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SPECTRAL UNMIXING OF UAV HYPERSPECTRAL DATA FOR DISEASE DETECTION IN COTTON CROP

Abstract

Hyperspectral remote sensing, coupled with unmanned aerial vehicles (UAVs), has proven to be a powerful tool for precision agricultural practices, providing high-resolution spatial and spectral information for accurate crop monitoring and management. In this study, we investigate the application of spectral unmixing techniques to UAV hyperspectral data for disease detection in cotton crops. Our main objective of this study is to develop a comprehensive approach that utilises advanced spectral analysis methods to accurately identify and map disease stress within agricultural fields to make timely interventions to mitigate crop losses. The hyperspectral data is collected using a UAV platform equipped with a high-resolution spectrometer, capturing spectral information from 400-1000nm wavelength range at the spectral resolution of 5nm. Preprocessing techniques are then applied to correct atmospheric effects and sensor noise, ensuring the integrity of the data for subsequent analysis. The deep learning-based spectral unmixing algorithm was employed to decompose the mixed pixel spectra into their constituent endmembers, representing various materials within the scene, such as healthy vegetation, diseased vegetation, and soil. Linear unmixing methods, such as Pixel Purity Index (PPI), Simplex Projection Unmixing (SPU), and non-linear techniques, such as Non-Negative Matrix Factorisation (NMF) and Vertex Component Analysis (VCA), were evaluated and compared with our deep learning-based approach. Following spectral unmixing, the endmembers are classified into different classes. Different classifiers use these endmembers to distinguish between healthy and diseased vegetation based on their spectral signatures, allowing for the creation of classified output showing the spatial distribution of disease stress within the cotton crop. These maps serve as valuable decision support tools for farmers and agronomists, enabling targeted interventions such as pesticide application or irrigation management to mitigate the impact of disease outbreaks. To validate the proposed approach, we collected ground truth data on disease severity through field surveys. The hyperspectral data acquired from UAVs was compared against traditional surveying and remote sensing techniques, demonstrating the advantages of high-resolution spectral information for disease detection in agricultural settings. Our study demonstrates the efficiency of deep learning-based spectral unmixing on UAV hyperspectral data for disease detection in cotton crops. Combining advanced spectral analysis techniques with deep learning technology provides a robust framework for the early detection and management of diseases, eventually contributing to improved crop health and yield stability in agricultural systems.