My project includes:

Mechatronics part:

1. Smart farming system
   1. Moisture sensor
   2. Temperature sensor
   3. Light sensor (LDR)
   4. PIR sensor
2. Solar 5V
3. Batteries
4. Servo 2
5. LCD display
6. Bluetooth
7. Buzzer
8. 7 LEDS
9. Motor

**Mechatronic Part of Your Smart Farming System**

The mechatronic system serves as the **core functional layer** of your project, integrating renewable energy, sensors, actuators, and communication modules to create a fully automated and sustainable solution for small-scale smart farming. Each component contributes uniquely to the operation:

**1. Smart Farming System (Sensors)**

These sensors ensure continuous monitoring and automation:

* **Moisture Sensor**
  + **Function**: Measures soil moisture levels with a range of **0 to 872**.
  + **Purpose**: When the reading drops below **300**, the pump is triggered to irrigate the soil automatically. This optimizes water usage, avoiding over-irrigation or under-irrigation.
* **Temperature Sensor**
  + **Function**: Monitors the ambient temperature, with a detection range of **0 to 125°C**.
  + **Purpose**: At temperatures exceeding **30°C**, the servo motor moves the retractable roof to **0 degrees**, shading the plants to protect them from heat stress.
* **Light Sensor (LDR)**
  + **Day/Night Detection**:
    - One LDR determines day and night.
    - During the day, the servo motor rotates to **180 degrees** to open the roof, while at night, it closes the roof (servo at **0 degrees**).
  + **Sun Tracking**:
    - Three additional LDRs optimize solar panel positioning, ensuring maximum energy capture by tracking sunlight.
* **PIR Sensor**
  + **Function**: Detects motion within its range, such as pests or intruders.
  + **Purpose**: Activates alarms (buzzer) and LEDs to deter threats and protect crops.

**2. Solar Power and Batteries**

* **Solar Panels**:
  + **Three 5V panels** power the system sustainably.
* **Batteries**:
  + Store excess solar energy, ensuring uninterrupted operation at night or in low sunlight conditions.

**3. Actuators**

Actuators convert the processed data into physical actions:

* **Servo Motors**:
  + Control the retractable roof for shading and optimal exposure.
* **Pump Motor**:
  + Powers the irrigation system, delivering water precisely when triggered by the moisture sensor.

**4. Output and Communication**

* **LCD Display**:
  + Shows real-time data from sensors, such as temperature, soil moisture, and light intensity.
* **Bluetooth**:
  + Transmits data to the website for farmers without internet access. Enables remote monitoring and control.
* **Buzzer and LEDs**:
  + PIR sensor triggers these outputs:
    - The buzzer provides audible alerts for detected movement.
    - The LEDs light up to scare pests away, acting as a visual deterrent.

**How It Works Together**

1. **Input**: Sensors continuously monitor environmental conditions.
2. **Processing**: A microcontroller analyzes the data against preset thresholds.
3. **Action**: Actuators respond dynamically, such as activating the pump, moving the roof, or repositioning solar panels.
4. **Communication and Alerts**: The system updates farmers via Bluetooth and provides local feedback through the LCD, buzzer, and LEDs.
5. **Power Management**: Solar panels and batteries ensure energy efficiency and sustainability.

**Key Advantages**

* **Automation**: Eliminates repetitive manual tasks, reducing labor for farmers.
* **Efficiency**: Optimizes water and energy use based on real-time conditions.
* **Adaptability**: Adjusts to varying weather conditions for optimal crop growth.
* **Sustainability**: Operates on renewable energy, promoting eco-friendly farming practices.

**3D Farm Design Update Summary**

The **3D farm design** is shaping up to be an efficient, sustainable, and innovative small-scale farming solution tailored to address challenges like climate change, limited resources, and labor constraints.

**Design Highlights**

1. **Farm Layout**:
   * **Overall Plot Size**: 70x100 feet.
   * **Farm Area**: Centralized 50x50 feet section optimized for crop cultivation.
   * **Rainwater Harvesting Tank**:
     + Size: 10x10 feet with a reverse cone-shaped lid of 20x20 feet.
     + Lid design maximizes rainwater collection during precipitation.
   * **Water Filtration System**:
     + Recycles household greywater (e.g., from dishwashing and bathing).
     + The filtered water flows directly into the tank, ensuring sustainable irrigation even in dry periods.
     + The system is designed for agricultural use, not potable water.
2. **Energy and Automation**:
   * **Solar Power**:
     + 3 Polycrystalline solar panels (200W each), producing up to 600W in optimal conditions.
     + Energy stored in lead-acid batteries for uninterrupted operation.
   * **Retractable Shade System**:
     + Protects crops from extreme heat or heavy rain.
     + Controlled by servo motors linked to environmental sensors.
   * **Sensors and Actuators**:
     + **Moisture, temperature, light (LDR), and PIR sensors** monitor conditions in real-time.
     + Automated systems adjust irrigation, shading, and pest deterrence based on data.
3. **Water Management**:
   * **Dual Water Source**:
     + Rainwater harvesting via the tank lid.
     + Filtered household greywater integrated for irrigation.
   * **Drip Irrigation System**:
     + Delivers water efficiently to crops, minimizing waste.
     + Controlled by soil moisture data.

**Key Features for Usability**

1. **Ease of Use**:
   * Designed for individuals with limited farming knowledge.
   * Automation minimizes manual intervention, making it accessible to anyone, including single parents or elderly farmers.
2. **Adaptability**:
   * Can be customized for different crop types and farm sizes.
   * Modular system allows for easy scaling and upgrading.
3. **Eco-Friendly Design**:
   * Renewable energy-powered systems.
   * Greywater reuse and rainwater harvesting reduce dependency on external water sources.

**Vision**

The updated 3D farm design empowers small-scale farmers with a low-cost, high-efficiency solution that prioritizes sustainability and resilience. It provides a clear pathway for implementing smart agricultural practices, making farming accessible to all, regardless of expertise or resources.