Project Report

Project Title:

Smart Plant Care System

Course:

Embedded Systems and IoT

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Abstract:

The main purpose of this project is to design an automatic irrigation and monitoring system that helps in watering plants without constant human attention. The system is built using NodeMCU ESP8266, a soil moisture sensor, DHT11 sensor, a relay module, and a small DC water pump. The soil moisture sensor checks the condition of the soil and if it is dry, the NodeMCU switches on the pump through the relay to supply water. Along with that, the DHT11 sensor continuously measures temperature and humidity, which are shown on a display so that the user can know the environmental conditions. A PIR sensor is also added to detect motion of any person or object near the system. This project reduces manual effort, saves water, and ensures that plants are always kept in proper condition.

1. Introduction

In modern agriculture and even in home gardening, watering plants at the right time is a big challenge. Many times, plants are either overwatered or left without water, which harms their growth. To solve this problem, we designed a simple but effective Smart Plant Care System

The system uses NodeMCU ESP8266 as the main controller. It takes input from different sensors such as soil moisture sensor for water level in soil, DHT11 for temperature and humidity, and a PIR sensor for detecting motion. When the soil is dry, the system automatically turns on a mini water pump using a relay, and when the soil has enough water, it switches the pump off. All the readings are shown on a display for easy monitoring. The PIR sensor adds an extra feature by alerting or recording movement around the system.This project is low-cost, easy to build, and useful for both small-scale farming and home gardening

2. Objectives

The main objectives of the project are:

- To design a system that can automatically water plants based on soil condition.
- To measure temperature, humidity, and soil moisture in real time.
- To detect movement around the plant using a PIR sensor.
- To make the system cost-effective, reliable, and simple for daily use.

3. System Architecture
3.1 Components Used

The following components were used in this project:

1. **NodeMCU ESP8266** – The microcontroller with Wi-Fi capability that controls the whole system.
2. **Soil Moisture Sensor** – Measures the water content in the soil.
3. **DHT11 Sensor** – Provides temperature and humidity readings.
4. **Relay Module (1-Channel)** – Works as a switch to control the water pump.
5. **Mini Water Pump (3–6V)** – Pumps water to the plant when soil is dry.
6. **PIR Sensor** – Detects human or object movement around the system.
7. **Push Button Switch** – Used for manual reset or testing.
8. **Breadboard** – For connecting all components together without soldering.
9. **Battery** – Provides power supply to the NodeMCU and pump.
10. **Jumper Wires** – Male–Male, Male–Female, and Female–Female wires used for connections.

3.2 Circuit Diagram

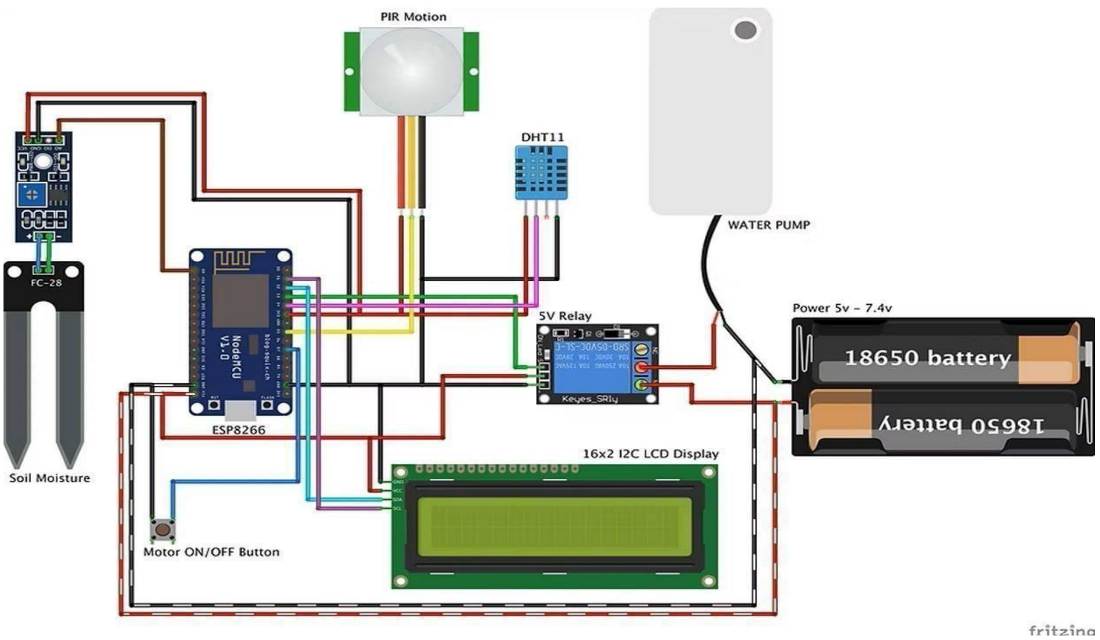

Fig 3.3: Circuit Diagram(Tinkercad)

Description:

In **Fig: 3.3** This project is a smart irrigation system designed and simulated in Tinkercad using an ESP8266 microcontroller. The system integrates a soil moisture sensor to check soil water levels, a DHT11 sensor to measure temperature and humidity, and a PIR motion sensor to detect nearby movement. All sensor data is displayed on a 16x2 I2C LCD screen for real-time monitoring. A 5V relay is connected to control a water pump powered by 18650 batteries, while a manual ON/OFF button allows direct motor control when needed. The ESP8266 processes the sensor readings and automatically turns the pump ON or OFF depending on the soil's moisture condition, ensuring proper irrigation without wastage. By simulating the circuit in Tinkercad, the design can be tested virtually before physical implementation, making it easier to troubleshoot, visualize connections, and validate functionality. This setup demonstrates how IoT-based smart irrigation can save water, reduce manual effort, and improve efficiency in plant care.

3.4: Real Visualization

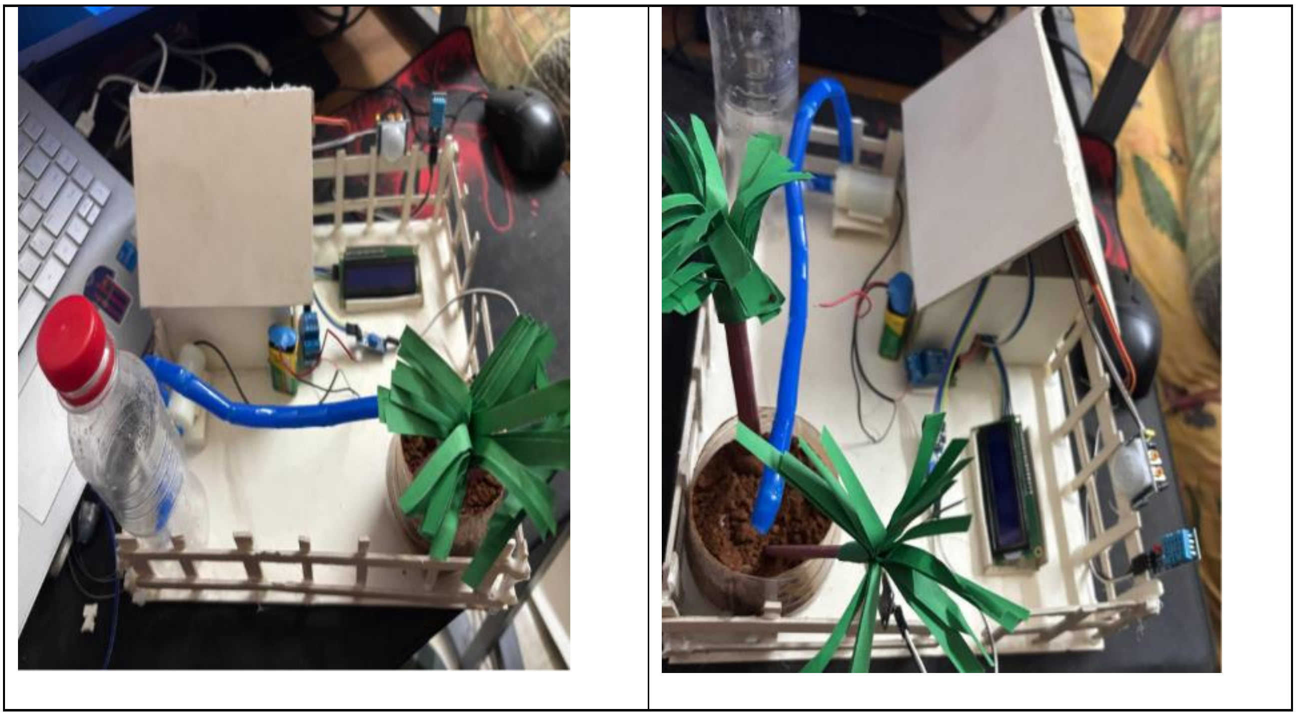

Fig: 3.4: Real project visualization

Description:

In Fig: 4 This is the real prototype of a smart irrigation system. The setup uses a water bottle as a reservoir, connected through a pipe to deliver water to the plant. A mini water pump is controlled by electronic components, while a soil moisture sensor detects the soil condition. A DHT11 sensor monitors temperature and humidity, and the data is shown on a 16x2 LCD display for real-time feedback. The system is powered by a battery and automatically waters the plant when the soil becomes dry, ensuring efficient water use. The model also includes a small garden-like setup with artificial plants to demonstrate how the system works in practice.

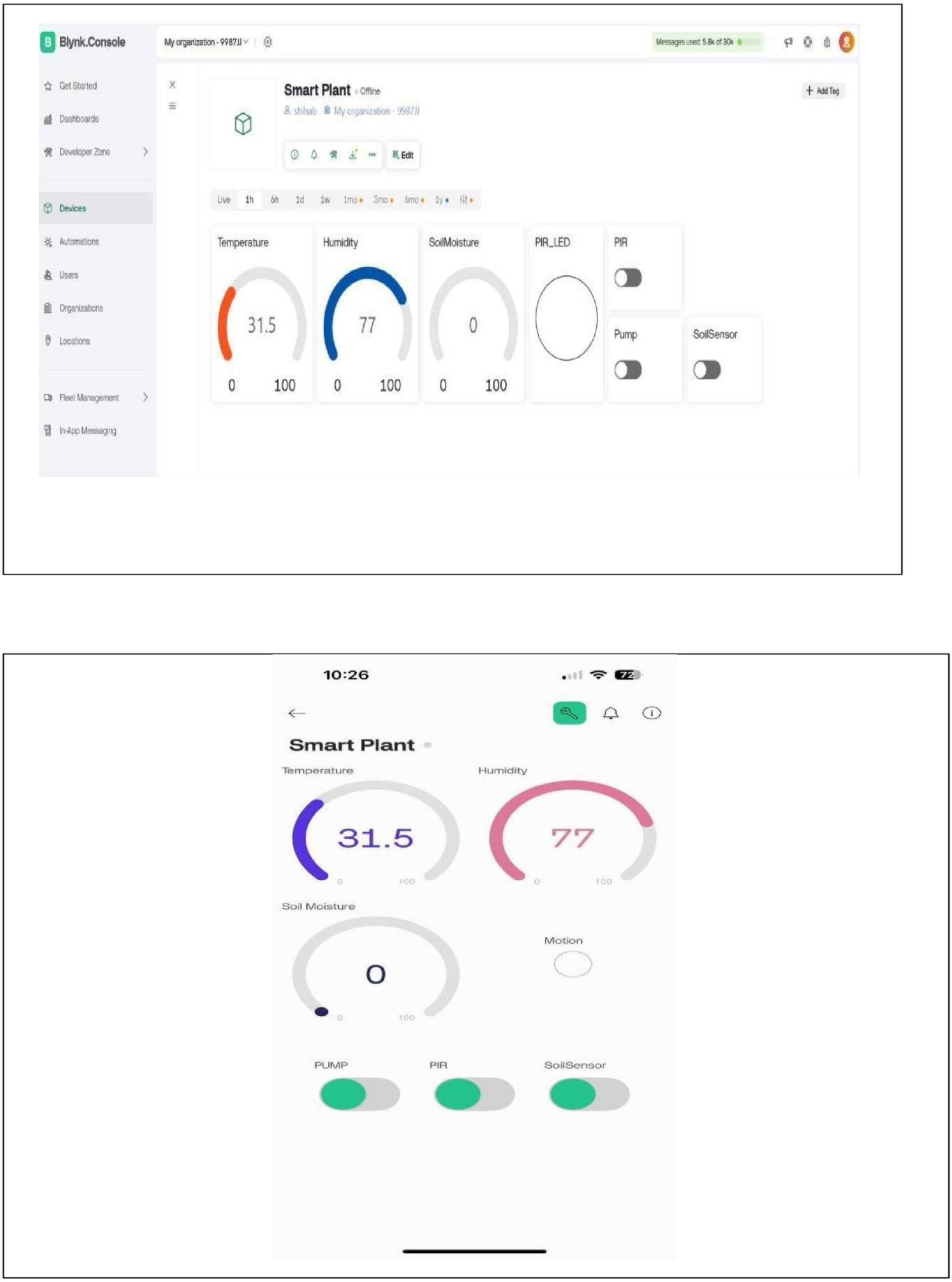

Fig 3.5: Blynk App Dashboard for Smart Plant Monitoring.

Description:

In Fig: 5 The Smart Plant System can be monitored and controlled through both the Blynk Console Web Interface and the Mobile Dashboard, ensuring flexibility and ease of use across devices.

Real-Time Sensor Readings (Live Data):

- Temperature: **31.5°C**
- Humidity: **77%**
- Soil Moisture: **0%**

Control Options (All Currently OFF):

- **Pump**: Activates the water pump to irrigate the plant.
- **PIR Sensor (PIR)**: Detects motion near the plant and can be enabled/disabled.
- **PIR_LED** : Turns on an LED light when motion is detected, linked to the PIR sensor.
- **SoilSensor**: Enables or disables soil moisture sensing functionality.

Interface Overview:

The Blynk Console Web Interface provides a detailed, interactive dashboard with advanced monitoring and control features.The Mobile Interface offers a simplified, user-friendly design for quick access to sensor data and system controls on the go.Together, these interfaces allow users to seamlessly monitor plant health and control irrigation or motion-based features anytime, anywhere.

4. Methodology

4.1 Hardware Design

The sensors and actuators are connected to the NodeMCU through the breadboard. The soil moisture sensor is placed in the soil to read its water content. The DHT11 sensor is connected to the NodeMCU for environmental readings. The PIR sensor is connected for detecting movement. The relay is connected between the NodeMCU and the water pump, so the pump only runs when the NodeMCU gives a signal. A push button is also used for manual operation or testing. The entire setup is powered by a battery.

4.2 Software Design

The NodeMCU was programmed using Arduino IDE with C++ code. Threshold values were defined for the soil moisture sensor. When the soil moisture goes below the threshold, the NodeMCU activates the relay, which turns on the water pump. Once the soil reaches the required moisture, the pump is turned off. The DHT11 sensor continuously sends temperature and humidity readings, while the PIR sensor checks for motion. All the values are shown on the display in real time.

4.3 Communication Protocol

The NodeMCU ESP8266 communicates with the Blynk platform over Wi-Fi. Sensor readings such as soil moisture, temperature, humidity, and motion detection from the PIR sensor are sent to the Blynk cloud in real time. The Blynk mobile app acts as the interface where users can monitor the data and receive updates. The app also allows manual control if required, making it more flexible and user-friendly.

5. Implementation

5.1 Sensor Data Acquisition

- The soil moisture sensor continuously measures the water content in the soil.
- The DHT11 sensor provides temperature and humidity readings.
- The PIR sensor detects motion near the system.
- All these readings are transmitted to the Blynk cloud for live monitoring.

5.2 Mobile Application Features

- Real-time dashboard shows soil moisture, temperature, humidity, and motion status.
- Notification alerts are sent when soil moisture is low or when motion is detected.
- Option for manual control of the water pump through the app.

5.3 Security Features

- Data transmission between NodeMCU and Blynk is encrypted using standard HTTPS.
- Blynk authentication token ensures that only authorized devices can connect.

6. Results

The Smart Plant Monitoring System was successfully implemented using the ESP8266 microcontroller, interfaced with DHT11 (for temperature and humidity), FC-28 (for soil moisture), and a PIR motion sensor. The system continuously monitors environmental conditions and displays real-time data on both a local 16x2 LCD and the Blynk mobile app. The water pump operates automatically when the soil moisture level falls below a set threshold, ensuring timely irrigation. Additionally, the pump can be controlled manually via a push-button or remotely through the Blynk app.Motion detection is enabled through the PIR sensor, with status updates shown in the app. All connected devices (pump, PIR, and soil sensor) can be switched ON/OFF remotely, making the system both interactive and user-friendly. The entire setup is powered by rechargeable 18650 batteries, offering portability and wireless operation.

7. Challenges and Solutions

- **Challenge:** Sometimes the soil moisture readings fluctuated.
  Solution: Used an average of multiple readings to make it stable.

- **Challenge:** Pump required more current than NodeMCU could handle.

  Solution: Used a relay and external power supply for the pump.

- **Challenge:** PIR sensor gave false triggers.

  Solution: Added small delay and calibration in the code.

8. Future Scope

- In the future, the project can be improved by adding:

- A mobile app to monitor readings remotely.

- Cloud storage for saving long-term plant data.

- Solar power for running the system without batteries.

- Additional sensors like pH or light sensor for more detailed plant health monitoring.

9. Conclusion

The project achieved its goal of creating an automatic irrigation and monitoring system. It can water plants automatically when needed, display soil moisture, temperature, and humidity, and also detect motion with the PIR sensor. The system is cost-effective, easy to build, and highly useful for small gardens, greenhouses, and even farms. This makes it a practical solution for saving water and reducing manual effort in plant care.

10. References

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