

# Digital Twin for Plant Health Monitoring

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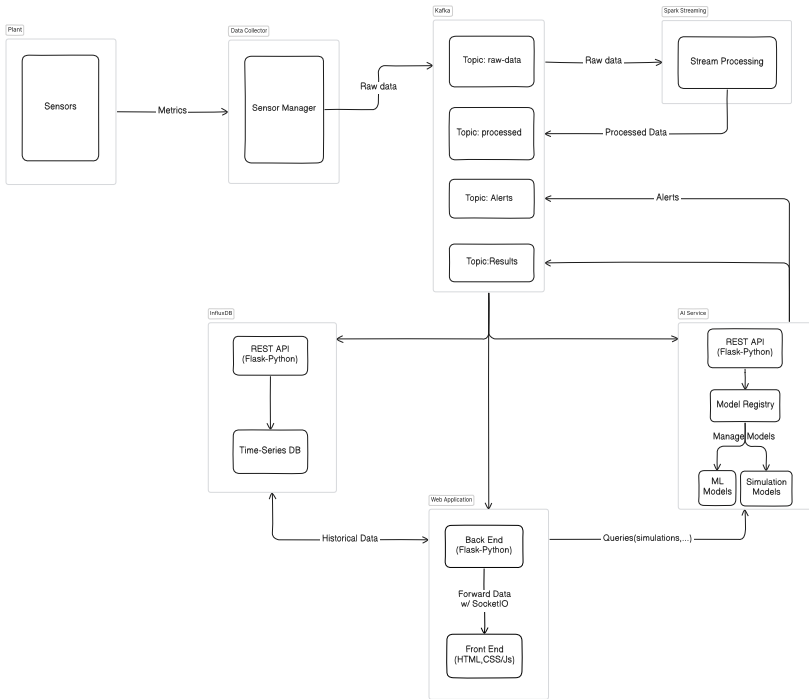
- ▶ **Critical role of agriculture**
  - ▶ Essential for food supply & economy
  - ▶ Facing challenges: population growth, shrinking farmland
- ▶ **Current issues**
  - ▶ Manual monitoring: time-consuming, subjective, not real-time
  - ▶ Need for better efficiency, sustainability, biodiversity

*How can we continuously, and reliably monitor plant health using digital twins for actionable insights?*

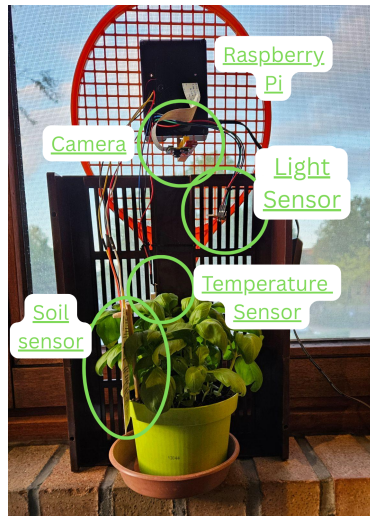
## Aim of This Project

Design a **modular, scalable digital twin** for real-time plant health monitoring.

- ▶ **Modular & Independent:** Each component (sensors, processing, storage, analytics, dashboard) is loosely coupled.  
**Easy test and implement.** Cloud-Ready
- ▶ **Robust Data Pipeline:** Data is cleaned, validated, and stored for both instant monitoring and historical trends.
- ▶ **Cloud-Ready:** Design supports migration to cloud

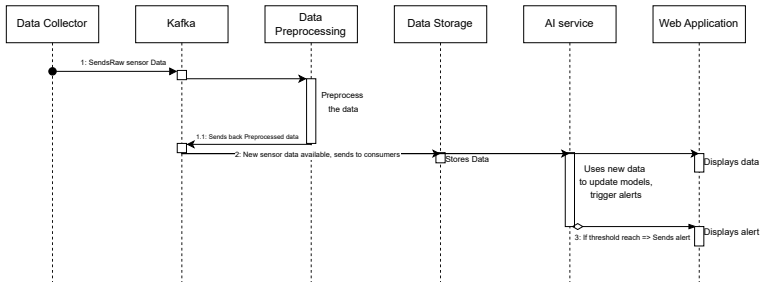


- ▶ **Sensor:**
  - ▶ Soil moisture, temperature, humidity, and light intensity sensors
  - ▶ **Direct connection via Raspberry Pi pins**
- ▶ **Data Acquisition Pipeline:**
  - ▶ Scheduled polling for real-time updates



Physical setup

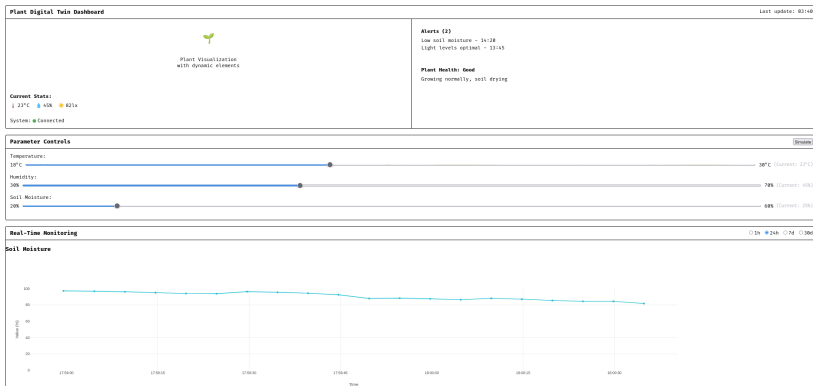
- ▶ **Modular Streaming:**  
Sensor data flows via **Kafka** for flexible, independent scaling.
- ▶ **Reliable & Extensible:**  
Add preprocessing/analytics modules.
- ▶ **Real-Time Preprocessing:**  
**Spark Streaming** for live cleaning and merging.
- ▶ **Efficient Storage:**  
**InfluxDB** enables fast trends, analytics, and archiving.







Sequence Diagram demonstrating the flow of the sensor readings in the system.

- ▶ **Real-time Visualization:**  
Live updates for sensor readings.
- ▶ **Historical Data Exploration:**  
Custom time-window selection for trend review (e.g. last 24 hours).
- ▶ **Responsive and Extensible:**  
Modular design allows easy addition of new charts for more sensors.





- ▶  **Data Preprocessing**
  - ▶ Handle anomalies, missing data
  - ▶ **Increase reliability**
- ▶  **Advanced Analytics & ML**
  - ▶ Forecasting, health state classification
  - ▶ **ML model registry**
- ▶  **Expanded Sensing & Automation**
  - ▶ Automated watering, lighting, heating
  - ▶ **Closed-loop control**
- ▶  **Enhanced UI**
  - ▶ Hardware/model control
  - ▶ **Modern, user-friendly**

*Goal: An intelligent, autonomous digital twin for plant health environment.*

Thank you for your attention!

