E-Bhoomi

SMART INDIA HACKATHON 2025

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TITLE PAGE

Problem Statement ID : **SIH25099**

Problem Statement Title: **AI-powered monitoring of crop health, soil condition, and pest risks using multispectral/hyperspectral imaging and sensor data.**

Theme : **Agriculture, FoodTech & Rural Development**

PS Category : **Software**

Team ID :

Team Name: **E-Bhoomi**

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IDEA TITLE

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Proposed Solution :

Spectral Indices :	Key vegetation indices **(NDVI, SAVI, NDRE, VARI, NAWI)** will be extracted from multispectral/hyperspectral imagery using drone and satellite images to assess crop vigor, nutrients, and water stress.
Deep Learning Analysis:	Hybrid **LSTM-CNN** processes spectral (bands) and spatial (patterns) features for stress, nutrient, and disease detection.
Low-cost sensors:	Measure soil moisture, NPK, humidity, and temperature for continuous ground-truth validation.
Data Fusion Layer:	Integrates sensor data with spectral indices to improve accuracy and alert
Smart control:	Automates irrigation and fertilization using sensor thresholds and AI predictions.
Interactive Maps:	Real-time crop health, soil condition, and pest risk visualization.
Predictive Analytics:	Yield estimation, disease forecasting, and intervention timing.
User Accessibility:	Mobile dashboards with multilingual support and farm equipment API integration.

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Real Time Graph of Sensor Data

Uniqueness:

- **Balaram AI** - An AI chatbot and Multimodal LLM Video Agent to help the farmer in farming, detecting disease and better understanding about the sensor data.
- **Bhoomi Doot** - An AI outbound calling system to help the user.
- Crop Health Monitoring using Drone and Satellite Imaging

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TECHNICAL APPROACH

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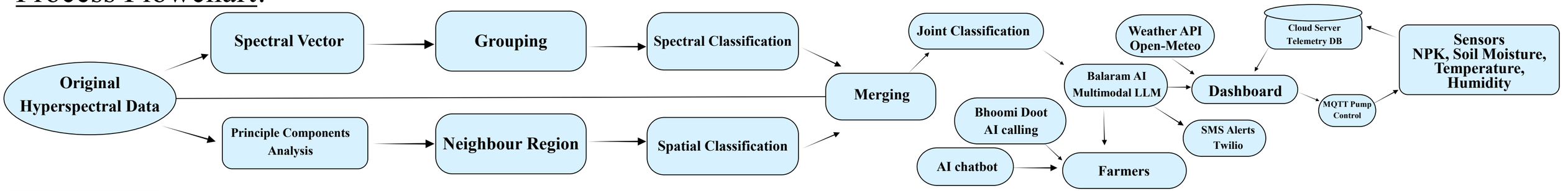
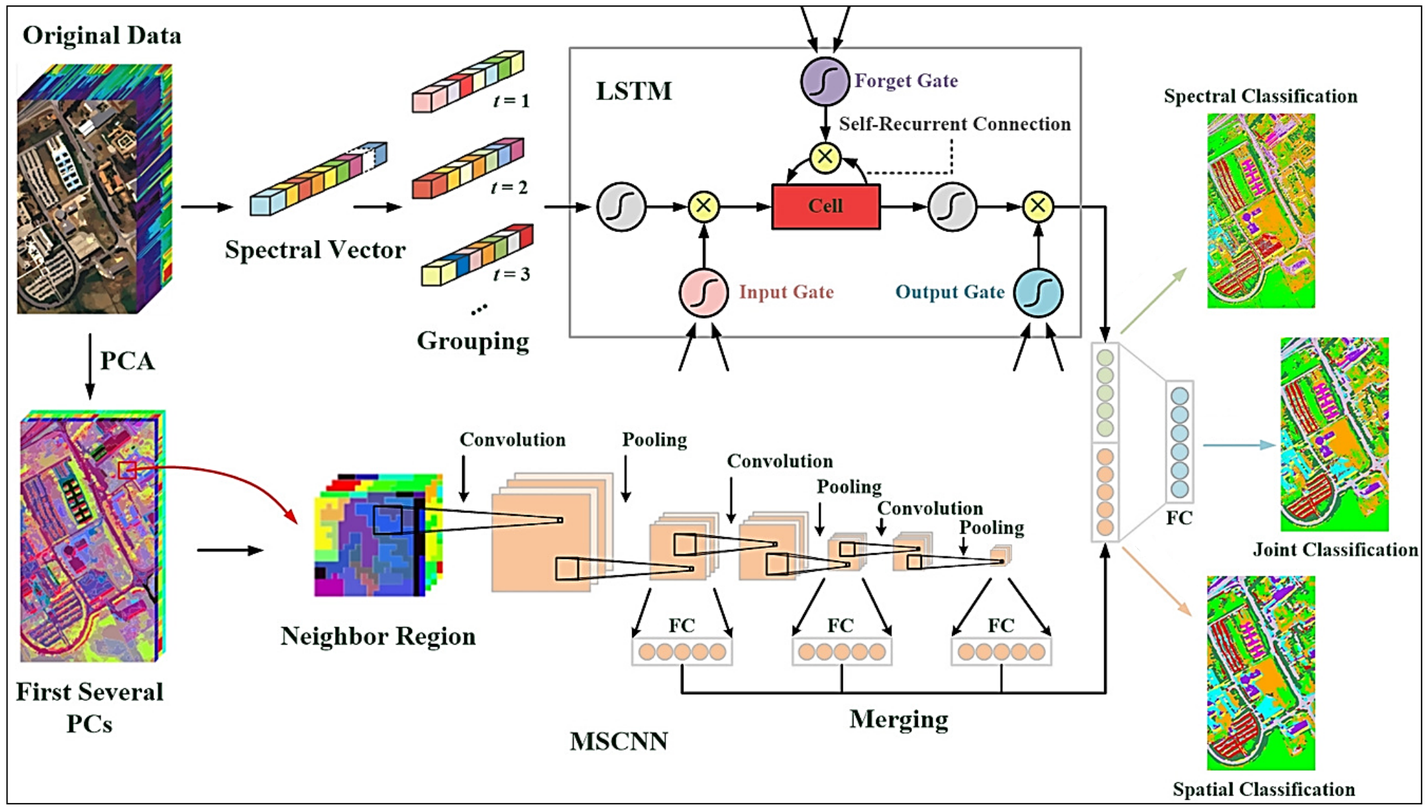
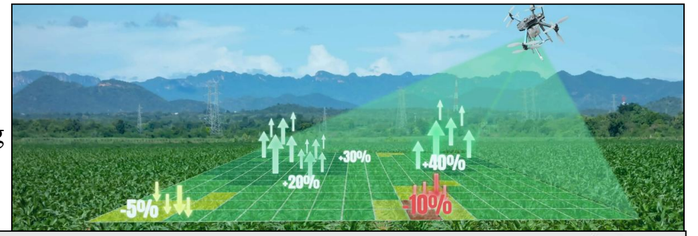
Process Flowchart:

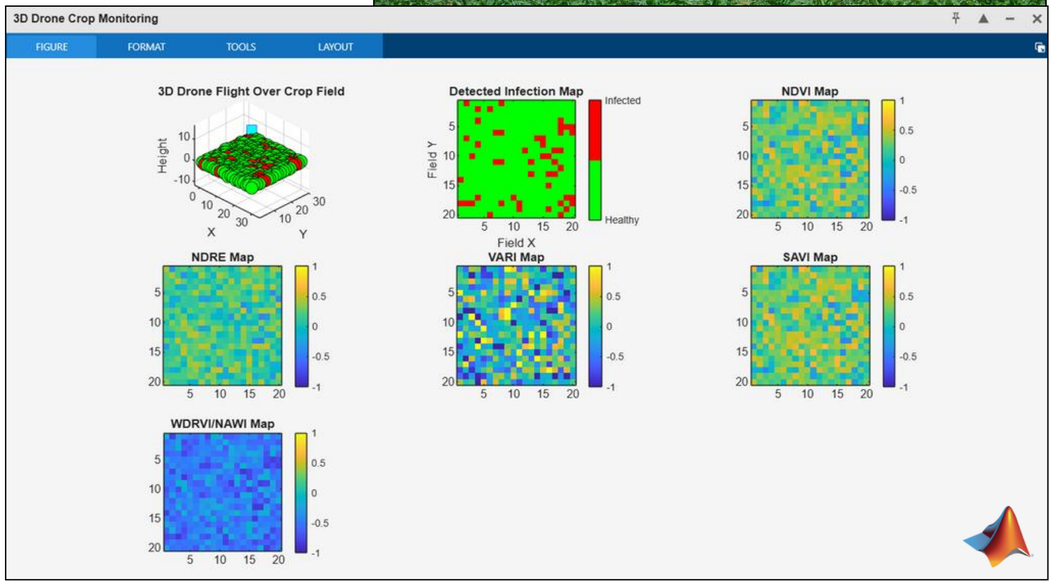




Drone Vision:

A MATLAB simulation for analysis crop condition using drone and satellite images.





FEASIBILITY AND VIABILITY

Technical Feaisblity

- Hyperspetrical imaging, IOT IOT sensors
- LSTM–CNN AI models
- High accuracy in stress, nutrient, & disease detection

Economic Feaisblity

- ROI: 10–25% yield increase
- 15-20% water savings
- 20-30% reduction of inputs

Operational Feaisbility

- AI dashboards
- Multinngal chatbot (Balaram AI)
- Outobiund calling (8hoomi Doot)
- Integration with farm equipment APIS

Environmental & Regulatory Sustainablity

- Promotes sustainable resource use & climate resllence
- Reduce ovevrse of fertllizers & chemicals
- Better Water Management pumps

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IMPACT AND BENEFITS

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Economic Benefits

Fertilizer Cost Reduction

- N_2 use per plant drops from 614 g to 128 g (72% reduction) through NPK sensor–guided dosing, directly enhancing farm profitability.

Yield Improvement

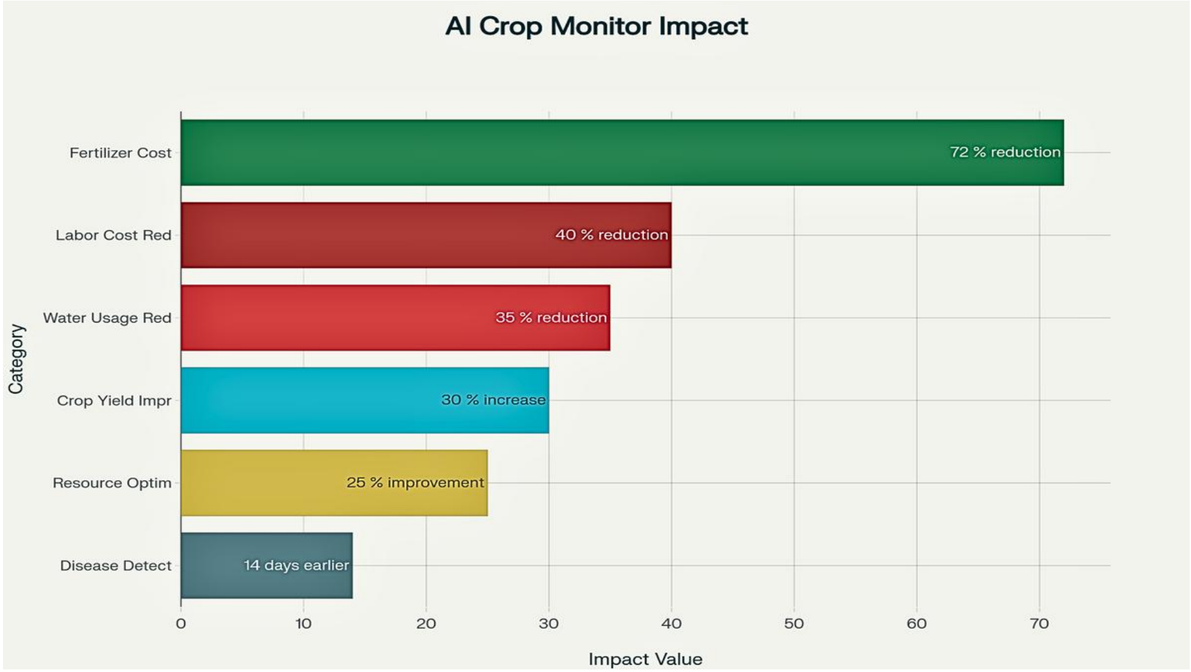
- AI-driven monitoring achieves up to 30% increase in crop yields by detecting stress early and optimizing inputs.

Water Usage Reduction

- Water consumption cut by 35% via precise irrigation scheduling based on real-time soil moisture and plant health data.

Labor Cost Reduction

- Automated, real-time field monitoring reduces manual inspection costs by 40%, allowing teams to focus on higher-value tasks



Environmental Impact

Water Conservation

- 20–50% water savings through targeted irrigation guided by hyperspectral and sensor data, detecting water stress before visible symptoms.

Chemical Use Reduction

- Pesticide and fungicide applications reduced by up to 22% via early disease and pest detection, lowering environmental exposure and preserving beneficial species.

Soil Health Improvement

- Continuous monitoring of NPK levels, moisture, and organic matter supports data-driven soil management, enhancing long-term fertility and ecosystem health.

Operational Advantages

Early Detection

- Identifies nutrient imbalances, diseases, and pest infestations before visible symptoms, enabling timely, targeted interventions

Precision Application

- Variable-rate input delivery based on field-specific data optimizes resource use and ensures each zone receives precisely what it needs.

Scalability

- Modular architecture supports deployments ranging from smallholder plots to large farms, making precision agriculture accessible and adaptable.

RESEARCH AND REFERENCES

- A hyperspectral plant health monitoring system for space crop production
  - **Publication**: Frontiers in Plant Science, 2023
  - **Link**: Click to view the Paper.
- Multispectral Plant Disease Detection with Vision Transformer
  - **Publication**: Nature Scientific Reports, 2023
  - **Link**: Click to view the Paper.
- Soil Health On-Demand Sensors—A Multi Parameter Field Study
  - **Publication:** PMC (PubMed Central), 2025
  - **Link:** Click to view Paper.
- Real-Time Soil Nutrient Monitoring Using NPK Sensors
  - **Publication:** International Journal of Experimental Research and Review, 2024
  - **Link:** Click to view Paper.
- CMTNet: a hybrid CNN-transformer network for UAV-based hyperspectral crop classification
  - **Author:** Xihong Guo, Quan Feng & Faxu Guo
  - **Link:** Click to view Paper