Title: Plant Guardian System - IoT-Based Smart Plant Monitoring and Security

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1. Introduction

The Plant Guardian System is an IoT-based smart monitoring and security project developed using NodeMCU ESP8266. This system is designed to automate plant care by monitoring key environmental parameters such as temperature, humidity, and soil moisture while also providing basic security by detecting motion near the plant.

The main goal of this project is to ensure that plants receive adequate water and protection without manual intervention. It integrates sensors and actuators like the DHT11 sensor, soil moisture sensor, servo motor, and a relay-controlled watering system, making it suitable for smart gardens, indoor plant care, or educational purposes.

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2. Components Used

- NodeMCU ESP8266

- DHT11 Temperature and Humidity Sensor

- Soil Moisture Sensor

- Relay Module

- Servo Motor

- IR Sensor (for motion detection)

- Buzzer

- LED (for intruder alert)

- Jumper wires, Breadboard

- USB Cable (for power and programming)

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3. Functional Overview

The Plant Guardian system performs the following tasks:

- Reads temperature and humidity using the DHT11 sensor.

- Monitors soil moisture and activates the water pump via relay if the soil is dry.

- Gives a warning alert if the temperature exceeds a certain threshold or if the soil is critically dry.

- Detects motion using an IR sensor and triggers a buzzer, LED, and servo motor as a security alert.

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4. Code Logic Explanation

- **Sensor Reading:** Temperature and humidity are read using the DHT11 sensor. Soil moisture is read using the analog pin connected to the sensor.

- **Thresholds:** A moisture threshold is defined to decide when to water the plant. Critical levels for temperature and moisture are used to generate warnings.

- **Relay Activation:** If soil moisture drops below the threshold, the relay turns ON, activating the water pump. When moisture is sufficient, the relay turns OFF.

- **Intruder Detection:** If motion is detected by the IR sensor, the system triggers a buzzer, lights up an LED (D4), and moves a servo motor (simulating a physical response like a robotic arm or cover).

- **Warnings:** Serial messages and buzzer alerts notify about extreme temperature or dry soil.

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5. Implementation and Process

1. All components were connected as per the designed circuit diagram.

2. The code was developed in Arduino IDE, tested using serial monitoring.

3. Each component was tested independently and then integrated.

4. Final testing involved simulating intrusions and varying moisture conditions to ensure proper system response
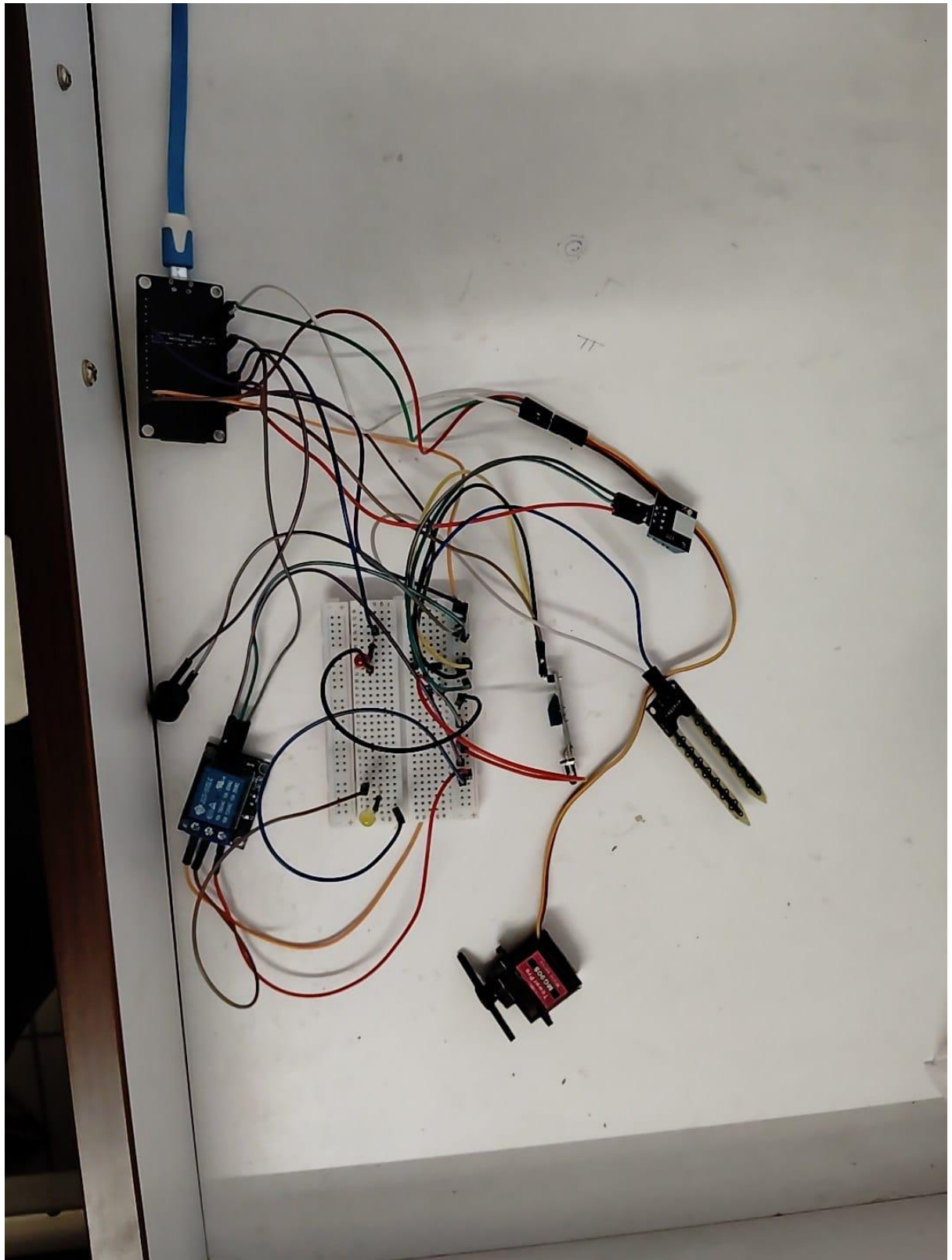
Final setup.

6.Output Description

After assembling and uploading the final code to the NodeMCU:

- The system began displaying real-time readings of temperature, humidity, and soil moisture on the serial monitor.

- When the soil was dry (moisture below 30), the watering relay was activated and a message "Soil is dry! Starting watering..." was printed.

- In case of critically low moisture (below 30), a buzzer warning was issued.

- When motion was detected (IR sensor triggered), a buzzer sounded, the LED on pin D4 turned on, and the servo motor moved to simulate a protective action.

- Warnings for high temperature and low humidity were printed appropriately based on sensor input.

- Overall, the system responded in real-time to environmental changes and intrusions as expected, creating a successful autonomous plant monitoring prototype.

```
Temperature (C): 34
Humidity (%): 20
WARNING: Low humidity! Possible plant dehydration.
Soil Moisture Level: 15
ALERT: Soil is critically dry!
Soil is dry! Starting watering...
No motion detected.
```

When the soil is dry and no motion is detected

```
Temperature (C): 34
Humidity (%): 20
WARNING: Low humidity! Possible plant dehydration.
Soil Moisture Level: 69
Soil is moist. No watering needed.
Motion detected! Intruder alert.
```

When the soil is sufficiently wet and motion is detected

7. Conclusion

The Plant Guardian System successfully automates plant care and provides basic intrusion alerts. It combines environmental sensing, automation, and basic robotics, providing a valuable hands-on experience with IoT, electronics, and coding. The system can be enhanced with Wi-Fi-based remote monitoring (e.g., via ThingSpeak) and mobile notifications for real-world applications.

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