# *Developing Hyperspectral-Imaging-Based Capabilities for Detecting and Quantifying Fungal Networks in Soils*

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Fungal organisms have attracted increasing attention in recent years due to their potential for a wide range of geo-environmental engineering applications, particularly those supporting environmental sustainability and resource circularity. For example, saprotrophic fungi have been explored for their ability to degrade hydrocarbon contaminants in the environment, to reduce soil erosion and for the creation of mycelium-based hydraulic barriers. However, unlocking the full engineering potential of fungi requires reliable methods for detecting and quantifying fungal growth. This remains challenging because individual hyphae are several microns in diameter and the fungal mycelial networks are embedded within complex soil substrates, making them difficult to observe using conventional imaging approaches. Furthermore, fungal growth can occur over extended areas and evolves dynamically over time, and in response to environmental conditions, requiring monitoring techniques capable of capturing information beyond the visible spectrum while providing large-area and temporal coverage. This work investigates the use of hyperspectral imaging (HSI) as a fast, non-destructive, and accurate tool for the detection and quantification of fungal networks in soils.

The underlying hypothesis is that fungal constituents, including pigments, proteins, and cell wall components, exhibit distinct absorption, reflection, and transmission characteristics across different wavelengths, resulting in potentially unique spectral signatures. HSI is expected to capture these subtle spectral variations, enabling these biological components to act as fungal biomarkers. Furthermore, the combined spatial and spectral information provided by HSI enables the generation of fungal distribution maps over large surface areas, supporting the accurate quantification of key parameters such as biomass, spatial extent, and growth dynamics.

This work evaluated the spectral signatures of *Pleurotus Ostreatus* (oyster mushroom) grown on agar, used as a reference background, and on a range of substrates, including sand, kaolin, beechwood, natural clay and mixed soil compositions. HSI data was acquired across the ultraviolet (250-500 nm), visible (400-1000 nm), and short-wave infrared (900-2500 nm) spectral regions. The results demonstrate the potential of HSI for the detection of *Pleurotus Ostreatus* through distinct spectral responses in both the ultraviolet and infrared ranges. In the ultraviolet region, fungal presence was associated with an absorption feature around 280 nm, attributed to ergosterol, a key sterol component of fungal cell membranes. In the infrared region, the fungal mycelial network exhibited enhanced contrast and rich textural information, enabling clear visualization and characterization of fungal growth.

While these preliminary results demonstrate the potential of HSI for fungal detection and characterization, substantial research is still required to fully exploit this capability. Future work will focus on the integration of HSI with advanced data processing and machine learning techniques to enable the quantification of fungal network dynamics over time and the estimation of key biological and structural properties.