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Diagnostic of plant pathogens in the early stage by using deep learning algorithms for different image types

Abstract

Apples are a globally significant fruit species, with apple scab caused by fungi being the most economically impactful disease affecting production. This research addresses the pressing need for innovative cultivation strategies in response to environmental concerns, fungicide resistance, and cost-effectiveness pressures. We propose the development of artificial intelligence solutions for the early-stage detection of apple scab through advanced imaging techniques, enabling precise horticultural practices for preventive diagnosis.

Traditional RGB imagery, while useful for detecting visible symptoms, reveals infections only after they manifest. In contrast, hyperspectral imaging captures a wider range of wavelengths, facilitating the identification of biochemical changes such as pigment concentration and moisture levels, thus allowing for earlier disease detection. We use Convolutional Neural Networks (CNNs) for image classification and feature extraction, training models to differentiate between healthy and diseased apple tissues using both RGB and hyperspectral data. Leveraging transfer learning, we optimize pre-trained models in scenarios with limited labeled data.

Our findings indicate that integrating deep learning with advanced imaging techniques such as hyperspectral and thermal imaging can significantly enhance early pathogen detection in precision agriculture. This approach promises to deliver real-time, accurate, and non-invasive diagnostics, thereby enabling timely interventions to mitigate the impact of plant diseases on apple production.