Living Optics

Snapshot Hyperspectral Imaging and NDVI: A New Approach to Detecting Box Tree Caterpillars

The box tree caterpillar, a new pest spreading rapidly across Europe, poses a serious threat to high-value topiary in ornamental gardens and parks. In just a matter of days, they can cause complete defoliation of boxwood plants. **Early detection is key;** if caught in time, appropriate actions can be taken to minimise damage. Remote sensing technologies, such as hyperspectral imaging, can offer solutions for detecting caterpillar infestations by capturing detailed spectral information revealing changes in plant health, such as reduced photosynthetic activity.

Acting before it's too late: The impacts of box caterpillar infestations

Box tree caterpillars are the larvae of a moth that feeds on box (Buxus Sempervirens) plants. Box plants are dense, evergreen shrubs commonly used in ornamental gardens as formal topiary. They are valued for its slow growth and ability to be shaped.

Caterpillars' infestations have various impacts:

- **Aesthetic Impact:** Severe defoliation and dieback caused by the caterpillar, leave plants looking bare and unsightly.
- **Economic Impact:** caterpillar damage will result in a lower amenity value, making box topiary less desirable for landscaping and ornamental use. In addition, replacements may be costly.
- **Impact on Boxwood:** Rapid defoliation, weakening of plant. Repeated attacks can lead to death.

Early signs of infestation include webbing and skeletonisation of leaves over feeding areas. Early intervention is critical to prevent irreversible damage. The Normalised Difference Vegetation Index (NDVI), commonly used to monitor plant health, enables to **track changes in real-time in chlorophyll and leaf structure.** Monitoring these changes allows horticulturalists to locate and target infestations in time.

Taking Hyperspectral Imaging Technology to the Field

The Living Optics hyperspectral imaging camera is a portable system enabling data capture in-field. Using this technology, data from boxwood plants exhibiting early signs of box tree caterpillar infestation were collected.

Field setup

Camera:
Living Optics hyperspectral snapshot camera mounted on a monopod for efficient scanning of topiary

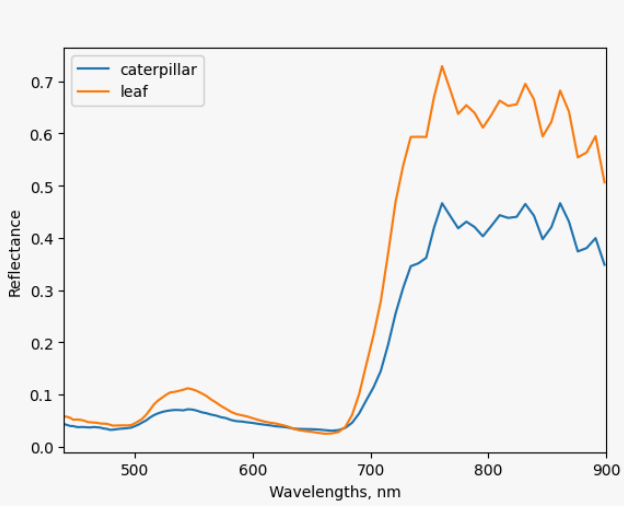
Calibration:
White reference captured to perform radiometric calibration, converting the camera's nominal radiance output into reflectance

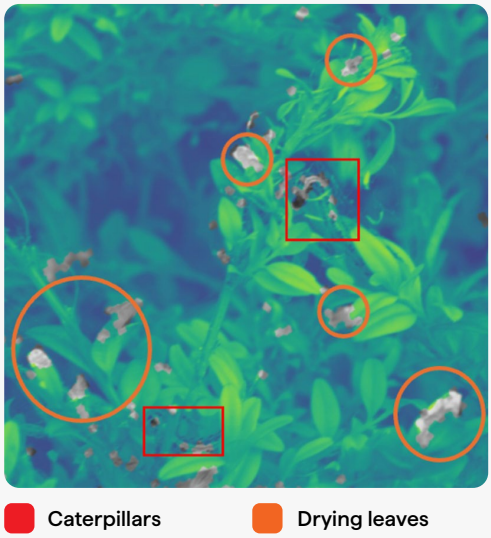
Capture rate:
Data collected under sunlight at 30 frames per second (FPS)

The hyperspectral videos revealed a spectral difference, particularly in the near infrared region of the spectrum, between the caterpillar and the healthy leaves spectra, as shown in the figure below (left). The right figure displays an NDVI map computed on a single frame.

Dying or damaged leaves, highlighted with orange circles, have lower NDVI score (displayed as grey in the map), indicating little to no photosynthetic activity. In contrast, brighter regions correspond to healthy leaves with higher activity.

These NDVI maps can be generated in real or near-real time, enabling rapid identification of stressed regions and a better understanding of the extend of the damages induced by the caterpillars.





Box Tree Caterpillar Detection Made Easy with Snapshot Hyperspectral Imaging and NDVI

This case study demonstrates the potential of combining snapshot hyperspectral imaging with NDVI analysis to screen high-value topiary in real-time for box tree caterpillar infestations.

The ability to identify subtle spectral changes associated with declining photosynthetic activity enables a targeted and timely intervention, preserving the aesthetic and economic value of ornamental topiaries.

As pests continue to pose a threat, integrating hyperspectral imaging into routine monitoring protocols offers an efficient, scalable, and field-deployable method for protecting high-value ornamental topiaries and monitoring their health.