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Machine Learning-Based Detection and Classification of Leaf Diseases in Plants Using High-Resolution Imaging

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Abstract: *Leaf diseases pose significant challenges in agriculture, impacting both crop yield and quality. Traditional identification methods, reliant on manual inspection, are often inefficient and prone to human error. In this paper, we propose a machine learning-based system for the automatic detection and classification of leaf diseases using high-resolution imaging. Our approach integrates deep learning models—specifically Convolutional Neural Networks (CNNs)—with advanced transfer learning techniques utilizing architectures such as VGG16, ResNet50, and EfficientNet-B0. The dataset was preprocessed using augmentation techniques and class-balancing strategies to improve model robustness and generalization. Among the tested models, EfficientNet-B0 achieved the highest performance with 92.8% accuracy. The model was further evaluated using precision, recall, F1-score, and ROC curves, and interpretability was enhanced via Grad-CAM visualizations. Additionally, the system is deployed via a user-friendly web/mobile application to enable real-time, on-site diagnosis for farmers. Our results demonstrate the potential of deep learning and high-resolution imaging for scalable, accurate, and accessible plant disease diagnostics, contributing to more sustainable and data-driven agricultural practices*

Keywords: Leaf Disease Detection, Machine Learning, Convolutional Neural Networks, VGG16, ResNet, Transfer Learning, Agriculture, Image Classification

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