Smart IoT-Based Greenhouse Automation Using ESP32 and CoAP

A comprehensive presentation on automated greenhouse control system development using ESP32, CoAP protocol, and multiple sensors

Smart IoT-based greenhouse automation system using ESP32 microcontroller

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Integration of DHT22, LDR, Soil Moisture Sensor & Servo Ventilation for comprehensive environmental monitoring and control in greenhouse settings. Utilizes advanced automation features for optimal plant growth.

CoAP protocol implementation enables remote monitoring and control capabilities, making this system ideal for modern smart agriculture applications.

Challenges and motivation in greenhouse farming

Automation gaps

Traditional systems lack automation and remote control capabilities, preventing efficient monitoring and adjustments without physical presence.

Control requirements

Effective greenhouse management demands precisely controlled ventilation and irrigation systems to maintain ideal growing environments.

Environmental fluctuations

Temperature, humidity, and moisture levels often experience inconsistent variations, impacting optimal crop growth conditions.

Manual monitoring

Traditional greenhouse systems rely on inefficient manual monitoring processes, limiting real-time response to environmental changes.

System architecture

Component flow from sensors through ESP32 to CoAP endpoints with automatic control.

Sensors

DHT22, soil moisture sensor, and LDR capture environmental data.

Actuators

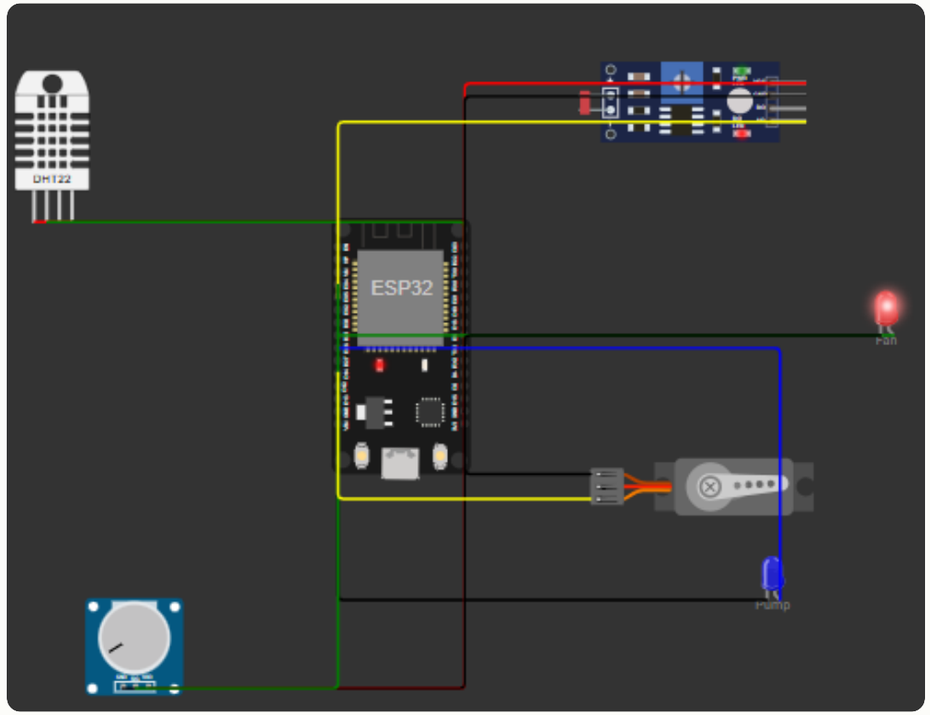
Fan, pump, and servo-controlled vent respond to conditions.

Controller

ESP32 functions as CoAP server managing data flow.

Automation

Control loop implementation handles system responses automatically.



Hardware

Hardware components and functionality

Components providing connectivity, monitoring, and automation for smart environmental control.

Indicator LEDs represent fan and pump operational status.

DHT22 sensor measures temperature and humidity levels accurately.

Servo motor controls the ventilation system for air circulation.

Light Detection Resistor monitors ambient light intensity continuously.

Potentiometer setup simulates soil moisture readings for plants.

ESP32 DevKit provides WiFi connectivity and CoAP server functionality.

System demonstration in Wokwi

Temperature increase triggering fan activation - Low soil moisture activating pump for fixed duration

Environmental triggers

CoAP GET requests

```
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losed)
 Wokwi-GUEST....

.2

(port 5683)

 | Humidity: 46.0% | Soil Moisture: 196 |
```

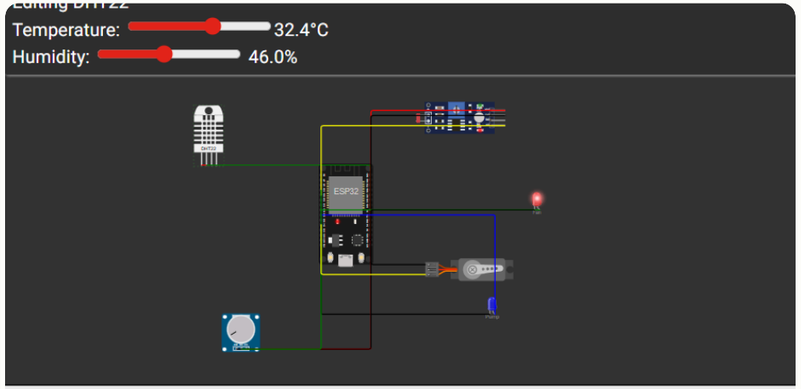
```
void autoControl() {
  if (!state.autoMode) return;

  // Fan Control
  if (state.temperature > TEMP_THRESHOLD || state.humidity > HUMIDITY_THRESHOLD) {
    if (!state.fanOn) startFan();
  } else if (state.fanOn) {
    stopFan();
  }

  // Pump Control (soil dry)
  if (state.soilMoisture > SOIL_THRESHOLD && !state.pumpOn) {
    Serial.println("Soil is dry — starting irrigation");
    startPump();
  }

  if (state.pumpOn && millis() - state.lastIrrigation > WATER_DURATION) {
    Serial.println("Irrigation complete — stopping pump");
    stopPump();
  }

  // Vent Control (with hysteresis)
  if (state.temperature > 32) {
    openVent();
  } else if (state.temperature < 28) {
    closeVent();
  }
```




```
Temperature: 32.4°C | Humidity: 46.0% | Soil Moisture: 196 | Light Level: 1001
Vent opened
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Results, applications and future expansion

Fully automated greenhouse environment control system with efficient water usage and real-time monitoring.

01

Efficient irrigation

Moisture-based irrigation system ensures optimal water usage, reducing waste and promoting plant health.

02

Future enhancements

Cloud dashboard, MQTT integration, real soil sensor calibration, and energy monitoring planned for system expansion.

03

Smart agriculture

Applications in greenhouses, nurseries, and smart farms for optimized plant growth and resource management.