RAJIV GANDHI INSTITUTE OF TECHNOLOGY

GOVERNMENT ENGINEERING COLLEGE

KOTTAYAM-686 501

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING

ECD 481 MINI PROJECT REPORT

Smart Agricultural Monitoring System

Report Submitted by

Alwin Philip (Reg. No: KTE22CS012)
Delsa Davis (Reg. No: KTE22CS026)
Jessin Sunny (Reg. No: KTE22CS036)
Jeswin T.J. (Reg. No: KTE22CS037)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRUVANANTHAPURAM

NOVEMBER 2025

RAJIV GANDHI INSTITUTE OF TECHNOLOGY

GOVERNMENT ENGINEERING COLLEGE

KOTTAYAM-686 501

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION
ENGINEERING

Vision of the Department

To be a centre of excellence in Electronics, Communication, and Intelligent Systems by fostering quality education, research and innovation for the betterment of society.

Mission of the Department

- Deliver high quality professional education in Electronics, Communication, Robotics, and Artificial Intelligence through cutting- edge facilities and learner-centric methodologies.
- Build strong theoretical and applied foundations that prepare students for advanced studies, research, and innovation in intelligent systems and emerging technologies.
- Promote technological advancement and interdisciplinary innovation to address societal challenges and contribute to sustainable development.

RAJIV GANDHI INSTITUTE OF TECHNOLOGY

GOVERNMENT ENGINEERING COLLEGE

KOTTAYAM-686 501

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that this report entitled ***SMART AGRICULTURAL MONITORING SYSTEM*** *is an authentic report of the project done by* ***Alwin Philip (Reg. No: KTE22CS012), Delsa Davis (Reg. No: KTE22CS026), Jessin Sunny (Reg. No: KTE22CS036), and Jeswin T.J. (Reg. No: KTE22CS037)*** *during the academic year* ***2025-26****, in partial fulfillment of the requirements for the award of the Minor Degree of Bachelor of Technology in Electronics and Communication Engineering of APJ Abdul Kalam Technological University, Thiruvananthapuram.*

GUIDE   COORDINATOR

HEAD OF THE DEPARTMENT

Acknowledgement

We wish to thank the many people who have helped us in completing this project.

We express our sincere gratitude to our Project Coordinators, **Dr. Sreeni K. G.**, Professor, Department of ECE, and **Dr. Renu Jose**, Professor, Department of ECE, Rajiv Gandhi Institute of Technology, Kottayam, for their inspiration and valuable guidance throughout the project.

We would also like to express our heartfelt thanks to our Project Guides, **Dr. Sreeni K. G.** and **Dr. Renu Jose**, who were a continual source of encouragement and support. We are deeply indebted to **Dr. David Solomon George**, Professor and Head of the Department of Electronics and Communication Engineering, for granting permission and providing all the necessary facilities to carry out the project in a systematic manner.

We sincerely thank our Principal, **Dr. Prince A.**, for providing us with all the necessary resources and support. Further, we extend our gratitude to all the teaching and non-teaching staff of the Department of Electronics and Communication Engineering for their cooperation and assistance during the course of the project.

Finally, we would like to express our deepest appreciation to our friends, families, and well-wishers for their constant guidance, help, and prayers that enabled us to complete this project successfully.

Alwin Philip
Delsa Davis
Jessin Sunny
Jeswin T. J.

Declaration

We, the undersigned hereby declare that the project report entitled **Smart Agricultural Monitoring System**, submitted for partial fulfilment of the requirements for the award of the degree of Bachelor of Technology of the **APJ Abdul Kalam Technological University, Kerala** is a bonafide work done by us under the supervision of **Dr. Renu Jose, Professor**. This submission represents our idea in our own words where ideas or words of others have not been included; we have adequately and accurately cited and referenced the original sources. We have adhered to the ethics of academic honesty and integrity and have not misrepresented or fabricated any data, idea or on our submission. We understand that any violation of the above can result in disciplinary actions from the institute and/ or University and can evoke penal action from the sources which have not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed as the basis for awarding any degree, diploma or similar title of any other university.

Name of Students: Signatures:

Alwin Philip (Reg. No: KTE22CS012)

Delsa Davis (Reg. No: KTE22CS026)

Jessin Sunny (Reg. No: KTE22CS036)

Jeswin T.J. (Reg. No: KTE22CS037)

Batch: 2022 - 2026 October 26, 2025

Abstract

Agriculture in flood-prone regions like Kerala faces significant challenges due to unpredictable rainfall, over-irrigation, and poor monitoring of field conditions. This project presents an IoT-based Smart Agricultural Monitoring System designed to automate irrigation, detect waterlogging, and enhance farm safety. The system employs sensors to monitor soil moisture, water levels, and environmental conditions in real time, using an ESP8266 microcontroller for data processing and communication. When critical thresholds are detected—such as excess water or excessive heat conditions or or fire, alerts are sent to farmers. The solution aims to optimize water usage, prevent crop damage, and enable remote farm management. Overall, the project demonstrates how this approach provides a cost-effective, reliable, and scalable framework for sustainable smart farming in rural areas.

Contents

List of Figures

Chapter 1

Introduction

1.1 Overview

Agriculture remains the backbone of the Indian economy, yet it continues to face several challenges due to climate variability, water scarcity, and inefficient farming practices. In regions such as Kerala, excessive rainfall and poor drainage systems often lead to waterlogging and flooding of farmlands. These conditions not only damage crops but also result in significant economic losses for farmers. On the other hand, manual irrigation practices can cause either water wastage or under-irrigation due to lack of real-time monitoring and control.

To address these challenges, the proposed **Smart Agricultural Monitoring System** aims to introduce automation and intelligent control mechanisms in irrigation systems. By integrating various IoT sensors, the system continuously monitors soil moisture, water levels, and environmental parameters. This data is processed by an ESP8266 microcontroller to make real-time decisions, thereby optimizing irrigation and preventing overwatering. Additionally, the system can detect fire in the farm environment and alert the farmer.

1.2 Problem Statement

Traditional farming methods rely heavily on manual intervention, leading to inefficiencies in irrigation management. In Kerala and other tropical regions, unpredictable rainfall frequently causes waterlogging, damaging crop roots and reducing yield. Moreover, the absence of automated systems makes it difficult to detect hazards such as fire at an early stage. Most rural agricultural setups also lack remote monitoring or alert systems, forcing farmers to depend on manual inspection, which is time-consuming and unreliable.

1.3 Objectives

The primary objectives of the proposed system are as follows:

- To develop an IoT-based solution for automating irrigation based on real-time soil moisture data.
- To detect waterlogging through continuous monitoring of water levels.

- To provide alerts to farmers in case of abnormal conditions such as excessive water or fire.
- To enable remote monitoring and control of irrigation systems, thereby reducing manual effort.
- To promote resource-efficient and sustainable agricultural practices suitable for rural and flood-prone regions.

Chapter 2

System Description

2.1 Overview

The proposed **Smart Agricultural Monitoring System** integrates multiple sensing and control modules that work together to monitor environmental parameters and automate irrigation. The system is centered around an ESP8266 microcontroller, which collects data from sensors, processes it, and activates actuators or sends alerts based on the conditions detected.

The block diagram of the system is shown in Figure 2.1. It consists of several key modules such as the microcontroller, sensors, actuator units and alert indicators.

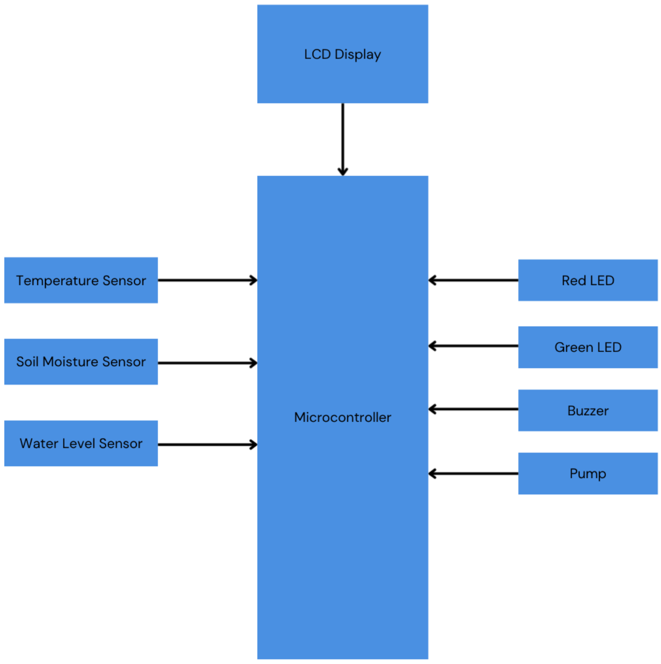

Figure 2.1: Block Diagram of the Smart Agricultural Monitoring System

2.2 System Modules

2.2.1 Microcontroller Unit

The microcontroller acts as the central processing unit of the system. It receives analog and digital signals from the sensors, processes the input data, and performs control actions accordingly..

2.2.2 Soil Moisture Sensor

The soil moisture sensor measures the volumetric water content in the soil. Based on the moisture level, the microcontroller decides whether irrigation is required. When the moisture level falls below a defined threshold, the system automatically activates the servo motor to open the irrigation valve. If the water level rises above a critical threshold indicating possible waterlogging, the system sends an alert and deactivates irrigation to prevent crop damage.

2.2.3 Temperature Sensor

The temperature sensor is used in the system to continuously monitor the surrounding environmental temperature of the agricultural field. If the temperature rises above a critical threshold, the system automatically triggers an alert to notify the farmer, enabling timely action to protect crops from heat stress or fire.

2.2.4 LCD Display Unit

An LCD display is used to show real-time readings from all sensors, such as moisture level, water level, and fire status. It helps the user monitor field conditions directly from the control unit.

2.2.5 Pump

The water pump is responsible for controlling the irrigation process. Based on soil moisture readings, the system automatically turns the pump on when the soil is dry and off when the desired moisture level is reached. This ensures efficient water usage and prevents both under- and over-irrigation in the field.

2.2.6 LED Indicators and Buzzer

A colored LEDs (red, green) and a buzzer are used as visual and audio indicators. These components alert the user to specific conditions such as high moisture (buzzer and green LED), or danger situations like fire (buzzer and red LED).

2.2.7 Circuit Diagram

The circuit diagram illustrates the working of the Smart Agricultural Monitoring System using the ESP8266 NodeMCU as the main control unit. Various sensors and components are integrated to monitor key environmental and soil parameters. The DHT11 sensor measures temperature and humidity, while the soil moisture sensor detects the soil's water content. These readings are displayed in real time on a 16x2 LCD display.

An L9110 motor driver module is used to control the DC water pump, which operates based on soil moisture readings. A fire sensor is included to detect any possible fire or high-temperature conditions in the environment. The red LED indicates a fire condition, while the green LED lights up when high soil moisture is detected. A buzzer is activated in both conditions to alert the user to take necessary action.

The breadboard is used to connect all components neatly, with power and ground rails ensuring proper voltage distribution. This setup combines sensing, control, and alert mechanisms to provide an automated, reliable, and efficient agricultural monitoring and safety system.

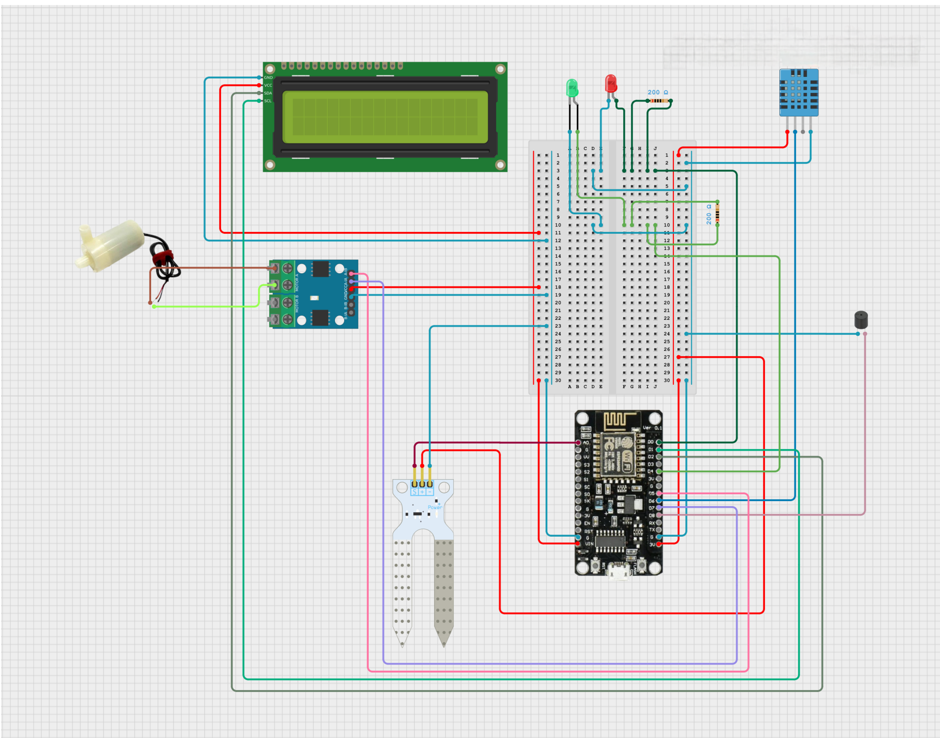

Figure 2.2: Circuit Diagram of the Smart Agricultural Monitoring System

2.3 Working

The Smart Agricultural Monitoring System operates automatically based on real-time data collected from the sensors connected to the ESP8266 NodeMCU microcontroller. When the system is powered on, the NodeMCU initializes all the sensors and begins continuous monitoring of temperature, humidity, soil moisture, and fire conditions.

The DHT11 sensor measures the surrounding temperature and humidity, while the soil moisture sensor determines the level of moisture in the soil. If the soil moisture level falls below a predefined threshold, the NodeMCU sends a signal to the L9110 motor driver, which activates the DC water pump to irrigate the soil. Once adequate moisture is restored, the pump automatically turns off.

Simultaneously, the fire sensor continuously monitors for the presence of fire or abnormal heat conditions. If a fire is detected, the red LED glows and the buzzer turns on to alert the user. Similarly, when the soil moisture level is high, the green LED lights up, and the buzzer also activates to indicate that the soil is sufficiently wet.

All sensor readings are displayed on the 16x2 LCD display for easy observation. Through this coordinated process of sensing, control, and alerting, the system ensures efficient irrigation management and enhances safety in agricultural fields.

Chapter 3

Hardware and Software Description

3.1 Hardware Description

The hardware of the Smart Agricultural Monitoring System is built around the ESP8266 microcontroller, which acts as the central processing unit. It interfaces with soil moisture sensor and DH11 Sensor to collect real-time environmental data. A L9110 motor driver is used to control the water pump, allowing automatic irrigation based on the soil's moisture level. LED indicators and a buzzer are incorporated to provide visual and audible alerts during abnormal conditions like fire or excess water. All components are powered through a regulated 5V DC supply and interconnected using jumper wires and a breadboard for testing and prototyping. This combination of sensors and control units ensures efficient automation, safety, and water management in agricultural applications.

3.1.1 ESP8266 Microcontroller

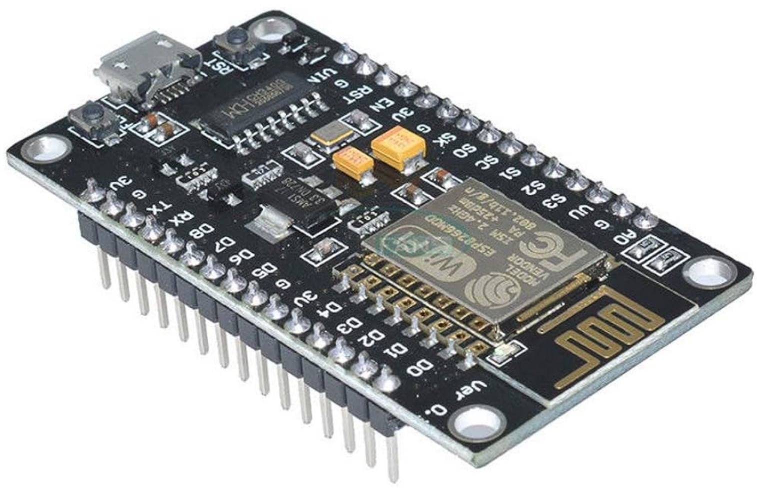

Figure 3.1: ESP8266 Wi-Fi Microcontroller Module

The **ESP8266** is a low-cost Wi-Fi-enabled microcontroller developed by Espressif Systems, widely used in IoT-based automation and monitoring applications. It features a powerful 32-bit Tensilica L106 processor, integrated Wi-Fi module, and multiple GPIO pins for sensor and actuator interfacing. The ESP8266 operates at 3.3V logic level and supports both analog and digital input/output operations. The microcontroller is programmed using the Arduino IDE, making it user-friendly and compatible with a wide range of IoT sensors and modules. In the proposed system, the ESP8266 processes sensor data from the soil moisture and temperature sensors and controls the pump, LEDs, and buzzer based on the environmental conditions. Its compact design, low power consumption, and ease of integration make it an ideal choice for smart agricultural systems. **Specifications:**

- Microcontroller: Tensilica L106 32-bit RISC processor
- Operating Voltage: 3.3V DC
- Flash Memory: 4 MB
- Clock Speed: 80 MHz (up to 160 MHz)
- GPIO Pins: Up to 17
- Communication Interfaces: UART, SPI, I^2C, PWM, ADC
- Wi-Fi Standard: IEEE 802.11 b/g/n
- Power Consumption: Low-power operating and deep-sleep modes supported
- Programming Platform: Arduino IDE or ESP-IDF

3.1.2 Temperature Sensor (DH11)

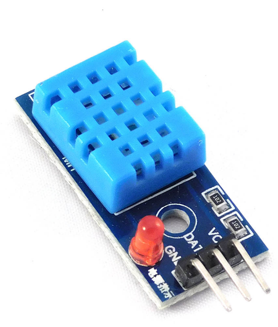

Figure 3.2: DH11 Sensor

The DHT11 sensor is used to measure the ambient temperature and humidity levels. It consists of a thermistor for temperature sensing and a capacitive humidity sensor, both integrated with a digital signal processor that provides calibrated output to the ESP8266.
Specifications:

- Operating Voltage: 3.3V – 5V DC
- Temperature Range: 0°C – 50°C

- Humidity Range: 20% – 90% RH
- Temperature Accuracy: ±2°C
- Humidity Accuracy: ±5% RH
- Output Interface: Digital

3.1.3 L9110

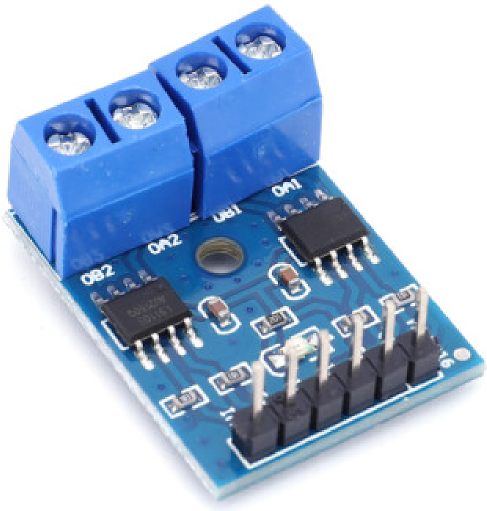

Figure 3.3: L9110 Motor Driver

The **L9110 motor driver module** is used to control the DC water pump in the Smart Agricultural Monitoring System. It acts as an interface between the ESP8266 microcontroller and the pump, providing sufficient current and voltage to drive the motor safely. The ESP8266 sends control signals to the IN1 and IN2 pins of the L9110 module to determine the pump's operation—either turning it ON or OFF based on soil moisture readings.
Specifications:

- Operating Voltage: 2.5V – 12V DC
- Continuous Output Current: 800 mA per channel
- Control Inputs: IN1 and IN2
- Number of Channels: 2
- Features: Low power consumption, built-in thermal protection, bidirectional control

3.1.4 Water Pump

Figure 3.4: Mini DC Water Pump

The **DC water pump** is used for irrigation when the soil moisture level drops below the threshold value. It is powered and controlled through the L9110 motor driver module, which receives control signals from the ESP8266 to turn the pump ON or OFF as needed. The motor driver ensures safe operation by providing the required current and voltage to drive the pump without overloading the microcontroller.

Specifications:

- Operating Voltage: 3V – 6V DC
- Typical Operating Current: 150 – 300 mA
- Flow Rate: 120 L/h
- Control Interface: Via L9110 motor driver (IN1 and IN2 pins)
- Application: Automatic irrigation and water circulation

3.1.5 Buzzer

Figure 3.5: Active Piezoelectric Buzzer

The **buzzer** is an audio alert device used in the system to notify the user of abnormal or emergency conditions such as fire detection, or excess water. It provides an immediate sound-based warning to ensure timely attention to the situation. The buzzer is connected to one of the GPIO pins of the ESP8266 microcontroller, which controls it based on sensor readings. When a critical condition is detected, the ESP8266 sends a high signal to activate the buzzer, producing a loud audible tone.
Specifications:

- Type: Active piezoelectric buzzer
- Operating Voltage: 3.3V–5V DC
- Sound Output: 85–95 dB at 10 cm
- Frequency: 2 kHz – 4 kHz
- Control Signal: Digital output from ESP8266 GPIO
- Function: Provides audio alerts for abnormal system conditions

3.1.6 Soil Moisture Sensor

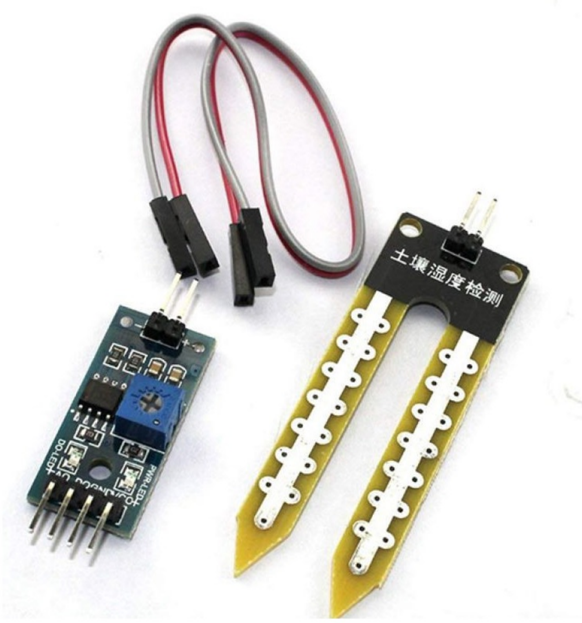

Figure 3.6: Soil Moisture Sensor

The **soil moisture sensor** measures the volumetric water content in the soil. It helps determine when irrigation is needed by detecting dry or wet soil conditions.
Specifications:

- Operating Voltage: 3.3V–5V
- Output Type: Analog
- Measurement Range: 0–100% soil moisture
- Interface: Analog signal to ADC pin
- Function: Detects soil humidity for irrigation control

3.2 Software Description

The software for the Smart Agricultural Monitoring System was developed using the **Arduino Integrated Development Environment (IDE)**. It is responsible for reading sensor data, processing the readings, controlling the water pump, and displaying real-time information on an **I^2C 16×2 LCD**. The program was written in **Embedded C/C++** using the Arduino framework, which provides high-level functions for easy hardware interfacing with the ESP8266 microcontroller.

3.3 Arduino IDE

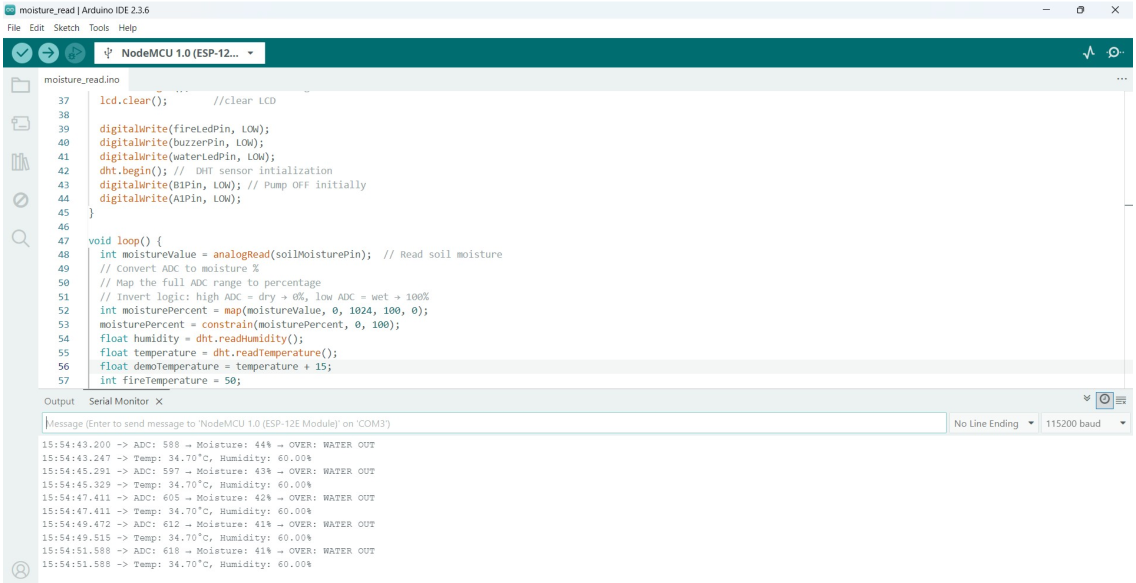

Figure 3.7: Serial Monitor

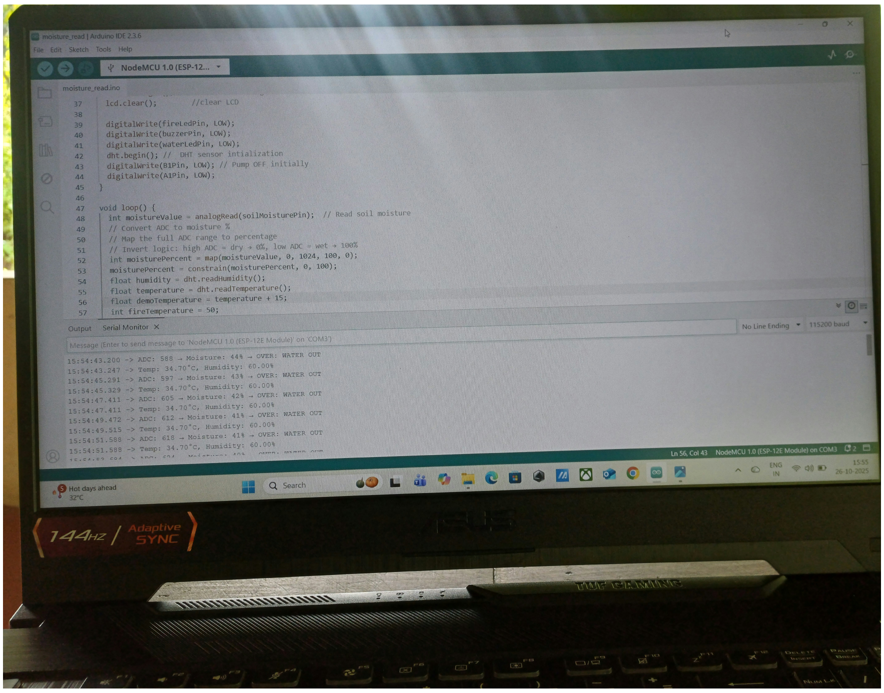

Figure 3.8: Working Environment

The **Arduino IDE** is an open-source development platform that supports code writing, compilation, and uploading to the ESP8266 board. It was used to implement the logic for automatic irrigation control based on soil-moisture readings.

3.3.1 Main Functions Implemented

- **Initialization:** Configures all sensor and actuator pins, including soil moisture sensor (A0), fire LED (D0), water level LED (D4), buzzer (D8), motor driver pins (D5, D7), and DHT11 sensor (D6). Initializes the LCD screen and sets initial states for LEDs, buzzer, and pump.
- **Sensor Reading:** Continuously reads soil moisture via analog pin A0 and environmental data (temperature and humidity) from the DHT11 sensor.
- **Mapping and Processing:** Converts the raw soil moisture ADC value (0–1023) into a percentage scale (0–100%). Reads temperature and humidity, checking for sensor errors.
- **Decision Logic:**
  - If temperature exceeds the fire threshold, triggers a fire alert, turns on the fire LED and buzzer, and displays the warning on the LCD.
  - If soil moisture exceeds the dry threshold, turns the water pump on to irrigate.
  - If soil moisture is below the wet threshold, turns the pump off, activates water-level LED and buzzer to indicate excess water.
  - If soil moisture is within the normal range, keeps pump off and all alerts inactive.
- **Display and Monitoring:** Updates the LCD with current moisture percentage, temperature, and status messages. Prints all readings and statuses to the serial monitor for debugging.

3.3.2 Software Flow

1. Initialize microcontroller, sensors, LCD, LEDs, buzzer, and pump.
2. Continuously read soil moisture, temperature, and humidity.
3. Convert soil moisture ADC value to percentage; check DHT11 readings for errors.
4. Check if temperature exceeds the fire threshold: if yes, trigger fire alert and corresponding outputs.
5. Check soil moisture against dry and wet thresholds:
   - Dry → turn pump on
   - Wet → turn pump off, indicate excess water
   - Normal → keep pump off and clear alerts

6. Update LCD with moisture percentage, temperature, and current status.
7. Print readings and status to the serial monitor.
8. Wait for 2 seconds before repeating the cycle.

3.3.3 External Libraries

The following external libraries are used in the Smart Agricultural Monitoring System:

- **Wire:** Provides I^2C communication protocol support, enabling the ESP8266 to interface with I^2C devices such as the LCD display.
- **LiquidCrystal_I2C:** Facilitates easy control of the 16x2 I^2C LCD, allowing display of sensor readings and status messages.
- **DHT:** Used to interface with the DHT11 temperature and humidity sensor, providing functions to read ambient temperature and relative humidity.

3.3.4 Simulation and Testing Tools

Initial logic verification was performed using **Tinkercad**, which allowed simulation of sensor inputs and relay control behavior before deployment on physical hardware. The **Serial Monitor** was used for real-time debugging, monitoring sensor readings, and calibrating soil moisture thresholds to ensure accurate and reliable operation of the system. Additionally, **Cirkit Designer** was used to create and visualize the circuit diagram, providing a clear representation of component connections for documentation and verification purposes.

Chapter 4

Results

4.1 Soil Moisture Monitoring and Automatic Irrigation

Figure 4.1: LCD Status: Water In

Figure 4.2: LCD Status: Fine

The system continuously monitors soil moisture using a soil moisture sensor. When the sensor detects that the moisture level falls below a predefined threshold, the ESP8266 microcontroller activates the motor driver, which in turn powers the water pump to irrigate the field. Irrigation continues until the soil reaches the desired moisture level, at which point the motor driver turns off the pump. If the soil moisture exceeds the upper threshold, the system signals excess water by turning on a green LED. This automated control ensures optimal soil hydration, prevents water wastage, and supports healthy crop growth.

4.2 Fire Detection

Figure 4.3: Fire Detection

The system uses a DHT11 sensor to continuously monitor the ambient temperature for fire detection. When the sensor detects abnormal temperature levels, it sends the data to the

ESP8266 microcontroller, which immediately triggers a buzzer and turns on a red LED to alert the farmer. This automatic alert mechanism ensures timely warnings, helping prevent damage to crops and farm property.

4.3 Excess Water Drainage Control

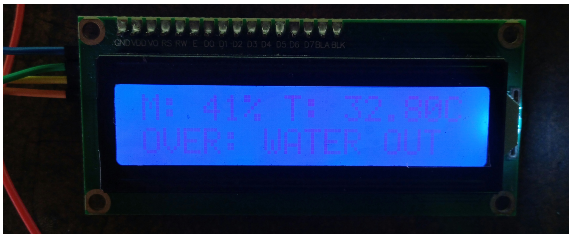

Figure 4.4: LCD Status: Water Out

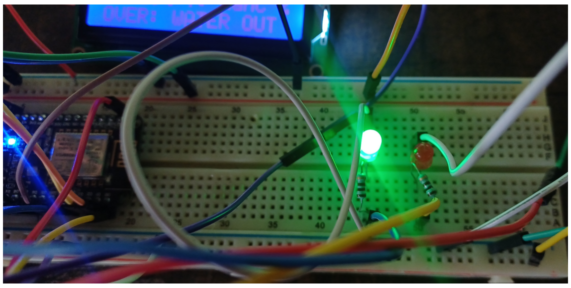

Figure 4.5: Green LED: Excess Water

The system monitors soil and field water levels using a soil moisture sensor. If the sensor detects that the soil is excessively wet, the ESP8266 microcontroller turns off the running pump to prevent overwatering. At the same time, a green LED and buzzer are activated to indicate excess water. This automatic control prevents waterlogging, protects crops, and maintains optimal soil conditions.

4.4 Final Prototype

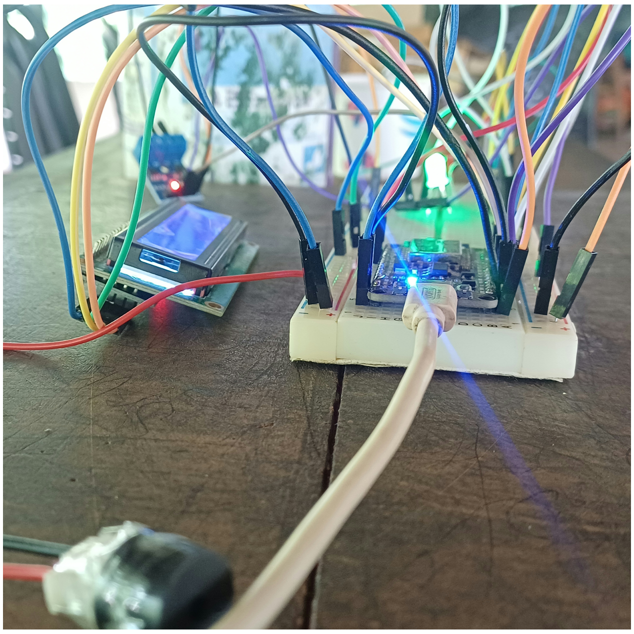

Figure 4.6: Prototype (Closer View)

Figure 4.7: Prototype (Far View)

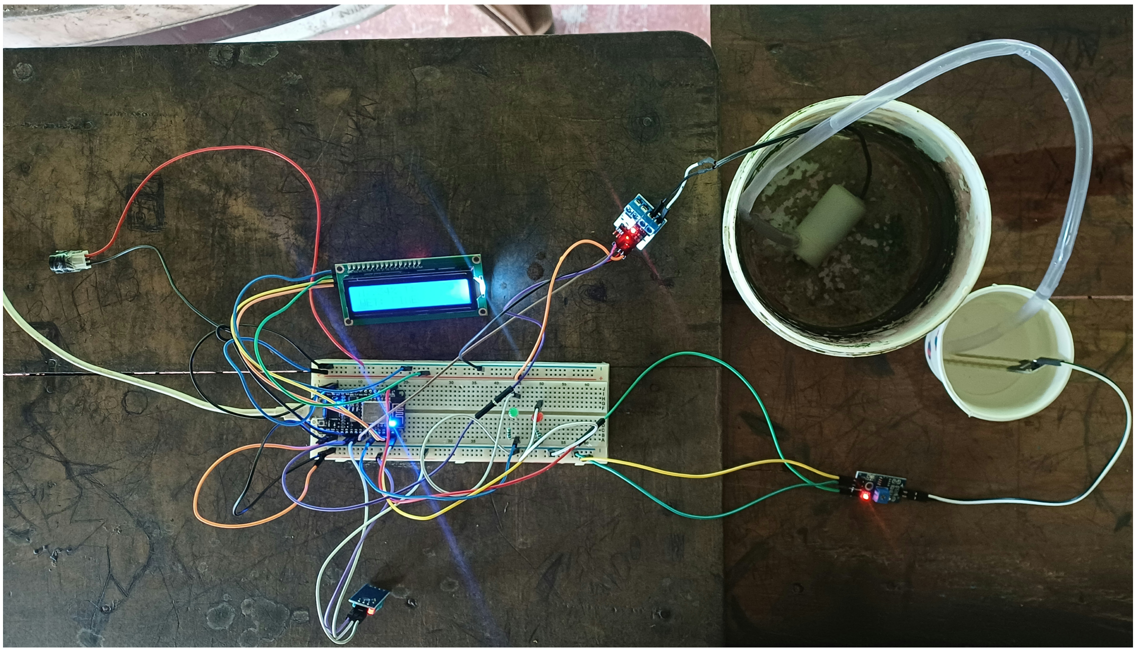

Figure 4.8: Prototype (Top View)

The final prototype integrates all components of the Smart Agricultural Monitoring System. It includes the ESP8266 microcontroller, soil moisture sensor, DHT11 temperature and humidity sensor, motor driver-controlled water pump, buzzer, LEDs for alerts, and an LCD display for real-time monitoring. The system automatically manages irrigation based on soil moisture, turns off the pump and signals excess water with a green LED and buzzer, and provides immediate alerts in case of high temperature (fire) with a red LED and buzzer. The prototype demonstrates the practical implementation of IoT-based smart farming, ensuring efficient water management, crop protection, and enhanced farm safety.

Chapter 5

Conclusion

The Smart Agricultural Monitoring System was developed as a functional prototype to demonstrate how automation and IoT can enhance agricultural efficiency and safety. The system integrates an ESP8266 microcontroller with a soil moisture sensor, DHT11 temperature and humidity sensor, motor driver–controlled water pump, buzzer, and LED indicators. Together, these components enable real-time monitoring of soil and environmental conditions, automatic irrigation control, and immediate alerts in abnormal situations.

The prototype efficiently manages irrigation by activating the pump when the soil becomes dry and turning it off once the required moisture level is achieved. It also detects excess water and fire-like conditions, providing visual and audible alerts using LEDs and a buzzer. This helps prevent waterlogging, conserve water, and protect crops. Overall, the project highlights the potential of smart farming technologies to achieve sustainable and intelligent agricultural practices, especially in flood-prone regions like Kerala.

Future Scope

The Smart Agricultural Monitoring System can be further improved and expanded in the following ways:

- Integration of cloud connectivity to enable remote monitoring and data storage.
- Development of a mobile application for real-time alerts and system control.
- Implementation of data logging for long-term analysis of soil and weather conditions.
- Extension of the system to manage multiple agricultural zones independently.
- Incorporation of solar power for energy-efficient and sustainable operation.
- Application of machine learning algorithms for predictive irrigation and crop health monitoring.

References

[1] M. Mavimbela, A. Mogorosi, X. Yokwana, and M. Sumbwanyambe. Development of a smart agricultural monitoring system. In *Proceedings of the 33rd Southern African Universities Power Engineering Conference (SAUPEC)*, pages 1–6, Pretoria, South Africa, 2025.

[2] C. P. Meher, A. Sahoo, and S. Sharma. Iot based irrigation and water logging monitoring system using arduino and cloud computing. In *Proceedings of the International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN)*, pages 1–5, Vellore, India, 2019.

[3] S. Gupta, V. Malhotra, and V. Vashisht. Water irrigation and flood prevention using iot. In *Proceedings of the 10th International Conference on Cloud Computing, Data Science and Engineering (Confluence)*, pages 260–265, Noida, India, 2020.