Living Optics

Weed Detection in Spinach Fields Using Hyperspectral Snapshot Imaging

Weeds are a persistent and costly challenge for farmers. Competing with crops for vital resources like nutrients, water, and sunlight, they can dramatically reduce yield and quality leading to substantial economic losses. As the demand grows to maximise productivity whilst minimising costs and environmental impact, new solutions are needed to support targeted weed control strategies.

Why traditional methods fall short

Weeds often resemble crops in shape, colour, and size, especially in early or dense growth stages—making them hard to identify using traditional methods. Historically, farmers have relied on manual labour and chemical herbicides to manage and control weeds. However, they came with limitations:

- Manual removal was time and labour-intensive.
- Chemical herbicides pose environmental and health risks.
- Chemical overuse promotes herbicide resistance.
- Uniform spraying wastes resources without precise weed location data.

A sustainable alternative: Hyperspectral Imaging

As the demand for sustainable weed management increased farmers have begun to seek ways to reduce herbicide use whilst maintaining crop health and productivity.

To meet these challenges, hyperspectral imaging (HSI) offers a promising path forward. HSI captures the unique spectral response of plants across hundreds of wavelengths. Unlike RGB cameras, HSI can detect subtle chemical differences in vegetation.

What HSI enables:

- Accurate weed identification; even in complex environments.
- Data-driven, site-specific weed control.
- Reduced herbicides use & operational costs.
- Real-time or near real-time field monitoring.
- High model performance with minimal training data.

Identifying Weeds in Spinach Fields

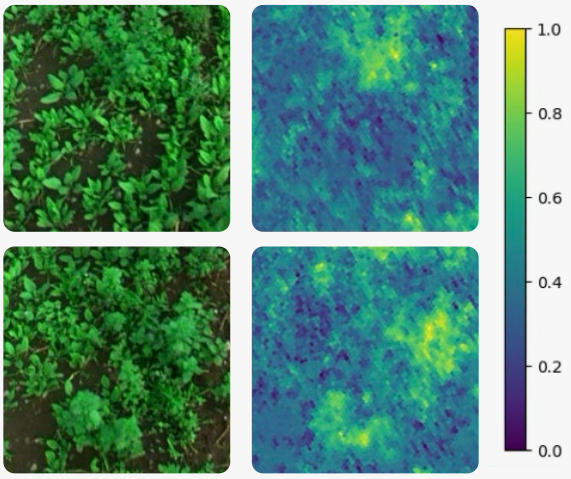
To demonstrate the utility of HSI in the field, a proof-of-concept (POC) was conducted to detect a specific weed species growing alongside mature spinach. This task posed a tough challenge due to their visual similarity. Using just a few seconds of video, from a few selected frames data was extracted, L2 normalised and used to train a spectral classifier. The model achieved 74% accuracy on previously unseen data, a strong result given the minimal input and the visual similarity between crop and weed.

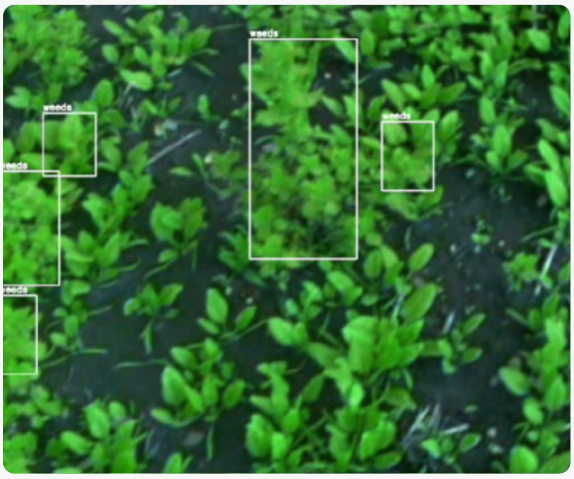
Field setup

Camera:
Living Optics hyperspectral snapshot camera

Configuration:
Handheld, walking at approximately 1 m/s

Capture rate:
30 frames per second





Left: Spectral classifier confidence map (brighter yellow = higher weed confidence)

Right: RGB image with bounding boxes over detected weeds

Field-Ready Precision Weed Management

The POC highlighted the value of the Living Optics hyperspectral imaging camera in real-world agricultural settings. With minimal training data, real-time capability, and solid performance, this technology is poised to make site-specific weed management smarter, faster, and more sustainable.