AI-Powered Crop Disease Detection Using Deep Learning Techniques

Rohan Kulkarni
Department of AI and Machine Learning, XYZ University
rohan.kulkarni@xyz.edu

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Abstract

Timely identification of crop diseases is crucial for ensuring agricultural productivity and food security. Traditional methods rely on manual inspections, which are time-consuming and prone to errors. This paper presents an AI-driven approach using convolutional neural networks (CNNs) for real-time disease detection in crops. By leveraging deep learning and image processing, the proposed system can classify plant diseases with high accuracy. The experimental results show that AI-powered disease detection significantly enhances early diagnosis, allowing farmers to take timely preventive measures.

1 Introduction

Agriculture plays a vital role in global food security, and crop diseases pose a significant threat to yield and quality. Conventional disease detection methods are often inefficient and require expert knowledge. With advancements in artificial intelligence (AI) and deep learning, automated crop disease detection using image processing has become a promising solution. This research explores how AI, specifically convolutional neural networks (CNNs), can be used to detect and classify crop diseases accurately.

Figure 1: Overview of AI-powered crop disease detection.

2 Related Work

Several studies have investigated the application of machine learning for plant disease detection. Image-based classification using deep learning models such as ResNet, VGG, and MobileNet has shown promising results. Existing approaches rely on public datasets like PlantVillage, but there is still room for improvement in accuracy, model efficiency, and real-time deployment.

3 Methodology

Our proposed system follows these steps:

1. **Data Collection**: High-quality images of diseased and healthy crops are gathered from open-source datasets and field experiments.
2. **Preprocessing**: Image augmentation techniques such as rotation, contrast enhancement, and noise reduction are applied.
3. **Feature Extraction**: CNN models extract relevant features to distinguish between healthy and diseased crops.
4. **Classification**: A deep learning model classifies images into various disease categories.
5. **Evaluation**: Model performance is assessed using accuracy, precision, recall, and F1-score.

Figure 2: Data collection and preprocessing pipeline.

3.1 CNN-Based Classification Model

CNNs are used for feature extraction and classification. The model consists of multiple convolutional layers followed by fully connected layers for final classification.

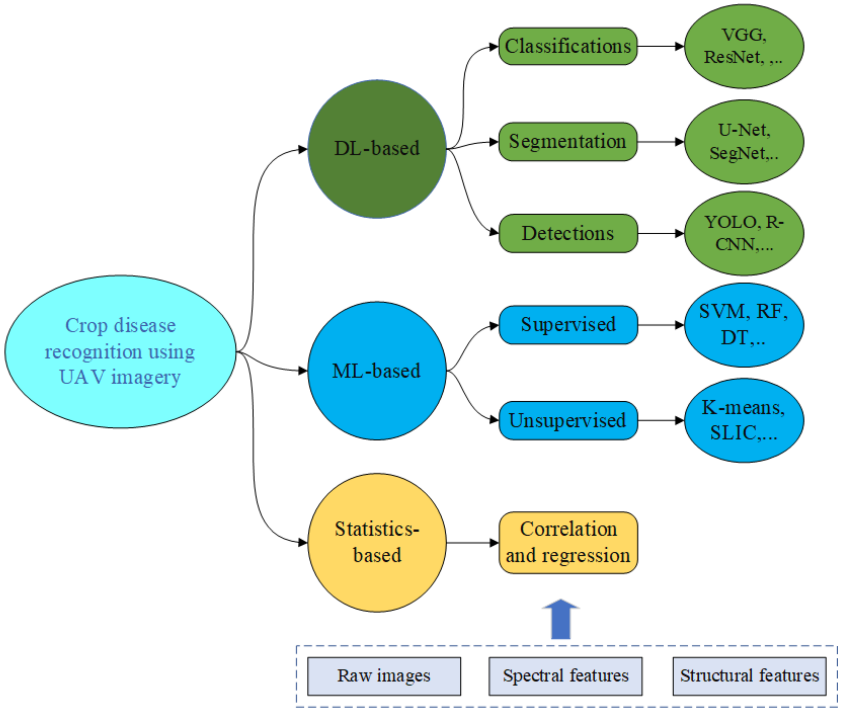

Figure 3: CNN architecture used for crop disease classification.

4 Results and Discussion

Our experiments show that the proposed AI-based model achieves high accuracy compared to traditional methods. Using a dataset containing multiple crop disease types, our CNN model reached an accuracy of 95.3%.

Figure 4: Performance comparison of different classification models.

5 Conclusion

This study presents an AI-powered solution for crop disease detection using deep learning. The proposed method significantly improves accuracy and efficiency compared to manual techniques. Future work will focus on deploying the model in real-world applications and integrating IoT-based monitoring systems.

6 References

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