LONDON METROPOLITAN UNIVERSITY

islington college
(इस्लिङ्टन कलेज)

Module Code & Module Title
CC4003NI Introduction to Robotics and IoT

IoT-Based Monitoring for ING Farm

Assessment Type
50% Development Report

Semester
2023 Autumn

Group members

London Met ID	Student Name
23048667	Pawan Pokhrel
23048578	Kabindra Bikram Karki
23048508	Suyash Koirala
23048631	Bibek Kumar Singh

Assignment Due Date:5th May, 2024
Assignment Submission Date:5th May, 2024
Word Count: 3417

I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

ACKNOWLEDGEMENT

We wish to express my profound gratitude to our supervisor **Mr. Shishir Subedi**, for his continuous support and suggestion without whom we could not have completed our project. His motivation and guidance helped us a lot. We would also thank Islington College Introduction to Robotics and IoT department for providing us this opportunity to carry out this study. We are heartfully thankful to **Mr. Shishir Subedi** for his constant guidance throughout the study. We feel deep sense of gratitude to him for his unconditional support and we are honored to have him as adviser.

Special thanks to all the group members for their support and help and to all the other friends who assisted us during the study. Lastly, we are thankful to our family members who supported us to complete this study.

Pawan Pokhrel and the group
May 2024

ABSTRACT

Precision farming methods might undergo a significant change thanks to the innovative solution provided by the Internet of Things-based farm monitoring system. Through the use of state-of-the-art sensor technology, cloud-based data processing, and intuitive interfaces, the system allows for the real-time monitoring of critical environmental factors that are critical to crop yield and health. Agricultural data is easily gathered, transferred, and analysed using a network of interconnected devices, including sensors, microcontrollers, communication modules, and cloud services. With a focus on the requirements of farmers, the user experience is created with them in mind, showcasing visually attractive dashboards and dynamic data visualizations. By providing farmers with practical insights, the system facilitates well-informed decision-making and optimizes the allocation of resources. The system's architecture incorporates scalability and flexibility to handle a range of farm sizes and configurations, hence guaranteeing responsiveness to changing agricultural methods.

Keywords: IoT (Internet of Things), Precision Agriculture, Farm Monitoring System, Sensor Technologies, Environmental Parameters, Cloud-Based Data Processing, User-Friendly Interfaces, Real-Time Monitoring, Agricultural Data Analysis, Scalability, Adaptability, Sustainable Farming, Decision Support, Resource Optimization, Collaboration.

TABLE OF CONTENT

Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER I: INTRODUCTION

1.1. Current Scenario

Nepal's agriculture industry is at a turning point as it struggles to meet modernization's expectations while maintaining traditional methods. Since a large percentage of the population depends on agriculture as their major source of income and the backbone of the economy, efficiency and innovation are critical. But the industry has a lot of obstacles to overcome, such as poor infrastructure, restricted access to contemporary technologies, and the negative effects of climate change. With real-time data on crop health and environmental conditions, IoT-based monitoring devices have the potential to completely transform agricultural operations in this setting. Through the use of this technology, Nepalese farmers may increase productivity, reduce resource consumption, and adjust to climate change, all of which will contribute to the sustainability of rural people' livelihoods and supply of food.

Despite the potential advantages, barriers including low technology knowledge and tight budgets among farmers prevent the IoT from being widely used in Nepalese agriculture. In addition, many agricultural areas are isolated and have rough terrain, which presents logistical issues for IoT infrastructure development and maintenance. To encourage the integration of IoT technology in agriculture, however, government agencies, research institutes, and private sector partners are putting forth concentrated efforts to overcome these obstacles. Nepal has the ability to use the revolutionary potential of the Internet of Things (IoT) in agriculture to create sustainable development and resilience in the face of modern problems. This may be achieved via focused capacity-building efforts, investments in rural infrastructure, and partnership with local people.

1.2. Problem Statement and Project as a Solution

The ongoing difficulty of effectively allocating water resources while guaranteeing ideal crop development is evident in Nepal's agricultural environment. Especially in the face of unpredictable weather patterns made worse by climate change, traditional irrigation techniques frequently prove insufficient, resulting in water waste and lower returns. It is clear that a solution is required that takes these problems into account and respects the socioeconomic reality of rural areas.

By implementing an Internet of Things (IoT)-based monitoring system specifically designed for Nepalese agriculture, our initiative aims to address this issue head-on. This technology attempts to provide farmers the information they need to enhance irrigation techniques by giving real-time data on important environmental parameters including temperature, humidity, water tank levels, and soil moisture content. By using the Blynk application to enable remote monitoring and control, farmers can make well-informed decisions based on the unique requirements of their crops. This approach conserves water resources, optimizes crop yields, and strengthens Nepal's agricultural sector's resilience to changing weather patterns.

1.3. Aim and Objectives

By deploying an Internet of Things-based monitoring system, this project seeks to solve the urgent problem of ineffective water resource management in Nepalese agriculture. Through the use modern technology, the project aims to increase crop yields, preserve water, and streamline irrigation procedures in order to support Nepal's agriculture industry's resilience and sustainability.

The project aims to empower Nepalese farmers with the tools and insights needed to enhance agricultural productivity while mitigating the impacts of climate variability. The major objectives of this IoT based farm monitoring are as follow:

- To create an IoT-based monitoring system that gathers data in real time on soil moisture content, water levels, temperature, and humidity.
- To make remote monitoring and control possible through the Blynk app, giving farmers easy access to irrigation management resources.
- To optimize irrigation techniques using data-driven insights from the IoT system with the goal of lowering water waste and increasing agricultural yields.
- to confirm the system's dependability and efficacy through extensive testing in various Nepalese agricultural environments.

CHAPTER II: BACKGROUND

2.1. System Overview

Modernizing Agriculture with IoT-Based Monitoring for ING farm focused on improving agriculture sector for effective yielding of crops, converting the agriculture towards new technologies by using new trends including various modern sensors to solve different problems about agriculture. Effective use of these sensors and implementation of the IoT system in real time according to the need of the farmers in the ING farm.

The hardware architecture consists of different sensors such as DHT11 Temperature/humidity sensor, Soil moisture sensor, Ultrasonic sensor, Buzzer, Water pump, LCD display(I2C) connected with micro controller. Temperature sensor plays pivotal role in measuring temperature of soi, air and crops, which is optimal for crop growth. Soil moisture sensor not only measures soil moisture but also used in effective growth of plant, protection of environment and water utilization.

ESP32 Module plays key part in providing wireless transmission and to send the processed data to the IoT platform in monitoring and analysis data in real time. Due to which the farmers are aware of their crop management and to take necessary action timely.

2.2. Design Diagrams (Hardware Architecture, Flowchart, Circuit diagram)

2.2.1. Hardware Architecture

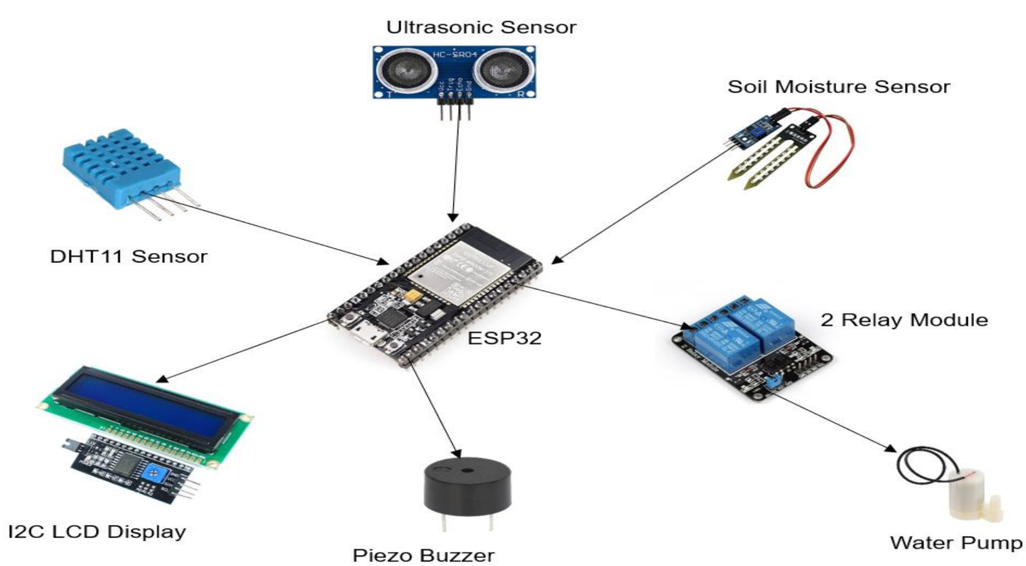


Figure 1: Hardware Architecture of the System

2.2.2. Flowchart

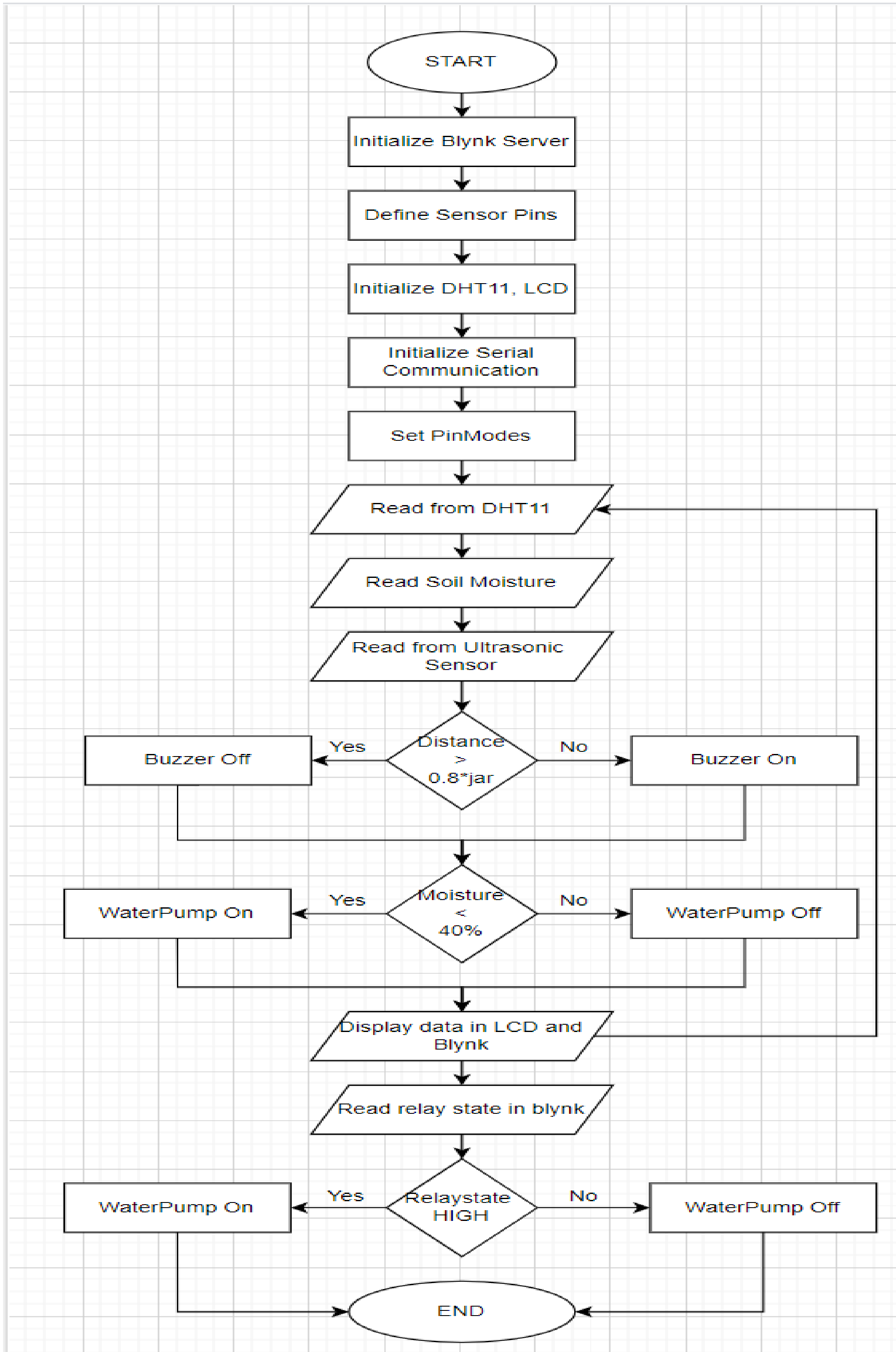


Figure 2: Flowchart of the mechanism of the system

2.2.3. Circuit Diagram

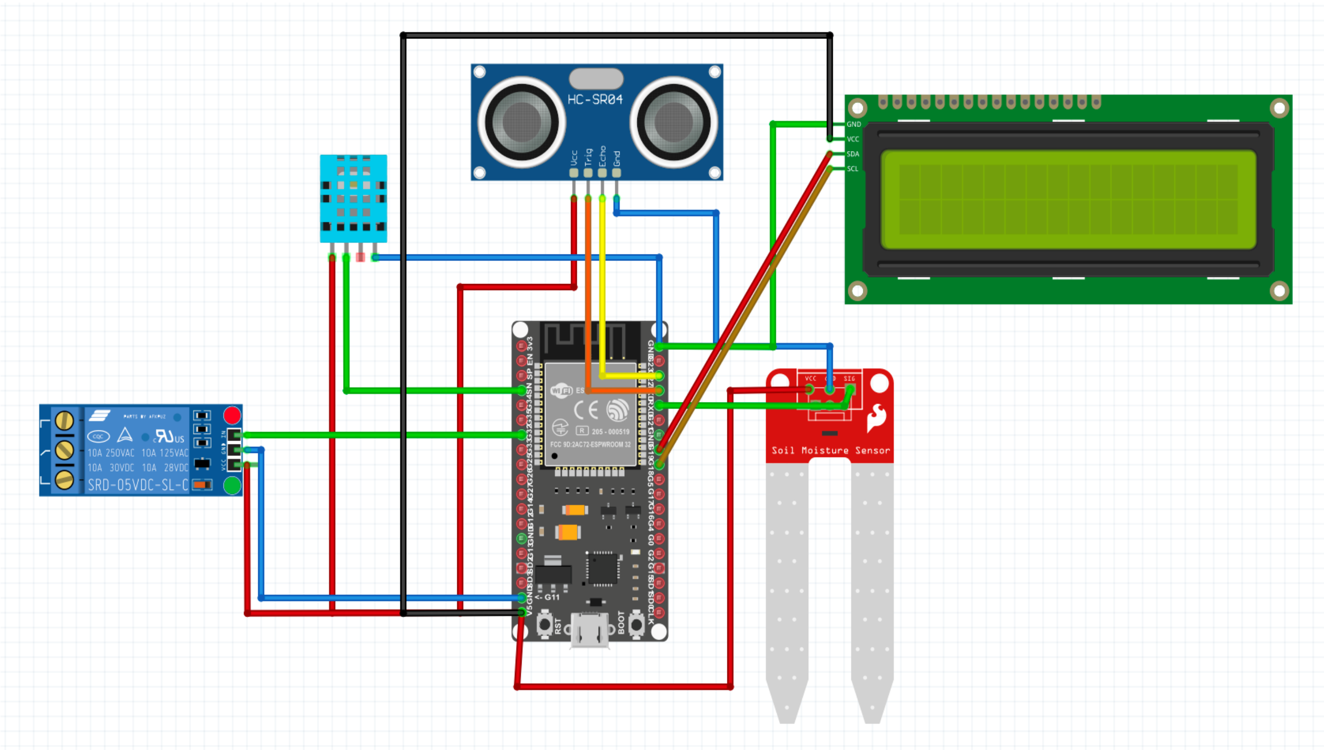


Figure 3: Circuit diagram of the project

2.3. Requirement Analysis

2.3.1. Hardware Components

i) ESP32 microcontroller

It's like small brain for electronic project which consist of mini-internet and Bluetooth inside it, which assist it to communicate to other devices too through Wi-Fi or Bluetooth, which is compatible with Arduino IDE. It is widely used for creating IOT application system.ESP32 is a 32-bit micro-controller. Bluetooth Low energy(BLE) using 802.11 b/g/n Wi-Fi network protocol which works at a frequency of 2.4 GHz.

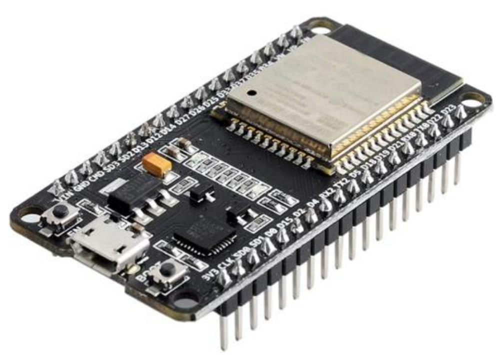


Figure 4: ESP32 microcontroller

ii) Ultrasonic Sensor

An ultrasonic sensor is a type of electronic device which uses ultrasonic sound waves to measure an object's distance and then transforms the reflected sound into an electrical signal. The sound that ultrasonic produced can't be heard by human beings. It calculated distance by using simple formulae of distance that speed of sound in air by twice of time taken.

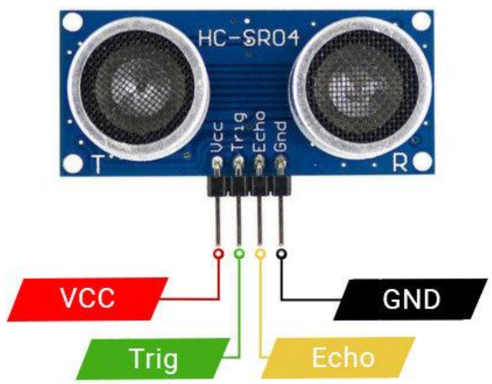


Figure 5: Ultrasonic Sensor

iii) DHT11 Temperature and Humidity Sensor

DHT11 is simple incredibly affordable digital temperature and humidity sensor. It measures the temperature and humidity. It is quite easy to use, time is crucial in order to capture data.

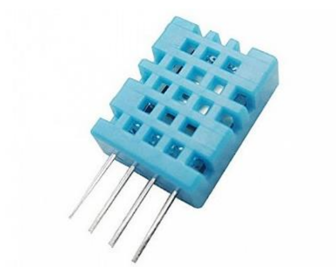


Figure 6: DHT11 Temperature and Humidity Sensor

iv) I2C LCD Display

LCD display is just used to display the output that we want to see in display. It is like rectangular in shape.

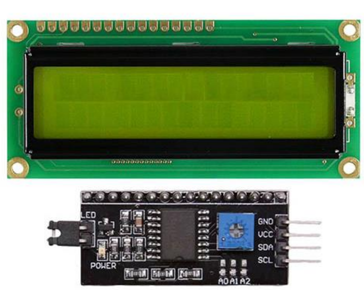


Figure 7: I2C LCD Display

v) Soil Moisture Sensor

Soil moisture sensor measures the moisture level in soil and helps in regulation of the irrigation system. The relationship between the computed property and soil moisture should be changed or may vary depending on ecological parameters such as soil type, temperature, and electric conductivity. The amount of moisture in the soil can affect the reflected microwave emission, which is utilized in hydrology and agriculture remote sensing.

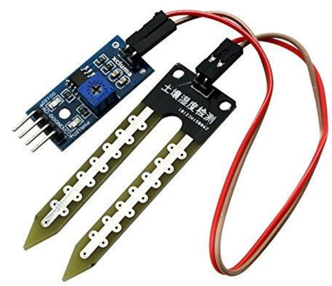


Figure 8:Soil Moisture Sensor

vi) Relay

A relay is essentially an electromechanical switch, relying on an electromagnet to toggle its state. It serves as a bridge between low-power control signals and high-power or high-voltage circuits, allowing for safe and efficient control of various electrical devices and systems.

Figure 9: 2 Relay Module

vii) Piezo Buzzer

A piezo buzzer uses piezoelectric vibrations to transform electrical energy into sound. It's frequently utilized in timers, alarms, and electronic equipment because it's small and effective. With a range of sizes and frequencies, it provides flexible possibilities for aural feedback.

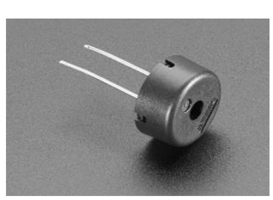


Figure 10: Piezo Buzzer

viii) Water Pump

Water pump is used in integration with other IoT-based components to transport water to a container or from a container to the field/soil.

Figure 11:Water Pump

ix) Jumper Wires

Jumper wires are tiny metal connections that connect two points without soldering. It has connector pins on both ends . it is mostly used in IOT project.

Figure 12: Jumper Wires

x) Breadboard

A breadboard is simply a board for providing the platform for building circuits on which allows you to put components and connections on the board without soldering. All overboard is full of holes. It has connection of signal terminal of in one column like if one is negative then, whole column in it is negative.

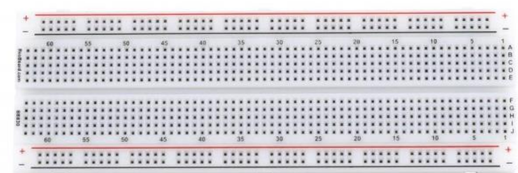


Figure 13: Breadboard

xi) Jar

A container was used as a water jar to store water required in the irrigation process.

Figure 14: Water Jar

2.3.2. Software Components

i) Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software platform for writing, compiling, and uploading code to Arduino microcontrollers. It offers an easy-to-use interface for working with Arduino-based projects and for programming and debugging them. The IDE comes with libraries and tools to help with quick prototyping and development of different electronic projects and Internet of Things applications, in addition to supporting a condensed version of the C++ programming language.

Figure 15: Demonstration of the Arduino IDE

ii) Blynk App

Blynk is an adaptable IoT platform that lets customers design and manage IoT projects with ease using a mobile application. It provides a drag-and-drop interface for creating control panels that are customisable and can be used to monitor and control connected devices remotely via the internet. Blynk is appropriate for home automation, industrial monitoring, and other Internet of Things applications since it offers a variety of widgets and functionality for integrating sensors, displays, and actuators.

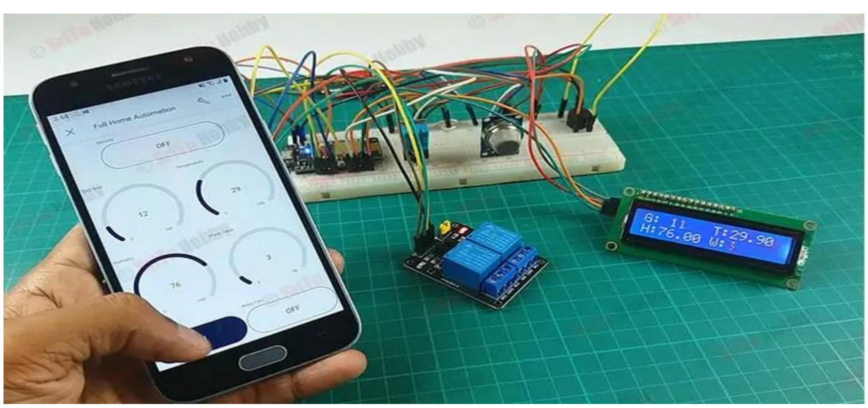


Figure 16: Demonstration of the use of Blynk Application

iii) Fritzing

Fritzing is an open-source software tool for creating and documenting electrical circuits. For the purposes of teaching and prototyping, it offers an intuitive interface for planning PCB layouts, producing circuit diagrams, and making schematic diagrams. Fritzing comes with a huge library of electronic parts that users may connect and arrange graphically to simulate and see circuits before they are ever built. It is extensively used for electronics design and experimentation by experts, educators, and amateurs alike.

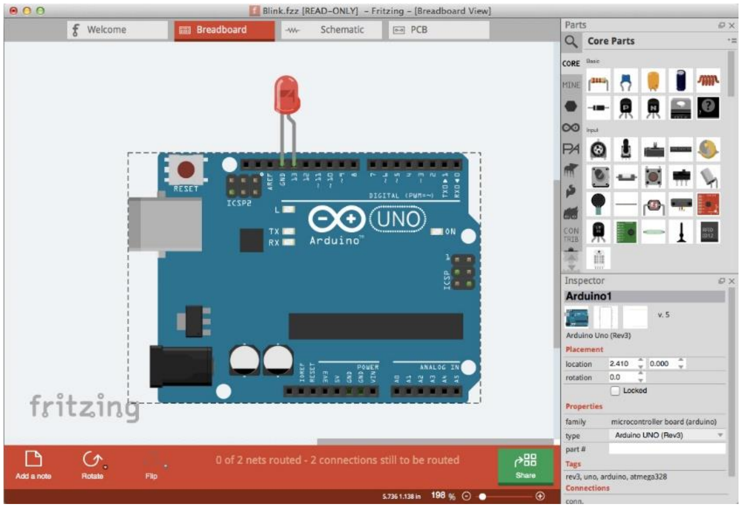


Figure 17: Demonstration of circuit simulation using Fritzing app

iv) Draw.io

Draw.io is a web-based diagramming tool that allows you to create a variety of diagrams, such as flowcharts, network diagrams, organizational charts, and more. It makes it easier to create visually stunning and educational diagrams by providing a large selection of shapes, symbols, and connections with an easy-to-use drag-and-drop interface. Draw.io is a popular option for individuals and teams working on diagramming projects because of its user-friendliness, collaboration tools, and connectivity with cloud storage providers like Dropbox, OneDrive, and Google Drive.

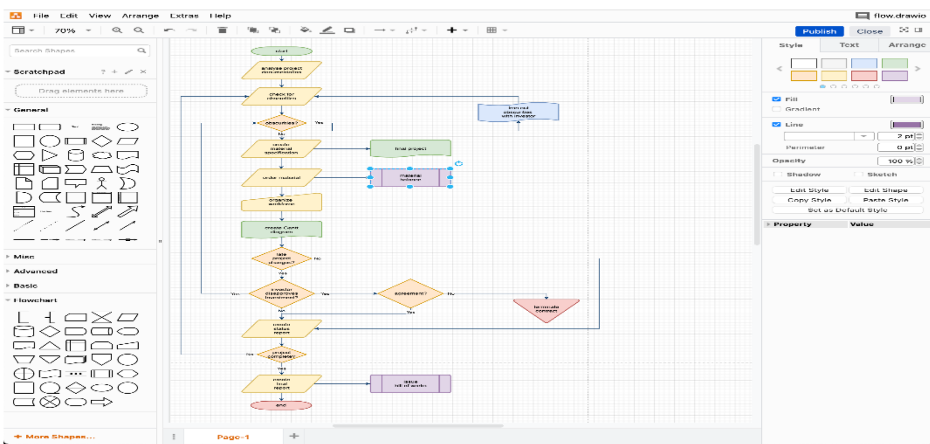


Figure 18: Web Based tool Draw.io for developing a flowchart

v) MS-Word

Microsoft Word is a versatile tool that is used for documentation and project planning. In this project, MS Word is used for documentation, System Architecture, Code documentation and testing.

Figure 19: MS-Word logo

CHAPTER III: CASE STUDY

Project: IOT Based Smart Agriculture Monitoring System

Authors: Aboubakar Bin Mushtaq, Muhammad Ammar, Hassan Ali

3.1. Introduction

The main objectives of the IOT based Smart Agriculture Monitoring System project was to ensure effective surveillance of large crop production areas. It aimed to monitor various parameters needed for plant growth on a big scale. The project consisted of several components like the Arduino UNO Atmega328 which cooperated with sensors such as light sensor, gas sensor, temperature/humidity sensor, soil moisture sensor. Similarly, Node MCU ESP8266 module was used for IOT connectivity (Aboubakar Bin Mushtaq, 2023).

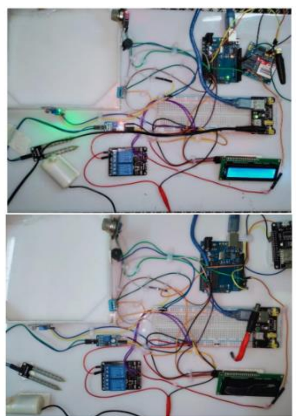


Figure 20: Picture of the project studied

The system established a connection between sensors and a microcontroller to wirelessly transmit data to an IoT platform (Thing Speak) through the NODE MCU ESP8266 Module for real-time observation. For maintenance purposes, features like the water pump took care of moisture levels while the buzzer functioned to give alerts on high toxic gas concentration gas detection.

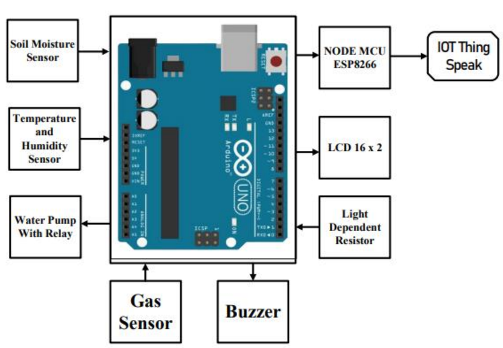


Figure 21: Hardware architecture of the studied project

3.2. Problem Statement

The objective of this report is to use NODE MCU ESP8266 module in implementing an IOT system in real-time. This will help solve agricultural problems by increasing crop yield with sensor incorporation. The system kept track of different farming indicators such as air quality, illumination levels, soil moisture content and temperature which are known to cause toxic gas presence, fluctuating light levels among others. Predictive analytics allowed farmers to make the most of resource distribution and foresee dangers even as they relied on remote monitoring capacities to make informed choices about irrigation programs, pest control measures as well as ecological management practices.

In summary: this project attempted to create IoT based monitoring system in preventing muti-dimensional agricultural problem. Consequently, this means that; By giving momentary feedback and recommendations for action taking by concerned persons or bodies involved with food production industries either directly or indirectly; the device would be expected to realize increase in output quantities per unit area thus leading into improvement of nutritional standards across various communities hence fostering sustainable agriculture within regions thereby enhancing resilience building at local level against adverse climatic conditions besides reinforcing economic prosperity among different societies engaged in farming activities.

3.3. System Analysis

In the project Smart Agricultural Monitoring system, there had been used many hardware components to collect data and enable monitoring in real time. In the project, Arduino UNO Armega328 was used as central microcontroller for the system which act as its brain. The management and controlling different sensors such as light sensor, gas sensor, temperature/humidity sensor, and soil moisture sensor and to collect information about necessary environmental conditions for good pant growth was its overall role on it.

To have wireless connectivity, NODE MCU ESP8266 was also used in the system. Due to this module, no interruption was faced which allowed clear transmission of data from a sensor to an IoT platform like Thing Speak where analyzation and monitoring part took place. Similarly, the components such as water pump, LCD display, buzzer & relay were also integrated in the system. These components were used in different roles such as irrigation control, data analysis, and to warn destructive environmental conditions for irrigation.

The system's data collecting relied heavily on the integration of sensors and microcontrollers. The sensors were coupled with ESP 32, and data on temperature, humidity, light, gas levels, and soil moisture were recorded, allowing farmers to easily build and improve irrigation systems.

NODE MCU ESP8266 Module played key part in providing wireless transmission and to send the processed data to the IoT platform in monitoring and analysis data in real time. Due to which the farmers were aware of their crop management and to take necessary action timely. To sum up, the use of IoT technology and the hardware component with their functionalities aimed in enhancement and optimization in agriculture and crop productivity.

3.4. Recommendation

In hindsight, recommendations for advancing IoT based Smart Agriculture Monitoring System could have followed several steps that could have been more efficient and user friendly for farmers as well as developers. For example, to achieve an irrigation optimization, a smart irrigation system could be recommended which uses IoT technology for precise crop harvesting. IOT- Based Drip Irrigation system could have been used. Similarly, Hydration sensors could have been used so that plant get optimum water. IoT feature like remote monitoring and control through a web or mobile interface could have been implemented so that farmers could take action regarding crop management in real time which ensure more optimization of resources and its productivity. In this era of modern technology, an IoT enabled Machine Learning-trained recommendation system could have been used for efficient water usage with nominal intervention of farmers. Overall, the project focused on IoT, sensor integration and data analysis which helped developers gained experience on IoT while addressing crucial issues in sustainable agriculture.

3.5. Conclusion

In conclusion, this demonstrates that the way IoT technology and sensor data are transforming agriculture is what matters most, since it enhances both agricultural productivity and quality. The capacity to monitor everything at all times, such as automatically doing irrigation and alerting farmers to threats, prevented many of them from losing crops by optimizing their use of resources.

Nevertheless, it recognized the necessity for frequent check-ups, repairs, and improvements in order to preserve efficiency and dependability while adapting to changing agricultural demands. Overall, the modernization was successful since it increased not just production but also agricultural sustainability, according to the technology-based monitoring using IoT devices project.

CHAPTER IV: DEVELOPMENT

4.1. Methodology

The project was initiated with a proper group co-ordination and planning on how the design of the project along with its development should be conducted so the smart IoT-based farm monitoring system ticks all the boxes for the users. A similar case was studied for a better idea and reference on the project.

The required resources for the IoT-based farm monitoring system were collected and utilized in the project. During the hardware resource gathering, multiple inoperative components were encountered which were all replaced with a proper functioning sensors and components. The software resource gathering was not quite a challenge as the free software available on the internet were sufficient for the system. The software used in the system are Arduino IDE for programming the microcontroller, Blynk to provide remote access to the users.

The task was divided among the group members according to their field of interests and specialities. The communication and collaboration among the team members made the development phase of the system fairly straightforward

4.2. Design

To clarify the structural integrity and functional coherence of the Internet of Things-based farm monitoring system, the architectural framework is outlined. A network of interconnected parts, including as sensors, microcontrollers, communication modules, and cloud-based data processing services, make up the system architecture. Together, these elements make it easier to gather, transfer, and analyze agricultural data in a seamless manner. This allows for the real-time monitoring of environmental factors that are vital to crop yield and health. Design flexibility and scalability are prioritized to ensure that the final product may be expanded in the future to meet changing farming techniques and technology improvements, as well as adaptability to a range of farm sizes and configurations.

Furthermore, the farm monitoring system's user interface design is painstakingly created to guarantee simple navigation and user involvement. With visually appealing dashboards, dynamic data visualizations, and adjustable options catered to the unique requirements and preferences of farmers, the interface embodies a user-centric approach. The interface attempts to give consumers actionable insights, expedite access to vital information, and support educated decision-making through iterative design processes and user input. In order to provide smooth usage across a variety of devices and platforms, attention is also paid to accessibility and responsiveness. The IoT-based farm monitoring system's overall design is a perfect blend of user-centric concepts and technological complexity, with the potential to transform agricultural management practices and support sustainable farming efforts.

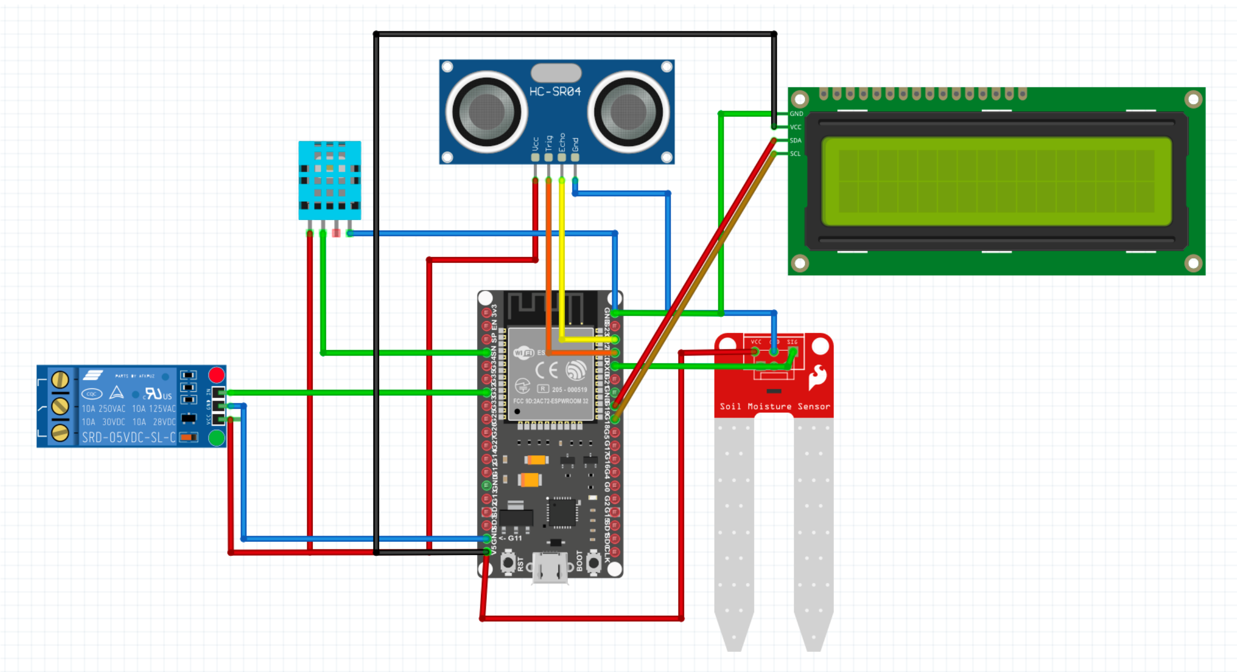


Figure 22: Circuit diagram of the project

4.3. Implementation

4.3.1. Phase 1: DHT11 sensor interfaced with ESP32

In this phase, ESP32 and DHT11 was connected , and VCC of DHT 11 was 5v voltage of ESP32, GND of DHT11 was connected to GND of ESP32. input pin of DHT11 was connected to pin 6 in ESP32. The voltage of 5 was given and DHT 11 detected the temperature and humidity.

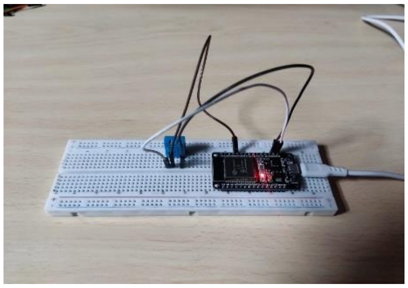


Figure 23: Test of DHT11

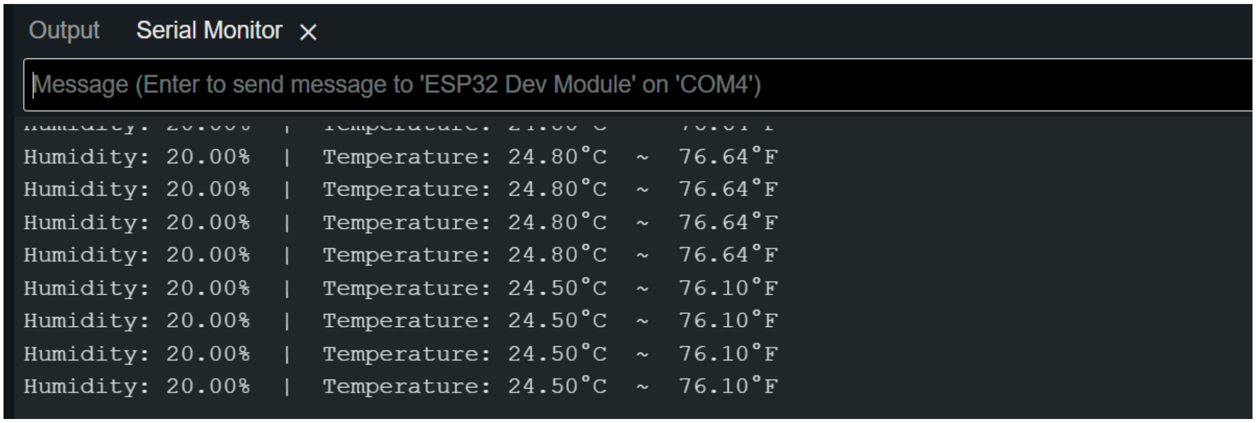


Figure 24: Screenshot of the serial monitor while testing the DHT11

4.3.2. Phase 2: ESP32 and Soil Moisture Sensor Connected

In this phase, ESP32 and Soil Moisture was connected. As usual, GND connected to GND, VCC connected to 5v voltage of ESP32. SIG pin was connected to 4 digital pin of ESP32. when voltage is input, it executed.

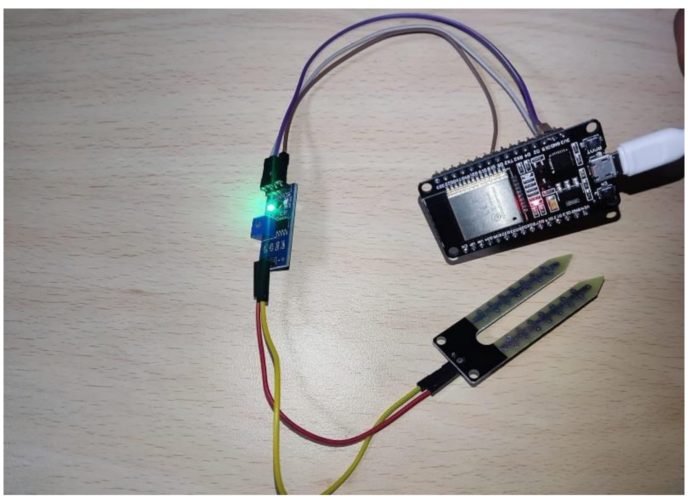


Figure 26: Test of Soil Moisture Sensor

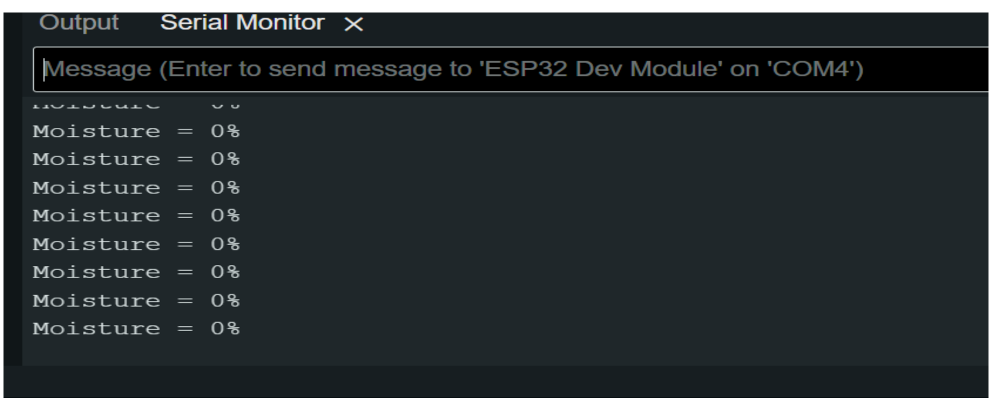


Figure 25: Screenshot for the moisture detection through sensors

4.3.3. Phase 3: Connecting I2C LCD with ESP32

Similarly, ESP32 and LCD was connected to later display ta temperature, humidity, moisture or any other environmental aspects. The VCC of LCD is connected to v5 of ESP32, and GND to GND, SCL pin connected to pin D22 digital pin and SDA pin connected to pin D21 digital pin of ESP32. when voltage was input, it showed the output.

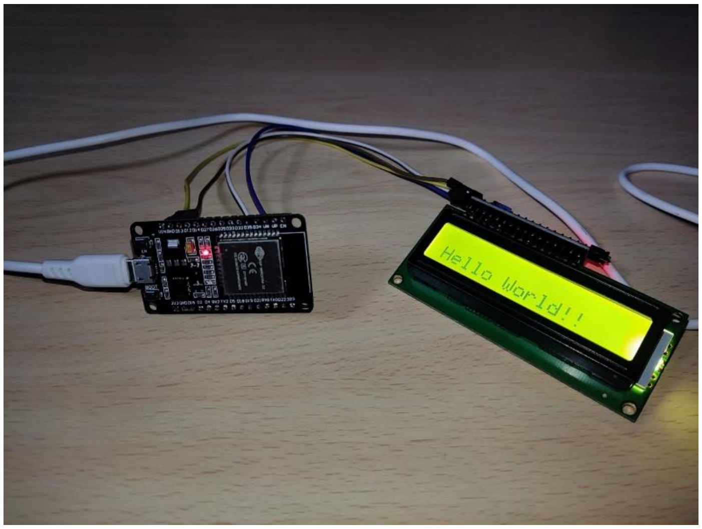


Figure 27: Test for the Wroking of I2C LCD Display

4.3.4. Phase 4: Connecting Ultrasonic Sensor and ESP32

Likely, ESP32 and Ultrasonic sensor was connected, as usually, GND connected to GND and VCC of Ultrasonic was connected 5v voltage. Trig pin connected to 6 digital pin mode of ESP32, and Echo pin connected to 6 digital pin mode of ESP32. when voltage was input, it executed.

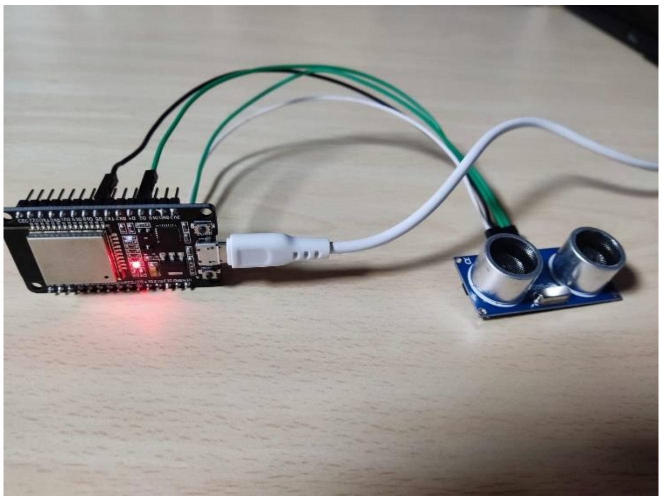


Figure 28:Test for the connection of Ultrasonic Sensor

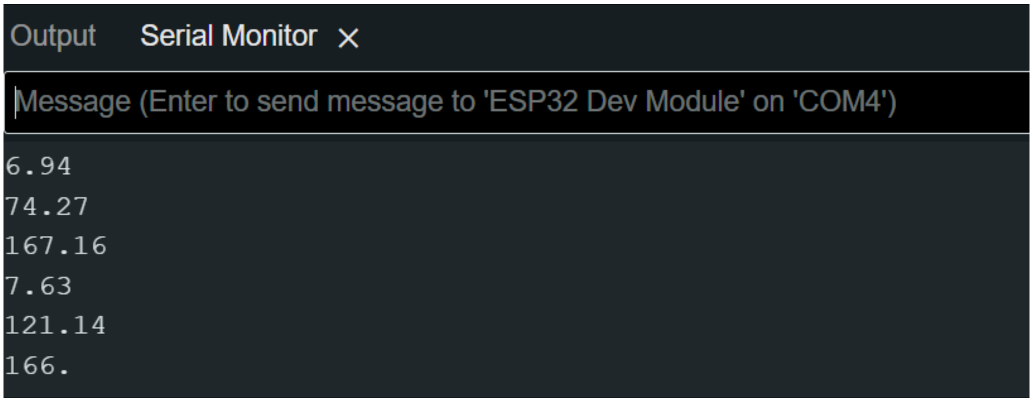


Figure 29: Serial monitor from the test of ultrasonic sensor

4.3.5. Phase 5: Connecting all the sensors with ESP32

In the final phase of the step-by-step development, the above-mentioned sensors were connected to ESP32 along with ultrasonic sensor for detection of water level in the container, piezo buzzer for a alarm when the container is filled, I2C LCD to display the temperature, humidity and moisture and the entire system is synced to the Blynk cloud.

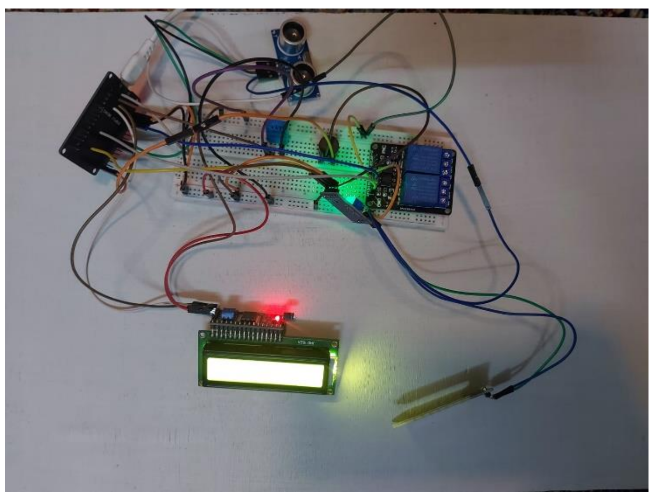


Figure 31: Connecting all the sensors and finalizing the design

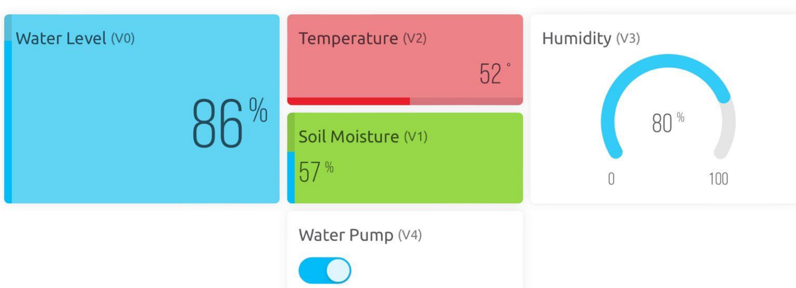


Figure 30: Screenshot of the Blynk app

CHAPTER V: RESULT AND FINDINGS

5.1. Test Cases

5.1.1. Test 1: Testing the operational status of DHT11 sensor

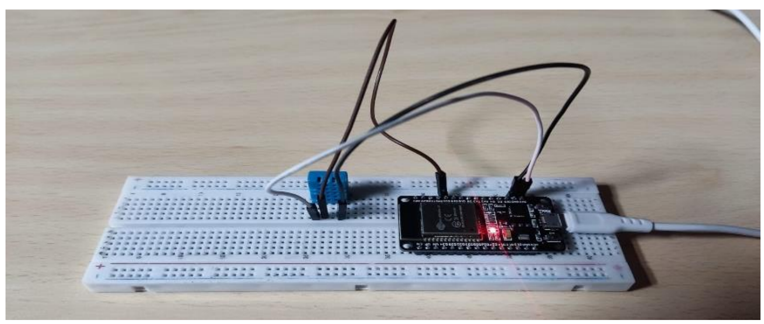
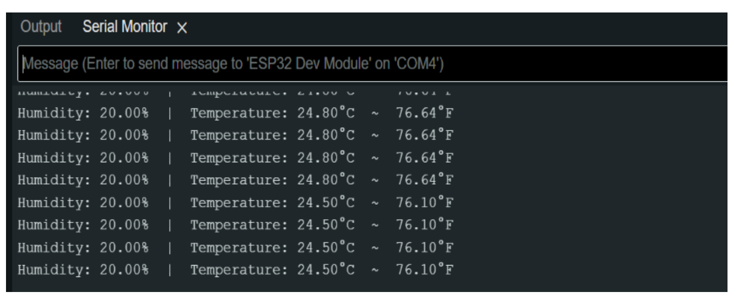
Test	1
Objective	To verify the operational status of the DHT11 sensor when interfaced with an ESP32.
Activity	The DHT11 sensor was connected to the ESP32, and the test sketch was executed.
Expected Result	The serial monitor would display temperature and humidity reading every 2 seconds.
Actual Result	The serial monitor displayed temperature and humidity reading as expected.
Conclusion	The test to verify the operational status of the DHT11 sensor was carried out successfully.
Output	 *Figure 33: Connecting DHT11 to ESP32*  *Figure 32: Successful connection of DHT11*

Table 1: Test 1

5.1.2. Test 2: Verification of the functionality of I2C LCD display

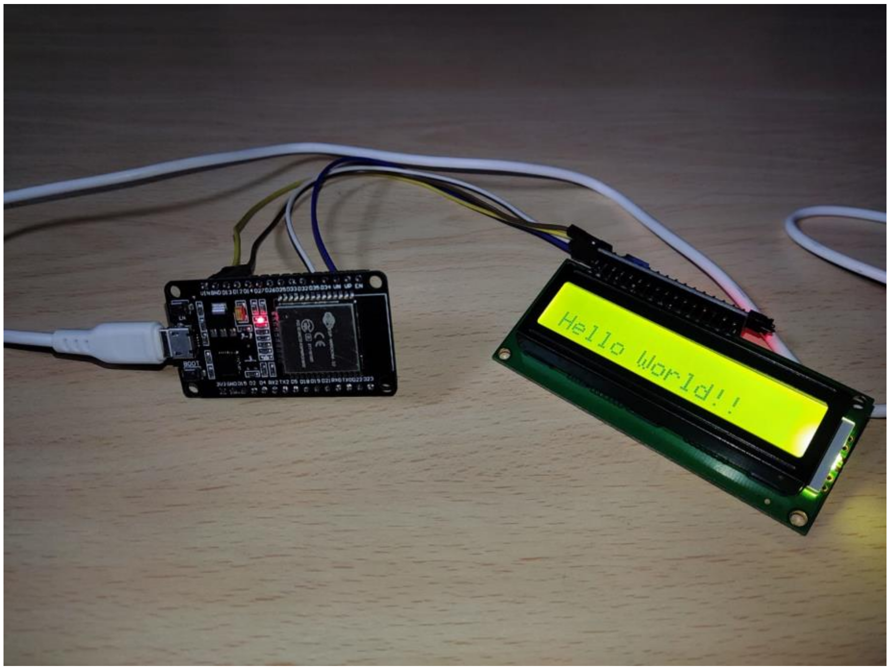
Test	2
Objective	To verify the functionality of I2C LCD display interfaced with an ESP32.
Activity	The I2C LCD was connected to the ESP32, and the "Hello World" sketch was uploaded and executed.
Expected Result	The LCD would display the message "Hello World!!".
Actual Result	The LCD displayed the message "Hello World!!" as expected.
Conclusion	The test to verify the functional status of the I2C LCD display when interfaced with ESP32 was carried out successfully.
Output	 Figure 34:I2C lcd

Table 2: Test 2

5.1.3. Test 3: Test for the working of Ultrasonic Sensor

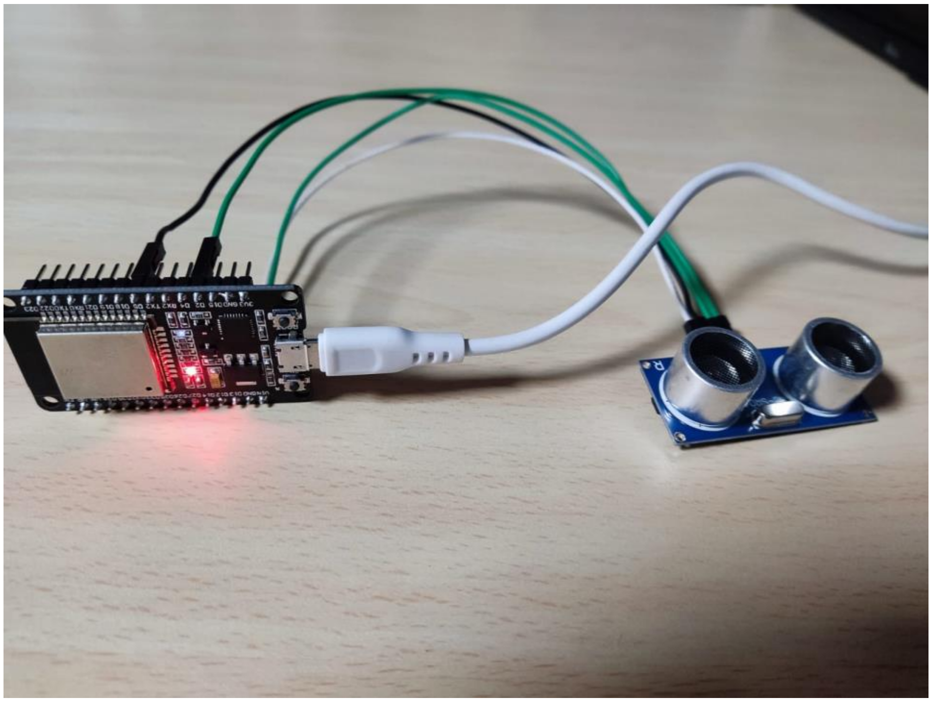
Test	3
Objective	To verify the operational status of the Ultrasonic sensor(HC-SR04)when interfaced with an ESP32.
Activity	The ultrasonic sensor was connected to the ESP32, and the test sketch was executed.
Expected Result	The serial monitor would display object’s distance readings.
Actual Result	The serial monitor displayed object’s distance readings as expected.
Conclusion	The test to verify the operational status of the Ultrasonic sensor was carried out successfully.
Output	 *Figure 35: Ultrasonic Sensor connected*

Table 3: Test 3

5.1.4. Test 4: Connection of soil moisture sensor

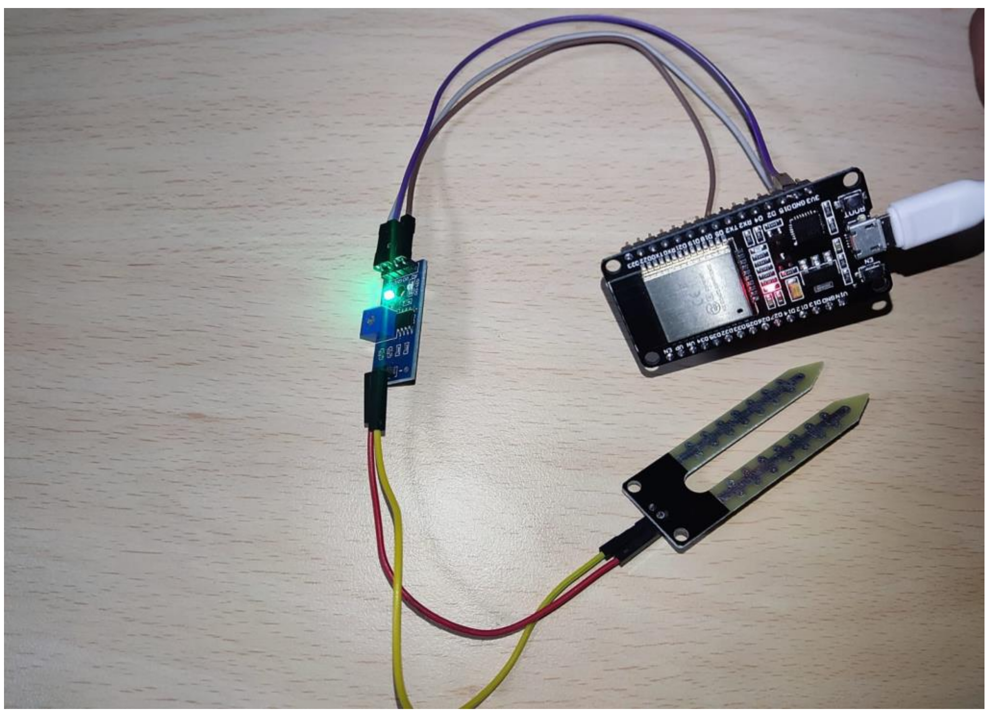
Test	4
Objective	To verify the operational status of the soil moisture sensor when interfaced with an ESP32.
Activity	Soil moisture sensor was connected to the ESP32, and the test sketch was executed.
Expected Result	The serial monitor would display moisture percentage reading.
Actual Result	The serial monitor displayed moisture percentage reading as expected.
Conclusion	The test to verify the operational status of the soil moisture sensor was carried out successfully.
Output	 *Figure 36: Soil Moisture Sensor connected*

Table 4: Test 4

5.2. Project Outcome

The culmination of our efforts in developing the IoT-based farm monitoring system has resulted in a robust and scalable solution tailored to meet the needs of modern agricultural practices. By combining cutting-edge sensor technology, cloud-based data processing, and intuitive user interfaces, our solution provides farmers with up-to-date information on critical environmental factors that affect crop yield and health. Our research has resulted in a comprehensive monitoring platform that can remotely check soil moisture, temperature, humidity, and light levels throughout agricultural fields. This allows for optimal resource allocation and proactive decision-making.

Moreover, the project's output goes beyond the simple gathering of data; it also includes tools for decision support and actionable intelligence that are intended to improve agricultural operations. Our technology uses machine learning and sophisticated analytics to deliver farmers predictive insights about crop growth trends, insect infestations, and irrigation needs. This allows farmers to plan ahead and take targeted interventions. All things considered, the project's output marks a substantial breakthrough in precision agriculture, enabling farmers to maximize harvests, preserve resources, and manage their land sustainably for long-term prosperity.

CHAPTER VI: FUTURE WORKS

6.1. Additional Features

To improve the usefulness and adaptability of the Internet of Things-based farm monitoring system, we plan to add a few more functions in later versions. These might involve integrating with cutting-edge weather forecasting systems to provide farmers access to real-time weather information and predictive analytics to help them make better decisions. Furthermore, in order to minimize crop damage and maximize production potential, we want to employ automated pest identification algorithms that make use of image recognition technology.

6.2. Integration with Emerging Technologies

Future plans call for the incorporation of cutting-edge technology to further expand the capabilities of the farm monitoring system. Drone technology integration for crop monitoring and aerial imagery is one area of investigation; this enables more thorough coverage and in-depth study of agricultural areas. Furthermore, there is potential for utilizing blockchain technology to enhance agricultural supply chain traceability and transparency, allowing producers to monitor the produce's journey from farm to table and cultivate customer confidence.

CHAPTER VII: CONCLUSION

7.1. Conclusion

To sum up, the creation of an Internet of Things-based farm monitoring system is a big advancement for precision agriculture. By combining state-of-the-art sensor technology, cloud-based data processing, and intuitive user interfaces, the system provides farmers with previously unattainable insights into critical environmental factors affecting crop yield and health. The initiative intends to disrupt traditional farming techniques and open the door for more sustainable and effective agricultural operations by providing farmers with real-time data and actionable insight.

Future research and development might take various different forms, building on the project's accomplishments and lessons gained. The goal of ongoing research and development will be to improve the monitoring system's capabilities, which will include integrating cutting-edge technology like artificial intelligence-powered predictive analytics, blockchain-based traceability, and drone imaging analysis.

In addition, outreach initiatives, knowledge-sharing initiatives, and collaborations with local stakeholders will be employed to promote increased adoption and cooperation within the agricultural sector. We may strive toward a future where technology-driven solutions enable farmers to overcome obstacles, boost production, and guarantee food security for future generations by embracing innovation and teamwork.

7.2. Recommendations

The IoT-based farm monitoring system's continual support and maintenance must be given top priority. This entails creating regular maintenance plans for software and hardware upgrades, offering farmers technical support, and carrying out recurring system impact analyses. To promote innovation and scalability, partnerships with industry and research institutes are advised. Stakeholders may successfully utilize the system's potential to promote precision agriculture methods by putting these ideas into practices.

REFERENCES

Aboubakar Bin Mushtaq, M. A. H. A., 2023. *IOT Based Smart Agriculture Monitoring System,* s.l.: Qazi.

APPENDIX

9.1. Appendix A: Source Code

```
#define BLYNK_TEMPLATE_ID "TMPL6vADFc_xw"
#define BLYNK_TEMPLATE_NAME "IoT CW"
#define BLYNK_AUTH_TOKEN "HECV_PZHR10n_zuEpSV345hQ0OMAB_V_"
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>

#define DHT11_PIN  4
DHT dht11(DHT11_PIN, DHT11);
#define TRIG_PIN   5 // ESP32 pin GPIO26 connected to Ultrasonic Sensor's TRIG pin
#define ECHO_PIN   18 // ESP32 pin GPIO25 connected to Ultrasonic Sensor's ECHO pin
#define BUZZER_PIN 19 // ESP32 pin GPIO17 connected to Piezo Buzzer's pin
#define DISTANCE_THRESHOLD 7 // centimeters
const int relay = 26;


// set the LCD number of columns and rows
int lcdColumns = 16;
int lcdRows = 2;
int _moisture,sensor_analog;
const int sensor_pin = 34;    /* Soil moisture sensor O/P pin */
float duration_us, distance_cm;
```

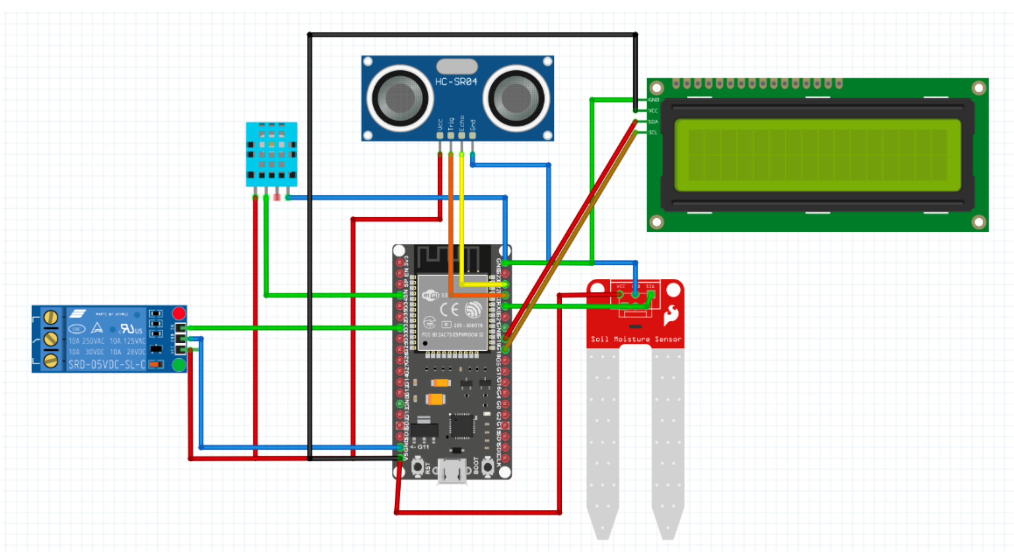
```
// set LCD address, number of columns and rows
// if you don't know your display address, run an I2C scanner sketch
LiquidCrystal_I2C lcd(0x27, lcdColumns, lcdRows);



char ssid[] = "kabindra";
char pass[] = "kabindra123";

void setup(){
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  // initialize LCD
  lcd.init();
  // turn on LCD backlight
  lcd.backlight();

  dht11.begin(); // initialize the DHT11 sensor
  Serial.begin (9600);        // initialize serial port
  pinMode(TRIG_PIN, OUTPUT);   // set ESP32 pin to output mode
  pinMode(ECHO_PIN, INPUT);    // set ESP32 pin to input mode
  pinMode(BUZZER_PIN, OUTPUT); // set ESP32 pin to output mode
  pinMode(relay, OUTPUT);
}

void loop(){

  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
```

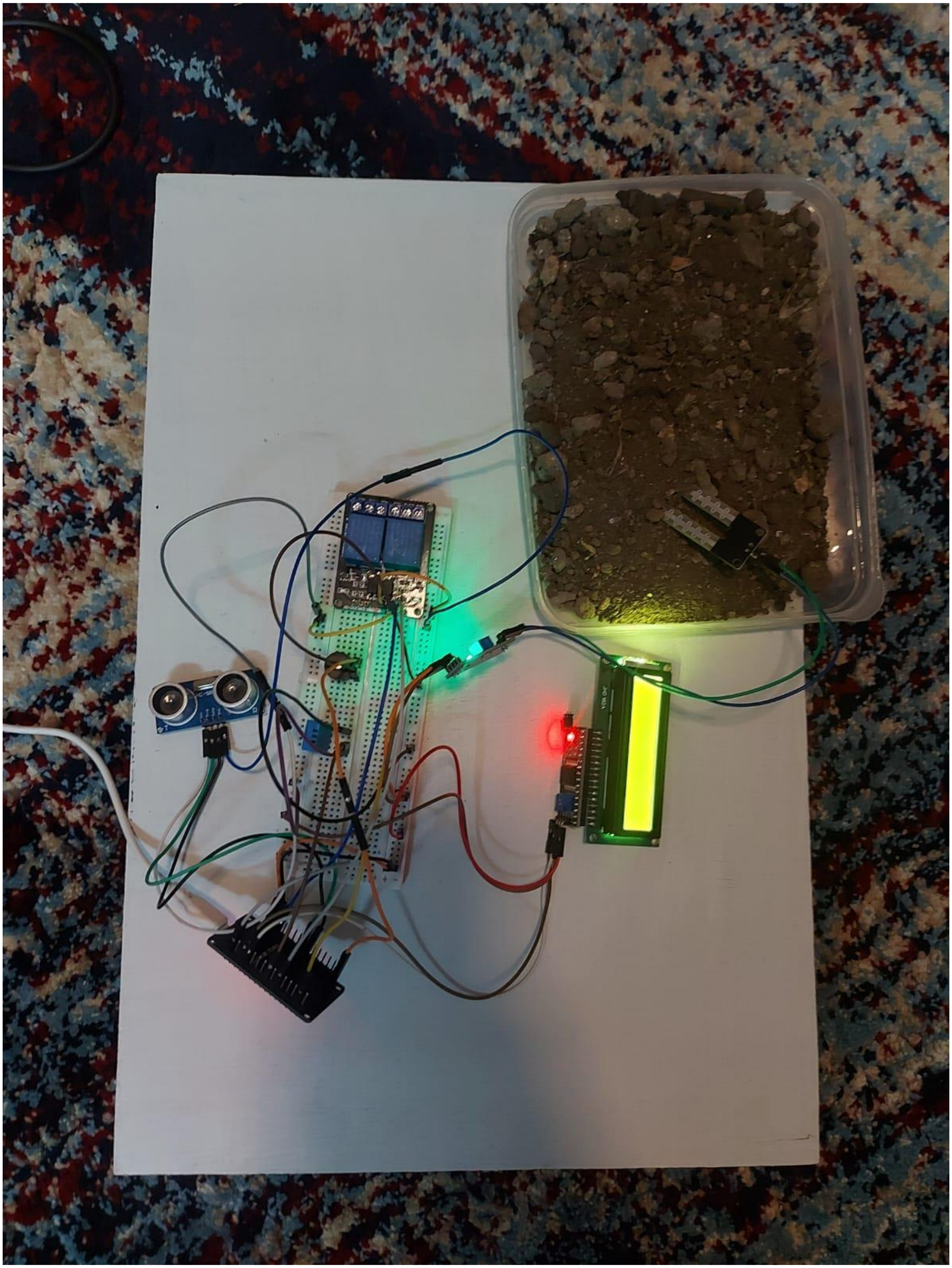
```
// measure duration of pulse from ECHO pin
duration_us = pulseIn(ECHO_PIN, HIGH);
// calculate the distance
distance_cm = 0.017 * duration_us;

if (distance_cm > DISTANCE_THRESHOLD)
  digitalWrite(BUZZER_PIN, HIGH); // turn on Piezo Buzzer
else
  digitalWrite(BUZZER_PIN, LOW);  // turn off Piezo Buzzer

// read humidity
float humi  = dht11.readHumidity();
// read temperature in Celsius
float tempC = dht11.readTemperature();
// read temperature in Fahrenheit
float tempF = dht11.readTemperature(true);
// set cursor to first column, first row

if ( isnan(tempC) || isnan(tempF) || isnan(humi)) {
  Serial.println("Failed to read from DHT11 sensor!");
} else {
  Serial.print("Humidity: ");
  Serial.print(humi);
  Serial.print("%");

  Serial.print("  |  ");
```

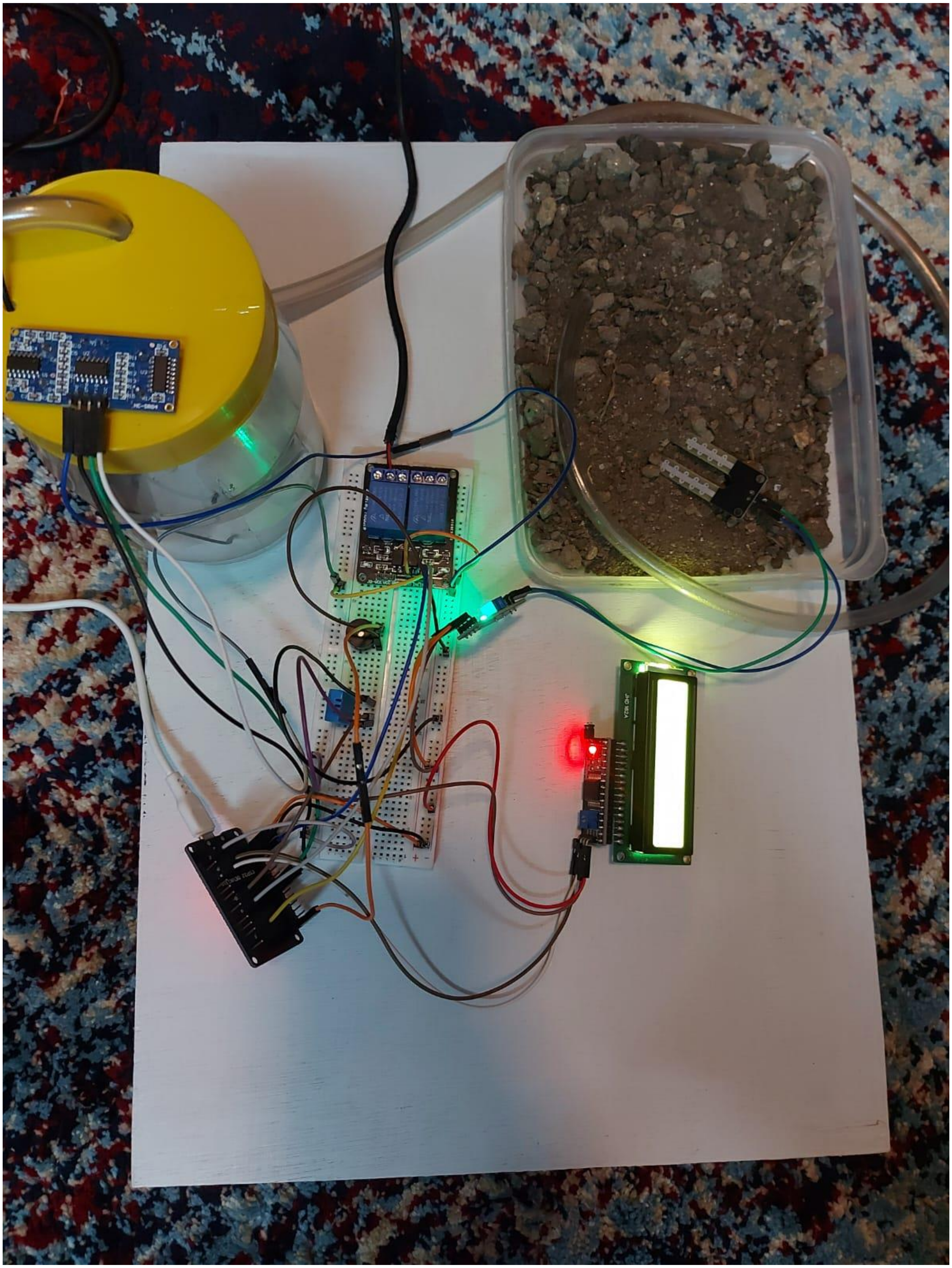
```
  Serial.print("Temperature: ");
  Serial.print(tempC);
  Serial.print("°C  ~  ");
  Serial.print(tempF);
  Serial.println("°F");
}

sensor_analog = analogRead(sensor_pin);
_moisture = ( 100 - ( ( sensor_analog/4095.00) * 100 ) );
Serial.print("Moisture = ");
Serial.print(_moisture);  /* Print Temperature on the serial window */
Serial.println("%");
delay(1000);              /* Wait for 1000mS */

// wait a 2 seconds between readings

lcd.setCursor(0, 0);
// print message
lcd.print("Moisture%=");

lcd.print(_moisture);



// clears the display to print new message

// set cursor to first column, second row
lcd.setCursor(0,1);
lcd.print("T=");
```

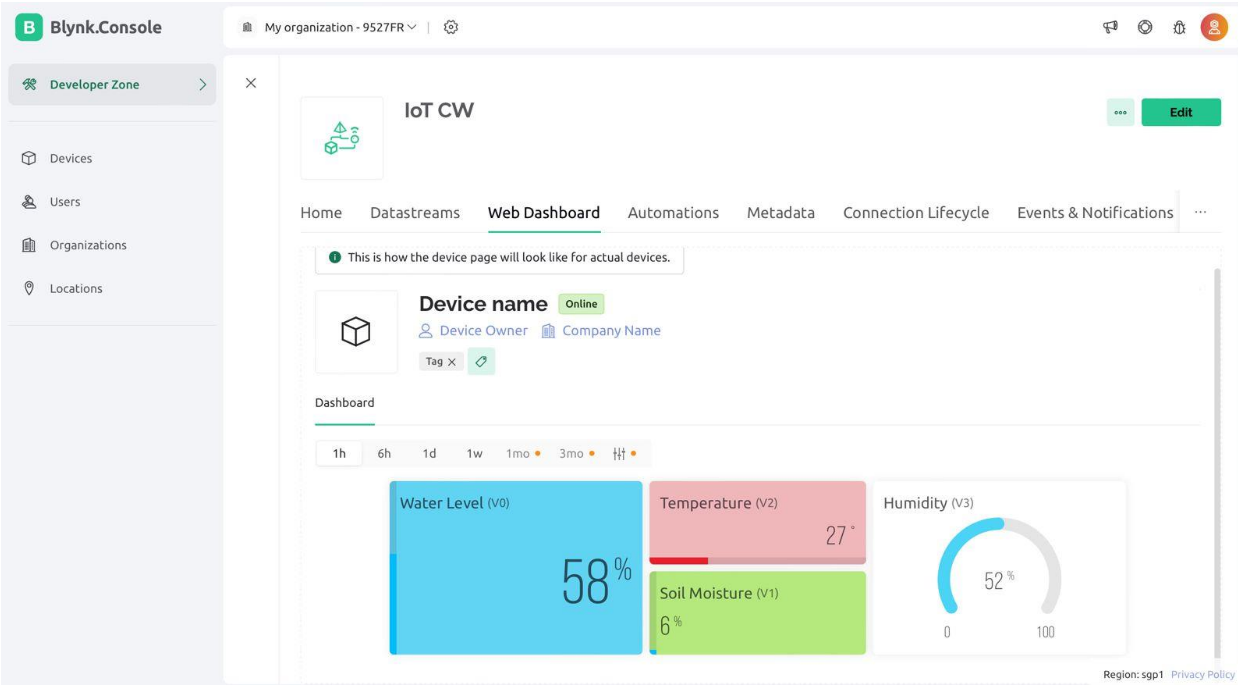
```
  lcd.print(tempC);



  lcd.print("H%=");
  lcd.print(humi);
  delay(1000);
  lcd.clear();

  Serial.print("DIstance=");
  Serial.print(distance_cm);
}
```

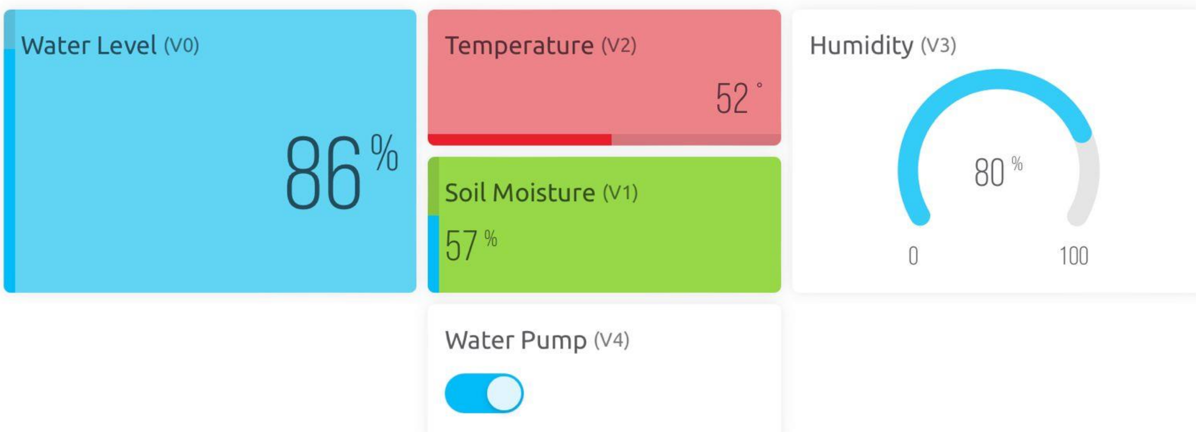
9.2. Appendix B: Screenshots of the System








Blynk.Console
My organization - 9527FR
Developer Zone
Devices
Users
Organizations
Locations
IoT CW
Edit
Home
Datastreams
Web Dashboard
Automations
Metadata
Connection Lifecycle
Events & Notifications
This is how the device page will look like for actual devices.
Device name
Online
Device Owner
Company Name
Tag
Dashboard
1h
6h
1d
1w
1mo
3mo
Water Level (V0)
58 %
Temperature (V2)
27 °
Soil Moisture (V1)
6 %
Humidity (V3)
52 %
0
100
Region: sgp1
Privacy Policy


Water Level (V0)
86 %
Temperature (V2)
52 °
Soil Moisture (V1)
57 %
Humidity (V3)
80 %
0
100
Water Pump (V4)