

Enhancing Paddy Leaf Disease Classification: A Dual Stream CNN and Handcrafted Feature Approach

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Rice is a vital global food crop, yet its production faces significant threats from leaf diseases that reduce both yield and quality. While automated disease classification models exist, current approaches face fundamental limitations: Deep learning approaches overlook critical texture patterns, and handcrafted features based approaches, which lack high level semantic understanding. To address these limitations, this approach proposes a hybrid dual stream architecture integrating Haar wavelets with EfficientNetV2M, achieving state-of-the-art performance across multiple benchmark datasets. Haar wavelets effectively capture both spatial and frequency characteristics, enabling explicit encoding of texture, edge, and structural information, while EfficientNetV2M extracts hierarchical semantic features. This method processes wavelet transformed images via convolutional layers and fuses them with EfficientNetV2M's features. This fusion enables the model to simultaneously leverage high level semantic context and detailed local patterns critical for distinguishing visually similar diseases. This approach was evaluated on three benchmark datasets: Mendeley, UCI, and RiceLeafV3 encompassing seven distinct (Bacterial Blight, Blast, Brown Spot, Leaf Scald, Tungro, Leaf Smut and Narrow Brown Spot) rice diseases. The model achieved superior testing accuracies of 99.94%, 96.44%, and 96.68% respectively, outperforming all existing state-of-the-art methods on each dataset. This work demonstrates that the fusion of wavelet based texture analysis and deep learning creates a more interpretable and accurate model for precision agriculture, offering farmers reliable disease classification while advancing computer vision methodologies for agricultural applications.

Keywords: EfficientNetV2M, Wavelet features, Dual stream, Paddy leaf diseases