VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELAGAVI -590 018

A Mini-Project Report on

WEATHER STATION USING ESP32

A Mini Project submitted in the partial fulfillment for the award of the degree

Bachelor of Engineering in Electronics and Communication Engineering

Submitted by

Bhagyashree	**1AY22EC020**
Nirmala	**1AY22EC059**
Abhishek	**1AY23EC401**
Pavan BS	**1AY23EC408**

Under the Guidance of
Dr. Nikita Kar Chowdhury
Assistant Professor
Department of ECE

2024-2025

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Acharya Institute of Technology

Acharya Dr. Sarvepalli Radhadrishnan Road, Soladevanahalli, Bengaluru-560107

ACHARYA INSTITUTE OF TECHNOLOGY

Acharya Dr. Sarvepalli Radhakrishnan Road, Soladevanahalli, Bengaluru 560107

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING.

CERTIFICATE

Certified that the Mini-Project entitled **"WEATHER STATION USING ESP32"** is carried out by **Bhagyashree (1AY22EC020), Nirmala (1AY22EC059) , Abhishek (1AY23EC401) and Pavan BS (1AY23EC408)** in the partial fulfillment for the award of the degree of Bachelor of Engineering in Electronics and Communication Engineering of Visvesvaraya Technological University, Belagavi during the year **2024-2025**. It is certified that all corrections/suggestions indicated for the assessment have been incorporated in the report deposited in the departmental library. The Mini-Project Report has been approved as it satisfies the academic requirement in respect of Mini-Project (BEC586) prescribed for the Bachelor of Engineering Degree.

……………………
Signature of Guide
Dr. Nikita Kar Chowdhury
Assistant professor
Dept of ECE, AIT

…………………
Signature of HOD
Dr. Rajeswari
Head of the Department
Dept of ECE, AIT

…………………
Signature of Principal
Dr. Rajeswari
Principal, AIT

Name of the Examiners Signature with date

1

2

DECLARATION

We the students of Fifth semester Electronics and Communication Engineering, Acharya Institute of Technology, Soladevanhalli Bengaluru -560107 declare that work entitled "WEATHER STATION USING ESP32" has been successfully completed under the guidance Dr. Nikita Kar Chowdhury, Assistant professor, Department of ECE, Acharya Institute of Technology, Bengaluru. This dissertation work is submitted to Visvesvaraya Technological University in partial fulfilment of the requirements for the awardof Degree of Bachelor of engineering in Electronics and Communication Engineering duringthe academic year 2024-2025. Further the matter embodied in the mini-project report has not been submitted previously by anybody for the award of any degree or diploma to any university.

Place: Bengaluru

Date:

Mini-Project Group:

Bhagyashree	**1AY22EC020**
Nirmala	**1AY22EC059**
Abhishek	**1AY23EC401**
Pavan BS	**1AY23EC408**

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Bhagyashree 1AY22EC020
Nirmala 1AY22EC059
Abhishek 1AY23EC401
Pavan BS 1AY23EC408

ABSTRACT

The system proposed in this paper is an advanced solution for monitoring the weather conditions at a particular place and making the information visible anywhere in the world. The technology behind this is the Internet of Things (IoT), which is an advanced and efficient solution for connecting things to the internet and connecting the entire world of things in a network. Here things might be whatever like electronic gadgets, sensors, and automotive electronic equipment. The system deals with monitoring and controlling the environmental conditions like temperature, relative humidity, and CO level with sensors and sends the information to the web page, and then plots the sensor data as graphical statistics. The data updated from the implemented system can be accessible in the internet from anywhere in the world.

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CHAPTER 1

INTRODUCTION

Here we introduce a smart weather reporting system over the Internet. Our introduced system allows for weather parameter reporting over the Internet. It allows the people to directly check the weather states online without the need of a weather forecasting agency. System uses temperature, humidity as well as rain with humidity sensor to monitor weather and provide live reporting of the weather statistics. The system constantly monitors temperature using temperature sensor, humidity using humidity sensor and also for rain.

Weather monitoring system deals with detecting and gathering various weather parameters at different locations which can be analysed or used for weather forecasting. The aim of this system is achieved by technologies such as Internet of Things (IOT) and Cloud. The idea of internet of things is to connect a device to the internet and to other required connected devices. Using Internet the information from the IOT device can easily be transferred to the cloud and then from the cloud to the end user. Weather Monitoring is an essential practical implementation of the concept of Internet of Things, it involves sensing and recording various weather parameters and using them for alerts, sending notifications, adjusting appliances accordingly and also for long term analysis. Also we will try to identify and display trends in parameters using graphical representation. The devices used for this purpose are used to collect, organize and display information. It is expected that the internet of things is going to transform the world by monitoring and controlling the phenomenon of environment by using sensors/devices which are able to capture, process and transmit weather parameters. Cloud is availability of computer system resources like data storage, computing power without direct active management of user. The data captured is transmitted to the cloud so that the data could be further displayed. Besides this, the system consists of components such as ESP32 board which is a microcontroller board consisting of 14 digital pins, a USB connection and a USB connection and everything used to support microcontroller; DHT22 is Temperature and humidity sensor which is used for detecting these mentioned parameters; WIFI module is used to convert the data collected from the sensors and then send it to the web server. So, in this way weather conditions of any location can be monitored from any remote location in the world. The system constantly transmits this data to the micro controller which now processes this data and keeps on transmitting it to the online web server over a wifi connection. This data is live updated to be viewed on the online server system. Also system allows user to set alerts for particular instances. In today's world many pollution monitoring systems are designed by different environmental parameters. Existing system model is presented IOT based Weather monitoring and reporting system where you can collect, process, analyze, and present your measured data on web server. Wireless sensor network management model consists of end device, router, gateway node and management monitoring centerAlso system allows user to set alerts for particular instances. In today's world many pollution monitoring systems are designed by different environmental parameters. Existing system model is presented IOT based Weather monitoring and reporting system where you can collect, process, analyze, and present your measured data on web server. Wireless sensor network management model consists of end device, router, gateway node and management monitoring center.

CHAPTER 2

LITURATURESURVEY

- The author describes an IoT-based weather monitoring system. The environmental parameter can be collected by sensors in this study. The author employs a variety of sensors to scale various parameters such as humidity, temperature, pressure, and rain value, including the LDR sensor. The temperature prototype is also used to compute the dew point value. The temperature sensor can be used to determine the temperature of a certain region, room, or location. The light intensity can be employed as described by the author with the help of the LDR sensor. The author employed an additional functionality of weather monitoring in this as an SMS alert system depending on the value of sensing parameters such as temperature, humidity, pressure, light intensity, and rain exceeding the value of the sensing parameters. [1]
- The author of this work depicts a low-cost live weather monitoring system using an OLED display. To measure the weather conditions, the author solely employs two devices: Wemos and OLED. Following the connection, the data will be stored in the cloud, and the data will be shown on the Thingspeak website. The data is shown on an OLED screen and in the cloud by the system. The author's goal is to obtain real- time weather information on an OLED display. [2]
- The author of the work also depicts a similar NodeMCU based weather reporting system where a android application is being used to display the stored data in the Thingspeak cloud. The android application uses APIs to collect the data from the Thingspeak server and display the same in the dashboard. but in the system only a temperature and rain sensor is interfaced. The importance of microcontroller zsensor outputs for data storage and acquisition is overlooked in many research articles and studies in this field. The data acquired from the device can be processed and charted

in real time with a weather station monitoring system, as seen in this article. That is, the details can be exhibited and observed in two ways: directly and indirectly. Direct methodology ensures that weather patterns are recorded and saved in a computer asclimatic conditions, whereas indirect methodology ensures that weather patterns are recorded and stored in a computer as long as the sensors calculate climatic conditions. The key challenge in this study is demonstrating and validating that microcontroller and their sensors can be coupled to a data collecting network to create a database system.[3]

- The author , presents an IoT-based weather monitoring system. 4 In this research, the environmental parameter can be retrieved through sensors. The author uses a different sensor to scale the various parameter like humidity, temperature, pressure, rain value & the LDR sensor is used. The system also calculates the dew point value from the temperature prototype. The temperature sensor can be used to measure the value of the particular area, room, or any place. With the help of the LDR sensor, the light intensity can be used as described by the author. The author in this used an additional functionality of the weather monitoring as SMS alert system based on the exceed the value of the sensing parameters as temperature, humidity, pressure, light intensity, and rain value. The author also adds an email and tweet post alerting system. The author in this system uses node MCU 8266, and various sensors.[4]
- The author , implement an IoT-based weather monitoring system, in this research paper, the author describes that how with the help of IoT technology, the weather can be monitored. And which provide the info of climate-changing conditions. With the help of this project, people can be aware of the climate condition changes. It gives an accurate and efficient output and the algorithm as the swarm is used to implement for further improving the accuracy. So, in this project, the author aims to make a weather

monitoring with the help of IoT. In this project, the hardware and software are used which makes it easy to implement. In the project, the author uses a different sensor to collect the information of the climate and stored it in the cloud. For this storage, the website www.thingspeak.com is commonly used for Internet of things projects. And from the cloud storage space, it extracts the whole weather data and uploads it to the android mobile application using an API key. Tools which detect the rain drops, is called rain sensor.[5]

CHAPTER 3

HARDWARE COMPONENTS

SL NO	COMPONENTS	QUANTITY
1	ESP 32	1
2	DHT 11	1
3	BMP180	1
4	SI1145	1
5	BREAD BOARD	1
6	HALL EFFECT SENSOR	1
7	LCD DISPLAY WITH I2C INTERFACE	1
8	ARDUINO UNO	1
9	MICRO USB CABLES	1
10	MALE TO FEMALE JUMPER WIRES	------

Table 3.1 : Components used

3.1.1 ESP 32

A low-cost System on Chip (SoC) that is perfect for Internet of Things (IoT) applications that need connection is the ESP32 microcontroller. It is a flexible option for developing Internet of Things applications because it has Bluetooth and Wi-Fi capabilities. The ESP32 has more functions than the ESP8266, which is solely meant for Wi-Fi networking. These include serial communication, high-resolution ADCs, and DACs. The ESPWROOM-32 module, two rows of IO pins (15 pins on each side), a micro-USB connection for programming and power, reset and boot buttons, power and user LEDs (attached to GPIO2, respectively), and an enable and boot button are all included in the ESP32 microcontroller. For IoT projects, the ESP32 microcontroller is a special and potent option because of these capabilities.

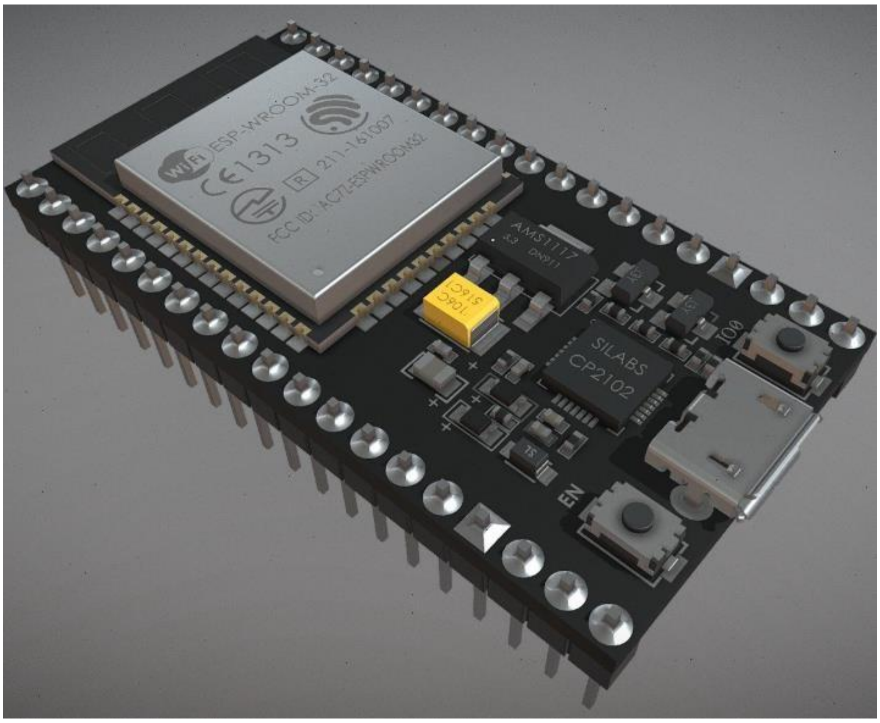

Figure 3.2: ESP32

3.1.2 DHT 11

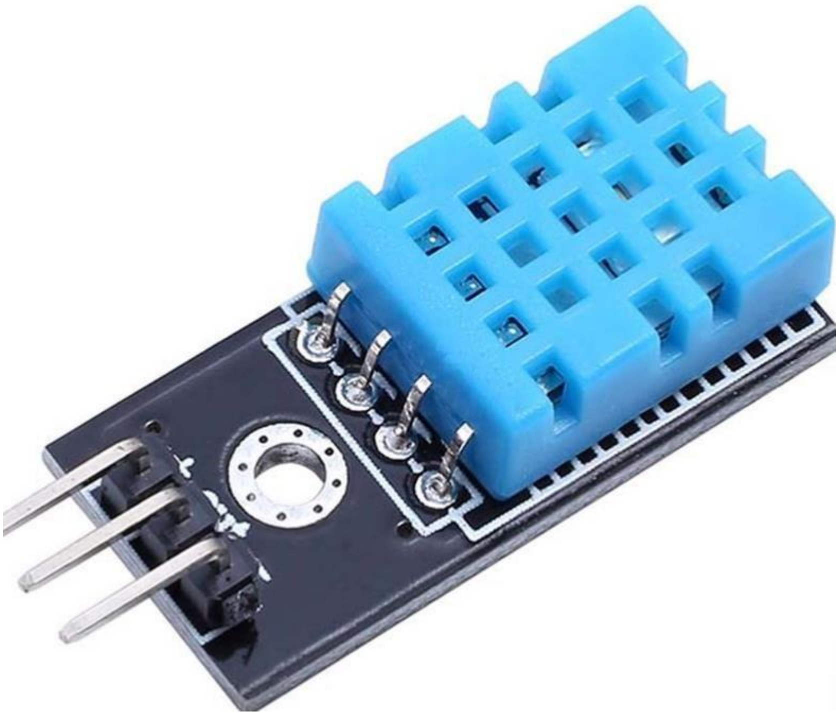

Figure 3.3. DHT 11

The DHT11 is a popular digital sensor used to measure temperature and humidity in various applications. It provides reliable and cost-effective environmental data for weather stations, home automation systems, HVAC systems, and industrial environments. Common uses include monitoring indoor climate for health and comfort, controlling heating and cooling systems, and measuring humidity in greenhouses or storage areas. The DHT11 is also used in educational projects and DIY weather stations due to its simplicity and ease of use. Despite its low accuracy compared to more advanced sensors, it is ideal for non-critical applications requiring basic environmental data.

3.1.3 BMP180

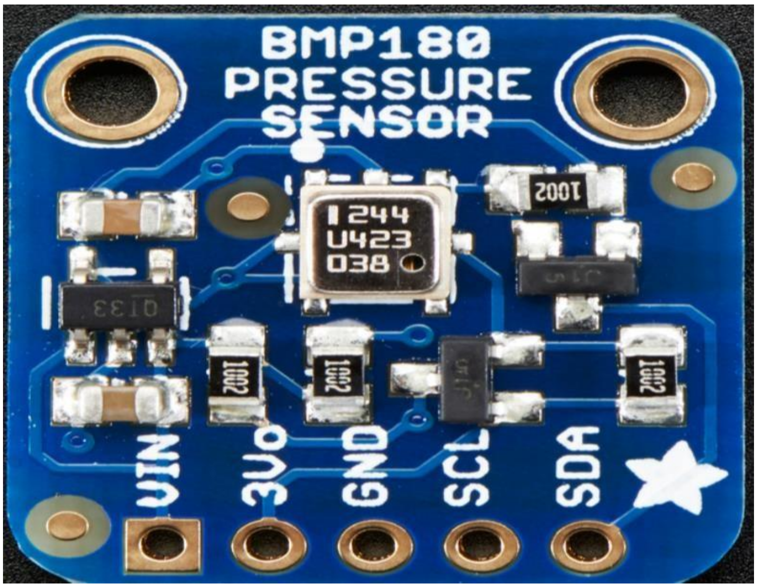

Figure 3.4: BMP180

The BMP180 is a high-precision barometer and temperature sensor developed by Bosch. It is designed to measure atmospheric pressure and temperature, providing accurate data for various applications such as weather forecasting, altitude measurement, and GPS enhancement. The sensor utilizes a MEMS (Micro-Electro-Mechanical Systems) technology to deliver precise measurements. It features a wide pressure range (300 to 1100 hPa) and high resolution (0.01 hPa), ensuring accurate results in different environmental conditions. Its low power consumption makes it ideal for portable devices, while the built-in calibration ensures reliable and stable readings over time.

3.1.4 SI1145

The SI1145 is a versatile environmental sensor by Silicon Labs, designed for accurate measurement of ultraviolet (UV) light, ambient light, and proximity. It features an integrated photodiode and digital signal processing, offering precise readings of UV index, ambient light intensity, and proximity to objects. The sensor is highly accurate with a wide operating range, making it suitable for applications such as wearable devices, health monitoring, and environmental sensing. With low power consumption and small form factor, the SI1145 ensures reliable performance in a variety of conditions, while providing accurate data for UV exposure tracking and ambient light sensing.

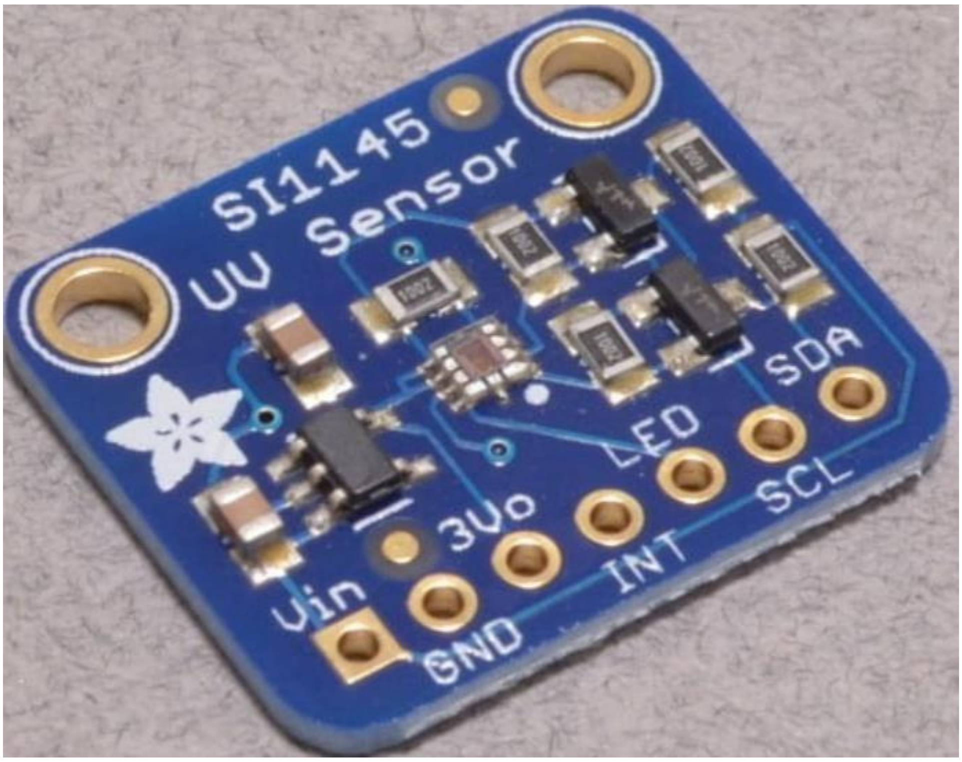

Figure 3.5: Sl1145

3.1.5 BREAD BOARD

A breadboard is a versatile tool used in electronics for prototyping and testing circuits without soldering. It consists of a grid of interconnected holes where electronic components, such as resistors, capacitors, and ICs, can be inserted. The rows and columns are electrically connected, enabling easy circuit construction and modification. Breadboards are commonly used by engineers, hobbyists, and students to build and experiment with designs. They support quick assembly and reconfiguration, which makes them ideal for iterative testing. Breadboards are available in various sizes and can handle both analog and digital circuits, offering a reliable, reusable platform for experimentation.

Figure 3.6: BREAD BOARD

3.1.6 HALL EFFECT SENSOR

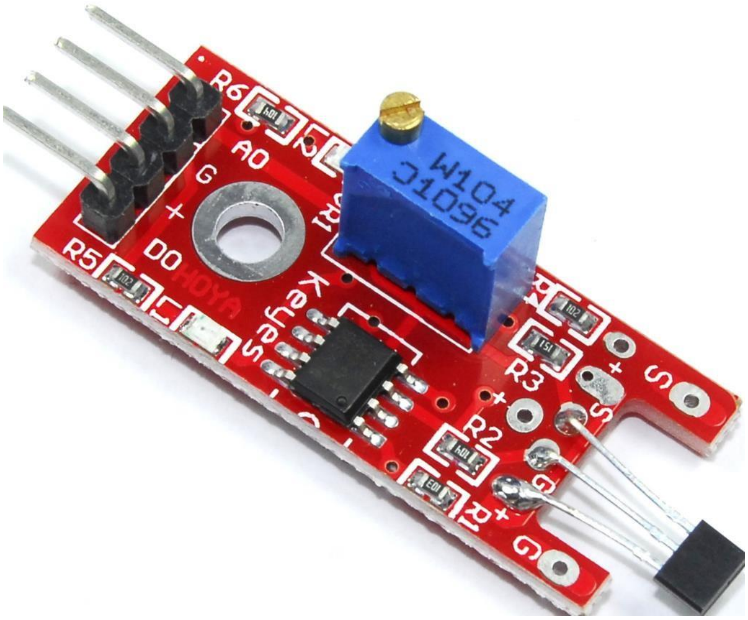

Figure 3.7: HALL EFFECT SENSOR

A Hall effect sensor detects magnetic fields and converts them into an electrical signal. It operates based on the Hall effect, which occurs when a current-carrying conductor is placed in a magnetic field, generating a voltage perpendicular to both the current and magnetic field. This voltage is measured by the sensor and used to determine the strength or polarity of the magnetic field. Hall effect sensors are commonly used in applications like speedometers, proximity sensors, current sensing, and brushless DC motor control. They are valued for their non-contact nature, high reliability, and ability to operate in harsh environments without wear.

3.1.7 LCD DISPLAY

An LCD (Liquid Crystal Display) is a flat-panel display technology that uses liquid crystals to produce images. It consists of layers of liquid crystals sandwiched between polarizing filters and electrodes. When an electric current passes through the liquid crystals, they align in a way that either blocks or allows light to pass through, creating images or text. LCDs are energy-efficient and offer clear, high-resolution displays, making them common in devices like TVs, smartphones, monitors, and calculators. They are thinner and lighter compared to older display technologies like CRTs, and can display colorful graphics, text, and video withhigh clarity.

Figure 3.8: LCD DISPAY WITH I2C INTERFACE

3.1.8 ARDUINO UNO

The Arduino Uno is a popular microcontroller board based on the ATmega328P chip. It is widely used in electronics and programming projects due to its simplicity and versatility. The board features 14 digital input/output pins, 6 analog inputs, a USB connection for programming, and a power jack. The Arduino Uno can be powered via USB or an external source, making it suitable for various applications. It supports the Arduino IDE (Integrated Development Environment) for coding and uploading programs. Its open-source nature encourages community-driven development and experimentation, making it ideal for hobbyists, students, and prototyping professionals.

Figure 3.9: ARDUINO UNO

3.1.9 MICRO USB CABLES

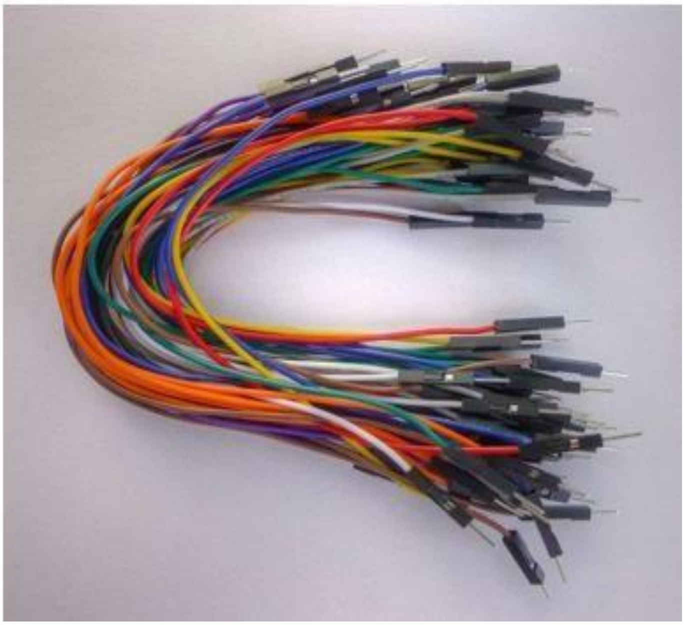

Figure 3.10: MICRO USB CABLES

3.1.10: MALE TO FEMALE JUMPER WIRES

Male to female jumper wires are essential components for prototyping and connecting electronic circuits. These wires provide accurate and reliable connections between components, such as sensors, microcontrollers, and breadboards. The male end features a pin that plugs into headers or sockets, while the female end has a receptacle to accept male pins. Available in various lengths and colors, these jumper wires ensure precise connections, minimizing signal loss or interference. Their versatility makes them ideal for use in both temporary breadboard setups and more permanent projects. Accurate and easy to use, they are a staple in electronics and DIY projects.

Figure 3.11: MALE TO FEMALE JUMPER WIRES

CHAPTER 4

DESIGNING AND WORKING

METHODOLOGY

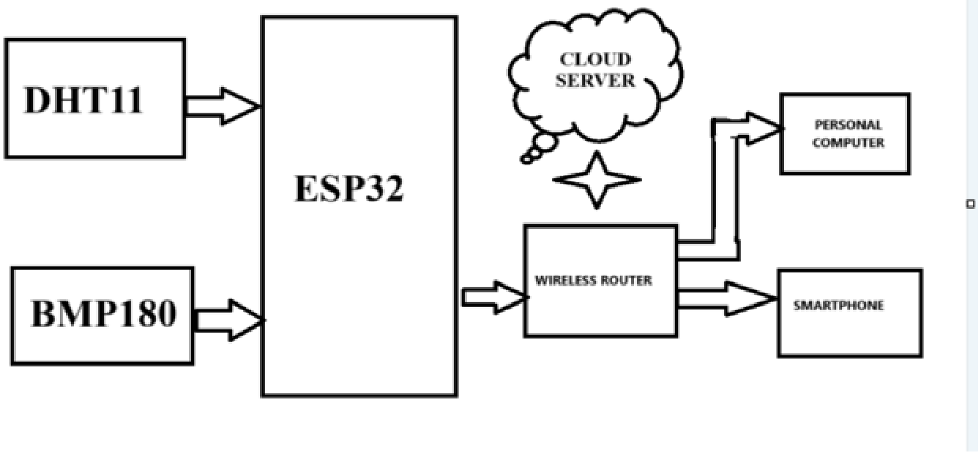

Figure 4.1 :WEATHER STATION USING ESP32

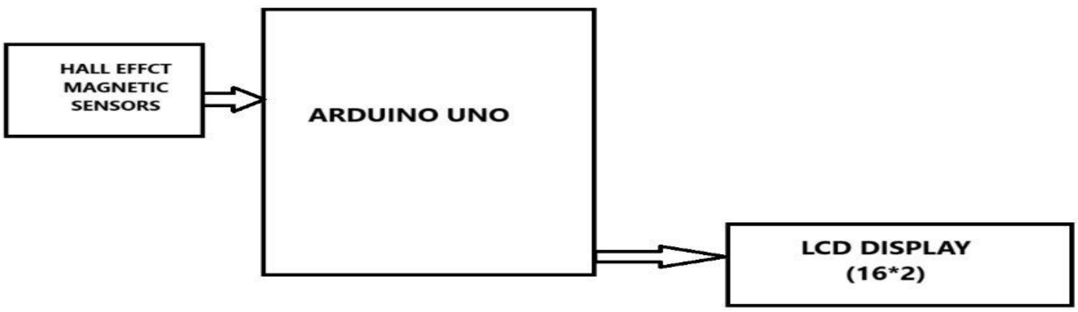

Figure 4.2: RAIN GAUGE USING ARDUINO UNO

WORKING PRINCIPLE:

Sensors measure environmental data (temperature, humidity, wind speed, etc.).ESP32 processes and sends data via Wi-Fi to ThingsPak Cloud using HTTP or MQTT.ThingsPak Cloud stores, processes, and visualizes the data, offering real-time monitoring, historical analysis, and alerts.User Interface* allows users to view, track, and manage weather data remotely.This system enables efficient weather monitoring and real-time decision-making based on environmental conditions, all powered by an affordable microcontroller (ESP32) and a cloud platform (ThingsPak Cloud).

A rain gauge, particularly a tipping bucket rain gauge, works by collecting rainwater in a small bucket that tips once a predefined amount of rain has accumulated. The tipping mechanism generates pulses, each corresponding to a specific amount of rainfall, which can then be counted and used to determine the total rainfall. This system can be integrated with Arduino or other microcontrollers to automate data collection and send it to a display or cloud-based monitoring platform for real-time tracking and analysis.

CHAPTER 5
Proposed System and Hardware Architecture

5.1. Features of purposed system

In IOT enabled weather monitoring system project, Arduino Uno measures 4 weather parameters using respective 4 sensors. These sensors are a temperature sensor, humidity sensor, light sensor, and rain level sensor. These 4 sensors are directly connected to Arduino Uno since it has an inbuiltAnalog to digital converter. The weather monitoring system gives high accuracy and reliability for weather monitoring and climate changing. It uses the renewable energy source like solar panel for charging the connected battery. Through the web, it access real time weather information and data. This system can be communicated over general packet radio service (GPRS) network. Low maintenance is required for end users. It is capable for storing data and providing it to the users as required.

5.2. Purposed Hardware Architecture

The implemented system consists of a microcontroller (ESP8266) as a main processing unit for the entire system and all the sensor and devices can be connected with the microcontroller. The sensors can be operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and updates it to the internet through Wi-Fi module connected with via blynk app then we can measure temperature, humidity, pressure and rain fall.

5.1 Circuit Diagram

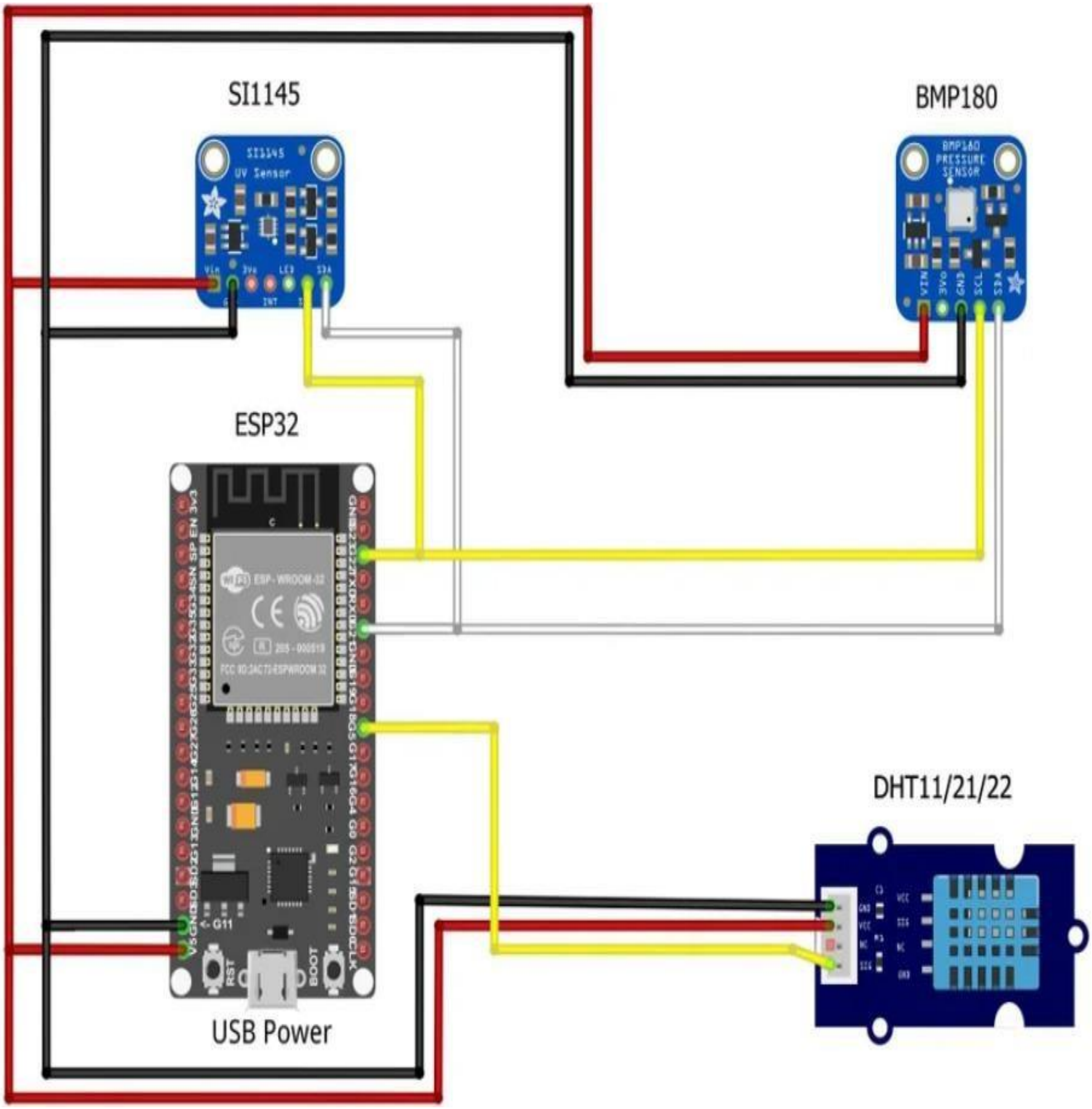

Figure 5.1. Circuit Diagram

ThingsPak Cloud is a cloud-based platform designed primarily for the Internet of Things (IoT) applications. It provides infrastructure and services that enable users to connect, manage, and monitor IoT devices and their data. The platform typically offers a variety of features such as device management, data storage, analytics, and communication for connected devices.

While there isn't a widely recognized or standardized "ThingsPak Cloud" in the IoT industry (as of my knowledge cutoff in 2023), the name suggests a cloud service geared towards managing and processing data from IoT devices. The concept could align with services provided by other popular IoT cloud platforms like AWS IoT, Google Cloud IoT, Microsoft Azure IoT, and others.

5.1.2 Circuit Diagram

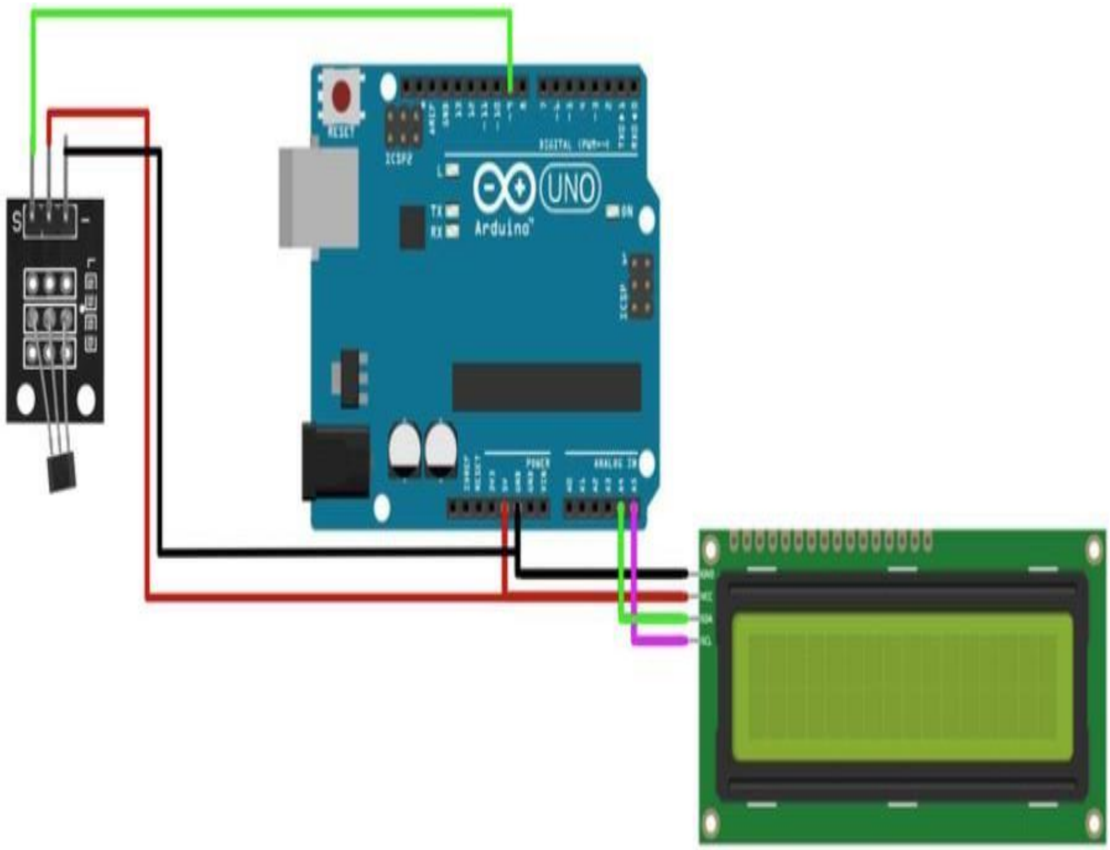

Figure 5.2. Circuit Diagram

Building a DIY Arduino Rain Gauge involves gathering the necessary components, wiring them correctly to the Arduino, coding the logic to count rainfall events, and then testing and deploying the system. It's a great way to learn about sensors, programming, and IoT. By customizing the system to suit your needs, you can track and monitor rainfall patterns over time in your area.

CHAPTER 6

SOFTWARE REQUIREMENTS

6.1.1: PROGRAM ON WEATHER STATION

```
#include <DHT.h>
#include <WiFi.h>
#include <WiFiClient.h>
#include <ThingSpeak.h>
#include <Adafruit_Sensor.h>
#include <BMP180>
#define DHTPIN 4
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
const char* ssid = "vivo T1 5G";
//ARDUINO AND RASPBERRY PI BASED PROJECT  BEEL456D
const char* password = "11111111";
WiFiClient client;
unsigned long myChannelNumber = 2783754;
const char * myWriteAPIKey = "OL9HCJVCMO39CVZ5";
uint8_t temperature, humidity , pressure;
void setup()
{
Serial.begin(9600);
dht.begin();
delay(10);
//Connect to WiFi network
Serial.println();
Serial.println();
Serial.print("Connecting to ");
Serial.println(ssid);
```

```
WiFi.begin(ssid, password);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
Serial.println("");
Serial.println("WiFi connected");
// Print the IP address
Serial.println(WiFi.localIP());
ThingSpeak.begin(client);
}
void loop()
{
temperature = dht.readTemperature();
humidity = dht.readHumidity();
pressure = dht.readPressure();
Serial.print("Temperature Value is :");
Serial.print(temperature);
Serial.println("C");
Serial.print("Humidity Value is :");
Serial.print(humidity);
Serial.println("%");
Serial.print("Pressure Value is :");
Serial.print(Pressure);
Serial.println("pa");
// Write to ThingSpeak. There are up to 8 fields in a channel,
allowing you to store up to


// pieces of information in a channel. Here, we write to field
1 and 2
ThingSpeak.writeField(myChannelNumber, 1, temperature,
```

```
myWriteAPIKey);

ThingSpeak.writeField(myChannelNumber, 2, humidity,
myWriteAPIKey);

ThingSpeak.writeField(myChannelNumber, 3, Pressure,
myWriteAPIKey);

delay(2000);

// ThingSpeak will only accept updates every 3 seconds.

}
```

6.1.2 PROGRAM ON RAIN GAUGE

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);
const float mmPerPulse = 0.173;
 //put here the value of rain in mm for each movement of the
bucket
float mmTotali = 0;
int sensore = 0;
int statoPrecedente = 0;
void setup() {
  pinMode(9, INPUT);

  lcd.init();
  lcd.init();
  lcd.backlight();
  lcd.setCursor(4,0);
  lcd.print("Pluviometro");
  lcd.setCursor(7,0);
  lcd.print("RESET");

  delay(1000);

  lcd.clear();
}

void loop() {
  sensore = digitalRead(9);

  if (sensore != statoPrecedente) {
    mmTotali = mmTotali + mmPerPulse;
  }

  delay(500);
  statoPrecedente = sensore;
  lcd.setCursor(4,0);
  lcd.print("Pluviometro");
  lcd.setCursor(2,0);
  lcd.print("Pioggia totale:");
  lcd.setCursor(2,0);
  lcd.print(mmTotali);
  lcd.setCursor(7,1);
  lcd.print("mm");
}
```

CHAPTER 7
APPLICATIONS, MERITS AND DEMERITS

7.1 Applications:

- **Engineering ,Industry And Infrastructure:** Applications of IoT in these areas include improving production, marketing, service delivery, and safety. IoT provides a strong means of monitoring various processes; and real transparency creates greater visibility for improvement opportunities. The deep level of control afforded by IoT allows rapid and more action on those opportunities, which include events like obvious customer needs, nonconforming product, malfunctions in equipment, problems in the distribution network, and more.

- **Government And Safety**: IoT applied to government and safety allows improved law enforcement, defense, city planning, and economic management. The technology fills in the current gaps, corrects many current flaws, and expands the reach of these efforts. For example, IoT can help city planners have a clearer view of theimpact of their design, and governments have a better idea of the local economy.

- **Home And Office:** In our daily lives, IoT provides a personalized experience from the home to the office to the organizations we frequently do business with. This improves our overall satisfaction, enhances productivity, and improves our health and safety. For example, IoT can help us customize our office space to optimize our work.

- **Health And Medicine**: IoT pushes us towards our imagined future of medicine which exploits a highly integrated network of sophisticated medical devices. Today, IoT can dramatically enhance medical research, devices, care, and emergency care. The integration of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organization.

7.2 Merits:

- Decreased field damaging conditions
- Improved safety and security
- High-quality receiving data
- Lesspower
- Accuracy is High
- Smartway to amonitor Environment
- The lowcost and efforts are less in this system.

7.3 Demerits:

Great influence by environment: the sensors and other equipment of automatic weather station are greatly influenced by the environment, such as encountering bad weather or polluted environment, which may affect the accuracy of observation data.

CHAPTER 8

OUTCOMES

8.1.1: ESP32 WEATHER STATION

RESULT:

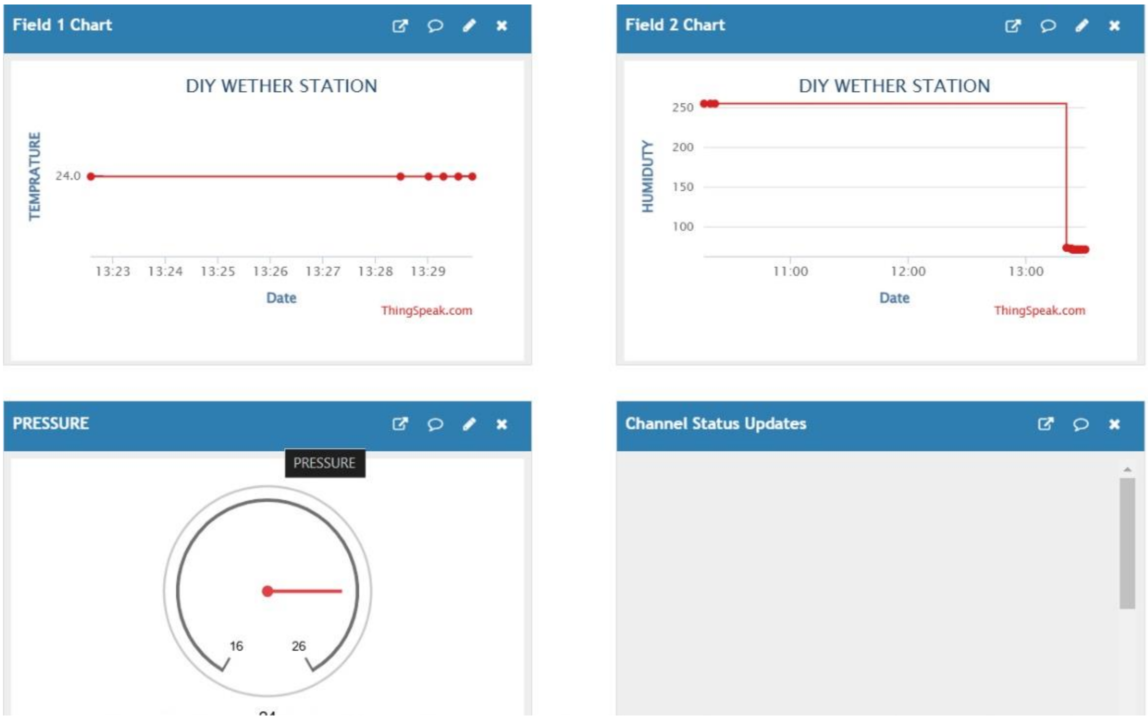

Figure 8.1: Weather station output

8.1.2 DIY ARDUINO RAIN GAUGE

RESULT:

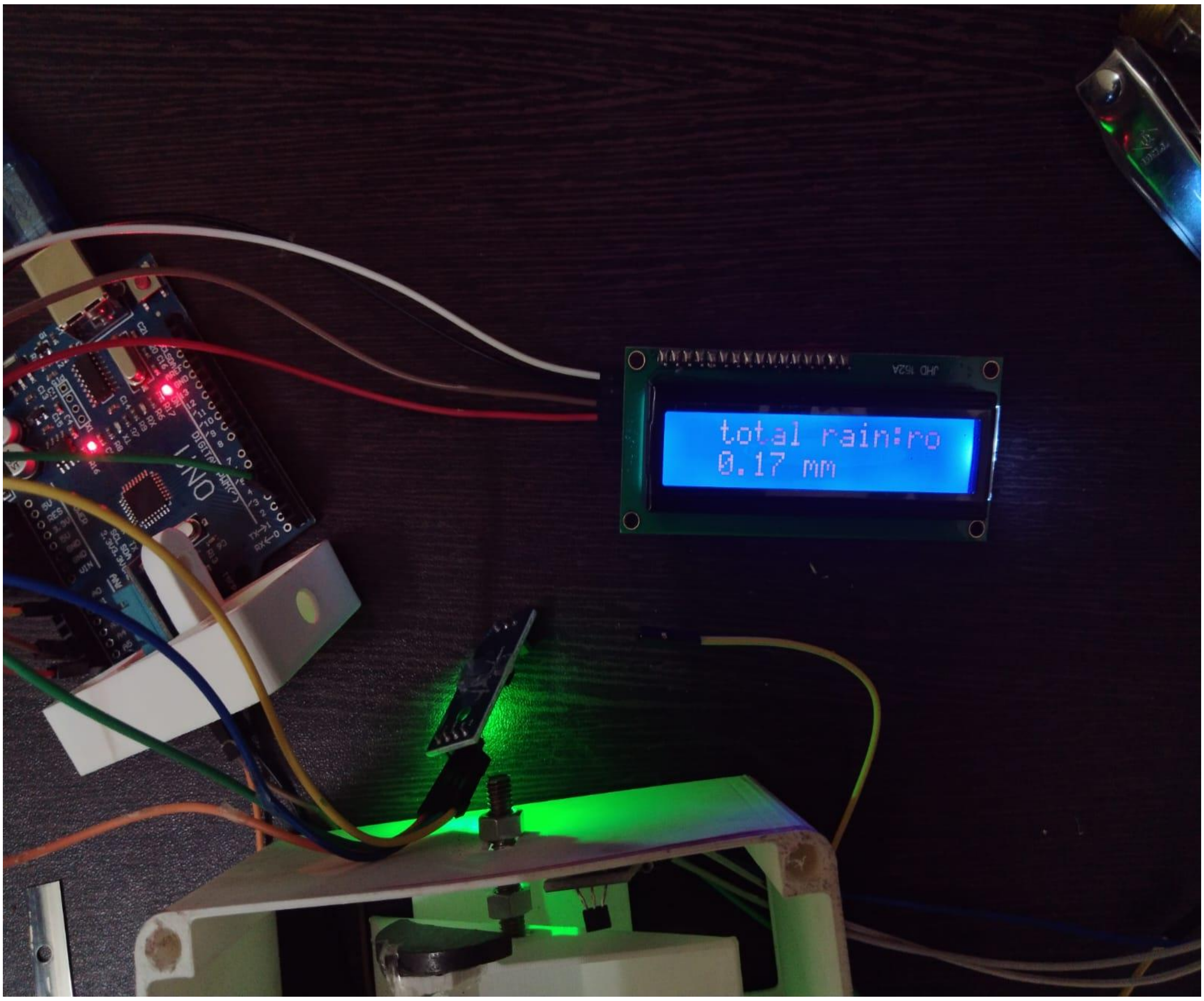

Figure 8.2: Rain Gauge Output

CHAPTER 9

CONCLUSION

self-protection (i.e., smart environment) to the environment. To implement this need to use the sensor devices in the environment for collecting the data and analysis. By using sensor devices in the environment, we can bring the environment into real life. Then the collected data and analysis results will be available to the user through the Wi-Fi. The smart way to monitor the environment an efficient, low-cost embeddedBy keeping the weather station in the environment for monitoring enables system is presented in this paper. It also sent the sensor parameters to the cloud. This data will be helpful for future analysis and it can be easily shared to other users also. This model can be expanded to monitor the developing cities and industrial zones for pollution monitoring. To protect the public health from pollution, this model provides an efficient and low-cost solution for continuous monitoring of environment.

FUTURE SCOPE

With the increasing adoption of IoT in various industries, including weather monitoring. we can expect to see more advanced and innovative solutions.Some possible developments include:

- More accurate forecasting: Technology and data analytics advancements will enable IoT-based weather monitoring systems. These systems will provide even more accurate forecasts.
- Integration with other systems: IoT-based weather monitoring systems can be integrated. These systems include smart homes and smart cities, enhancing their capabilities. For example, a smart home could adjust its temperature settings based on real-time weather data.
- Machine learning: Using machine learning algorithms, IoT-based weather monitoring systems can continuously learn from past data. This enables them to improve their forecasting abilities over time.

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