SMART INDIA HACKATHON 2025

- **Problem Statement ID –** SIH25264
- **Problem Statement Title-** Prediction of optimum maturity of Sugarcane crop by using hand hold user (farmer) friendly digital tool/device.
- **Theme-** Agriculture, FoodTech & Rural Development
- **PS Category-** Hardware
- **Team ID-** 118361
- **Team Name-** TechPhantom

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Nirmaan

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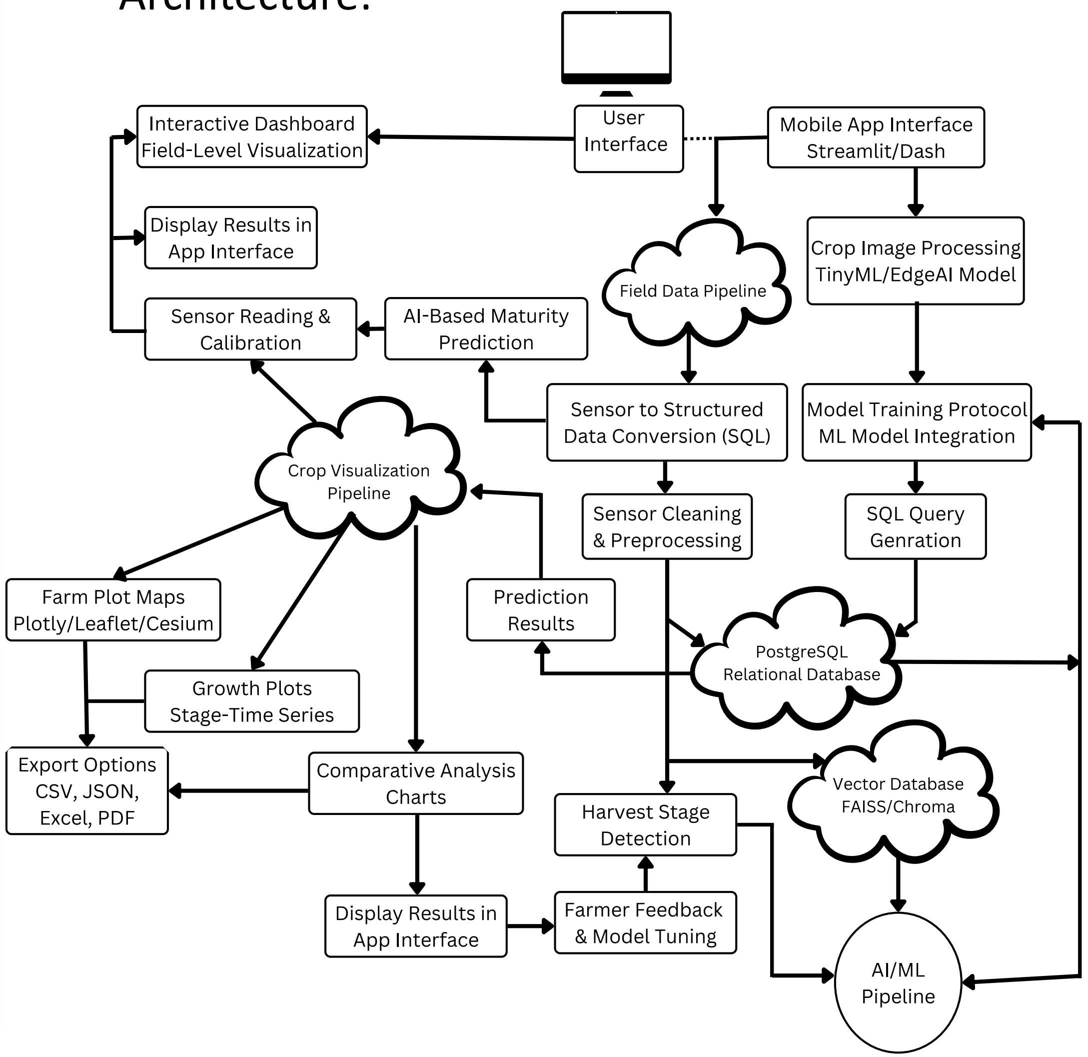
- **Idea:** Build an AI + IoT-based handheld tool to predict optimum sugarcane maturity. The device will use sensors and ML models to analyze sucrose content, crop images, and weather data for accurate harvest timing. It helps farmers decide the best cutting time to maximize sugar yield and profit.
- **Problem:** Farmers harvest sugarcane based on experience, not data. Incorrect timing leads to low sucrose content and reduced sugar recovery. Manual maturity checking is slow, inaccurate, and varies by region and cane type. A digital solution is needed to automate and standardize maturity prediction.
- **Solution:** AI/ML model integrates sensor and image data to predict sucrose level and readiness. Device scans the cane using NIR sensor and camera, analyzes readings via trained model, and sends results to mobile app. Output shows maturity score and harvest window with real-time alerts.
- **Description:**
  - IoT sensors (NIR, temperature, humidity, soil) and camera collect crop data.
  - ML model predicts sucrose %, maturity stage, and optimal harvest period.
  - Mobile app (multilingual) displays maturity index and advisory in farmer-friendly way.
  - Cloud backend stores field data, enabling regional maturity analytics and scheduling.

Architecture:



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TECHNICAL APPROACH

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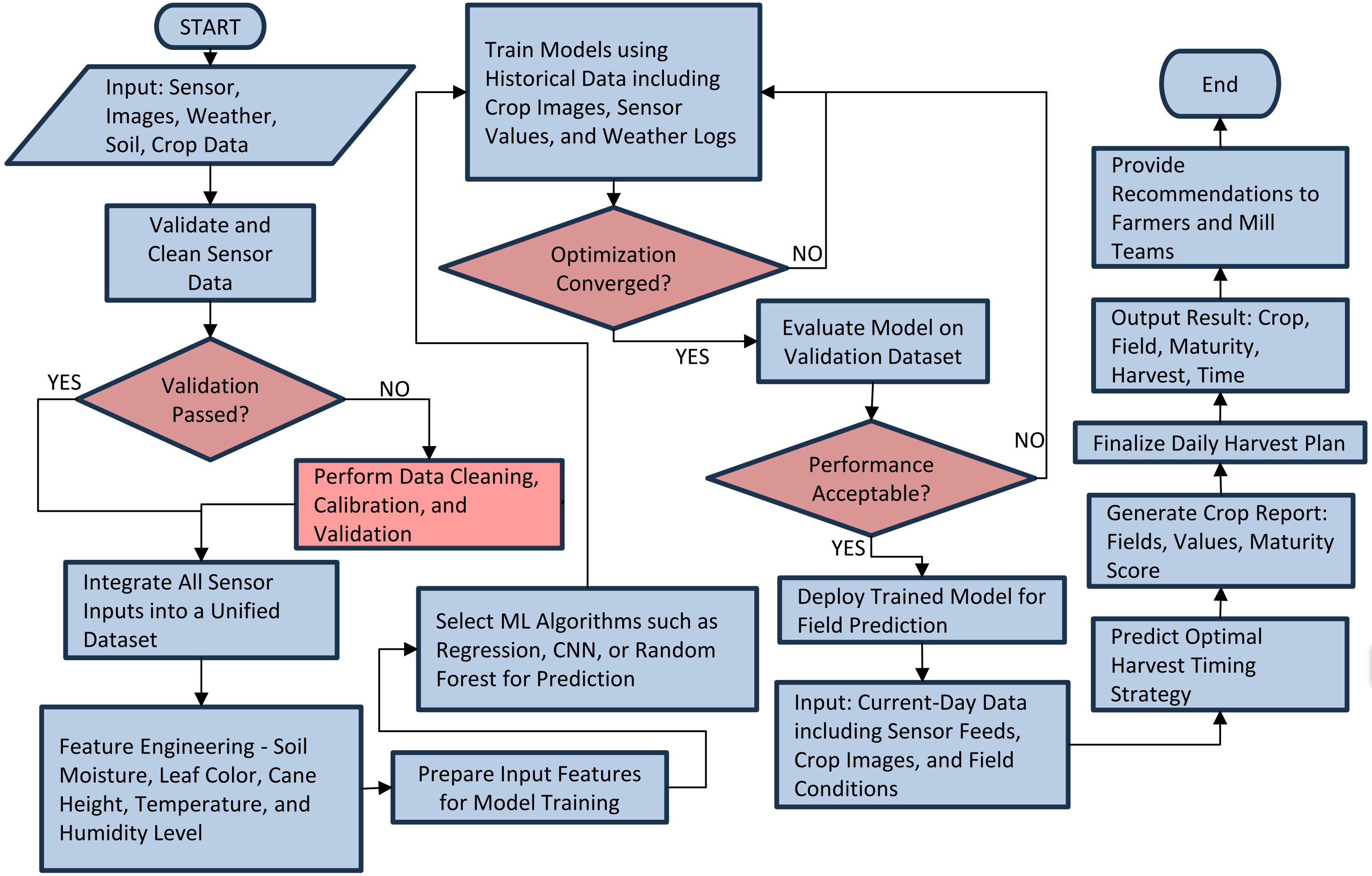
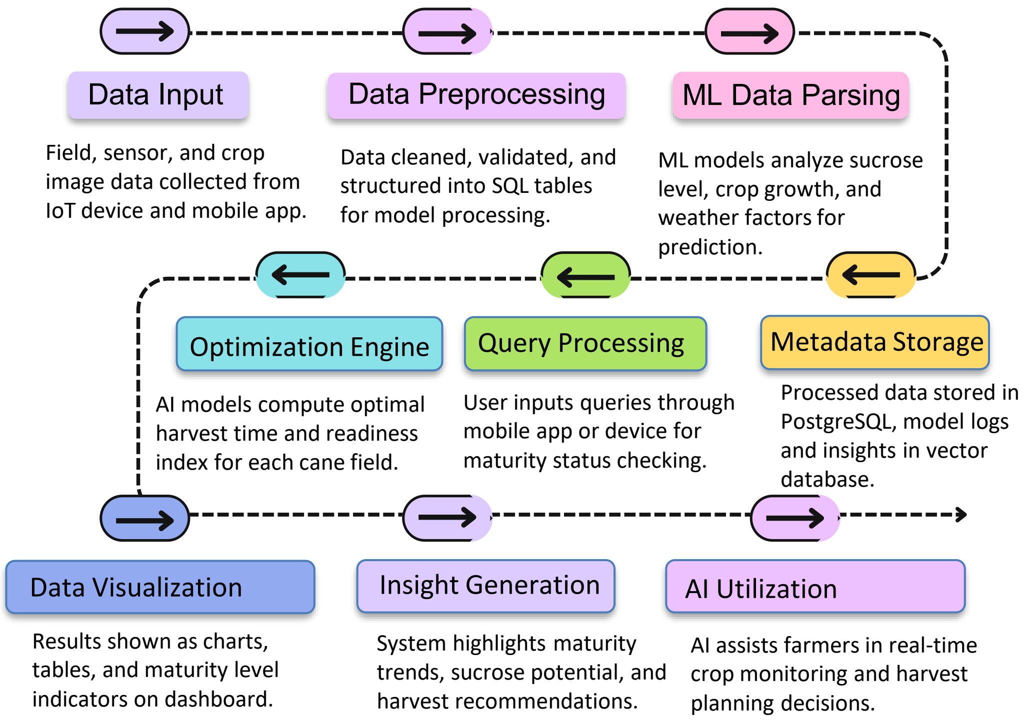


Workflow Diagram:



MySQL learn Flask OpenSSL TensorFlow JS

Prototype:- https://github.com/OldStager01/nirmaan.git

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FEASIBILITY AND VIABILITY

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Feasibility Analysis

- AI/ML Tech: Uses regression and image-based models for sugarcane maturity prediction.
- Data Formats: Sensor, image, and weather data stored in SQL or cloud DB for analytics.
- Pretrained Models: Uses trained ML models for sucrose estimation and maturity scoring.
- Dashboards: Built using Streamlit/Plotly to show crop maturity trend and harvest alerts.

Potential Challenges

- Field data may vary due to weather, soil, or cane variety differences across regions.
- AI models must work under noise, incomplete sensor data, and inconsistent lighting.
- Requires reliable connectivity and scalable system for multi-field data collection.

Potential Risks

- Ensuring data privacy for farm and location data is critical for farmer trust.
- Hardware malfunction or calibration errors can affect prediction accuracy.
- Proper device testing, data encryption, and backup are needed for reliability.

Strategies

- Adaptive models: Continuously update ML models with new field data each season.
- Secure access control: Encrypt user and field data with restricted cloud access.
- Regular updates: Calibrate sensors and retrain models for accurate field prediction.

Key Differentiators

1. AI-based crop maturity prediction system
2. Integrated sensor and weather data platform
3. ML-driven sucrose and harvest optimization
4. Interactive dashboard for crop visualization
5. Future expansion to all cane-growing regions

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IMPACT AND BENEFITS

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- **Potential Impact**
  - It improves harvest planning by enabling real-time insights on crop maturity, sucrose level, and field readiness to support farmers and mills.

- **Benefits of the solution (social, economic, environmental, etc.)**
  - Social: Helps farmers make data-driven harvest decisions and avoid income loss.
  - Economic: Increases sugar yield and revenue through optimal harvest scheduling.
  - Environmental: Reduces crop wastage and transport loss, promoting sustainability.

- **Enhanced Ocean Data Utilization**
  - Crop data can be analyzed and visualized directly, improving farm efficiency and transparency.
  - Continuous Improvements: Expands to cover all major sugarcane regions for large-scale adoption.
  - User Empowerment: Mobile app and device interface enable easy use and informed decisions.

USPs:

1. **Data Integration:** Unified crop and sensor data
2. **Real-Time Tracking:** Live crop dashboards
3. **Smart Analysis:** AI-based maturity prediction
4. **Yield Optimization:** Increased sugar recovery

Product Status: 80% product built completed and further built is on progress. Testing and validation process are next to be undergone

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RESEARCH AND REFERENCES

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- **Document Link**

1. The overall problem with solving approach is explained in this Document. (https://drive.google.com/drive/folders/1LreQUFa6sR-C8YBrmFWaHhETmHmC59Wr?usp=sharing).

- **Research Paper**

1. A Machine Learning-based Approach for Crop Yield Prediction and Fertilizer Recommendation (https://ieeexplore.ieee.org/document/9777230).

- **Research Paper**

1. IoT-Based Precision Agriculture Using Smart Sensors and Cloud Computing for Crop Monitoring and Yield Optimization (https://ieeexplore.ieee.org/document/10775023)

- **Streaming & Visualization**

1. Real-Time Data Streaming with Kafka (https://kafka.apache.org/documentation/)
2. Plotly (Data Visualization) (https://plotly.com/python/)

- **Cloud Platform & InfluxDB** (ideal for sensor data)

1. To receive, store, and process sensor and user data, and to host the Machine Learning model: (https://aws.amazon.com/iot-core/), (https://www.influxdata.com/).