Project Proposal: Smart Greenhouse

Student Information:

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Project Title:

Smart Greenhouse

Project Description:

The Smart Greenhouse project aims to design an IoT-based system that automates and monitors greenhouse conditions using the ESP32 Development Kit. This system integrates various sensors and actuators to control environmental parameters such as temperature, humidity, soil moisture, and water levels in wells. Additionally, it incorporates an ESP32-CAM module with a servo motor for angular movement, providing real-time monitoring. A web interface will enable users to remotely control and visualize data. An OLED display using the I2C protocol will be added outside the greenhouse, allowing users to see all internal data without accessing the web interface. The system will also include a CO_2 sensor to monitor air quality and trigger automated ventilation using a stepper motor, ensuring optimal growing conditions for plants.

Key Features:

- **ESP32-CAM & Servo Motor:** Provides an adjustable camera for real-time greenhouse monitoring.
- **Temperature & Humidity Sensor:** Collects environmental data for statistical analysis and decision-making.
- **Soil Moisture Sensor & Water Pump:** Automatically activates a water pump when soil moisture reaches a critical level.
- **Liquid Level Sensor:** Measures water levels in wells and alerts users if levels are too low.
- **LDR Light Sensor:** Monitors light levels and enables automatic lighting control. Users can also manually control lighting through the web interface.
- **CO_2 Sensor & Automated Ventilation:** Monitors CO_2 levels and triggers automated ventilation if levels exceed the safe threshold to maintain optimal plant growth.
- **Relay Module:** Controls emergency power shutdowns when necessary.
- **Web Interface:** A simple UI for remote control and real-time data visualization.
- **OLED Display:** Uses the I2C protocol to display real-time greenhouse data outside the greenhouse.

System Architecture:

A **system architecture diagram** will be included in the final report, outlining sensor integration, data flow, and communication between the ESP32 microcontroller and the web interface.

Components Used:

- **Microcontroller:** ESP32 Development Kit
- **Camera Module:** ESP32-CAM
- **Display:**
  - OLED Display (I2C protocol)
- **Sensors:**
  - DHT11 (temperature & humidity)
  - LDR Light Sensor
  - Capacitive Soil Moisture Sensor
  - Soil Moisture Sensor
  - XKC-Y25-NPN Liquid Level Sensor
  - MH-Z19B CO_2 Sensor
- **Actuators:**
  - Relay Module
  - Water Pump
  - Servo Motor: SG90 or equivalent
  - Stepper Motor (for automated ventilation control)
- **Software & Communication:**
  - Arduino IDE
  - Firebase/MQTT
  - RTSP (Real-Time Streaming Protocol)
  - HTTP
  - Web Dashboard (React/HTML & JavaScript)
  - Azure Services

Expected Outcome and Challenges:

The project aims to develop an automated greenhouse monitoring system with real-time data tracking. A web-based control panel will allow remote adjustments and decision-making. An OLED display will provide on-site real-time data access without needing a web connection.

Potential Challenges:

- **Sensor Calibration:** Ensuring accurate readings from different environmental sensors.
- **Power Management:** Optimizing energy consumption for continuous operation.
- **Real-Time Data Updates:** Ensuring timely and reliable communication between sensors and the web interface.
- **OLED Display Integration:** Ensuring proper real-time data display using the I2C protocol.
- **CO_2 & Pressure Sensor Accuracy:** Ensuring that CO_2 and pressure-based automation functions correctly in varying environmental conditions.

Possible Solutions:

- **Optimizing Sensor Placement** to enhance accuracy.
- **Implementing Low-Power Modes** in ESP32 to save energy.
- **Using Efficient Communication Protocols** such as RTSP, MQTT for reliable data transfer.
- **Testing OLED Display Communication** to ensure smooth real-time data visualization.
- Implementing Adaptive Ventilation Control based on CO_2 and pressure readings.

GitHub Repository Link:

Smart Greenhouse Repository