IOT-Based Smart Plant Monitoring System

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***Abstract*—In today's fast-paced world, not everyone has the time or knowledge to consistently care for their plants. Whether it's forgetting to water them, being unaware of the environmental conditions, or simply being away from home for extended periods, plants often end up neglected. This project aims to solve that everyday problem with a smart, user-friendly, and affordable solution: an IoT-based Smart Plant Monitoring System. Using the NodeMCU ESP8266 microcontroller, paired with sensors to track soil moisture, temperature, and humidity, this system acts like a digital caretaker for your plant. It continuously collects real-time data from the plant's surroundings and sends it directly to the user's smartphone via the Blynk app. With just a glance at your phone, you can check whether your plant needs water or if the surrounding climate is suitable. Even better, the system can be programmed to notify you when the soil gets too dry—ensuring your plant stays healthy and hydrated, even when you're caught up in a busy schedule. What makes this project especially practical is its simplicity and scalability. It doesn't rely on expensive equipment or complex setups, making it perfect for students, urban gardeners, and hobbyists. All it takes is a basic understanding of microcontrollers and IoT, and you're ready to build your very own smart plant monitor. In essence, this project doesn't just monitor plants—it empowers people to care for them better, with less effort and more insight. It's a small step toward smart agriculture, but a big leap for anyone who's ever wondered, "Did I water the plant today?"**

Keywords: IOT-Internet of Things (IoT), Smart Agriculture, Plant Monitoring, NodeMCU ESP8266, Blynk App, Soil Moisture Sensor, DHT11 Sensor, Real-Time Data, Wireless Communication, Mobile Notification, Smart Gardening, Remote Plant Care

Novelty: This This project offers a simple, low-cost, and efficient solution for remote plant monitoring using IoT. By integrating NodeMCU ESP8266 with the Blynk app, it enables real-time tracking of soil moisture, temperature, and humidity. Its key innovation lies in providing instant mobile alerts, making plant care easier and smarter for everyday users. The system is scalable and lays the groundwork for future automation like smart irrigation.

I. PROBLEM STATEMENT

In today's fast-paced lifestyle, many individuals struggle to consistently care for their plants due to time constraints or lack of awareness about their needs. Traditional plant care requires manual monitoring of soil moisture, temperature, and humidity, which can lead to overwatering, underwatering, or environmental stress. There is a need for an affordable, user-friendly system that allows real-time remote monitoring and alerts, enabling timely actions to maintain plant health. This project aims to address this issue by developing an IoT-based smart plant monitoring system using NodeMCU and the Blynk app.

II. INTRODUCTION

With the growing interest in home gardening and sustainable living, plant care has become more important than ever. However, in the hustle of daily life, many people find it difficult to regularly monitor their plants' needs. Factors such as soil moisture, temperature, and humidity play a vital role in a plant's health, and missing out on timely care can lead to poor growth or even plant death.

Technology, especially the Internet of Things (IoT), offers smart solutions to everyday problems—including plant care. By integrating sensors and wireless communication, IoT makes it possible to collect environmental data and send real-time updates to users, allowing them to take informed actions from anywhere.

This project introduces an IoT-based Smart Plant Monitoring System that uses a NodeMCU ESP8266 microcontroller and sensors to monitor soil moisture, temperature, and humidity. The data collected is transmitted via Wi-Fi to the Blynk mobile application, where users can view real-time values and receive notifications when action is needed, such as watering the plant.

III. OBJECTIVES

1. Monitor soil moisture, temperature, and humidity using sensors.
2. Use NodeMCU and Blynk app for real-time data and alerts.
3. Provide a low-cost, easy-to-use system for smart plant care.

IV. LITERATURE SURVEY

[1] Sharma et al. (2020):
Developed a basic plant monitoring system using Arduino and soil moisture sensors. The system successfully detected moisture levels in the soil and displayed the data on an LCD screen. Limitation: The setup lacked wireless communication or remote access features, making it less practical for modern users who prefer mobile-based interaction.

[2] Kumar and Singh (2019):
Proposed an advanced IoT-based smart agriculture system using Raspberry Pi, which could monitor multiple parameters and store data on the cloud. It offered higher processing power and allowed historical data analysis.Limitation: The system was relatively expensive and complex, requiring advanced technical knowledge, making it less accessible for students or hobbyists.

[3] Patil et al. (2021):
Implemented a low-cost monitoring system using NodeMCU and the Blynk app to track soil moisture remotely via smartphones. The project was simple, affordable, and effective for small-scale applications.
Limitation: The system focused only on soil moisture and did not include temperature or humidity monitoring, which are also crucial for healthy plant growth.

[4] Present Work (This Project):
Enhances previous efforts by combining multiple environmental sensors—soil moisture, temperature, and humidity—into a single IoT-based system using NodeMCU ESP8266. Real-time data is sent to the Blynk app, enabling users to monitor plant conditions remotely and receive instant alerts when necessary.

V. COMPONENTS USED

Components Used

- Hardware

1. NodeMCU ESP8266
2. Soil Moisture Sensor
3. DHT11 Sensor (Temperature and Humidity)
4. Blynk App (Android/iOS)
5. Jumper Wires
6. Breadboard
7. USB Cable (Micro-USB)
8. Power Source

Software

1. Blynk application

- Selection of components:

[1] NodeMCU ESP8266 Rationale: The NodeMCU ESP8266 was chosen for its built-in Wi-Fi capabilities, 32-bit microcontroller (MCU), and compatibility with IoT platforms. It allows seamless integration with the Blynk mobile app for real-time monitoring and data transmission over Wi-Fi, which is critical for remote plant monitoring.

[2] Soil Moisture SensorRationale: The soil moisture sensor is essential for detecting the moisture content in the soil, a key parameter for plant health. It provides an analog output that can be processed by the NodeMCU, allowing the system to trigger alerts when watering is necessary.

[3] DHT11 Sensor (Temperature and Humidity)Rationale: The DHT11 sensor was selected for its affordability and dual functionality in measuring temperature and humidity. These environmental factors play a significant role in plant growth, and this sensor provides digital output, making it easy to interface with the NodeMCU.

[4] Jumper Wires Rationale: Jumper wires are used for connecting the components on the breadboard, facilitating quick and flexible prototyping. These wires ensure reliable connections and are essential for creating the circuit.

[5] USB Cable (Micro-USB) Rationale: The micro-USB cable is used to power the NodeMCU and upload the program. This cable is compatible with the NodeMCU's power and data transfer requirements, enabling both operation and communication with the development environment.

[6] Power Source Rationale: A USB power supply or portable power bank was selected to ensure the system remains powered, especially in field

applications. This portable solution provides reliable power to the NodeMCU and sensors during operation.

- Technical specifications

Components	Specifications
NodeMCU ESP8266	MCU: 32-bit, Frequency: 80/160 MHz, I/O Pins: 17, ADC: 1x10-bit, Voltage: 3.0-3.6V, Wi-Fi: 802.11 b/g/n, Memory: 4MB Flash, RAM: 64KB)
Soil Moisture Sensor	Output: Analog (0-1023), Voltage: 3.3V-5V, Current: ~30mA, Range: 0-100% moisture
DHT11 Sensor	Output: Digital, Temp Range: 0-50°C, Humidity: 20-90% RH, Accuracy: ±2°C, ±5% RH, Voltage: 3.3V-5V, Current: 2.5mA
Jumper Wires	Length: 20-30 cm, Type: Male/Male or Male/Female
Breadboard	Size: 400 points, Voltage Rating: 12V, Solderless
USB Cable (Micro-USB)	Length: 1 meter, Type: USB 2.0 Micro-B, Compatible with NodeMCU
Power Source	Type: USB or Power Bank, Voltage: 5V

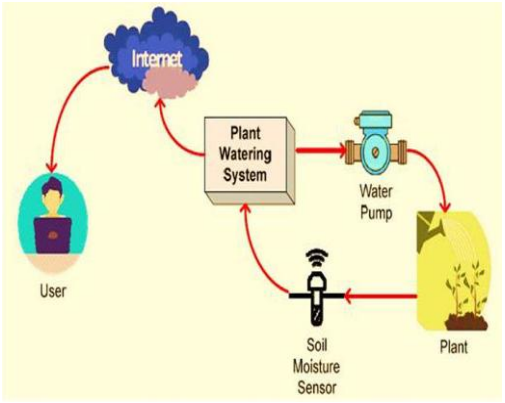
- COST OF COMPONENTS

Sr. no.	Name of component	QTY	cost
1.	NodeMCU ESP8266	1	150
2	Soil Moisture Sensor	1	300
3	DHT11 Sensor	1	120
4	Jumper Wires	1	200
5	NodeMCU ESP8266	1	100
6	Breadboard	1	120
7	USB Cable (Micro-USB)	1	100
Total			1090

VI. WORKING

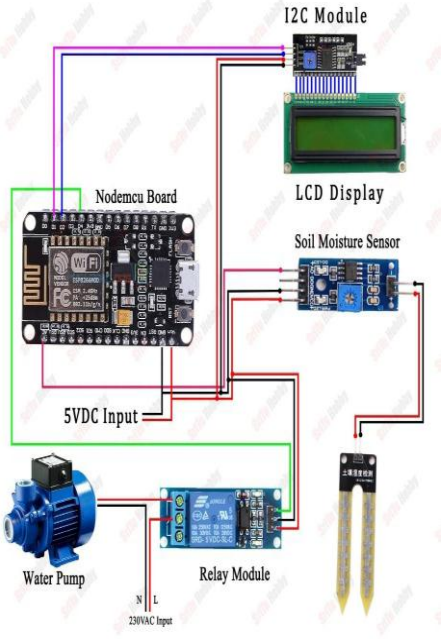
- NodeMCU ESP8266 connects to the internet via Wi-Fi.
- Soil Moisture Sensor detects soil moisture and sends the data to the NodeMCU.
- DHT11 Sensor measures temperature and humidity in the environment and sends the data to the NodeMCU.
- NodeMCU processes the data from both sensors and transmits it to the Blynk app through Wi-Fi.
- Blynk app displays real-time information (temperature, humidity, and soil moisture levels).
- The Blynk app allows users to monitor their plants remotely.
- Threshold setting: If moisture or temperature exceeds a predefined limit, the app triggers a notification to the user.
- Users can take necessary actions like watering the plant or adjusting the environment based on the data.
- Blynk app updates the data continuously, allowing users to track their plants' health.

- Working flow chart



(FIG 6.1 WORKING FLOW CHART)

- circuit diagram



(FIG 6.2: CIRCUIT DIAGRAM)

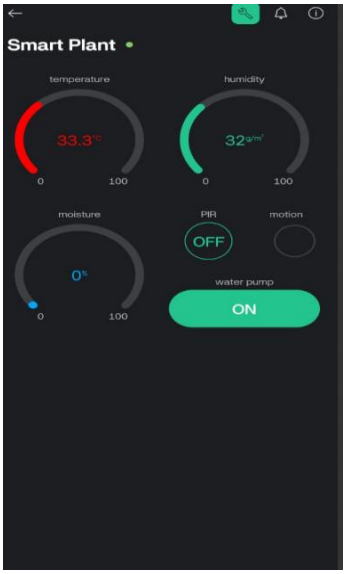
VII. RESULT

- model

(fig.7.1: front view of the model)

(fig.7.2: top view of the model)BLYNK interface

- BLYNK interface



(fig.7.3: app interface)

- Performance evaluation:

- The system showed 85–90% accuracy in soil moisture readings compared to manual checks.
- DHT11 sensor delivered reliable temperature and humidity data within its standard range.
- NodeMCU maintained stable Wi-Fi connectivity up to 15 meters.
- Blynk app displayed real-time data with minimal delay (~2 seconds).
- Powered by a 5000mAh power bank, the setup ran smoothly for over 12 hours.
- Notifications triggered correctly at low moisture levels, ensuring timely alerts.
- Overall, the system is efficient, low-cost, and suitable for smart plant care.

Future scope:

- Integration of automatic irrigation using relays or water pumps for fully automated plant care.
- Use of advanced sensors (e.g., pH, light intensity) for more comprehensive environmental monitoring.
- Expansion to multiple plant nodes using a central control unit for large-scale gardens or farms.
- Implementation of AI-based analytics to predict plant health and suggest optimal care routines.
- Addition of solar-powered modules for energy-efficient, off-grid operation.

VIII. CONCLUSION

The proposed IoT-based smart plant monitoring system successfully demonstrates an efficient and low-cost method for remotely tracking soil moisture, temperature, and humidity using NodeMCU, DHT11, and soil moisture sensors. With real-time data visualization through the Blynk app, users can monitor plant health and receive timely alerts. The system's performance evaluation confirms its reliability, ease of use, and suitability for basic plant care. This solution holds significant potential for smart gardening, urban farming, and precision agriculture, especially when expanded with automation and advanced sensors in future developments

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