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🌱 What is SmartGrow

Product Description for Developers
SmartGrow: A Modular IoT System for Scalable Plant Monitoring and Automation

- Overview:
  SmartGrow is a component-based, IoT-driven system designed for real-time home plant care and monitoring. Built with a focus on modularity, scalability, and maintainability, it integrates sensor data acquisition, automation control, and intuitive user interfaces within a reliable and decoupled architecture.

- Key Technical Features:

  - Component-Based Architecture: High cohesion and low coupling for easy plug-and-play of modules (e.g., soil sensor, temperature sensor, actuator).
  - Microcontroller Integration: Low-power MCU which is ESP32 with Wi-Fi capability, supporting periodic sensor data collection (~30s interval) and real-time actuation (<3s response).
  - IoT Communication Stack: Uses APIs for device communication. Data is encrypted in transit with secure authentication for user sessions.
  - Web & Mobile Frontend: Built with responsive frameworks, enabling real-time dashboard updates, manual override actions, and visualized historical data trends.
  - Automation Engine: Threshold-based logic triggers watering, lighting, or ventilation per user-defined plant profiles. Manual override support included.
  - Database & Backend: Modular backend (Node.js/Python Flask) with NoSQL/SQL storage for logging environmental data, system actions, and plant configurations.
  - Testing & CI/CD: Automated unit and integration tests, plus weekly Scrum-driven builds with continuous integration pipelines.

🌱 Product Description for End Users

SmartGrow: The Smart Way to Care for Your Plants, Anytime, Anywhere

Overview:
SmartGrow is your intelligent home gardening assistant that takes the guesswork out of plant care. Whether you're growing herbs, vegetables, or houseplants in a cozy apartment or balcony garden, SmartGrow ensures each plant gets exactly what it needs to thrive.

What It Does:

- **Monitors Plant Health:** Tracks soil moisture, light, temperature, and humidity in real time for each plant.

- **Automates Care:** Automatically waters your plants and adjusts lights or fans when conditions aren't ideal.

- **Personalized for Every Plant:** Assign care profiles (like "basil" or "fern"), and SmartGrow tailors the care based on each plant's unique needs.

- **Easy to Use:** Check plant status, get alerts, or water manually through a simple app or web dashboard, no matter when you're at home or away.

- **Expandable System:** Add more plants easily and manage them all from the same app.

- **Sustainable & Smart:** Energy-efficient, with support for solar-powered modules. Designed to work even if a sensor fails to keep your plants safe.

Why You'll Love It:

- Save time and avoid over/under-watering

- Keep all your plants happy, even with a busy schedule

- View beautiful charts of your plants' history and progress

- Reliable and secure, with automatic alerts and quick actions

SmartGrow makes plant care simple, smart, and scalable. Perfect for students, plant lovers, and future urban gardeners.

⚠️ Safety Precautions and Warnings

Your safety and the longevity of your SmartGrow system depends on following a few important guidelines. Please read and follow the precautions below before setting up or operating the device.

🔨 Electrical Safety

- **Use only the recommended power supply.**
  Using an incompatible power source may damage components or cause overheating.

- **Never handle wiring with wet hands.**
  Water and electronics can be a dangerous combination. Always dry your hands before touching the wires or sensors.

- **Disconnect power before maintenance**
  Always unplug or power off the system before adjusting wiring, changing sensors, or cleaning the unit.

💧 Water and Moisture

- **Keep control electronics dry.**
  The microcontroller, relay board, and power adapter must not be exposed to water. Place them in a dry, elevated area away from plant pots and watering tubes.

- **Check for leaks regularly.**
  Ensure tubing is properly connected and secure to prevent accidental spills on electrical components.

- **Avoid submerging sensors.**
  Soil moisture sensors are designed for partial soil insertion. Do not fully submerge them in water.

🔥 Temperature and Ventilation

- **Do not place near heat sources.**
  Avoid placing the system near stoves, radiators or direct sunlight where components could overheat.

- **Provide ventilation for control units.**
  Ensure there is adequate airflow around the control box and power supply to prevent overheating.

⚒ System Usage and Maintenance

- **Do not force sensor connections.**
  Match pins correctly and connect gently. Forcing a component into the wrong port may cause permanent damage.

- **Handle electronics with care.**
  Avoid dropping or shaking the control unit or sensors, as internal parts may be damaged.

- **Keep away from small children and pets.**
  Loose wires, water pumps, and small electronic parts can be hazardous if mishandled.

🔐 Data and Privacy

- **Protect your login credentials.**
  Never share your SmartGrow dashboard username or password.
- **Secure your Wi-Fi connection.**
  Ensure your home network uses WPA2 or WPA3 security to prevent unauthorized access to your device.

⚙️ System Components

The system is made up of modular components designed to monitor and care for a variety of plants. Each component plays a specific role in maintaining a healthy growing environment.

☐ Plant Modules

Each plant is housed in its own **SmartGrow module**, which includes:

- A plant pot or tray

- Embedded sensors

- Tubing for watering

- Mounts for optional lighting or fans

> **Note:** The system supports multiple plant modules. You can expand the setup by adding more modules over time.

📡 Sensors

Sensors collect real-time data from each plant module. These values are used for automated decision-making and dashboard display.

- **Soil Moisture Sensor:**
  Measures how wet or dry the soil is. Triggers automatic watering if levels fall below the threshold set for that plant type.

- **Light Sensor:**
  Measures ambient light intensity. Helps determine if grow lights need to be activated.

- **Temperature Sensor:**
  Detects air temperature around the plant. Ensures plants are not too hot or cold.

- **Humidity Sensor:**
  Tracks surrounding humidity. Useful for plants like ferns that require moist air.

⚙️ Actuators

Actuators are the components that gives action based on sensor readings or user commands.

- **Water Pump:**
  Automatically waters the plant when soil moisture is too low, or when triggered manually.

- **Grow Light:**
  Provides supplemental light if natural sunlight is insufficient for the selected plant profile.

- **Cooling Fan:**
  Helps regulate temperature and airflow, particularly useful for high-heat environments or enclosed setups.

  Each actuator can be **automated or manually controlled** via the SmartGrow dashboard or mobile app.

🧠 Controller Unit

This is the central "brain" of the system. It connects all sensors and actuators, processes logic, and sends/receives data from the dashboard.

- **Microcontroller ESP32:**
  Reads sensor input and activates actuators based on preset rules.

- **Wi-Fi or Bluetooth Module:**
  Allows real-time data syncing and remote control via the web/mobile interface.

- **Power Supply:**
  Feeds electricity to sensors, pumps, lights, and fans.

❓How SmartGrow Works

SmartGrow is designed to make plant care smarter, easier, and more personalized by combining sensor readings, automation rules, and user input into one connected system.

Each sensors continuously monitors key environmental factors and responds with the right actions either automatically or through user control.

The system works in real-time and supports both **autonomous care** and **manual overrides** via a web/mobile dashboard.

//attach diagram here

📦 What's in the Box

Aside from your own plant, our system will provide you with the complete components to take care of your beloved plants ! The items are as follows:

- Microcontroller Board ESP32 x 1
- Soil moisture sensor x 1
- Light sensor x 1
- Air Quality sensor x 1
- Fans x 1
- LED Lights Strip x 1
- Watering tubes, pumps and reservoir

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📱 System Requirement

☐ Connectivity

- **Wi-Fi Network**

- **Internet Access:**

    - Required for remote monitoring, receiving notification and firmware updates

- **SmartGrow Controller:**

    - Must be within Wi-Fi signal range

🎛 Device Compatibility

- **Web Dashboard:**

    - Modern browsers supported:

- **Mobile App:**

    - **iOS:** Version 13.0 and above

⚡ Hardware Requirements

- **Power Supply:**

    - USB power adapter (5V, 2A minimum)

    - Surge protection recommended

- **Supported Devices:**

    - SmartGrow Controller

    - Soil moisture, temperature, humidity, and light sensors

    - Water pump, grow light, cooling fan

🛠️Hardware Installation Instructions

Step 1: Prepare Plant Modules

- Place each plant in its pot
- Ensure pots have proper drainage to avoid overwatering.

Step 2: Insert Sensors

1. **Soil Moisture Sensor**:

    - Insert the prongs vertically into the center of the soil (approximately halfway down).

    - Avoid placing too close to the plant stem.

2. **MQ2 Air Sensor**:

    - Place the sensor inside the room where the plant is located

    - Ensure proper airflow around the sensor.

3. **Photoresistor Light Sensor**:

    - Mount facing upwards near the top edge of the plant module.

○ Ensure it is not obstructed by leaves.

Step 3: Connect Actuators

1. **Water Pump**
   ○ Place the 12V DC pump outside the external water reservoir.
   ○ Attach tubing from the water tank outlet to the pump's input nozzle.
   ○ Connect tubing from the pump's outlet to the watering inlets on each plant module.

2. **LED Light**:

   ○ Attach above or beside the plant at adjustable height.

   ○ Position to evenly distribute light.

3. **Cooling Fan**:

   ○ Mount beside the plant module.

   ○ Angle to circulate air across plant leaves

Step 4: Connect to the Controller

● Plug sensor cables into their respective ports on the **SmartGrow Controller Unit**.

● Plug actuator wires into marked output ports (Water, Light, Fan).

● Ensure all connectors are firm but not forced.

Step 5: Power Up

● Connect the controller to a 5V/2A USB power supply.

● Ensure the controller LED indicator lights up.

● Wait for the system to initialize (approx. 10–15 seconds).

Step 6: Connect to Wi-Fi

● Follow instructions in the **dashboard or mobile app** to join your home Wi-Fi network.

● Ensure stable signal strength at the installation location.