1.Synopsis

1)Introduction

The Plant Monitoring and Control System project is all about helping plants grow better by using technology. Imagine a system that can check how your plants are doing, just like a doctor checks a patient. This system uses different sensors to keep an eye on important things like temperature, humidity, soil moisture. With the increasing demand for sustainable agriculture and the need for precision farming, this project addresses the challenges faced by farmers and horticulturists in maintaining ideal conditions for plant growth.The core components of the system include temperature, humidity, soil moisture. These sensors continuously collect data, which is then processed and analyzed to monitor the plant's environment in real-time. The system is designed to automatically adjust the conditions based on the data collected. For instance, if the soil moisture level drops below a predefined threshold, the system will trigger an irrigation mechanism to water the plants. Additionally, users can access the data remotely through a mobile application, allowing them to monitor their plants from anywhere and make informed decisions.What makes this project really cool is that you can check everything from your phone. So if you're away from home, you can still see how your plants are doing and make changes if needed. This system helps farmers and gardeners take better care of their plants, saves water, and makes sure they grow healthy and strong. Overall, it's about using smart technology to make gardening easier and more efficient.In conclusion, the Plant Monitoring and Control System represents a significant advancement in agricultural technology. By utilizing IoT (Internet of Things) principles, this project not only improves the efficiency of plant care but also promotes sustainable practices by reducing water and resource waste. The implementation of such a system can lead to increased productivity, reduced labor costs, and ultimately a more sustainable approach to agriculture. This project is not just about technology; it is about fostering a deeper connection between humans and nature through smarter, more responsible farming practices.

2)Literature survey / Existing system

A literature review for the Plant Monitoring and Control System project involves examining existing research and technologies related to plant growth monitoring, sensor technologies, and automated control systems. Many studies highlight the importance of environmental factors in plant growth. Research shows that temperature, humidity, soil moisture, and light significantly impact plant health and yield. For instance, a study by Zhang et al. (2019) emphasizes that maintaining optimal soil moisture levels can increase crop yields by up to 30%. This underscores the need for systems that can monitor and adjust these conditions in real-time. In terms of technology, various sensor types have been developed to measure environmental parameters accurately. According to Kumar and Gupta (2020), advancements in IoT (Internet of Things) have led to the creation of smart sensors that can communicate data wirelessly. These sensors are crucial for a plant monitoring system as they provide continuous data, allowing for timely interventions.Several existing systems have been implemented in agricultural practices. For example, the Smart Agriculture System developed by Lee et al. (2021) integrates multiple sensors and a cloud-based platform to monitor crops. Their findings indicate that such systems can reduce water usage by 40% while improving crop health. This supports the idea that a Plant Monitoring and Control System can lead to more sustainable farming practices.Additionally, mobile applications play a significant role in modern agricultural technology. Research by Patel et al. (2022) highlights how mobile platforms can enhance user engagement by providing real-time alerts and data visualization. This feature is essential for farmers who may not be on-site frequently, allowing them to make informed decisions quickly.In conclusion, the literature supports the need for a Plant Monitoring and Control System that utilizes sensor technology and IoT principles. By building on existing research and technologies, this project aims to create a comprehensive solution for optimizing plant growth and promoting sustainable agricultural practices.

3)Problem Statement

Water scarcity is a growing global issue, and inefficient irrigation methods contribute significantly to water wastage. Traditional irrigation techniques rely on manual monitoring and watering schedules, which often result in overwatering or underwatering, negatively impacting plant health and leading to unnecessary water consumption. This problem is particularly critical in areas where water resources are limited, and optimizing water use is essential for sustainable agriculture and gardening.The need for a smarter, more automated solution in modern agriculture has become crucial, especially in regions facing water scarcity. By integrating the Internet of Things (IoT) into agricultural irrigation systems, it is possible to monitor soil moisture levels in real-time, automate irrigation based on precise data, and minimize water usage.The goal of this project is to develop a Soil Irrigation System using IoT that ensures efficient water usage by continuously monitoring the soil moisture content. The system will automatically trigger irrigation when moisture levels fall below a defined threshold, significantly reducing water wastage and improving crop yield. The system will also allow for remote monitoring and control via a mobile app or web interface, providing farmers with real-time insights into soil conditions, water usage, and irrigation status.

By utilizing IoT technology, this system aims to make irrigation more efficient, sustainable, and accessible to farmers, contributing to better water management, optimized agricultural practices, and increased crop production

4)Objectives

1.Collect Data: The system will gather real-time environmental data using sensors, including soil moisture levels, temperature, and humidity. These sensors will continuously monitor the plant's surroundings to ensure accurate and timely irrigation decisions.

2.Prepare Data: The collected sensor data will be processed and analyzed to remove inconsistencies and ensure accuracy. The system will convert raw data into meaningful information, such as identifying patterns in soil moisture variations and determining optimal watering schedules.

3.Build Models:A decision-making model will be developed to determine when to activate or deactivate the water pump based on sensor readings. This model will use predefined threshold values for soil moisture and environmental conditions to automate the irrigation process efficiently.

4.Test Models:The developed model will be tested in different environmental conditions to evaluate its performance and accuracy. Adjustments will be made based on real-time observations to improve the reliability and efficiency of the irrigation system.

5)Software Requirement Specification

1.Functional Requirement: These define the system's primary functions:

1. **Sensor Data Collection:**
   - The system should read soil moisture, temperature, and humidity data at regular intervals.
2. **Automated Water Pump Control:**
   - If soil moisture drops below a threshold, the system should activate the water pump.
   - If moisture levels are adequate, the pump should remain off.
3. **Real-Time Monitoring via IoT:**
   - Sensor data should be transmitted to a cloud-based IoT platform (Blynk).
   - Users should be able to view real-time sensor readings.

4. **Remote Control via Mobile App:**
    - Users should be able to turn the water pump on/off via the mobile app.
5. **Alert Notifications:**
    - The system should send notifications if moisture levels are too low or too high.
6. **Data Logging and Analysis:**
    - Store historical sensor data for trend analysis and optimization.

2.Non-Functional Requirements: These define the system's quality attributes:

1. **Reliability:**
    - The system should function without failure for continuous operation.
2. **Scalability:**
    - The design should allow additional sensors or actuators to be added
3. **Security:**
    - IoT communication should be secured using encryption to prevent unauthorized access.
4. **Usability:**
    - The mobile app should have an intuitive and user-friendly interface.
5. **Power Efficiency:**
    - The system should operate on low power to ensure long battery life.

3. User Interface Requirement

1. **Mobile App Interface (Blynk)**

- **Dashboard:** Displays real-time soil moisture, temperature, and humidity readings.
- **Control Panel:** Provides a button to manually control the water pump.
- **Notifications:** Displays alerts when soil moisture is low or high.

Software	Description
Arduino IDE	Programming environment for NodeMCU
Blynk App	Mobile application for IoT monitoring
C/C++	Programming language used in Arduino IDE
Wi-Fi	Internet connectivity for data transmission

2.Microcontroller Interface

- **NodeMCU (ESP8266):** Should provide serial output for debugging.

4. Hardware & Software Requirements

- **Hardware Requirements**

Component	Description
NodeMCU (ESP8266)	Microcontroller with Wi-Fi capability
Soil Moisture Sensor	Measures soil water content
DHT11 Sensor	Measures temperature and humidity
Relay Module	Controls the water pump
Water Pump	Pumps water for irrigation
Power Supply	Battery or adapter for continuous operation
Jumper Wires	For hardware connections

5.Performance Requirements

- **Response Time:** The system should process sensor data within **2 seconds** and update the app in real-time.
- **Data Update Rate:** Sensor data should be updated every **10 seconds**.
- **Pump Activation Time:** The pump should activate **within 1 second** of detecting low moisture.
- **Battery Life:** Should last at least **48 hours** on a single charge.

6.Any Other Requirement

- **Environmental Conditions:** The system should work in temperatures between **0°C to 50°C** and humidity levels of **20% to 90% RH**.
- **Network Dependency:** The system requires **Wi-Fi connectivity** for IoT-based monitoring.
- **Maintainability:** The system should support **firmware updates** via USB or OTA (Over-the-Air).

6)Hardware Requirement Specification:The soil irrigation system is designed as a smart plant monitoring and control system using IoT components. Below are the necessary hardware components for the project:

1. Microcontroller Unit (MCU)

NodeMCU (ESP8266) :

- Built-in Wi-Fi for IoT connectivity
- 10 General Purpose Input/Output (GPIO) pins
- Compatible with Arduino IDE for programming

2. Sensors

- **Soil Moisture Sensor**
    - Detects soil moisture levels
    - Operating Voltage: 5V
    - Analog Interface
- **DHT11 (Temperature & Humidity Sensor)**
    - Temperature Range: 0°C to 50°C (±2°C accuracy)

- Humidity Range: 20-90% RH (±5% RH accuracy)

3. Actuators

Relay Module (5V): Controls water pump switching**.** Normally Open (NO) and Normally Closed (NC) contacts

- **Water Pump**:Low-power DC pump for irrigation. Connected via relay for automated control

4. Power Supply

- **Battery Pack (Rechargeable)** :Provides power backup for continuous operation

5. Additional Components

- **Jumper Wires**:For connecting components
- **Breadboard** :For prototyping circuits
- **Plastic Tubing** :For water delivery from pump to plants

6)Methodology / Planning of Work / Proposed Work

1. Project Overview

The soil irrigation system is an IoT-based smart irrigation solution that monitors environmental parameters such as soil moisture, humidity, and temperature. The system automates plant watering based on sensor data and sends real-time updates to a mobile application.

2. Data Set Required

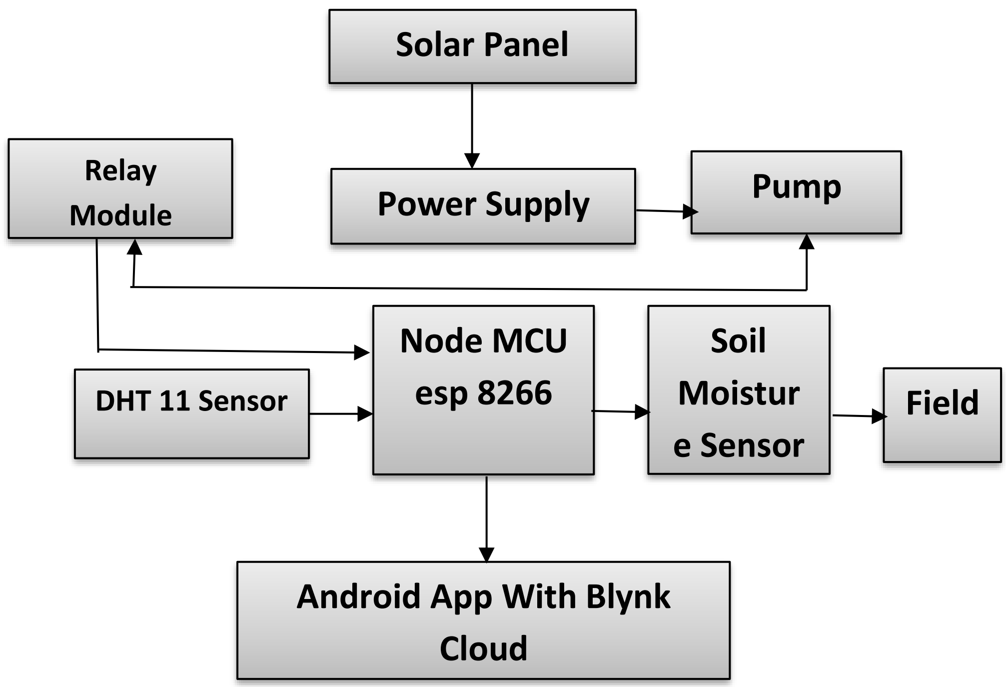
To train and test the system, the following data will be collected:

- **Soil Moisture Levels** (Analog values from the soil moisture sensor)
- **Temperature Readings** (From the DHT11 sensor)
- **Humidity Levels** (From the DHT11 sensor)
- **Water Pump Activation Logs** (When and how long the pump is turned on)

3.Method of Data Collection

- **Real-time sensor data acquisition**: Data will be gathered from soil moisture and temperature/humidity sensors at regular intervals.
- **Storage & Transmission**: Data will be processed in NodeMCU and sent to the Blynk cloud platform.
- **Mobile App Monitoring**: Data will be displayed on a user-friendly Blynk dashboard for remote monitoring and control.

4. Proposed Block Diagram



7. Algorithm / Working Steps

Step 1: Initialization

- Initialize NodeMCU and connect to Wi-Fi
- Initialize sensors and relay module
- Configure Blynk for IoT integration

Step 2: Data Collection

- Read moisture levels from the soil moisture sensor
- Read temperature and humidity from the DHT11 sensor

Step 3: Decision Making

- If soil moisture is **below the threshold**, turn **ON** the water pump
- If soil moisture is **above the threshold**, turn **OFF** the water pump
- Send real-time updates to the Blynk app

Step 4: Data Visualization & Remote Control

- Display live sensor readings on the Blynk app
- Allow users to manually control the pump if needed

8)References

8) References

Oniline Reference:-

https://www.techiqbal.com/plant-monit...

Offline Refernce:-

[1] Dr. Narayan G. Hegde, "Water Scarcity and Security in India", BAIF Development ReseachFoundation, Pune.

[2] Marvin T. Batte, "Changing computer use in agriculture: evidence from Ohio", Computers and Electronics in Agriculture, Elsevier science publishers, vol. 47, 1–13, 2005

[3] Csótó, Magyar, "Information flow in agriculture – through new channels for improved effectiveness", Journal of Agricultural Informatics 1 (2), 25–34, 2010

[4] Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network by Yunseop (James) Kim, Member, IEEE, Robert G. Evans, xand William M. Iversen, IEEE Transaction on Instrumentation and Measurement, VOL.5

Project Guide/Project Co-ordinator

Mr. Rajwardhan S. Todkar

HOD (AIML)

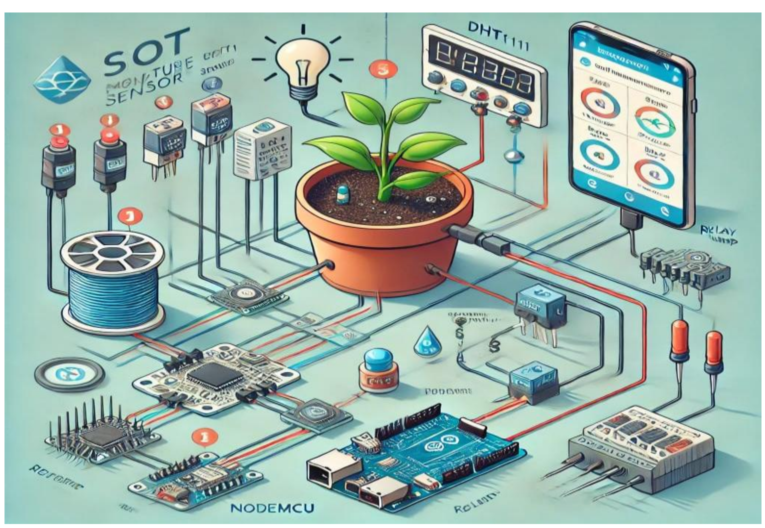
Mr. Ravindra S. Kamble

2.Introduction

2.1 Object Overview

The primary objective is to reduce water wastage, minimize human intervention, and ensure timely irrigation based on actual soil moisture levels. It also seeks to enhance the sustainability of farming practices by offering a scalable and user-friendly platform for farmers. The soil irrigation system is an IoT-based smart irrigation solution that monitors environmental parameters such as soil moisture, humidity, and temperature. The system automates plant watering based on sensor data and sends real-time updates to a mobile application. To develop an automated irrigation system that utilizes Internet of Things (IoT) technologies to monitor soil moisture, temperature, humidity, and weather conditions, optimizing water usage for agricultural applications.

IoT-based smart irrigation systems operate by continuously collecting data from various sensors placed in the soil. These sensors monitor parameters such as soil moisture, temperature, and humidity. The collected data is then transmitted to a central processing unit, which analyzes the information to determine the optimal irrigation schedule. Based on this analysis, the system can automatically activate or deactivate irrigation systems, ensuring that crops receive the appropriate amount of water at the right time.



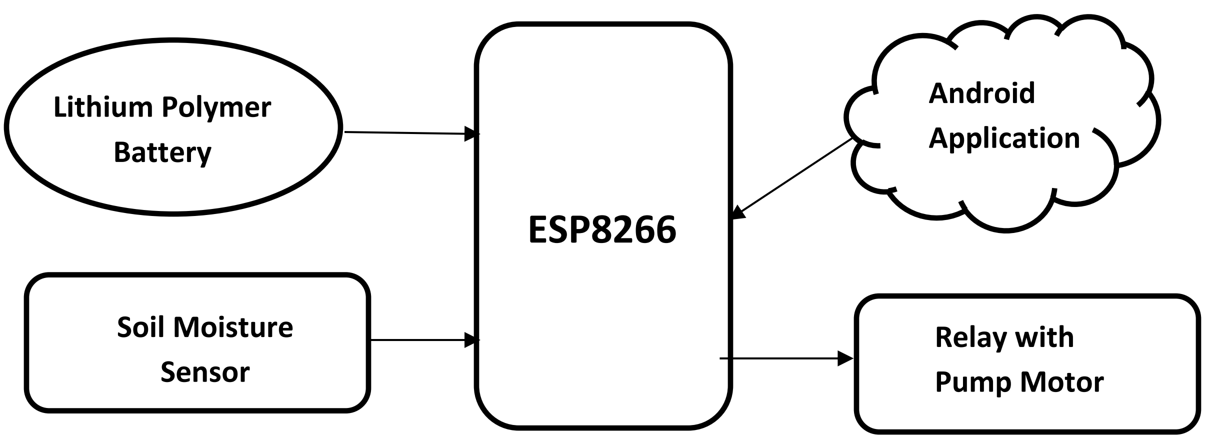
2.2 Problem Statement

Water scarcity is a growing global issue, and inefficient irrigation methods contribute significantly to water wastage. Traditional irrigation techniques rely on manual monitoring and watering schedules, which often result in overwatering or underwatering, negatively impacting plant health and leading to unnecessary water consumption. This problem is particularly critical in areas where water resources are limited, and optimizing water use is essential for sustainable agriculture and gardening.

The need for a smarter, more automated solution in modern agriculture has become crucial, especially in regions facing water scarcity. By integrating the Internet of Things (IoT) into agricultural irrigation systems, it is possible to monitor soil moisture levels in real-time, automate irrigation based on precise data, and minimize water usage.

The goal of this project is to develop a Soil Irrigation System using IoT that ensures efficient water usage by continuously monitoring the soil moisture content. The system will automatically trigger irrigation when moisture levels fall below a defined threshold, significantly reducing water wastage and improving crop yield. The system will also allow for remote monitoring and control via a mobile app or web interface, providing farmers with real-time insights into soil conditions, water usage, and irrigation status.

By utilizing IoT technology, this system aims to make irrigation more efficient, sustainable, and accessible to farmers, contributing to better water management, optimized agricultural practices, and increased crop production.



2.3 Objectives

1.Collect Data:

The system will gather real-time environmental data using sensors, including soil moisture levels, temperature, and humidity. These sensors will continuously monitor the plant's surroundings to ensure accurate and timely irrigation decisions.

2.Prepare Data:

The collected sensor data will be processed and analyzed to remove inconsistencies and ensure accuracy. The system will convert raw data into meaningful information, such as identifying patterns in soil moisture variations and determining optimal watering schedules.

3.Build Models:

A decision-making model will be developed to determine when to activate or deactivate the water pump based on sensor readings. This model will use predefined threshold values for soil moisture and environmental conditions to automate the irrigation process efficiently.

4.Test Models:

The developed model will be tested in different environmental conditions to evaluate its performance and accuracy. Adjustments will be made based on real-time observations to improve the reliability and efficiency of the irrigation system.

5.Create Tools:

A user-friendly interface, such as a mobile application using Blynk, will be developed to allow users to monitor sensor readings, receive alerts, and manually control the irrigation system if needed. This tool will enhance accessibility and ease of use, making the system practical for various applications, including home gardening and large-scale agriculture.

3.Literature survey / Existing system

A literature review for the Plant Monitoring and Control System project involves examining existing research and technologies related to plant growth monitoring, sensor technologies, and automated control systems.

Many studies highlight the importance of environmental factors in plant growth. Research shows that temperature, humidity, soil moisture, and light significantly impact plant health and yield. For instance, a study by Zhang et al. (2019) emphasizes that maintaining optimal soil moisture levels can increase crop yields by up to 30%. This underscores the need for systems that can monitor and adjust these conditions in real-time.

In terms of technology, various sensor types have been developed to measure environmental parameters accurately. According to Kumar and Gupta (2020), advancements in IoT (Internet of Things) have led to the creation of smart sensors that can communicate data wirelessly. These sensors are crucial for a plant monitoring system as they provide continuous data, allowing for timely interventions.

Several existing systems have been implemented in agricultural practices. For example, the Smart Agriculture System developed by Lee et al. (2021) integrates multiple sensors and a cloud-based platform to monitor crops. Their findings indicate that such systems can reduce water usage by 40% while improving crop health. This supports the idea that a Plant Monitoring and Control System can lead to more sustainable farming practices. Additionally, mobile applications play a significant role in modern agricultural technology. Research by Patel et al. (2022) highlights how mobile platforms can enhance user engagement by providing real-time alerts and data visualization. This feature is essential for farmers who may not be on-site frequently, allowing them to make informed decisions quickly.

In conclusion, the literature supports the need for a Plant Monitoring and Control System that utilizes sensor technology and IoT principles. By building on existing research and technologies, this project aims to create a comprehensive solution for optimizing plant growth and promoting sustainable agricultural practices.

4.Basic System Architecture

4.1Outline of the Proposed

The proposed IoT Soil Irrigation System aims to create a smart, automated, and efficient solution for agricultural irrigation by leveraging the power of Internet of Things (IoT) technology. The system is designed to monitor real-time soil conditions and environmental factors to optimize water usage and improve crop productivity. It integrates sensors, microcontrollers, wireless communication, and cloud services to enable remote monitoring and control of irrigation activities.

1. Working Principle

Sensing: Soil moisture sensors are embedded in the ground to continuously monitor the water content. If moisture falls below a predefined threshold, a signal is sent to the microcontroller.

Processing: The microcontroller interprets this data, checks the threshold, and decides whether to turn on the water pump.

Actuation: If needed, the controller activates the pump, which irrigates the soil until the desired moisture level is restored.

Data Transmission: Sensor readings and system status are sent to the cloud via the IoT module.

Remote Monitoring and Control: Users can view real-time data on their smartphone or PC and manually override the system if necessary. Alerts and Automation: The system can also send alerts (SMS, email, app notification) for maintenance, dry soil, or system failures.

2. Features and Benefits

Automation: Fully automates the irrigation process, reducing labor and human error.

Water Efficiency: Delivers water only when needed, based on real-time soil data.

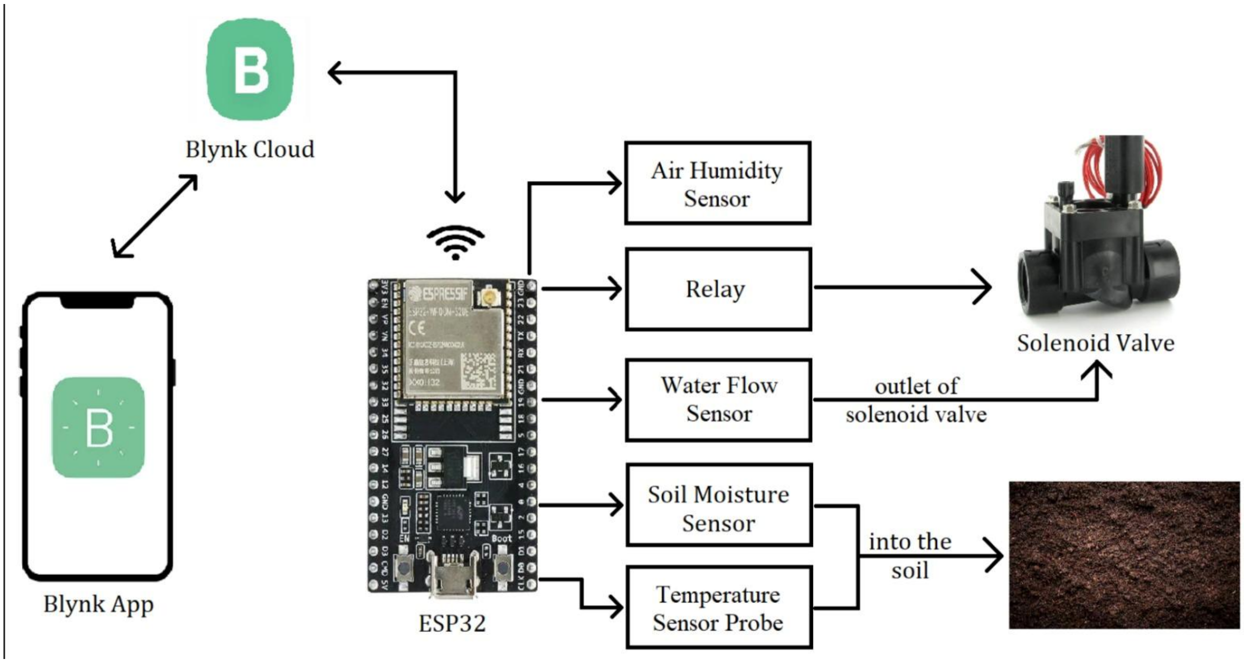
Remote Monitoring: Farmers can manage fields from distant locations.

Scalability: Easily adaptable for farms of various sizes.

Data Logging: Stores historical data for analysis and improvement of irrigation strategies.

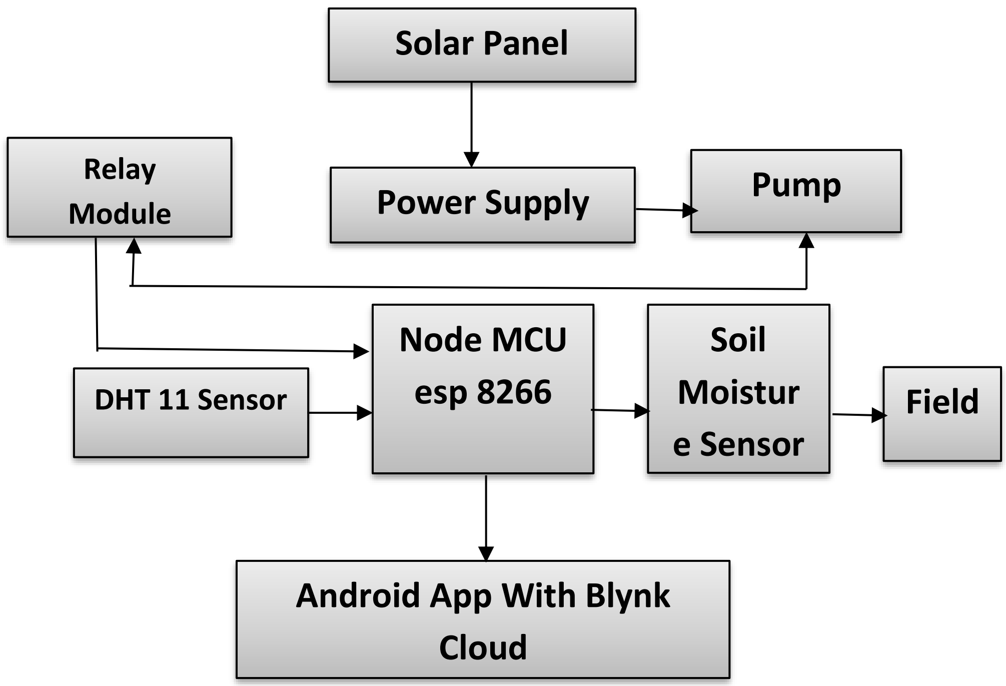
Low Cost and Energy Efficient: Designed with affordable components suitable for rural applications.

4.2 Proposed system block diagram

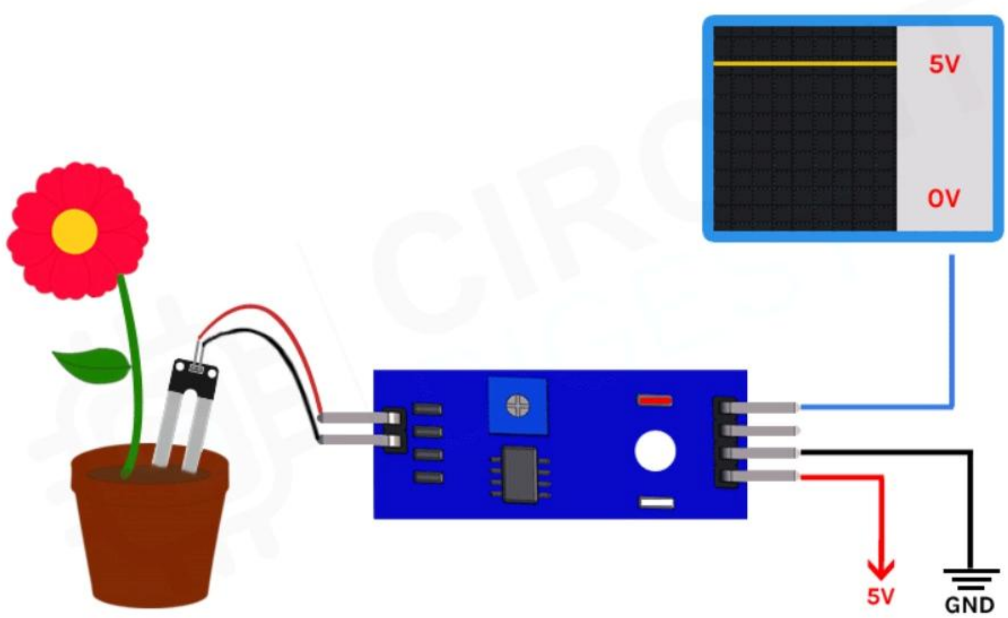


5. Design

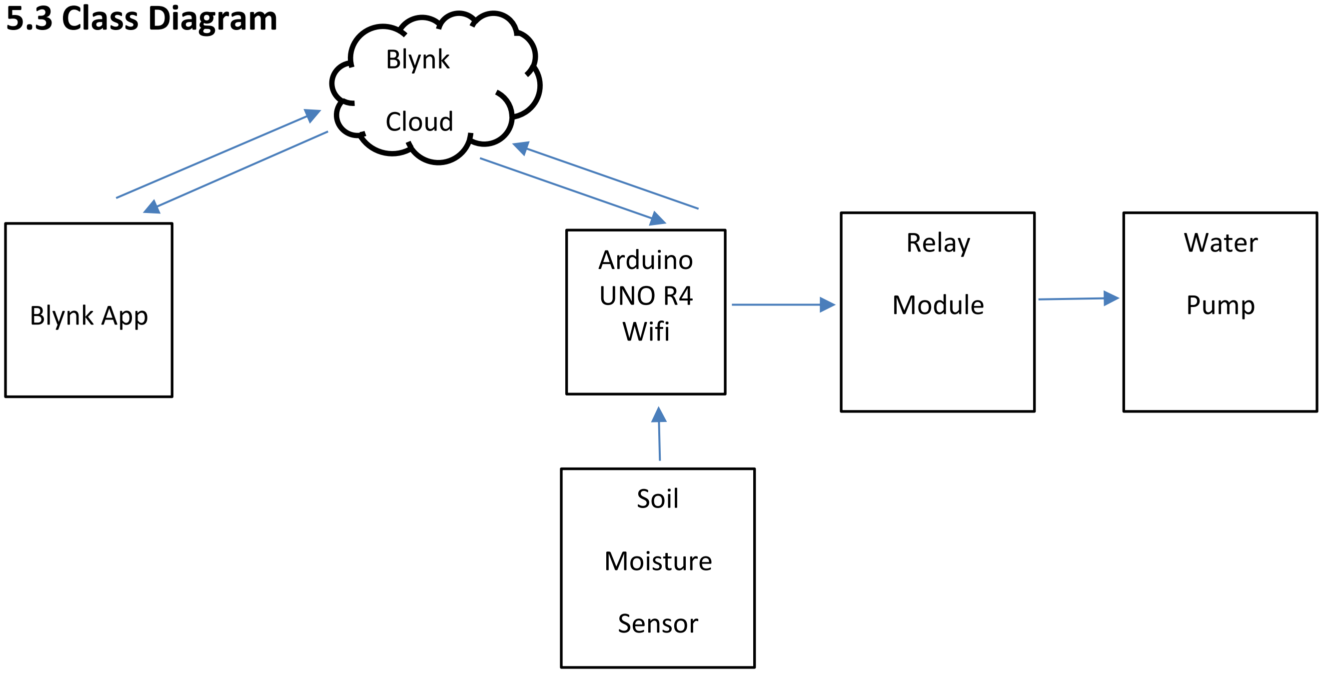
5.1 Data Flow Diagram



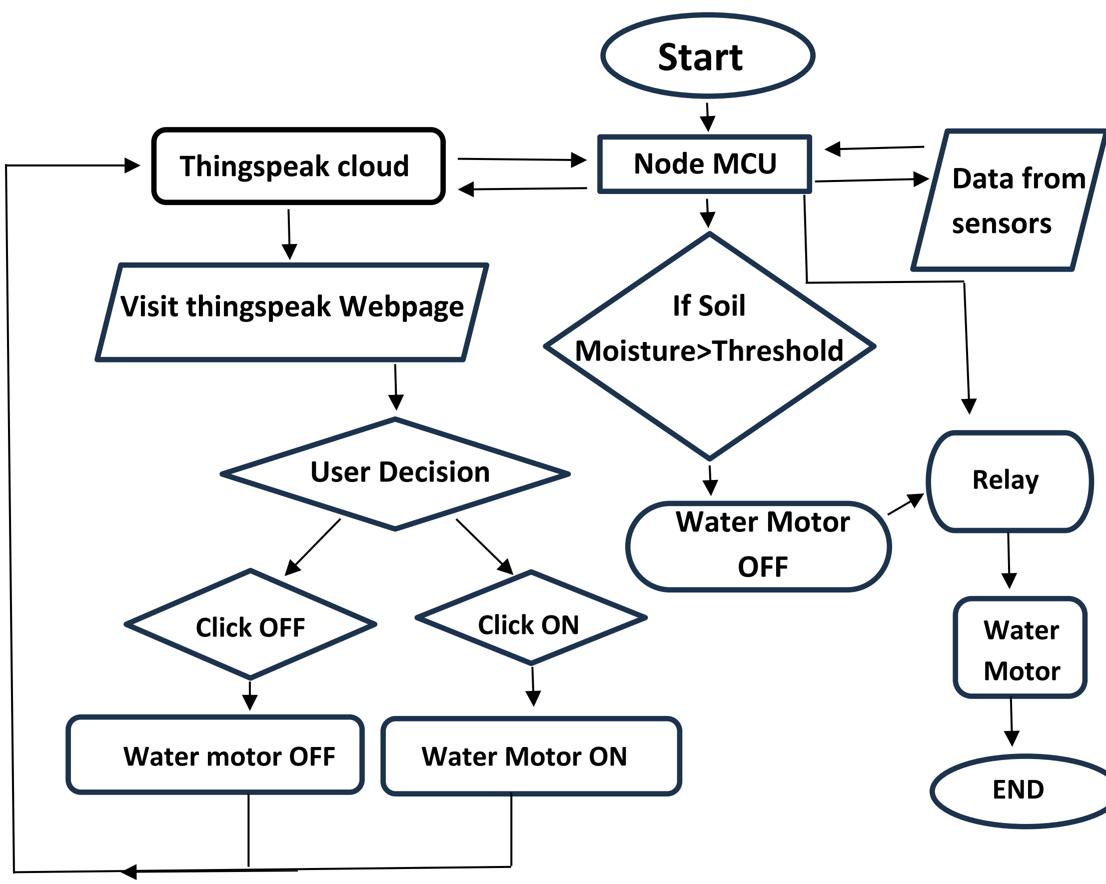
5.2 Use Case Diagram



5.3 Class Diagram

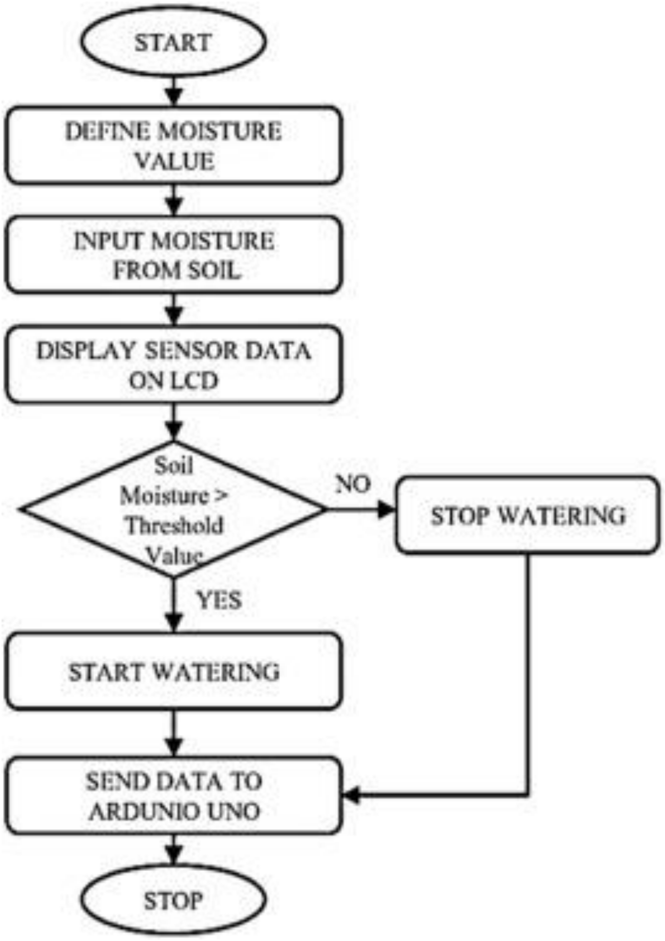


5.4 Activity Diagram



6. Implementation

Algorithm



An **IoT-based Smart Irrigation System** leverages real-time sensor data to automate and optimize agricultural watering. By monitoring soil moisture, temperature, humidity, and weather conditions, the system determines the precise amount of water needed and activates irrigation accordingly. This approach conserves water, reduces energy costs, and enhances crop health by preventing over or under-watering. Additionally, remote monitoring and control via mobile or web applications provide farmers with greater flexibility and efficiency in managing their irrigation practices.

Test Case ID	IOTSI_01	Test Case Description	Test the real-time soil moisture sensing and automatic pump control using NodeMCU and moisture sensor.		
Created By	Samruddhi Vilas Wagare Sanika Chandrakant Jadhav Sanjyot Sardar Patil Sarangi Suhas Bendre	Reviewed By	Mr. Rajwardhan S. Todkar	Version	1.0

QA Tester's Log	Initial testing complete in version 1.0

Tester's Name	Samruddhi Wagare, Sanika Jadhav, Sanjyot Patil, Sarangi Bendre	Date Tested	18/03/2025	Test Case (Pass/Fail)	Pass

S #	Prerequisites:
1	NodeMCU board connected via USB.
2	Soil moisture sensor connected to A0 pin.
3	Relay and pump wired as per circuit.
4	Blynk app configured with correct auth token.

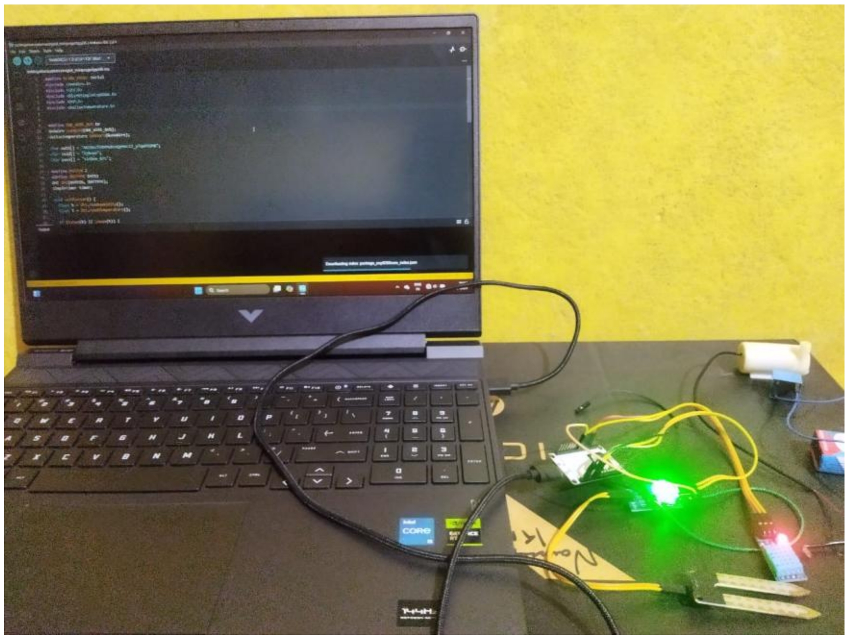
S #	Test Data
1	Dry soil sample (simulate low moisture).
2	Wet soil sample (simulate sufficient moisture).
3	
4	

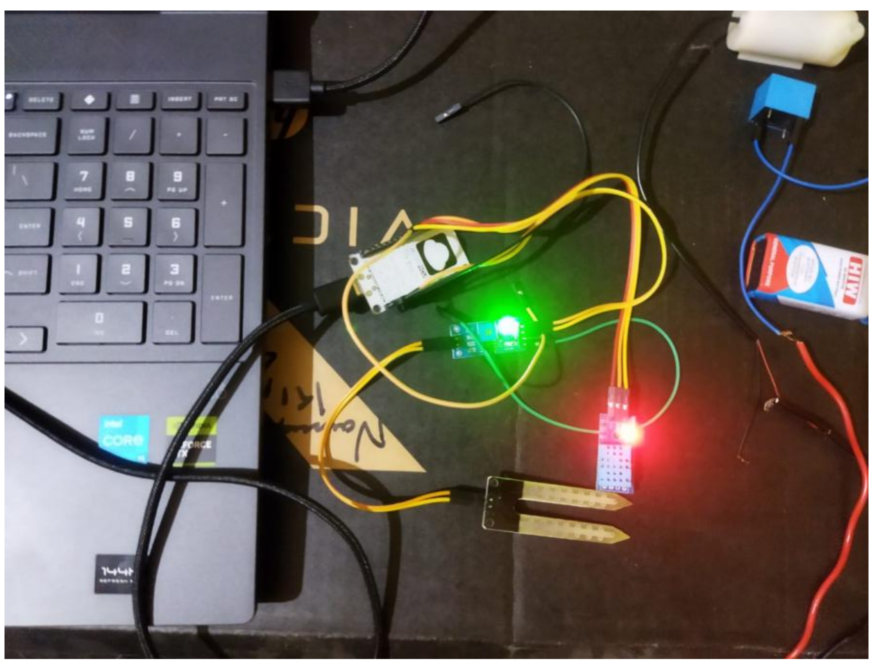
Test Scenario	Verify that the system reads real-time soil moisture, and activates the relay and pump when moisture is below the threshold.

Step #	Step Details	Expected Results	Actual Results	Pass / Fail / Not executed / Suspended
1	Power the system and upload the code to NodeMCU.	System initializes and starts serial monitor.	As Expected	Pass
2	Insert moisture sensor in dry soil.	Moisture % is low, below threshold.	As Expected	Pass
3	Observe relay and pump.	Relay turns ON, pump starts watering.	As Expected	Pass
4	Insert sensor in wet soil.	Moisture % is high, above threshold.	As Expected	Pass
5	Observe relay and pump.	Relay remains OFF, pump stays OFF.	As Expected	Pass

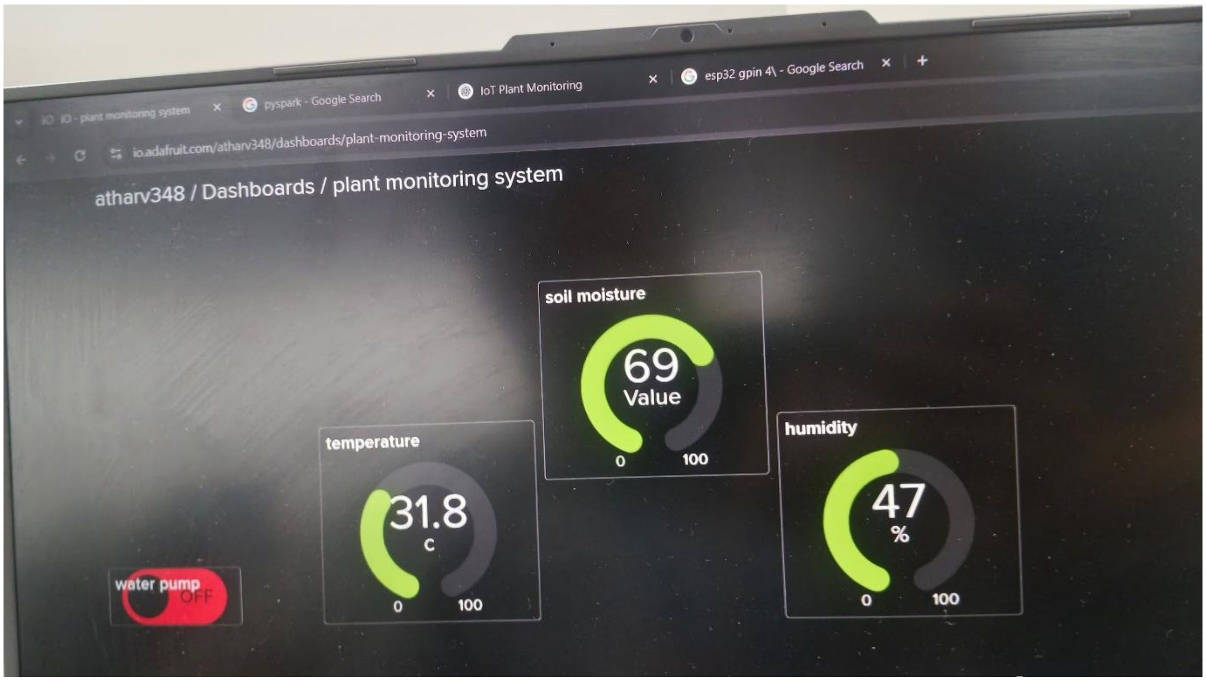
8. Project Screenshots

8.1 Data visualization Screenshots





8.2 Data Analysis Screenshots



9.Conclusion & Future Work

1.conclusion

The automated irrigation system has the potential to significantly improve water efficiency and plant health, helping farmers and gardeners maintain crops with minimal manual intervention. By leveraging IoT technologies such as NodeMCU, sensors, and wireless communication, the project showcases how embedded systems can be used for real-time monitoring and control in agriculture.

2.Future Work

Integration of Weather Forecasting APIs: The system can be enhanced by integrating real-time weather forecasts to prevent unnecessary watering when rain is expected, further improving water efficiency.

Mobile Notification & Control Enhancements: The mobile app can be upgraded to provide intelligent alerts, graphical data trends, and manual control options from any location.

Nutrient Monitoring: Future versions can include sensors to monitor soil nutrients (NPK levels) and recommend or automate fertilizer application.

Machine Learning for Smart Irrigation Decisions: By analyzing historical soil and weather data, the system can learn and predict optimal irrigation schedules using machine learning techniques.

4. Future Scope

The system can be expanded with additional features such as:
Integration with weather forecast APIs for predictive irrigation.
Solar-powered operation for off-grid areas.
Fertilizer and pH monitoring systems.
AI-based irrigation optimization.
This proposed system contributes significantly to smart agriculture by promoting precision farming, conserving resources, and supporting sustainable agricultural practices.

References

1] Online references

https://www.techiqbal.com/plant-monitoring-system-using-nodemcu

2] Offline References

a. Dr. Narayan G. Hegde, "Water Scarcity and Security in India", BAIF Development Research Foundation, Pune.

b. Marvin T. Batte, "Changing computer use in agriculture: evidence from Ohio", Computers and Electronics in Agriculture, Elsevier science publishers, vol. 47, 1–13, 2005

c. Csoto, Magyar, "Information flow in agriculture – through new channels for improved effectiveness", Journal of Agricultural Informatics 1 (2), 25–34, 2010

d. Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network by Yunseop (James) Kim, Member, IEEE, Robert G. Evans, xand William M. Iversen, IEEE Transaction on Instrumentation and Measurement, VOL.5