A Project Report

On

"Plant Health Monitoring System using IOT"

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CERTIFICATE

This is to certify that,

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has successfully completed her T.Y B. Tech Internet of Thing on the topic entitled **“Plant Health Monitoring System using IOT”** This work has been carried out as part of the requirements for the award of the degree of Bachelor of Computer Engineering and is submitted in partial fulfilment of the prescribed syllabus for the academic year 2024-25.

Prof. J. Ishwari
(Guide)

Dr.M.A. Jawale
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CONTENTS

1. Abstract

The **"IoT Based Smart Plant Monitoring System"** is an innovative and automated solution aimed at simplifying plant care by leveraging real-time environmental data and Internet of Things (IoT) technologies. The system is designed to monitor critical parameters necessary for healthy plant growth, including **soil moisture, ambient temperature, humidity, and motion detection**. These variables are continuously sensed using appropriate modules such as the **FC-28 soil moisture sensor**, **DHT11 temperature and humidity sensor**, and **PIR motion sensor**.

All the sensors are seamlessly integrated with a **NodeMCU ESP32** microcontroller, which acts as the brain of the system. This microcontroller is equipped with inbuilt Wi-Fi capabilities, allowing it to send and receive data wirelessly. The system continuously monitors sensor readings and makes intelligent decisions based on the current soil moisture level. When the moisture content falls below a predefined threshold, the system automatically activates a **relay module** to power a **DC water pump**, effectively irrigating the plant without any human intervention.

In terms of user interaction and data accessibility, the system utilizes mobile-based interfaces developed using platforms such as **MIT App Inventor** and **Blynk**. These apps allow users to **remotely monitor the plant's status** in real time, including temperature, humidity, and soil moisture levels. Users can also manually control the irrigation system from their smartphones, adding a layer of flexibility and control.

To ensure long-term data storage and further analysis, the system is connected to **Firebase**, a real-time cloud database. This integration allows sensor data to be logged continuously, enabling users to track trends, analyse environmental changes, and make informed decisions to optimize plant care. Additionally, data

visualization and alert features can be implemented to enhance the user experience.

The project emphasizes **affordability, scalability, and energy efficiency**, making it suitable for both **home gardeners** and **small-scale farmers**. It reduces the need for manual monitoring, conserves water by irrigating only when necessary, and contributes to improved plant health and growth. Furthermore, the system is eco-friendly, easy to deploy, and adaptable to various plant types and environmental conditions. With further enhancements such as solar power integration and machine learning algorithms for predictive analytics, this system holds great potential to contribute to the field of **smart agriculture and sustainable living**.

2.Problem Definition

In today's busy lifestyle, maintaining regular plant care is a challenge, often leading to over- or under-watering. Traditional irrigation methods are inefficient and wasteful, especially as water becomes an increasingly limited resource. To address this, we propose an **IoT-based Smart Plant Monitoring System** that automates plant care using real-time data.

The system employs a **NodeMCU ESP32 microcontroller** connected to sensors for **soil moisture, temperature, humidity, and motion**. It monitors conditions in real time and triggers a **relay-controlled water pump** when soil moisture is low. A **mobile app** (via MIT App Inventor or Blynk) allows users to **remotely monitor and control** the system. Sensor data is also stored in **Firebase** for analysis and decision-making.

This solution is **scalable, low-cost, energy-efficient, and user-friendly**, suitable for home gardening and small-scale agriculture. It aims to **conserve water**, enhance **plant health**, and promote **sustainable farming practices** through automation and data-driven insights.

3.Introduction

In recent years, the integration of **Internet of Things (IoT)** technologies into daily life has transformed how we manage and monitor various systems, including those in the agricultural and gardening sectors. With the rapid advancement of smart technology and the increasing demand for automation, the application of IoT in **agriculture and home gardening** has gained significant momentum. From optimizing irrigation practices to monitoring plant health, IoT-based solutions offer a data-driven approach to managing plant care more efficiently and sustainably.

One of the major challenges faced by both home gardeners and small-scale farmers is the **inconsistent monitoring of plant conditions**, which often results in inadequate watering, nutrient imbalance, or exposure to unsuitable environmental conditions. Manual plant care is not only time-consuming but also prone to human error. Additionally, with **climate change and water scarcity** becoming global concerns, there is a growing need for intelligent systems that can **conserve resources while ensuring plant health**.

This project aims to design and implement a **Smart Plant Monitoring System** that uses IoT to **automate irrigation and continuously monitor environmental conditions**. The system is built around a **NodeMCU ESP32 microcontroller**, which acts as the central processing unit, connected to a variety of environmental sensors such as **soil moisture**, **temperature**, **humidity**, and **motion detection**. These sensors gather real-time data, which is used to make informed decisions about irrigation and plant care.

A key feature of this system is its ability to **automatically activate a water pump** when soil moisture levels fall below a predefined threshold. This is achieved through the use of a **relay module** that is triggered based on sensor input. In addition to automation, the system offers **remote access and control** through a mobile application developed using platforms like **MIT App**

Inventor or **Blynk**, allowing users to monitor and control the system from anywhere.

Moreover, the system stores data in a **Firebase real-time cloud database**, enabling users to **analyse historical trends**, evaluate environmental conditions, and make data-driven decisions to improve plant growth. This feature is especially beneficial for users who are often away from home or manage multiple plants across different locations.

The proposed system is designed to be **affordable, scalable, and energy-efficient**, making it ideal not only for **urban home gardening** but also for **small-scale agricultural applications**. By automating plant care and leveraging cloud-connected analytics, this project contributes to the vision of **smart, sustainable, and precision farming**, ultimately promoting responsible resource usage and better crop yield.

4.Literature Review

IoT (Internet of Things) based plant monitoring systems have gained increasing attention due to the global push for smarter agriculture and sustainable gardening practices. These systems integrate sensor networks, microcontrollers, and cloud platforms to automate monitoring and control tasks, leading to optimized plant care with minimal human intervention.

Numerous research efforts and prototypes have explored various implementations. A study by Pasika and Gandla proposed a cost-effective smart system using IoT, which focused on real-time soil moisture monitoring and automated irrigation, significantly improving water use efficiency and plant health【1】. Mukta et al. developed a system that used temperature, humidity, and moisture sensors connected to a cloud database, enabling remote decision-making and environmental logging【2】.

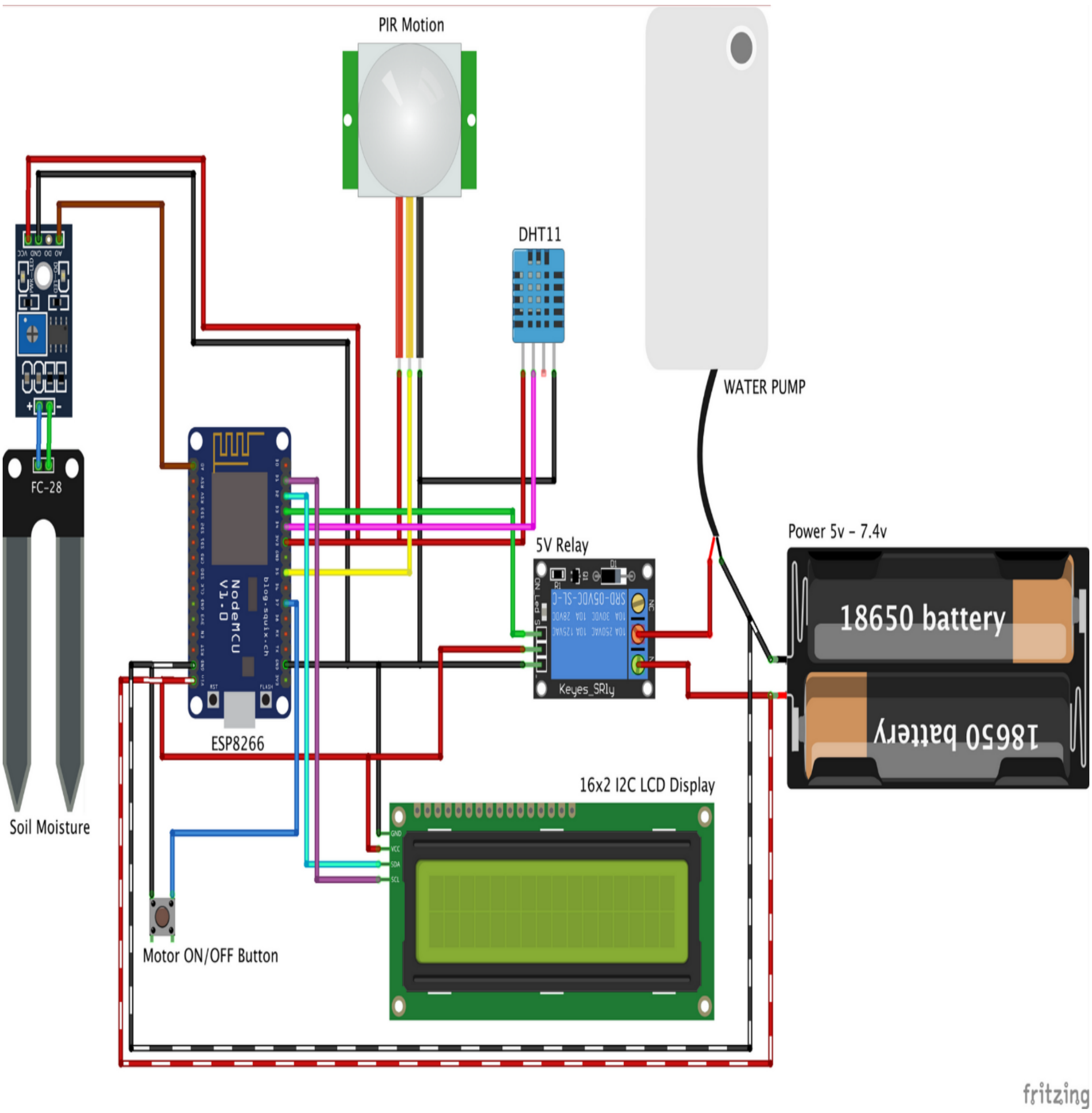
More advanced systems, such as those described by Sugapriyaa et al., emphasized real-time responsiveness using wireless sensor networks and mobile interfaces for user-friendly monitoring and control【5】. These systems often use platforms like NodeMCU or Arduino integrated with sensors (e.g., DHT11, soil moisture sensors) and cloud services such as Firebase or Blynk for data storage and visualization.

Machine learning integration is another growing area of research. Researchers have begun embedding AI to predict irrigation schedules and detect anomalies in environmental data, allowing even smarter automation and adaptation to plant-specific needs【3】. Additionally, energy-efficient designs using solar power and low-power sensors are being explored to ensure long-term sustainability, especially in remote or off-grid areas【4】.

Key Observations:

- Soil moisture, temperature, and humidity sensors form the core of most systems.
- Real-time monitoring and automation greatly enhance plant care efficiency.
- Remote access via mobile apps (MIT App Inventor, Blynk) enables flexibility.
- AI/ML integration and solar power are key directions for future enhancements.
- Firebase and similar platforms are effective for real-time data handling.

5.System Architecture/Flow



Circuit Diagram – Theory and Explanation

The circuit represents the hardware setup of an **IoT Based Smart Plant Monitoring System**, designed to automate irrigation and monitor plant health parameters using various sensors and components.

✎ Power Supply:

- The entire system is powered by two **18650 Li-ion batteries** providing **5V to 7.4V**, enough to run the NodeMCU, sensors, LCD, and relay-driven water pump.

▯ Microcontroller – NodeMCU ESP8266:

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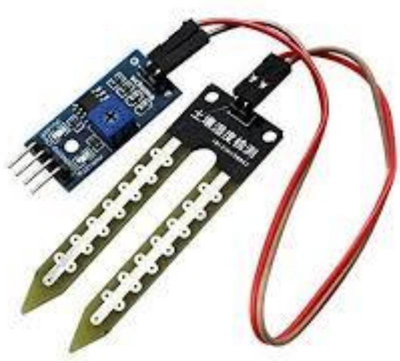
- The central control unit is the **NodeMCU ESP8266** (v1.0), which contains:
    - Built-in **Wi-Fi** for communication with cloud services or mobile apps.
    - Multiple GPIO pins to interface with sensors and modules.

Sensors and Modules:

1. **Soil Moisture Sensor (FC-28):**



- Measures water content in the soil.
- Sends **analogy or digital signals** to the NodeMCU to determine if the plant needs watering.

2. **DHT11 Sensor:**

- Measures **temperature and humidity** in the surrounding environment.

- Provides **digital output** to the microcontroller for display and control decisions.

3. **PIR Motion Sensor:**

- Detects movement near the plant, used either for security or presence detection.
- Triggers alerts or actions based on motion sensing.

💧 **5V Relay Module + Water Pump:**

- The **relay** acts as a switch to control the **DC water pump**.
- When soil moisture falls below a threshold, NodeMCU activates the **relay**, powering the pump to irrigate the plant.

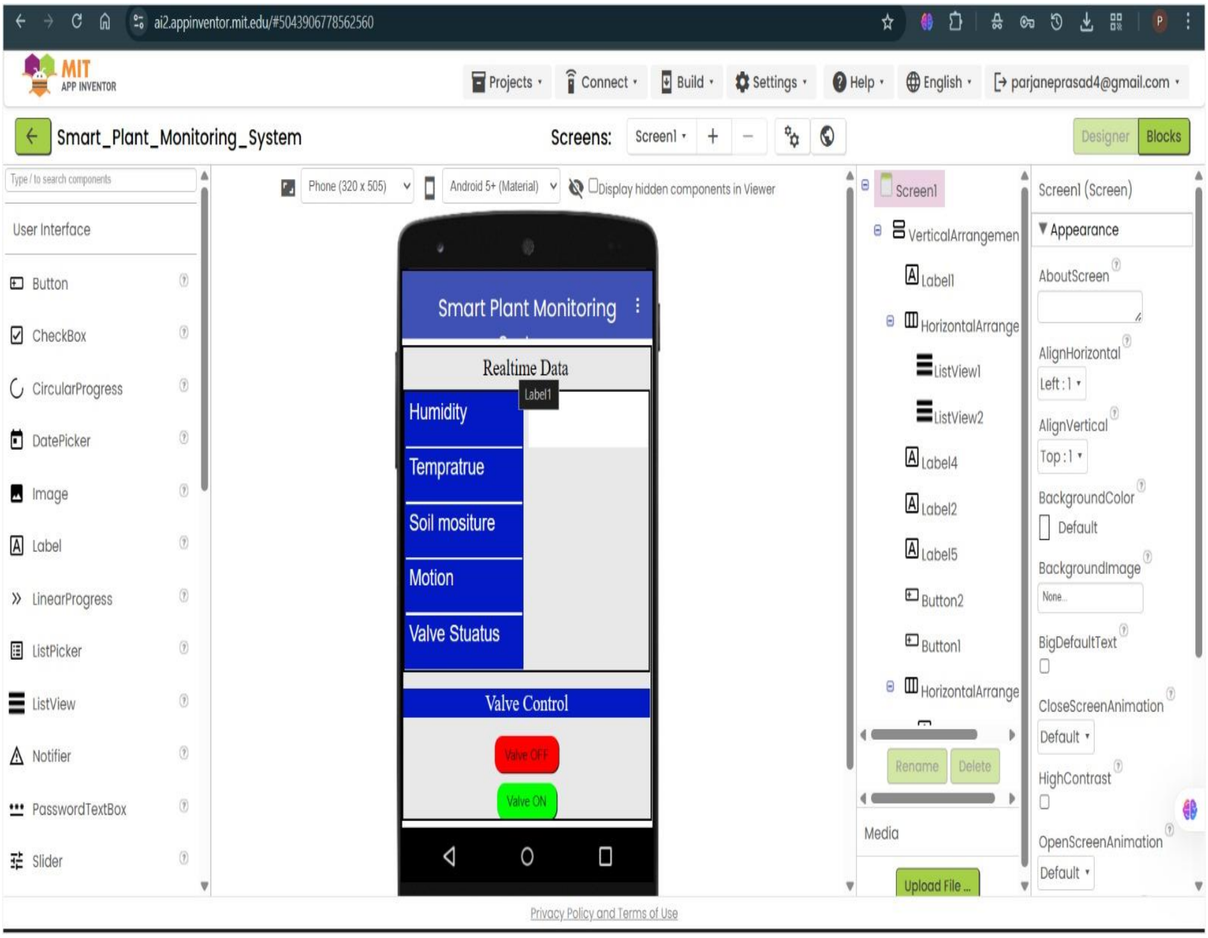
□ Push Button (Motor ON/OFF):

- Manually control the motor for testing or override.
- Connected to a digital pin for ON/OFF toggling logic.

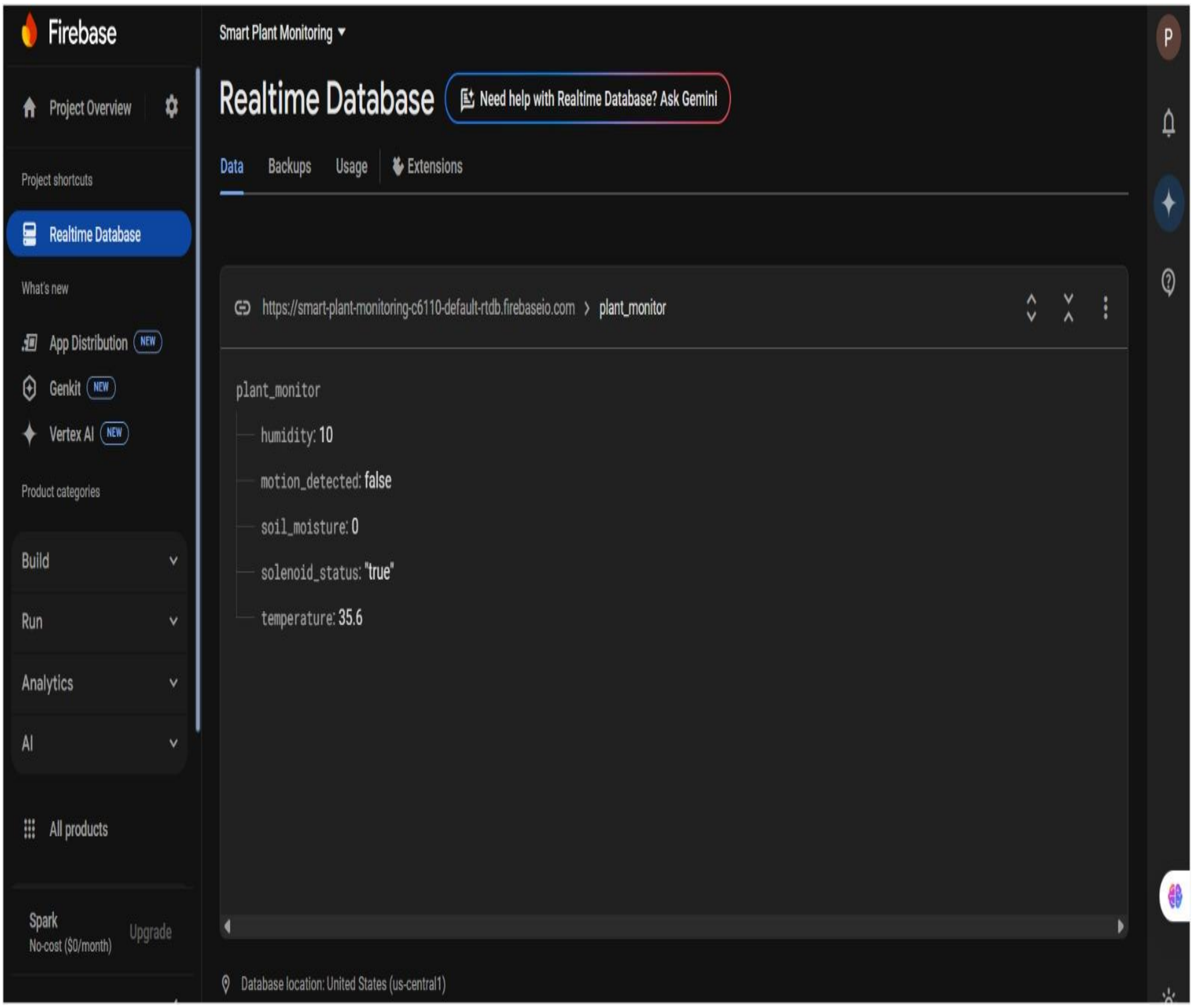
📡 Working Principle:

1. Sensors continuously read environmental data.
2. NodeMCU processes sensor inputs and compares moisture level against the threshold.
3. If moisture is low, the relay is triggered, turning ON the water pump.
4. Sensor data is also displayed on the LCD and can be sent to cloud/mobile apps.
5. Motion detection can optionally alert the user or trigger logs.

6.APK (app) Interface



7.Real-time Database using Firebase



8.Results

The developed IoT Based Smart Plant Monitoring System was successfully implemented and tested under controlled environmental conditions. The system effectively monitored key environmental parameters such as soil moisture, temperature, humidity, and motion, providing accurate and consistent real-time data. These readings were displayed on an LCD interface and simultaneously transmitted to a cloud database using Firebase, allowing continuous data logging and analysis. One of the most significant outcomes of the system was its ability to automatically control irrigation based on real-time soil moisture readings. When the moisture levels dropped below the predefined threshold, the system triggered the relay module to activate the water pump, ensuring that plants received adequate watering without requiring human intervention. This feature functioned flawlessly during testing and ensured optimal soil conditions for plant health. The mobile application, built using MIT App Inventor, allowed users to remotely monitor environmental parameters and control the water pump when necessary. This added a high level of convenience and accessibility, especially for users managing their plants from remote locations. The system also supported manual override features and notifications, enhancing user interaction and trust. Through multiple test iterations, the system demonstrated high reliability, responsiveness, and adaptability. It responded quickly to changes in environmental conditions and was able to restore optimal levels in a timely manner. The automated process resulted in improved water efficiency, reducing unnecessary usage and ensuring sustainability. Data collected during the tests revealed that plants maintained under the smart system exhibited healthier growth compared to those watered manually or irregularly. The consistent moisture levels and favorable environmental control led to better plant development and reduced the risk of overwatering or underwatering. Overall, the system proved to be a robust and practical solution for smart gardening and small-scale agriculture.

9.Conclusion

The **IoT Based Smart Plant Monitoring System** represents a significant advancement in the direction of **smart agriculture** and **sustainable living**. By integrating real-time environmental monitoring, intelligent automation, cloud data storage, and mobile-based remote access, the system provides a modern, efficient, and user-centric approach to plant care. It addresses common challenges such as irregular watering, inefficient resource use, and the inability to monitor plants consistently—particularly for busy individuals, urban dwellers, and small-scale farmers.

The project has successfully demonstrated the ability to **monitor key environmental parameters** like soil moisture, temperature, humidity, and motion with high accuracy. It has also proven its effectiveness in automating irrigation based on real-time data, thereby conserving water and ensuring optimal conditions for plant health. The inclusion of a mobile application has significantly enhanced usability, allowing users to interact with the system remotely and make timely decisions.

One of the most valuable aspects of the system is its **low-cost design**, which relies on readily available components like NodeMCU ESP32, DHT11, and soil moisture sensors. This makes the solution accessible and scalable for a wide range of applications—from **home gardening setups** to **greenhouse management** and **small-scale agricultural farms**.

The project lays a strong foundation for **future enhancements**, such as incorporating **machine learning** for predictive irrigation, **weather-based control logic**, or integration with **IoT dashboards** for advanced analytics. With such improvements, the system can evolve into a comprehensive smart farming platform capable of supporting broader agricultural goals and promoting **environmental conservation**.

10.References

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Suggestions