetch (wind speed)from API
4. Identify sensors .
5. Read sensors value.
6. publish by mqtt .
7. Make sure the system is power off.
8. Exist site .

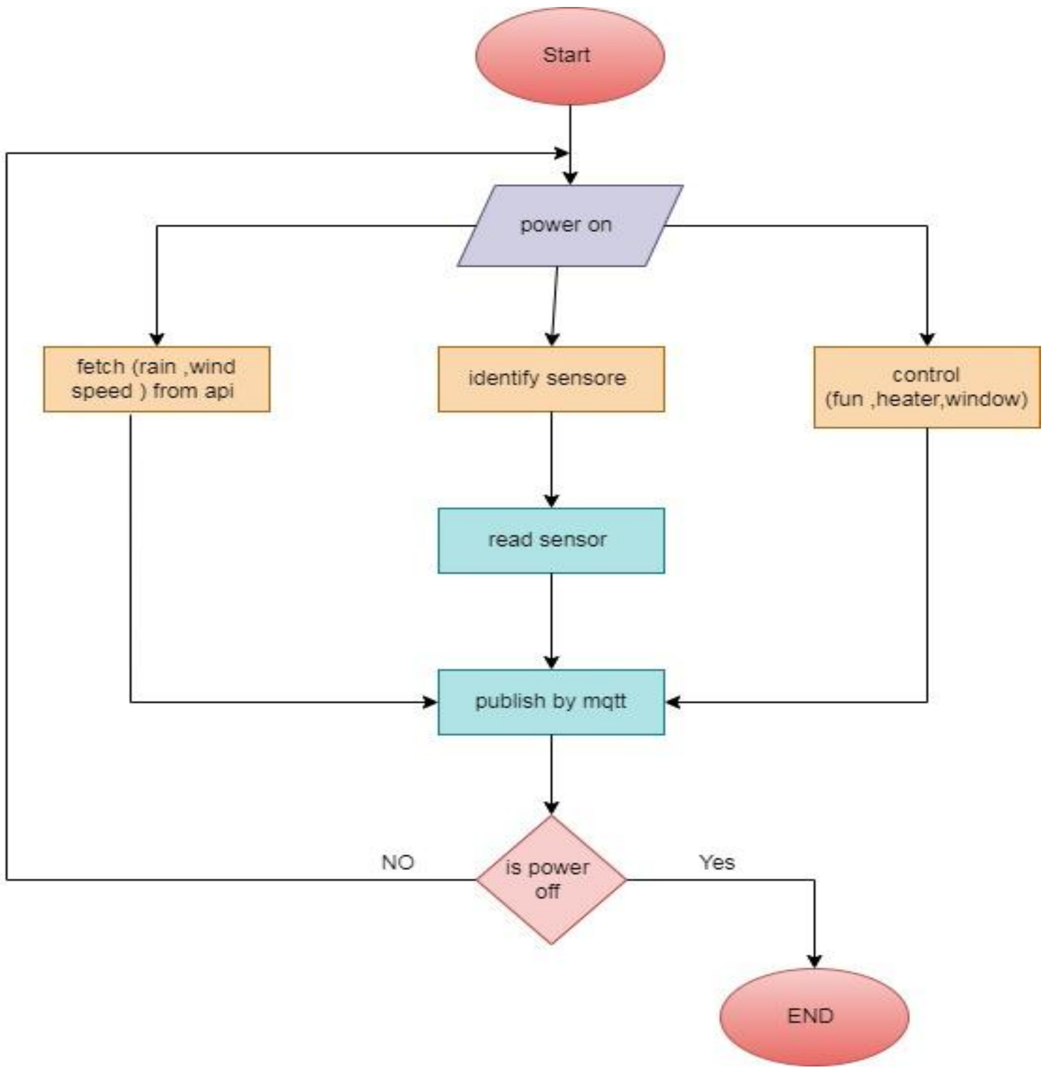


Figure 14:flow chart(hardware)

Chapter 4:

Software & Hardware Implementation

4.1 Overview

This chapter describes the implementation of the software and the hardware of this project, including the circuit connection, and programming of the microcontrollers.

4.2 Weather API:

sign up to use our fast and easy-to-work weather APIs for free. In case your requirements go beyond our freemium account conditions, you may check the entire list of our subscription plans. You can read the How to Start guide and enjoy using our powerful weather APIs right now.

The site of weather api (https://openweathermap.org/api)[11].

This figure15: show how to sign api site :

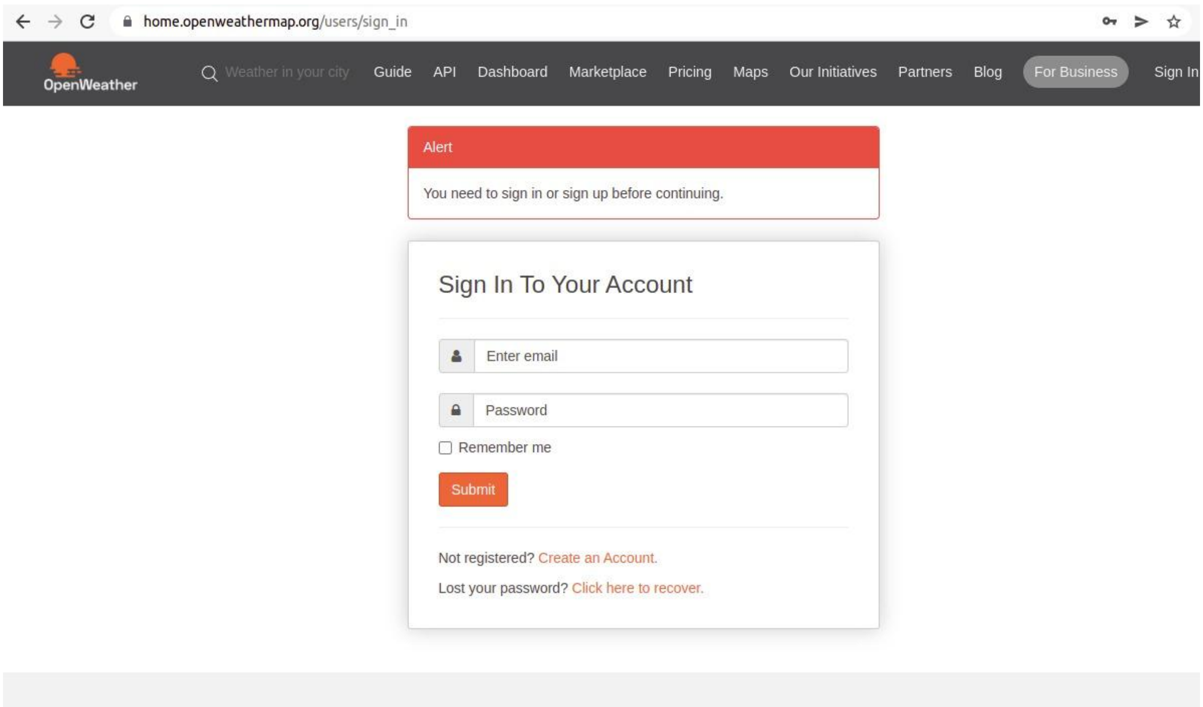


Figure 15:sign api

The figure16: shows how to bring the KEY and enter the city number according to its existing number in order to bring the required data

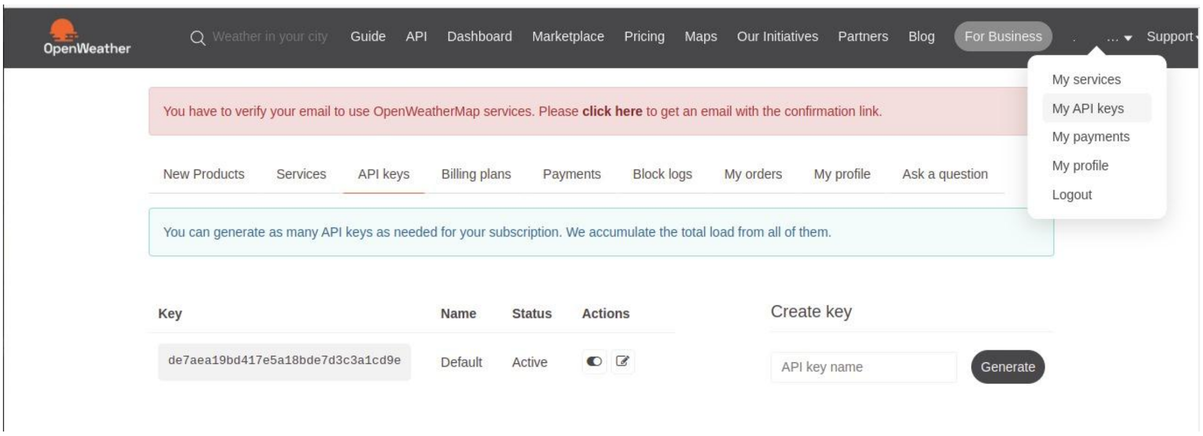


Figure 16:fetch data

4.3 MQTT: The Standard for IoT Messaging

MQTT (originally an initialism of MQ Telemetry Transport) is a lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP, however, any network protocol that provides ordered, lossless, bi-directional connections can support MQTT .It is designed for connections with remote locations where resource constraints exist or the network bandwidth is limited. The protocol is an open OASIS standard and an ISO recommendation (ISO/IEC 20922)[12].

4.4 Software Implementation tools

This section will provide some information about the main programs and software Technologies used in our project.

4.4.1 XAMMP(web page)

XAMPP is a free and open-source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, Maria DB database, and interpreters for scripts written in the PHP and Perl programming languages. Since most actual web server deployments use the same components as XAMPP, it makes transitioning from a local test server to a live server possible[1].

The web page consists of 7 user interfaces, which are:

1. **Login page:** You must enter the correct username and password in order to go to the main page.

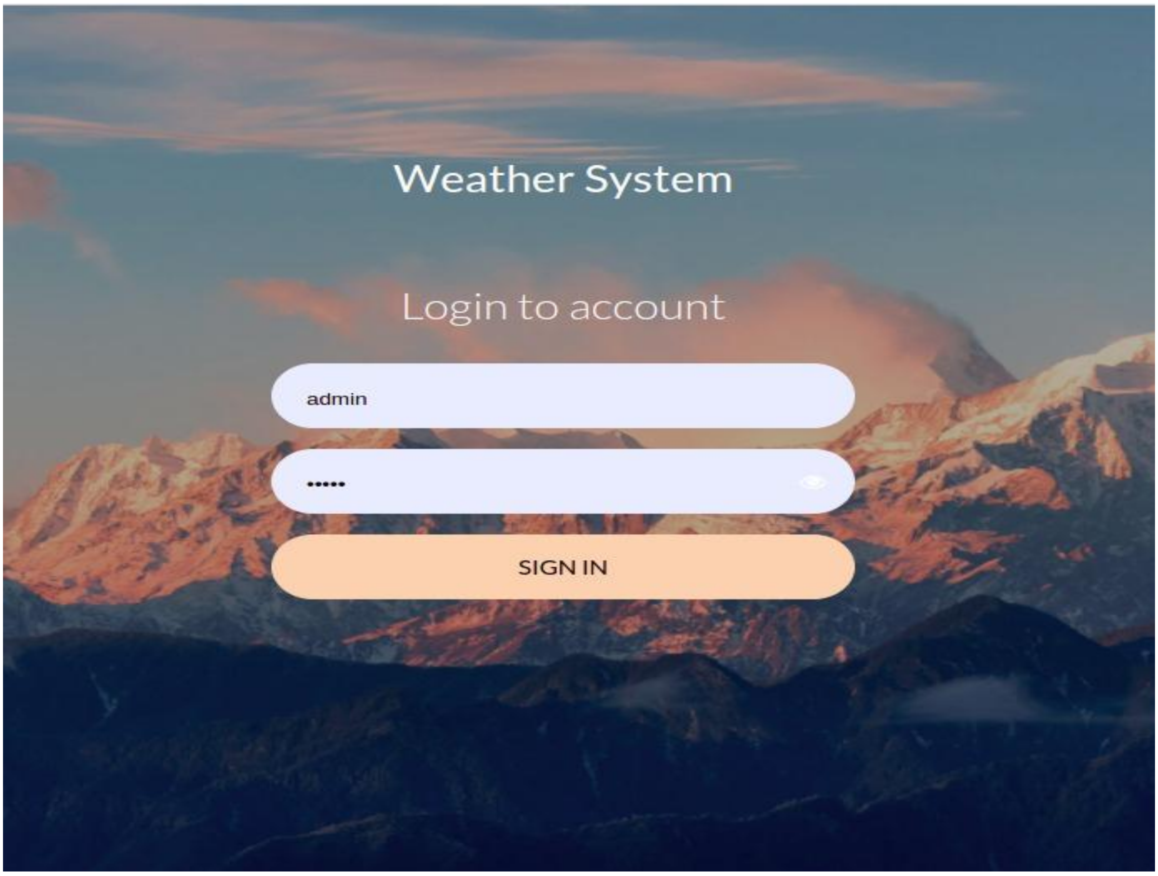


Figure 17:Login page

2. **Home page:** Home page: contains a set of icons, when you click on them, they will be transferred to other pages for example (home ,users ,MQTT setting ,logout……) , It also contains a group of images when you click on it, either converting to pages or giving results on the same home page.

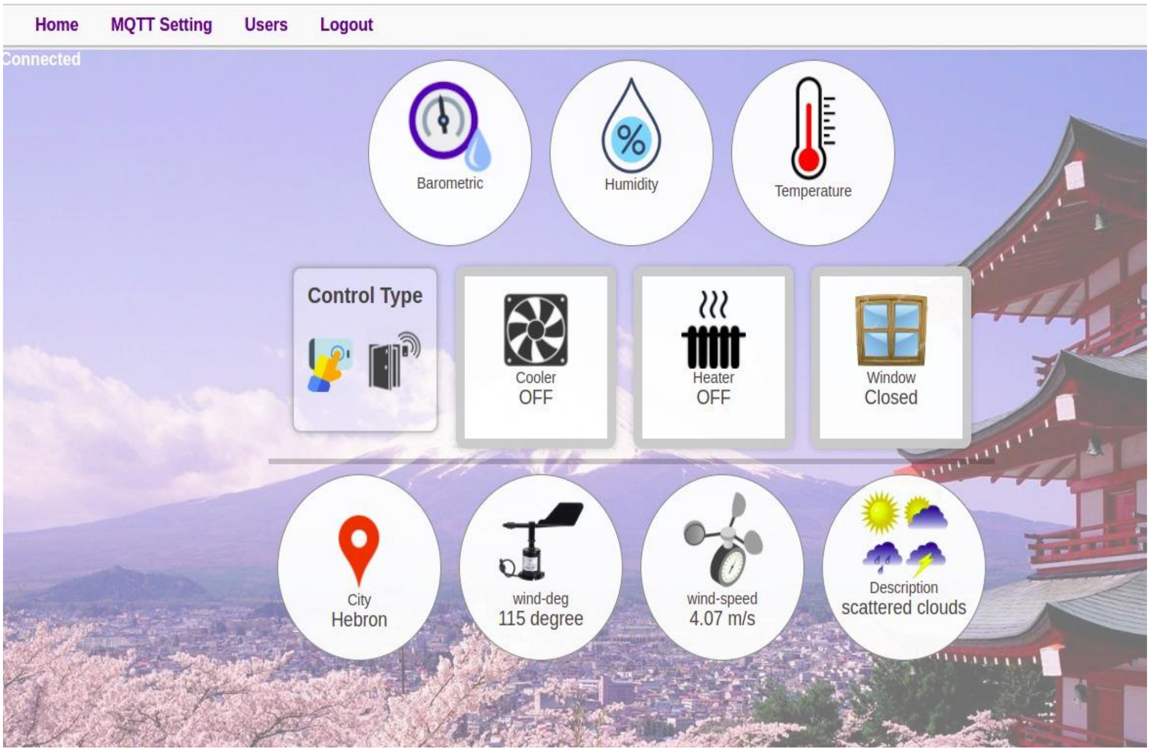


Figure 18:home page

3. **MQTT setting page :** MQTT settings are set by entering each of the(broker ,port ,client id ,username ,password) and save this data.

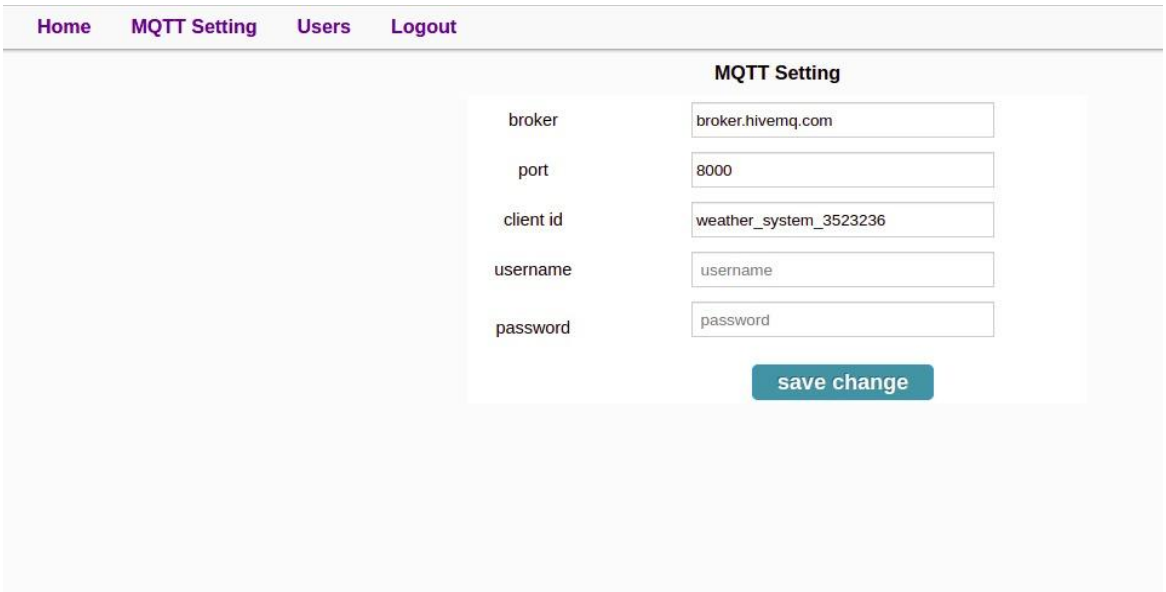


Figure19 :MQTT page

4. **Users page:** Users are inserted, deleted, or modified where they are entered (name ,identification ,status, update ,delete/restore).

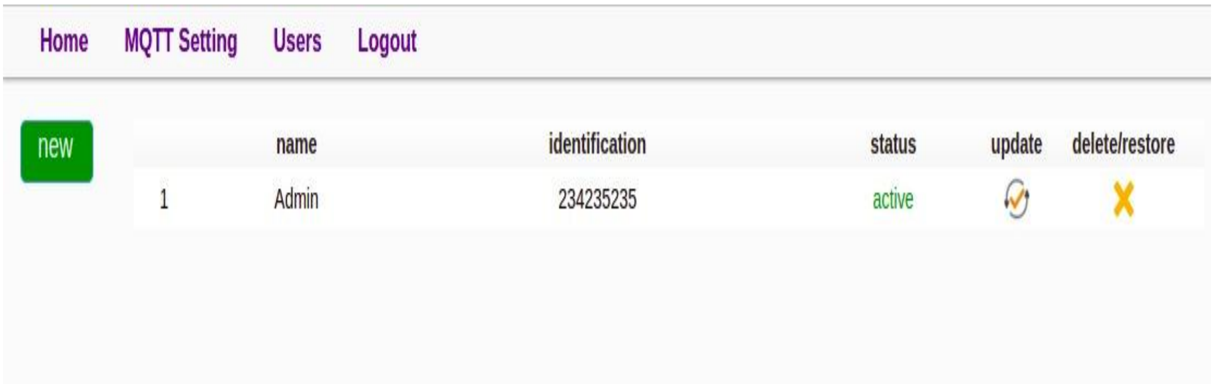


Figure 20:Users page

5. **Barometric sensor page:** When you click on the image of the barometric sensor on the main page, you will be transferred to the report page for this sensor, as shown in the figure 19.

Figure 21:Barometric sensor page

6. **Temperature sensor page:** When you click on the image of the Temperature sensor on the main page, you will be transferred to the report page for this sensor, as shown in the figure20.

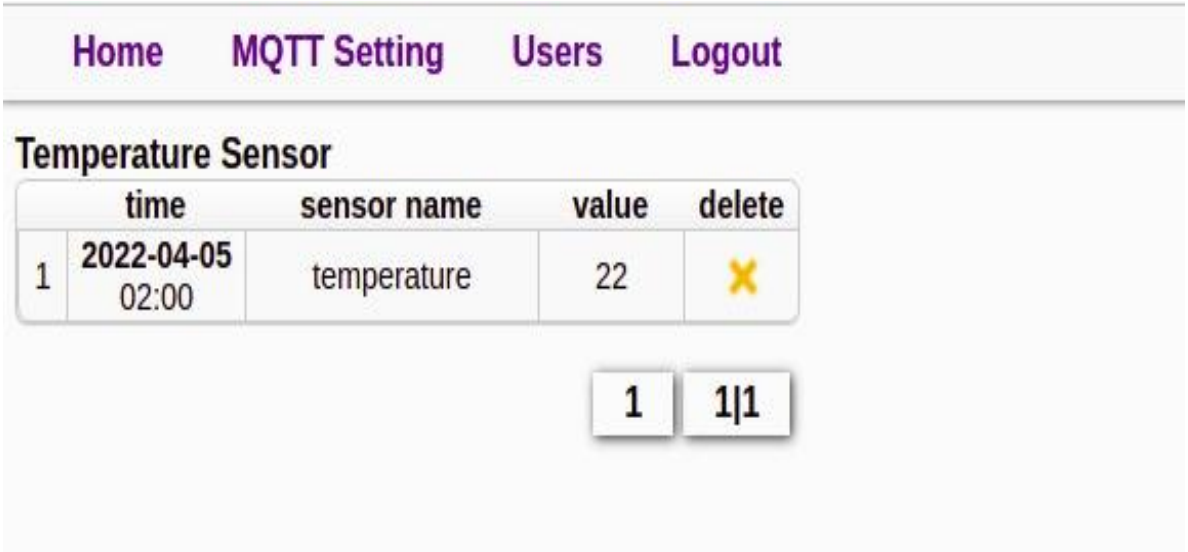


Figure 22:Temperature sensor page

7. **Humidity sensor page:** When you click on the image of the Humidity sensor on the main page, you will be transferred to the report page for this sensor, as shown in the figure21.

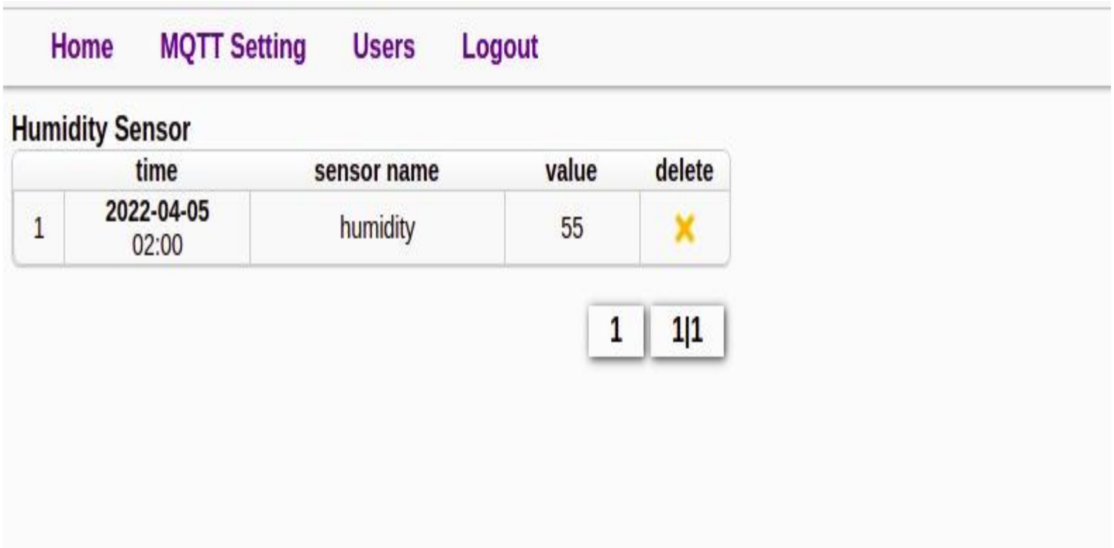


Figure 23:Humidity sensor page

4.5Hardware Implementation

This section will provide some information about the hardware implementations of project.

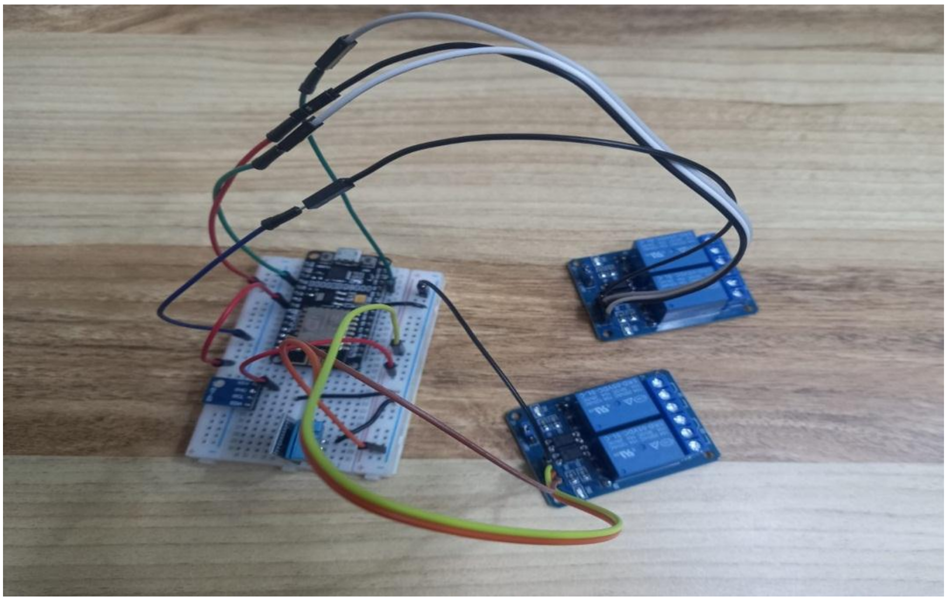


Figure 24:hardware test

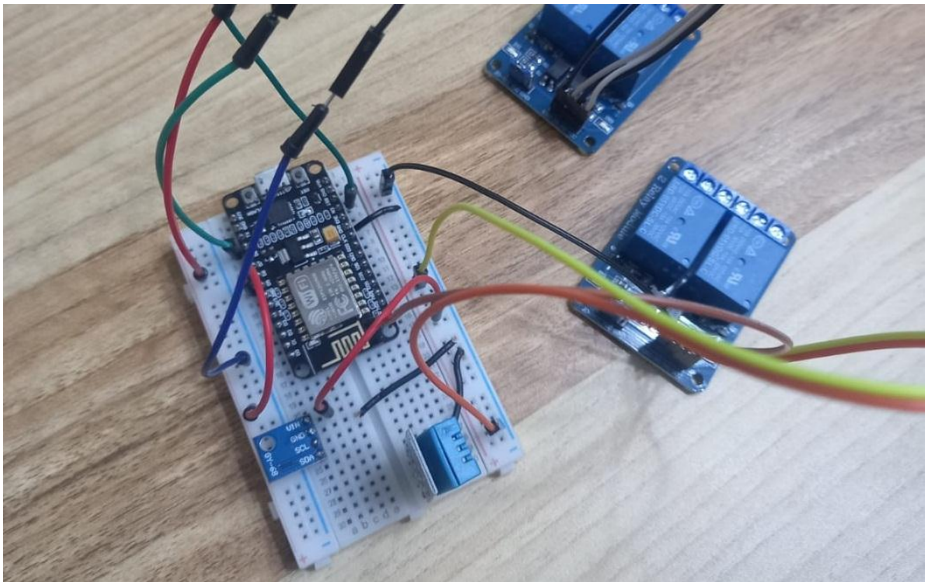


Figure 25: hardware test

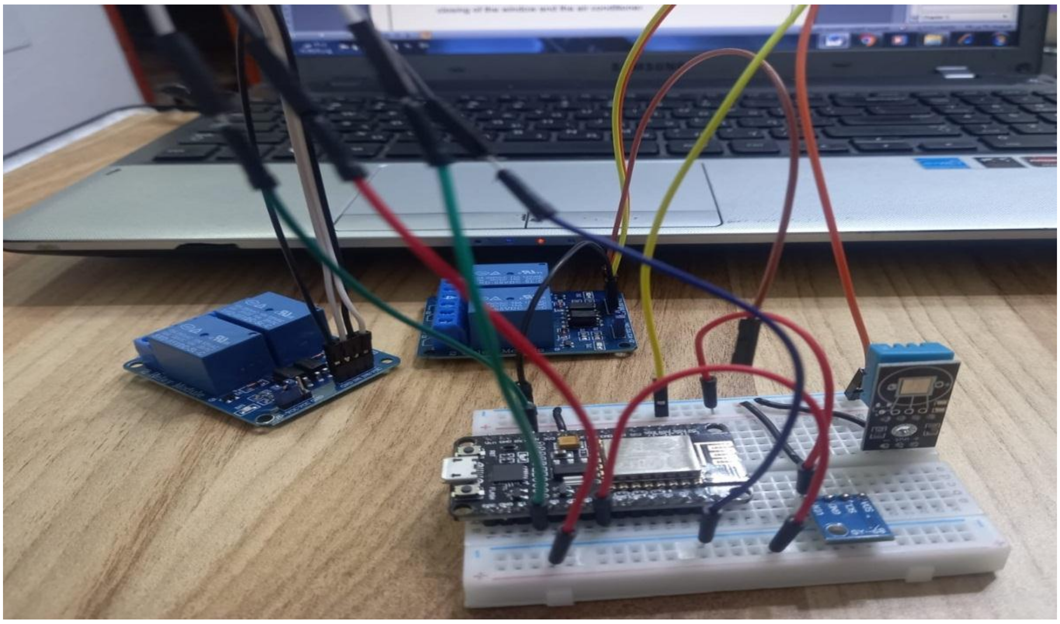


Figure 26:hardware test

4.6 Implementation Results

By the end of the implementation process ,the designed system measures atmospheric pressure, temperature and humidity. The system is linked to an web page and a database and communicates with the API site to fetch the wind speed from the site of this data and send it through the MQTT, and the system takes advantage of sensors such as DHT11 and BOSCH BMP180,relay ,thermoelectric cooler TEC1-12706–40X40MM and controlling the opening and closing of the window and controlling heating or the fan .

Figure 27:final result

Figure 28:final result

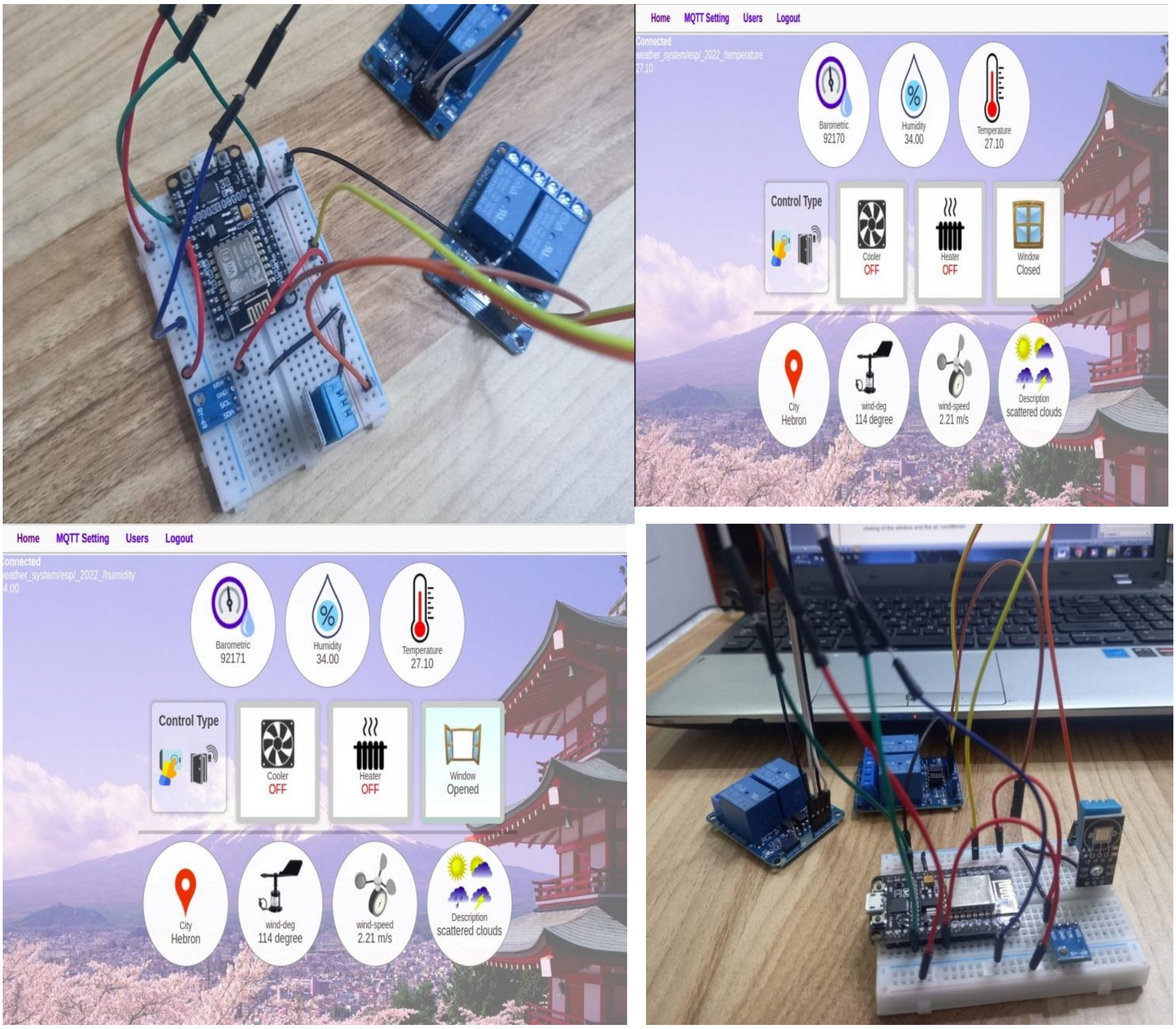


Figure 29:Implementation Results

4.7 Implementation Issues

During the implementation of the project, we faced many obstacles and we had to take Several issues to achieve the most appropriate design for the system and access to the best features Related to the objectives of the project.

These issues and results are summarized as follows:

1. Libraries associated with some sensors, where we encountered problems in finding the appropriate libraries for sensors in order to run the code on them.
2. MQTT: We do not have enough information and experience about the mqtt, so we have worked on research and continuous study in order to understand the mqtt and work to apply it in our project correctly.
3. We encountered a problem in the process of connecting both hardware and software.
4. Finding the best sites that give correct and accurate values of wind speed in any area.

Chapter 5

Validation & Testing

5.1 Overview

In this chapter we will discuss the testing of all component of the system and the results obtained. We test all the parts to ensure that all of the functions work perfectly and without errors.

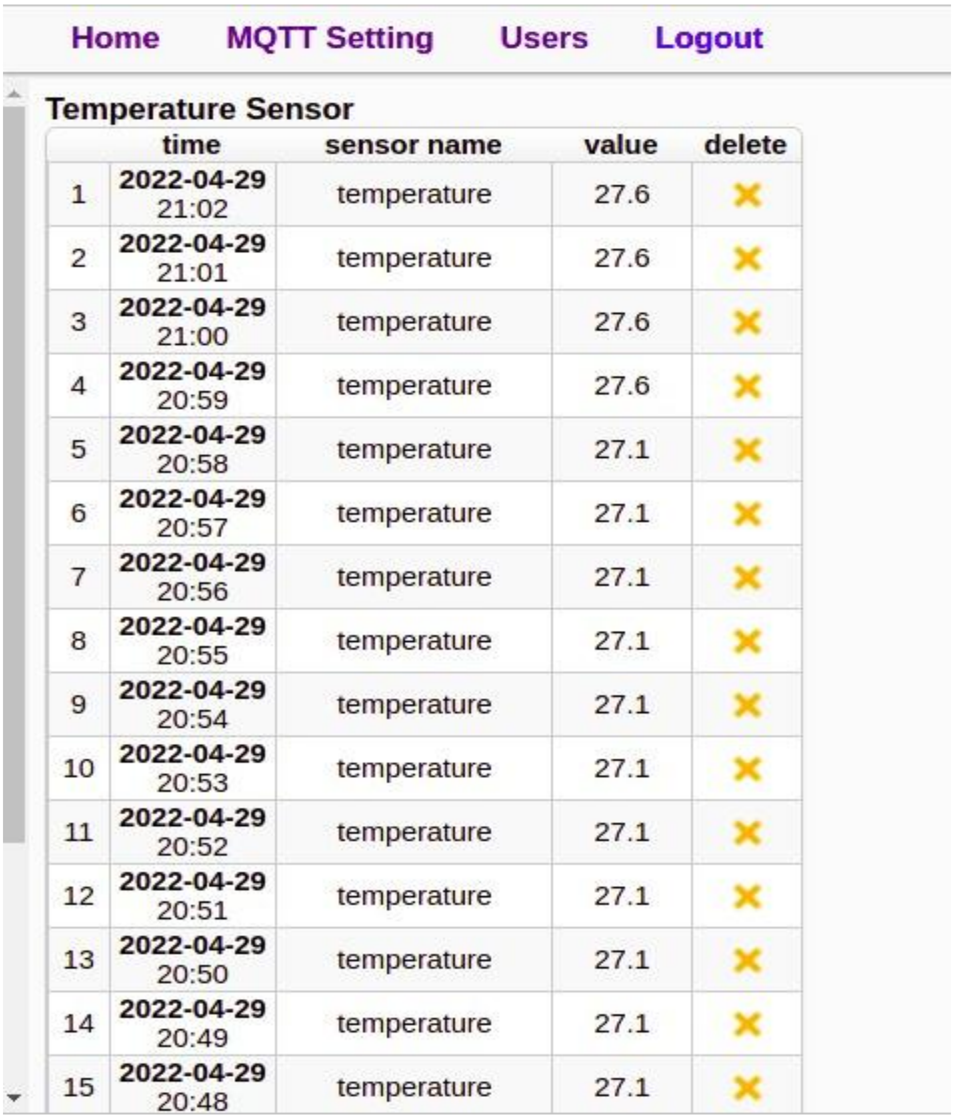
5.2 Software Testing

5.2.1 Testing web page

We used HTML , JavaScript and php to design a web page to receive data. we designed the web page interfaces (many Button to move the interfaces, log in & MQTT setting & users.......) to check and test the functionality of the project :

1. Received data.
2. determine temperature .
3. determine humidity.
4. Determine atmospheric pressure .
5. control of the window.
6. adjust MQTT settings.
7. Fetch wind speed.
8. control of the fan and heating .

5.2.2 Testing web page (temperature sensor)



Home MQTT Setting Users Logout

Temperature Sensor

	time	sensor name	value	delete
1	2022-04-29 21:02	temperature	27.6	✕
2	2022-04-29 21:01	temperature	27.6	✕
3	2022-04-29 21:00	temperature	27.6	✕
4	2022-04-29 20:59	temperature	27.6	✕
5	2022-04-29 20:58	temperature	27.1	✕
6	2022-04-29 20:57	temperature	27.1	✕
7	2022-04-29 20:56	temperature	27.1	✕
8	2022-04-29 20:55	temperature	27.1	✕
9	2022-04-29 20:54	temperature	27.1	✕
10	2022-04-29 20:53	temperature	27.1	✕
11	2022-04-29 20:52	temperature	27.1	✕
12	2022-04-29 20:51	temperature	27.1	✕
13	2022-04-29 20:50	temperature	27.1	✕
14	2022-04-29 20:49	temperature	27.1	✕
15	2022-04-29 20:48	temperature	27.1	✕

Figure 30:Testing web page (temperature sensor)

5.2.3 Testing web page (humidity sensor)

Home MQTT Setting Users Logout

Humidity Sensor

	time	sensor name	value	delete
1	2022-04-29 21:02	humidity	33	×
2	2022-04-29 21:01	humidity	33	×
3	2022-04-29 21:00	humidity	33	×
4	2022-04-29 20:59	humidity	33	×
5	2022-04-29 20:58	humidity	34	×
6	2022-04-29 20:57	humidity	34	×
7	2022-04-29 20:56	humidity	34	×
8	2022-04-29 20:55	humidity	35	×
9	2022-04-29 20:54	humidity	35	×
10	2022-04-29 20:53	humidity	35	×
11	2022-04-29 20:52	humidity	34	×
12	2022-04-29 20:51	humidity	34	×
13	2022-04-29 20:50	humidity	34	×
14	2022-04-29 20:49	humidity	33	×
15	2022-04-29 20:48	humidity	34	×

Figure 31:Testing web page (humidity sensor)

5.2.3 Testing web page (barometric sensor)

Home MQTT Setting Users Logout

Barometric Sensor

	time	sensor name	value	delete
1	**2022-04-29** 21:03	barometric	92181	
2	**2022-04-29** 21:02	barometric	92172	
3	**2022-04-29** 21:01	barometric	92175	
4	**2022-04-29** 21:00	barometric	92169	
5	**2022-04-29** 20:59	barometric	92169	
6	**2022-04-29** 20:58	barometric	92174	
7	**2022-04-29** 20:57	barometric	92170	
8	**2022-04-29** 20:56	barometric	92172	
9	**2022-04-29** 20:55	barometric	92171	
10	**2022-04-29** 20:54	barometric	92170	
11	**2022-04-29** 20:53	barometric	92166	
12	**2022-04-29** 20:52	barometric	92169	
13	**2022-04-29** 20:51	barometric	92164	
14	**2022-04-29** 20:50	barometric	92160	
15	**2022-04-29** 20:49	barometric	92160	

Figure 32:Testing web page (barometric sensor)

5.3 Weather api testing(code)

In the figure31, the API code shows the weather site:

We are in JavaScript code work to analyze the JSON and convert it to the interface or GUI interface.

```
<script>
const key = 'de7aea19bd417e5a18bde7d3c3a1cd9e';
if(key=='') document.getElementById('temp').innerHTML = ('Remember to add your api key!');

function weatherBallon( cityID ) {
    fetch('https://api.openweathermap.org/data/2.5/weather?id=' + cityID+ '&appid=' + key)
    .then(function(resp) { return resp.json() }) // Convert data to json
    .then(function(data) {
        drawWeather(data);
    })
    .catch(function() {
        // catch any errors
    });
}
function drawWeather( d ) {
  var celcius = Math.round(parseFloat(d.main.temp)-273.15);
    var fahrenheit = Math.round(((parseFloat(d.main.temp)-273.15)*1.8)+32);
  var description = d.weather[0].description;

    document.getElementById('description').innerHTML = description;
    //document.getElementById('temp').innerHTML = celcius + '&deg;';
    document.getElementById('location').innerHTML = d.name;
    document.getElementById('wind-speed').innerHTML =  d.wind.speed+" m/s";
    document.getElementById('wind-deg').innerHTML = d.wind.deg+" degree";

}
window.onload = function() {
    weatherBallon( 285066 );//https://openweathermap.org/find --- click on city name will open => https://-
openweathermap.org/city/285066
}
</script>
```

Figure 33:code of api

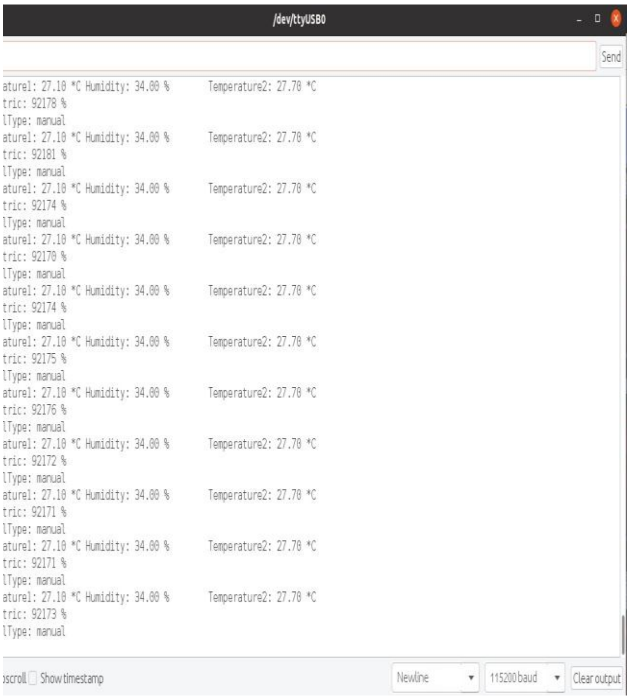
The shape of the data that the API website is back in the form of JSON:

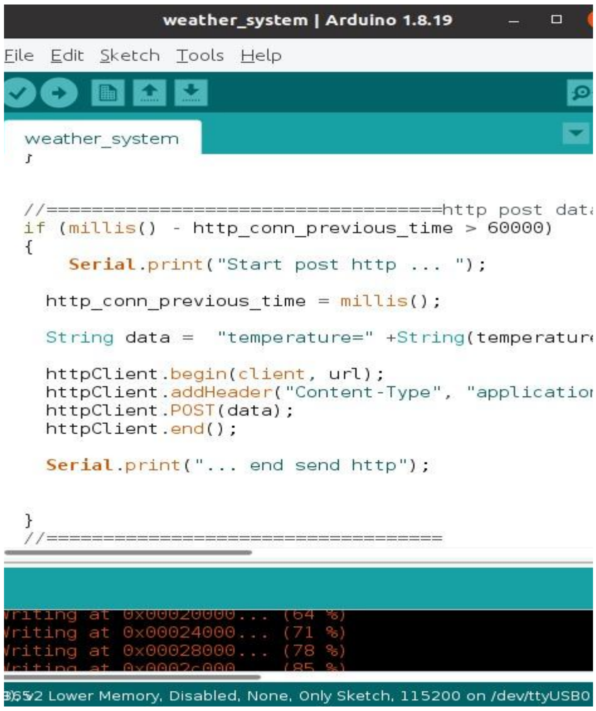

```
{
  "coord":{
    "lon":-79.42,
    "lat":43.7
  },
  "weather":[
    {
      "id":804,
      "main":"Clouds",
      "description":"overcast clouds",
      "icon":"04n"
    }
  ],
  "base":"stations",
  "main":{
    "temp":292.15,
    "pressure":1023,
    "humidity":72,
```

```
    "temp_min":291.15,
    "temp_max":293.15
  },
  "visibility":14484,
  "wind":{
    "speed":5.7,
    "deg":130
  },
  "clouds":{
    "all":90
  },
  "dt":1537837200,
  "sys":{
    "type":1,
    "id":3721,
    "message":0.0039,
    "country":"CA",
    "sunrise":1537873704,
    "sunset":1537916966
  },
  "id":6167865,
  "name":"Toronto",
  "cod":200
}
```


5.4 Hardware Testing

In this section we will discuss the testing of components.





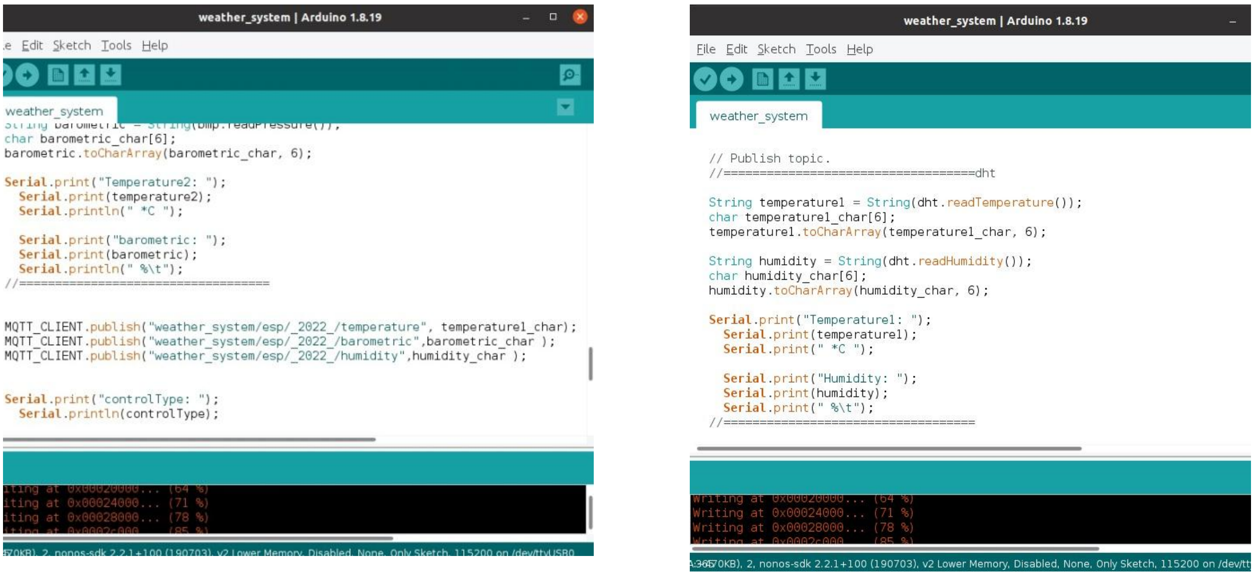


Figure 34:test code

5.5 System Test

After ensuring that all the parts are working properly, we started assembling and integrating the parts with each other to make the system ready to operate.

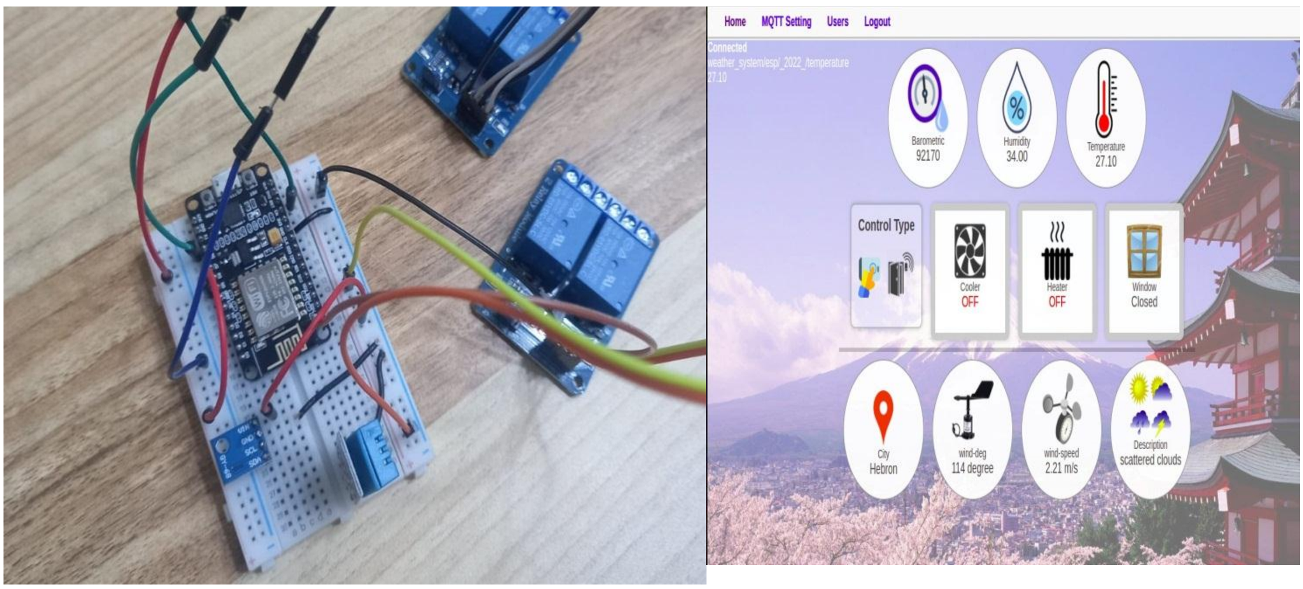


Figure 35:system test

Chapter 6
Conclusion & Future work

6.1 Overview

In this chapter, we will conclude the challenges, final result and future work of our project.

6.2 Final Result

1. An integrated system was made between hardware and software.
2. The system works to measure the humidity,
3. The system works to measure atmospheric pressure.
4. The system works to measuring the temperature .
5. The system fetch the wind speed .
6. The system works to open and close window .
7. The system works to turn on fan and heater .

6.3Futures Works

The system can be developed in the future by adding new sensors such as providing electric power in case of heavy rain or strong winds to avoid power outages and other electronic parts.

6.4 Conclusion

At the end of the project we were able to measure the temperature, humidity, and atmospheric pressure and fetch the values of wind speed from a weather website through a specific api and we were also able to control the windows, fan and heating and display all these results on the website we worked on.

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