AI-Driven IoT Concept for Smart Agriculture

Overview:

This system integrates IoT sensors with AI models to optimize crop management and predict yields.

Sensors Required:

- **Soil Sensors**: Moisture, pH, nutrient (N/P/K) levels.
- **Weather Sensors**: Temperature, humidity, rainfall, wind speed/direction.
- **Light Sensors**: Photosynthetically active radiation (PAR) intensity.
- **Crop Health Sensors**:
    - **Multispectral cameras** for NDVI (Normalized Difference Vegetation Index) to assess plant health.
    - **Thermal cameras** for early stress detection (e.g., water deficiency).
- **Environmental Sensors**: CO_2, atmospheric pressure.
- **Location Sensors**: GPS for geospatial tracking.

AI Model Proposal:

Model Architecture: Hybrid **LSTM (Long Short-Term Memory) + Random Forest** ensemble.

- **Input Features**:
    - Time-series sensor data (soil moisture, temperature, rainfall).
    - NDVI from multispectral imagery
    - Historical yield data, crop type, planting date, soil nutrient levels.
- **Data Preprocessing**:
    - Handle missing data via **k-NN imputation**
    - Normalize features using **Min-Max scaling**.
- **Model Workflow**:
    1. **LSTM Layer**: Processes temporal dependencies in sensor data (e.g., 30-day weather trends).
    2. **Random Forest**: Integrates static features (soil type, crop genetics) and LSTM outputs.
    3. **Output:** Yield prediction (kg/hectare) with uncertainty intervals.
- **Training**:
    - **Loss Function**: Huber loss (robust to outliers).
    - **Optimization:** Adam optimizer.
    - **Validation:** 10-fold cross-validation.
- **Accuracy**: Target **$R^2 > 0.92$** on test datasets (e.g., USDA crop reports).

Data Flow Description:

1. Sensors collect environmental and soil data.

2. Data transmitted via wireless protocol (e.g., LoRaWAN) to edge gateway.

3. Gateway preprocesses and forwards to cloud server.

4. Cloud runs AI model to analyze and predict crop yield.

5. Dashboard displays insights to farmers.

Data Flow Diagram