

CropIntel 2.0: AI Based Smart Grape Disease Detection and Soil Health Analysis System

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Abstract - Agriculture plays an important role in economic growth and food production. Crop diseases and poor soil conditions significantly affect agricultural productivity and crop quality. Traditional disease monitoring methods are time-consuming and highly dependent on expert supervision. To overcome these limitations, this paper presents CropIntel 2.0, an AI-based smart grape disease detection and soil health analysis system. The proposed system uses a lightweight Convolutional Neural Network (CNN) model for grape leaf disease classification and integrates soil parameter analysis for intelligent agricultural recommendations. Parameters such as Nitrogen (N), Phosphorus (P), Potassium (K), pH, moisture, humidity, and temperature are analyzed to provide fertilizer and treatment suggestions. The backend architecture is implemented using FastAPI for low-latency processing and MySQL for secure data management. Experimental analysis demonstrates improved disease prediction accuracy and faster response time compared to traditional agricultural systems. The proposed framework supports precision farming and sustainable agriculture through data-driven decision-making.

Key Words: Smart Agriculture, Deep Learning, CNN, FastAPI, Precision Farming, Crop Disease Detection, Soil Health Analysis.

1. INTRODUCTION

Agriculture is one of the most important sectors contributing to economic development and food security. Farmers often face significant crop losses due to delayed disease detection, improper fertilizer usage, and poor soil management. Traditional crop monitoring techniques rely on manual observation and expert supervision, which are often inaccurate, time-consuming, and inaccessible in rural regions.

Recent advancements in Artificial Intelligence (AI) and Deep Learning (DL) technologies have enabled the development of intelligent agricultural systems capable of automated disease detection and analysis. Convolutional Neural Networks (CNNs) have shown remarkable success in image-based crop disease classification due to their ability to automatically extract important image features.

CropIntel 2.0 is proposed as an intelligent agricultural framework that integrates CNN-based grape disease detection with soil health analysis. The system detects diseases such as Downy Mildew, Black Rot, Anthracnose, and Powdery Mildew while simultaneously analyzing soil parameters including Nitrogen (N), Phosphorus (P), Potassium (K), pH, moisture, humidity, and temperature.

The proposed system provides:

- Real-time crop disease detection
- Intelligent fertilizer recommendations
- FastAPI-based low-latency prediction
- Scalable and efficient deployment

The integration of AI technologies enables improved agricultural decision-making and supports sustainable farming practices.

3. PROPOSED SYSTEM

The proposed CropIntel 2.0 system consists of multiple processing stages including image preprocessing, disease detection, soil analysis, and recommendation generation.

3.1 Image Preprocessing

The uploaded grape leaf images undergo preprocessing techniques such as:

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The uploaded grape leaf images undergo preprocessing techniques such as:

- Image resizing
- Noise reduction
- Normalization
- Data augmentation

These preprocessing techniques improve image quality and enhance model performance.

3.2 Disease Detection Using CNN

The preprocessed images are analyzed using a lightweight CNN model trained on grape leaf datasets. The system classifies diseases including:

- Downy Mildew
- Black Rot
- Anthracnose
- Powdery Mildew

3.3 Soil Health Analysis

The system analyzes soil parameters such as Nitrogen (N), Phosphorus (P), Potassium (K), pH, moisture, humidity, and temperature to identify nutrient deficiencies and soil conditions.

3.4 Recommendation System

Based on disease prediction and soil analysis results, the system generates:

- Fertilizer recommendations
- Treatment suggestions
- Preventive agricultural guidance

3.5 Backend and Database

The backend architecture is implemented using FastAPI for asynchronous processing and REST API communication. MySQL database is used for secure storage of prediction reports and user information.

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Table 1: Disease Classification Results

Sr. No.	Disease Name	Accuracy (%)
1	Downy Mildew	95.45
2	Black Rot	93.64
3	Anthracnose	94.55
4	Powdery Mildew	96.82

Table 2: Soil Analysis Results

Sr. No.	Parameter	Value	Status
1	Nitrogen (N)	32 mg/kg	Adequate
2	Phosphorus (P)	18 mg/kg	Low
3	Potassium (K)	240 mg/kg	Adequate
4	pH	6.2	Optimal

4. RESULTS AND DISCUSSION

The proposed CropIntel 2.0 system demonstrates improved performance compared to traditional agricultural monitoring systems. The CNN model achieved high classification accuracy with low prediction time. FastAPI enabled efficient backend processing and improved response speed.

The integration of soil analysis improved agricultural recommendations and supported better farming decision-

making. The proposed framework provides an efficient and scalable solution for smart agriculture applications.

The proposed framework supports precision agriculture and sustainable farming practices by enabling data-driven agricultural decision-making.

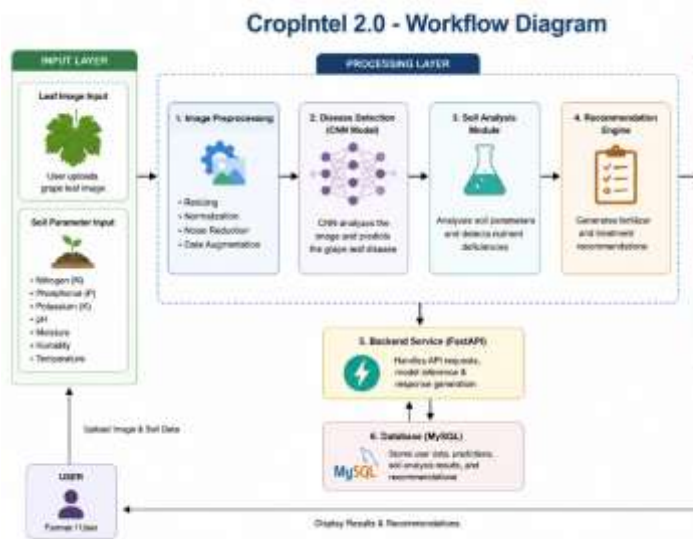
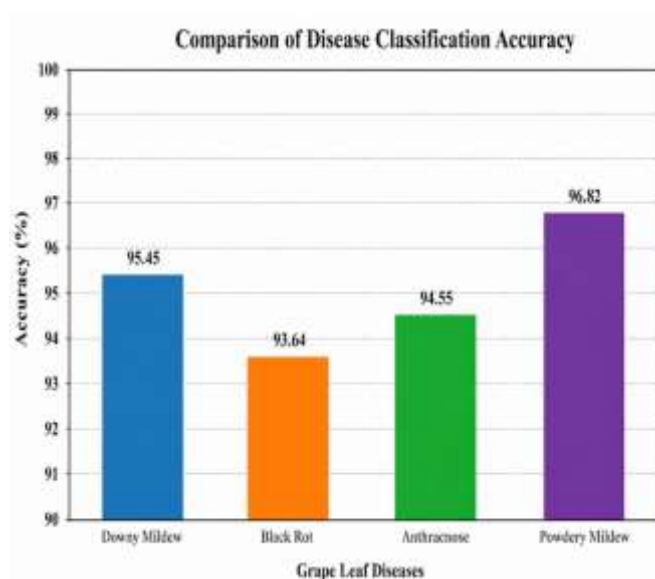


Fig -1: Workflow Diagram

Charts



3. CONCLUSIONS

CropIntel 2.0 presents an AI-based smart agriculture framework for grape disease detection and soil health analysis. The proposed system combines CNN-based image classification with soil parameter analysis to improve farming productivity and reduce crop losses. The integration of FastAPI and MySQL technologies enables low-latency prediction, scalable deployment, and secure data management. Experimental analysis demonstrates improved prediction accuracy and faster response time compared to traditional agricultural systems.

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REFERENCES

- S. Sladojevic et al., "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification," Computational Intelligence and Neuroscience, 2016.
- K. P. Ferentinos, "Deep learning models for plant disease detection and diagnosis," Computers and Electronics in Agriculture, 2018.
- A. Kamilaris and F. X. Prenafeta-Boldú, "Deep learning in agriculture: A survey," Computers and Electronics in Agriculture, 2018.
- M. Too et al., "A comparative study of fine-tuning deep learning models for plant disease identification," Computers and Electronics in Agriculture, 2019.
- A. Krizhevsky et al., "ImageNet Classification with Deep Convolutional Neural Networks," NIPS, 2012.
- Sandler et al., "MobileNetV2: Inverted Residuals and Linear Bottlenecks," CVPR, 2018.
- Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions," CVPR, 2017.
- FastAPI Documentation.
- TensorFlow Documentation.
- MySQL Documentation.