SHIV NADAR UNIVERSITY CHENNAI

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SCHOOL OF ENGINEERING

PROJECT REPORT

IoT BASED PLANT MONITORING SYSTEM

A PROJECT REPORT

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Introduction to Internet of Things and Laboratory

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CONTENTS

ABSTRACT

The plant monitoring system is a technology-based solution that aims to help gardeners and farmers to optimize their plant growth by monitoring key environmental factors such as temperature, humidity, and soil moisture.

The plant monitoring system is designed to provide real-time monitoring of the environmental conditions, and it can be used to alert users when the conditions fall outside of the desired range for plant growth. This can help gardeners and farmers to take corrective action before it is too late, reducing the risk of plant stress or death. The system can also be used to track the progress of the plant growth, providing valuable insights into the plant's needs for better care and management.

The plant monitoring system is an effective way to optimize plant growth by providing accurate and reliable monitoring of the key environmental parameters. It is a valuable tool for anyone who wants to ensure that their plants are growing in the best possible conditions.

INTRODUCTION

Plant growth and health are largely determined by the environmental conditions in which they are grown. Temperature, humidity, and soil moisture are among the key environmental factors that have a significant impact on plant growth. Monitoring these factors is essential to ensure that plants are growing in optimal conditions. The plant monitoring system that detects temperature, humidity, and soil moisture is designed to help gardeners and farmers optimize plant growth by providing real-time monitoring of the environmental conditions.

OVERVIEW:

The plant monitoring system is a technology-based solution that aims to help gardeners and farmers to optimize their plant growth by monitoring the temperature, humidity, and soil moisture. This system uses a NodeMCU microcontroller, DHT11 temperature and humidity sensor, and soil moisture sensor to detect these parameters. The collected data is then transmitted to a cloud-based database for further analysis.

MOTIVATION:

The motivation behind developing a plant monitoring system is to help gardeners and farmers optimize plant growth by providing accurate and real-time monitoring of the environmental conditions in which the plants are growing. With the help of this system, gardeners and farmers can take corrective action before it is too late, reducing the risk of plant stress or death. Moreover, the system can provide insights into the plant's needs, enabling better care and management.

OBJECTIVES:

The main objectives of the plant monitoring system are as follows:

- To monitor the temperature, humidity, and soil moisture of the plant's environment in real-time.
- To alert the user when the environmental conditions fall outside of the optimal range for plant growth.
- To provide insights into the plant's needs for better care and management.
- To track the progress of the plant growth and health over time.
- To optimize plant growth and health by ensuring that the plants are growing in the best possible conditions.

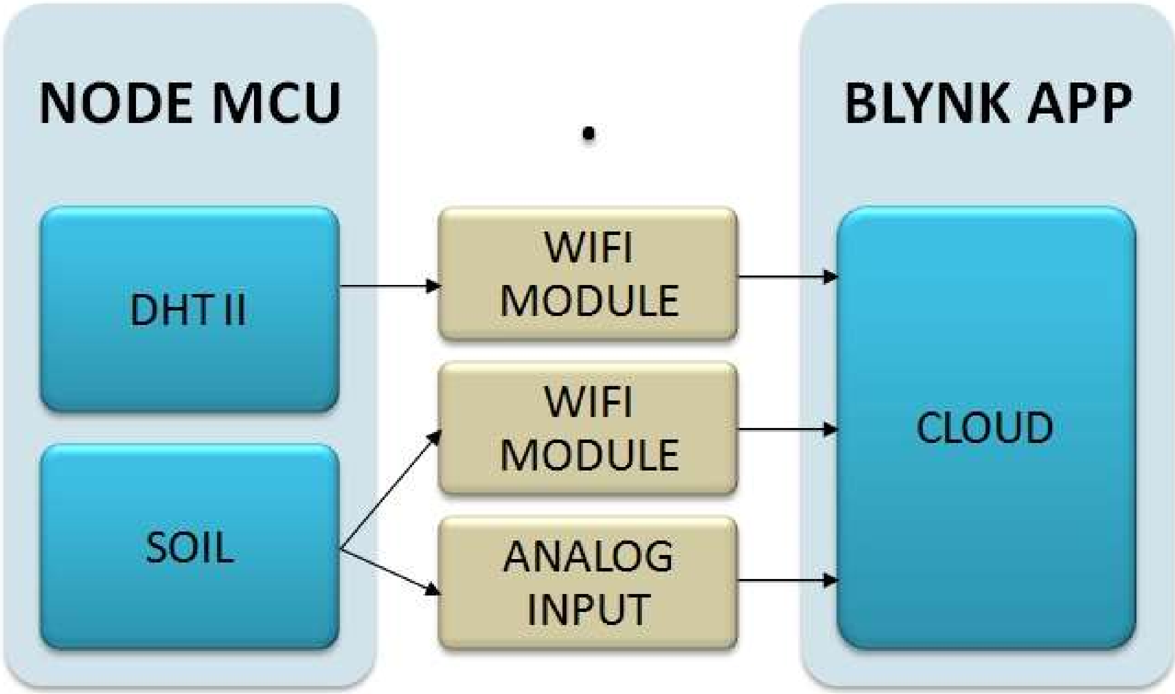
Overall, the plant monitoring system is an essential tool for anyone who wants to optimize plant growth and health. By using this system, gardeners and farmers can ensure that their plants are growing in optimal conditions, reducing the risk of plant stress or death and improving the overall health of their plants.

LITERATURE SURVEY

1. **Paper Title: “"An IoT-Based Smart Plant Monitoring System”**
    a. **Authors:** S. V. Athawale, Mitali Solanki, Arati Sapkal, Ananya Gawande & Sayali Chaudhari
    b. **Summary:** In this modern era of fast-moving technology, we can do things which we could never do before and to do these tasks there is a necessity to build a platform to perform these tasks. This paper puts forth the home automation technique for smart plant watering system. A smartphone empowers the user to be updated with their current garden status using IoT from any part of the world. The system uses Node ESP8266 as the microcontroller interfacing unit.
2. **Paper Title: “IoT Based Automated Plant Monitoring System”**
    a. **Authors:** Sudha K, Rizwana H
    b. **Summary:** This paper proposes an IoT-based automated plant monitoring system using NodeMCU ESP8266 and DHT11. The system monitors temperature, humidity, and soil moisture and sends the data to a web server using Wi-Fi. The authors used Blynk mobile app for visualization and control of the system. The proposed system can help in improving the yield of crops by providing the optimal conditions for growth.
3. **Paper Title: “IoT-based Smart Agriculture Monitoring System using NodeMCU”**
    a. **Author:** Asha B, Remya R, Raja Kumar N
    b. **Summary:** This paper proposes an IoT-based smart agriculture monitoring system using NodeMCU ESP8266 and DHT11. The system monitors temperature, humidity, and soil moisture and sends the data to a cloud server using MQTT protocol. The authors used a mobile app for visualization and control of the system. The proposed system can help in reducing water consumption and improving crop yield by providing the optimal conditions for growth.
4. **Paper Title: “IoT-Based Plant Monitoring System for Precision Agriculture”**
    a. **Author:** Shreya N, Bhavya T, Dhananjay P
    b. **Summary:** This paper proposes an IoT-based plant monitoring system for precision agriculture using NodeMCU ESP8266 and DHT11. The system monitors temperature, humidity, and soil moisture and sends the data to a cloud server using MQTT protocol. The authors used a mobile app for visualization and control of the system. The proposed system can help in reducing water consumption and improving crop yield by providing the optimal conditions for growth.
5. **Paper Title: “IoT-Based Agriculture Monitoring System using NodeMCU”**
    a. **Author:** Ravi Teja K, Praveen Kumar T, Sai Kumar K
    b. **Summary:** This paper proposes an IoT-based agriculture monitoring system using NodeMCU ESP8266 and DHT11. The system monitors temperature, humidity, and soil moisture and sends the data to a cloud server using MQTT protocol. The authors used a mobile app for visualization and control of the system. The proposed system can help in reducing water consumption and improving crop yield by providing the optimal conditions for growth.

PROPOSED METHODOLOGY

BLOCK DIAGRAM



The diagram shows the following components:

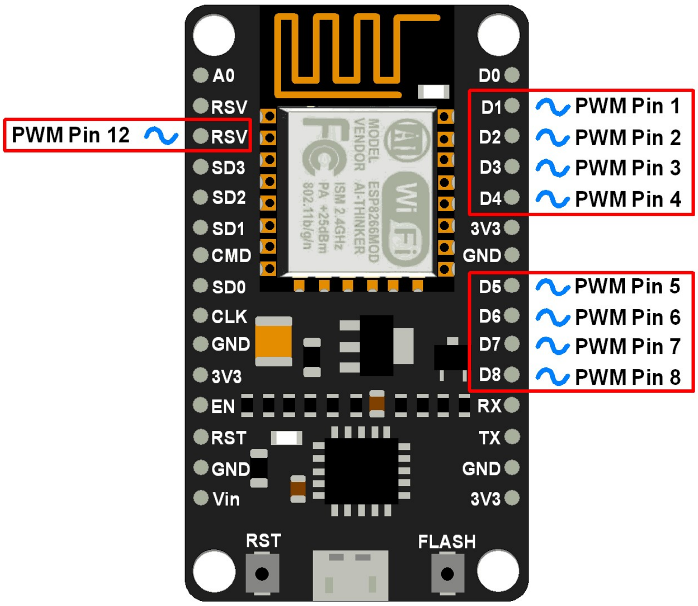
- **NodeMCU board**: This is the main controller of the system. It is equipped with Wi-Fi capabilities that enable it to connect to the internet and communicate with the Blynk app.
- **DHT temperature and humidity sensor:** This sensor is connected to the NodeMCU board and is used to measure the temperature and humidity levels in the plant's environment.
- **Soil moisture sensor:** This sensor is connected to the NodeMCU board and is used to measure the moisture content in the soil.
- **Blynk app:** This is a mobile application that communicates with the NodeMCU board over the internet. It provides real-time data on temperature, humidity, and soil moisture levels and allows users to remotely monitor and control the plant's environment.

The block diagram shows how the components are interconnected. The DHT and soil moisture sensors are connected to the NodeMCU board, which is then connected to the internet via Wi-Fi. The Blynk app com

municates with the NodeMCU board over the internet, receiving data from the sensors and providing real-time information to the user.

PIN DIAGRAM

Node MCU ESP8266



NodeMCU is an open-source firmware and development board based on the ESP8266 Wi-Fi chip. The ESP8266 has a total of 17 GPIO (General Purpose Input/Output) pins, which can be used for a variety of purposes such as digital input/output, analog input, PWM (Pulse Width Modulation), and communication interfaces.

Here's a brief explanation of the NodeMCU ESP8266 pins:

1. **3V3:** This pin provides a 3.3V power supply output.
2. **GND:** This is the ground pin for the power supply.
3. **VIN:** This pin can be used to power the NodeMCU board using an external power supply (recommended voltage range is 5-9V).
4. **A0:** This is an analog input pin that can be used to measure voltage levels between 0 and 3.3V.
5. **D0:** This is a digital input/output pin that can be used for general-purpose applications.
6. **D1:** This pin is used for the I2C interface (SCL - Serial Clock).
7. **D2:** This pin is used for the I2C interface (SDA - Serial Data).
8. **D3:** This is a digital input/output pin that can be used for general-purpose applications.
9. **D4:** This is a digital input/output pin that can be used for general-purpose applications, and is also used for the onboard LED.
10. **D5:** This is a digital input/output pin that can be used for general-purpose applications, and is also used for PWM output.
11. **D6:** This is a digital input/output pin that can be used for general-purpose applications, and is also used for PWM output.
12. **D7:** This is a digital input/output pin that can be used for general-purpose applications.
13. **D8:** This is a digital input/output pin that can be used for general-purpose applications, and is also used for the onboard flash memory.
14. **RX:** This pin is used for serial communication (RX - Receive).

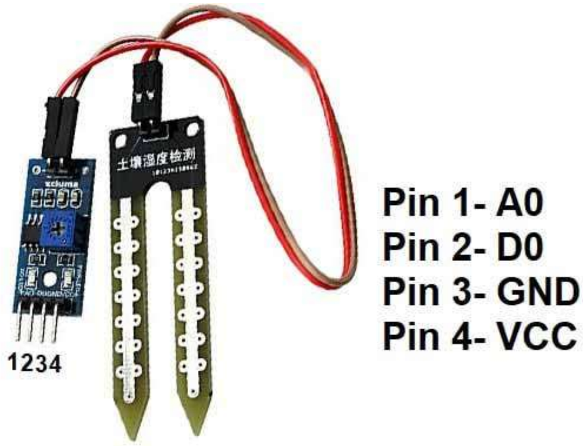
15. **TX:** This pin is used for serial communication (TX - Transmit).
16. **SD2:** This is the second data line for the onboard flash memory.
17. **SD3:** This is the third data line for the onboard flash memory.

DHT 11 Temperature Sensor

The DHT11 is a low-cost temperature and humidity sensor that uses a digital signal output to communicate with a microcontroller. It has three pins that are used for power supply, data communication, and a resistor:

1. **VCC:** This pin is used to provide power to the sensor. It requires a voltage of 3-5.5V.
2. **GND:** This is the ground pin of the sensor, which is connected to the ground of the microcontroller.
3. **Data:** This pin is used to transmit the digital signal output from the sensor to the microcontroller. It uses a single-wire communication protocol.

Soil Moisture Sensor

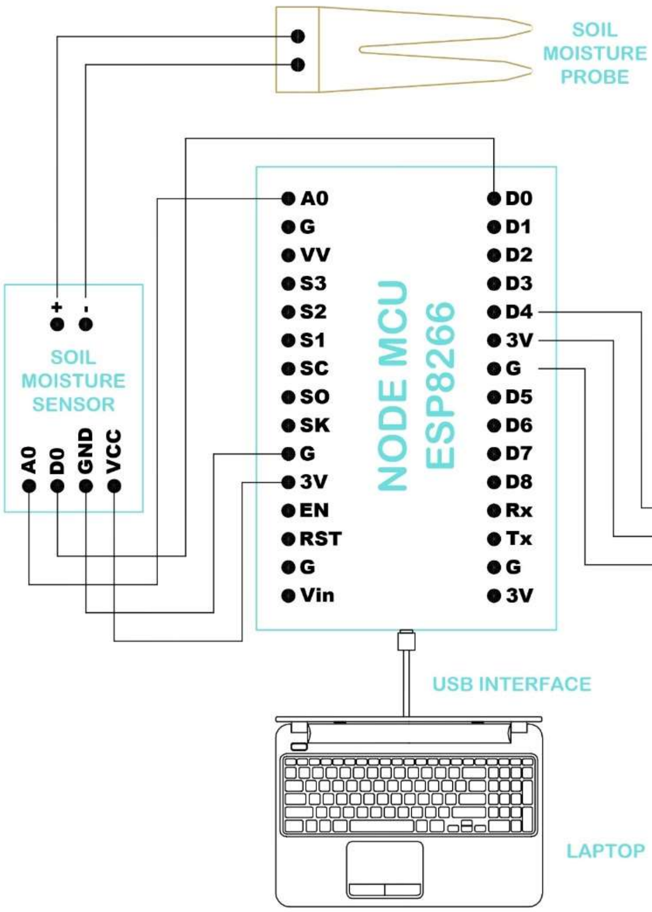


A soil moisture sensor is an electronic device that is used to measure the amount of moisture in soil.

1. **VCC:** This pin is used to provide power to the sensor. It requires a voltage of 3-5.5V.
2. **GND:** This is the ground pin of the sensor, which is connected to the ground of the microcontroller.
3. **Analog Output:** This pin is connected to the microcontroller's analog input to provide the soil moisture readings. The output voltage of the sensor varies according to the amount of moisture in the soil.
4. **Digital Output:** Some soil moisture sensors also have a digital output pin that can be connected to a digital input pin on the microcontroller. The digital output is a binary signal that indicates whether the soil moisture level is above or below a set threshold value.

The resistive soil moisture sensor works by measuring the changes in resistance of two conductive probes inserted into the soil. The resistance between the probes decreases as the soil moisture content increases. This change in resistance is converted into an analog or digital signal that can be read by the microcontroller.

CIRCUIT DIAGRAM



The diagram shows the following components:

- **NodeMCU board:** This is the main controller of the system. It is powered by a USB port and has several pins that are used to connect the sensors.
- **DHT11 temperature and humidity sensor:** This sensor has three pins - VCC, data, and ground. The VCC pin is connected to the 3V3 pin on the NodeMCU board, the data pin is connected to pin D4, and the ground pin is connected to the GND pin.
- **Soil moisture sensor**: This sensor has three pins - VCC, data, and ground. The VCC pin is connected to the 3V3 pin on the NodeMCU board, the data pin is connected to pin A0 (analog input), and the ground pin is connected to the GND pin.
- **USB port:** This is used to power the NodeMCU board.

The circuit diagram shows how the sensors are connected to the NodeMCU board. The DHT11 sensor is connected to pin D4, which is a digital input/output pin. The soil moisture sensor is connected to pin A0, which is an analog input pin.

HARDWARE USED

S.No	Hardware	Specifications	Qty
1	Node MCU board	ESP 8266	1
2	Temperature and Humidity sensor	DHT 11	1
3	Soil Moisture sensor	FC-28	1
4	Breadboard		1
5	Jumper wires		As required

SOFTWARE USED

S.No	Software	Specifications
1	Arduino IDE	v2.0
2	Blynk app (available for iOS and Android)	v1.2.0

METHODOLOGY OF PROJECT

1. **Gather the required materials:**
   NodeMCU, DHT11 temperature and humidity sensor, soil moisture sensor, breadboard, jumper wires, and a power supply.

2. **Connect the DHT11 sensor to the NodeMCU:**
   Connect the VCC pin of the DHT11 to the 3.3V pin of the NodeMCU, the GND pin to the GND pin of the NodeMCU, and the data pin to a digital pin of the NodeMCU (e.g. D2).

3. **Connect the soil moisture sensor to the NodeMCU:**
   Connect the VCC pin of the soil moisture sensor to the 3.3V pin of the NodeMCU, the GND pin to the GND pin of the NodeMCU, and the analog output pin to an analog pin of the NodeMCU (e.g. A0).

4. **Upload the Blynk app code to the NodeMCU:**
   Write a code for the NodeMCU that reads the data from the sensors and sends it to the Blynk app. The code should include the Blynk library, the WiFi connection details, and the sensor reading functions.

5. **Create a Blynk app:**
   Create a new project in the Blynk app and add the required widgets to display the temperature, humidity, and soil moisture readings. The widgets can be added from the app's widget box, and their properties can be customized to display the sensor data.

6. **Connect the Blynk app to the NodeMCU:**
   Generate an auth token in the Blynk app and copy it to the NodeMCU code. This will allow the NodeMCU to communicate with the Blynk app over the internet.

7. **Test the system:**
   Power up the NodeMCU and open the Blynk app. The app should display the real-time temperature, humidity, and soil moisture readings from the sensors.

8. **Install the system:**
   Install the NodeMCU and the sensors in the plant's pot or soil. Ensure that the sensors are securely fixed and that their probes are inserted into the soil at an appropriate depth.

9. **Monitor the system:**
   Use the Blynk app to monitor the temperature, humidity, and soil moisture readings of the plant. The app can also be configured to send alerts when the readings go outside the desired range.

`

PROGRAM CODE

```
#include <DHT.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

#define DHTPIN D2
#define DHTTYPE DHT11

DHT dht(DHTPIN, DHTTYPE);

#define SOILPIN A0

char auth[] = "f4HvEa2zggcIxDmPfex7JVEn4y6Bnz7L";
char ssid[] = "SSN";
char pass[] = "Ssn1!Som2@Sase3#";

void setup()
{
  Serial.begin(9600);
  pinMode(SOILPIN, INPUT);
  dht.begin();
  Blynk.begin(auth, ssid, pass);
}

void loop()
{
  Blynk.run();

  float h = dht.readHumidity();
  float t = dht.readTemperature();

  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }

  int soil = analogRead(SOILPIN);
  soil = map(soil, 0, 1023, 100, 0);

  Blynk.virtualWrite(V1, t);
  Blynk.virtualWrite(V2, h);
  Blynk.virtualWrite(V3, soil);

  delay(2000);
}
```

RESULTS

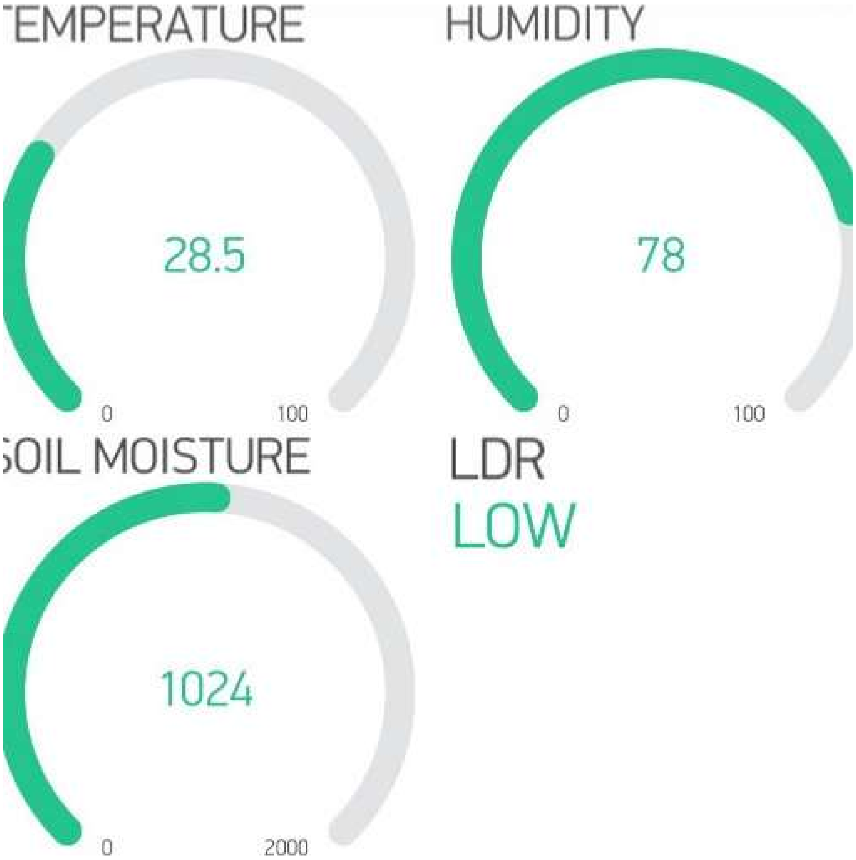
Software

Arduino IDE:

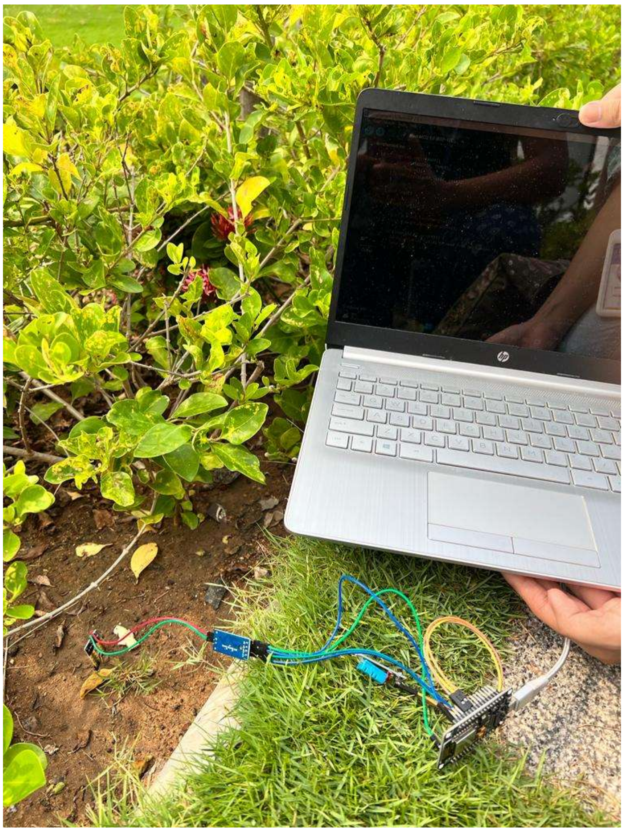
```
Output
. Variables and constants in RAM (global, static), used 29612 / 80192 bytes (36%)
║   SEGMENT  BYTES    DESCRIPTION
╠══ DATA     1556     initialized variables
╠══ RODATA   2112     constants
╚══ BSS      25944    zeroed variables
. Instruction RAM (IRAM_ATTR, ICACHE_RAM_ATTR), used 61247 / 65536 bytes (93%)
║   SEGMENT  BYTES    DESCRIPTION
╠══ ICACHE   32768    reserved space for flash instruction cache
╚══ IRAM     28479    code in IRAM
. Code in flash (default, ICACHE_FLASH_ATTR), used 252324 / 1048576 bytes (24%)
║   SEGMENT  BYTES    DESCRIPTION
╚══ IROM     252324   code in flash
esptool.py v3.0
Serial port COM4
Connecting....
Chip is ESP8266EX
Features: WiFi
Crystal is 26MHz
MAC: 48:55:19:c8:8e:a2
Uploading stub...
Running stub...
Stub running...
Configuring flash size...
Auto-detected Flash size: 4MB
Compressed 288624 bytes to 211437...
Writing at 0x00000000... (7 %)
Writing at 0x00004000... (15 %)
Writing at 0x00008000... (23 %)
Writing at 0x0000c000... (30 %)
Writing at 0x00010000... (38 %)
Writing at 0x00014000... (46 %)
Writing at 0x00018000... (53 %)
Writing at 0x0001c000... (61 %)
Writing at 0x00020000... (69 %)
Writing at 0x00024000... (76 %)
Writing at 0x00028000... (84 %)
Writing at 0x0002c000... (92 %)
Writing at 0x00030000... (100 %)
Wrote 288624 bytes (211437 compressed) at 0x00000000 in 18.9 seconds (effective 122.4 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
```

Blynk App:



Hardware



APPLICATIONS

There is a vast range of applications for a plant monitoring system, which is one of the reasons why we chose it. Some of them include

1. **Agriculture:** In large-scale agriculture, keeping an eye on the soil's temperature, humidity, and moisture content can help farmers make the most of their irrigation and fertilization systems, resulting in higher crop yields.

2. **Indoor gardening:** Indoor gardens, such as those grown in a greenhouse or a hydroponic system, can have their environmental conditions monitored using an IoT-based plant monitoring system. By doing this, you can guarantee the plants' ideal growing conditions.

3. **Landscaping:** To develop and maintain aesthetically beautiful outdoor settings, landscape architects and garden designers can employ an IoT-based plant monitoring system. The system can be used to track the temperature, humidity, and moisture content of the soil and modify the irrigation and watering schedules accordingly.

4. **Studying the effects of various environmental circumstances on plant growth and development :** Plant scientists can employ an IoT-based plant monitoring system. This could enhance our comprehension of plant physiology and pave the way for the creation of innovative agricultural technology.

5. **Home gardening:** To assure the health and wellbeing of their plants, home gardeners can utilise an IoT-based plant monitoring system. They can receive alerts from the system when the plants require water or fertiliser, and it can also offer information about the environmental factors that influence plant growth.

A plant monitoring system powered by the Internet of Things can help maximise plant development, cut down on resource waste, and raise agricultural production.

INFERENCE OF MINI PROJECT

- This is a real-time, remote monitoring and management solution for plants after developing an IoT-based plant monitoring system. The technology enables users to take proactive steps to optimize the growth of your plants by revealing insights into the environmental factors that affect plant growth.

- Patterns and trends can be found in the data the system collects, which will allows user to make more knowledgeable decisions about when to water plants, when to fertilize them, and other aspects of plant care. In order to take prompt remedial action, alerts and notifications can be set up to notify the user when the environmental circumstances veer outside of the desired range.

- Overall, an Internet of Things (IoT)-based plant monitoring system may assists in maximising the health and productivity of plants while reducing resource waste, resulting in more sustainable and effective agriculture

LIMITATIONS OF AN IoT BASED PLANT MONITORING SYSTEM

Here are some potential limitations of plant monitoring systems:

1. **Limited accuracy:** Plant monitoring systems may not always be accurate due to environmental factors such as interference from nearby equipment or changes in lighting conditions. This can lead to inaccurate data collection, which can affect the effectiveness of the system.

2. **High cost:** Some plant monitoring systems can be expensive to purchase and maintain, especially if they require specialized sensors or equipment. This may make it difficult for some users, such as small-scale farmers or hobbyists, to implement the system.

3. **Limited scalability:** This IoT based - plant monitoring system may be limited in their scalability, meaning they may not be suitable for larger agricultural operations or commercial applications.

4. **Limited compatibility:** Our current working module may only be compatible with certain types of plants or growing environments. This can limit their usefulness for users who are interested in monitoring a variety of plants.

5. **Technical expertise required:** This may require technical expertise to install and maintain, including knowledge of sensors, data collection, and data analysis. This can be a barrier for users who do not have the necessary skills or resources.

CONCLUSION

In conclusion, a plant monitoring system is a valuable tool for farmers, gardeners, and plant researchers. By using IoT-based sensors to monitor environmental conditions such as temperature, humidity, and soil moisture levels, the system can provide real-time data on plant health and growth. This data can be used to optimize plant growth, reduce resource waste, and improve agricultural productivity.

With advancements in IoT technology and sensor development, plant monitoring systems are becoming increasingly affordable and accessible. As a result, more farmers, gardeners, and researchers are adopting these systems to improve their plant management practices.

Overall, a plant monitoring system can help promote sustainable agriculture by reducing resource waste, increasing crop yields, and improving plant health. It is a valuable tool for anyone who wants to take a data-driven approach to plant care and management.

FUTURE WORKS

The scope and utility of the project are now known, and there is a plan to work on it in the years to come, eventually developing it for large-scale, real-time use. One way to take the project a step forward is by adding a green shade that is automatically operated to optimize the amount of sunlight received by the plant. Another element that can be incorporated is the entry of data for widely grown crops and area-specific weather and soil type information on the Blynk app with preset controls. The user can also be suggested optimal conditions.

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