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A Study of AI-Driven Multiclass Plant Disease Classification Using Optimized Image Processing and Machine Learning

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ABSTRACT

AI-driven multiclass plant disease classification using optimized image processing and machine learning techniques provides an efficient and scalable solution for modern precision agriculture. Crop plants are vulnerable to a wide range of diseases, and early identification of specific disease types is essential for effective treatment and yield protection. Traditional diagnostic methods rely on manual inspection, which can be time-consuming, subjective, and limited in large-scale farming environments. In the proposed AI-based framework, high-quality leaf images are first captured and subjected to preprocessing steps such as noise removal, background segmentation, color normalization, and contrast enhancement to improve image clarity. Feature extraction is then performed using advanced techniques, including Convolutional Neural Networks (CNNs), which automatically learn discriminative features such as texture patterns, lesion shapes, and color variations. These features are fed into optimized machine learning classifiers for multiclass categorization of diseases. Techniques such as data augmentation, hyperparameter tuning, dropout regularization, and cross-validation are employed to enhance accuracy and prevent overfitting. The system demonstrates improved precision, recall, and F1-score across multiple disease categories under varying environmental conditions.