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Spectral imaging for the agriculture industry

Evolution in remote sensing

Enabling precision farming on a large scale

Spectral imaging as a general concept combines characteristics of imaging and spectroscopy technologies. Optical spectral imaging particularly makes use of visible, near infrared and short-wave infrared spectral range, has been demonstrated to be a very powerful tool in identifying, classifying, and mapping specific targets across whole scenery image in various application scenarios.

Spectral Imaging is especially useful in the agricultural domain, where crop/vegetation in different conditions has unique spectral characteristics. With more robust and rugged imaging product integrated with various platforms, agritech has been undertaking revolutionary improvements for remote sensed inspection. Multispectral imaging, hyperspectral imaging, and SIF (solar-induced fluorescence) imaging can be broadly derived depending on spectral bands and resolution needed.

Multispectral Imaging

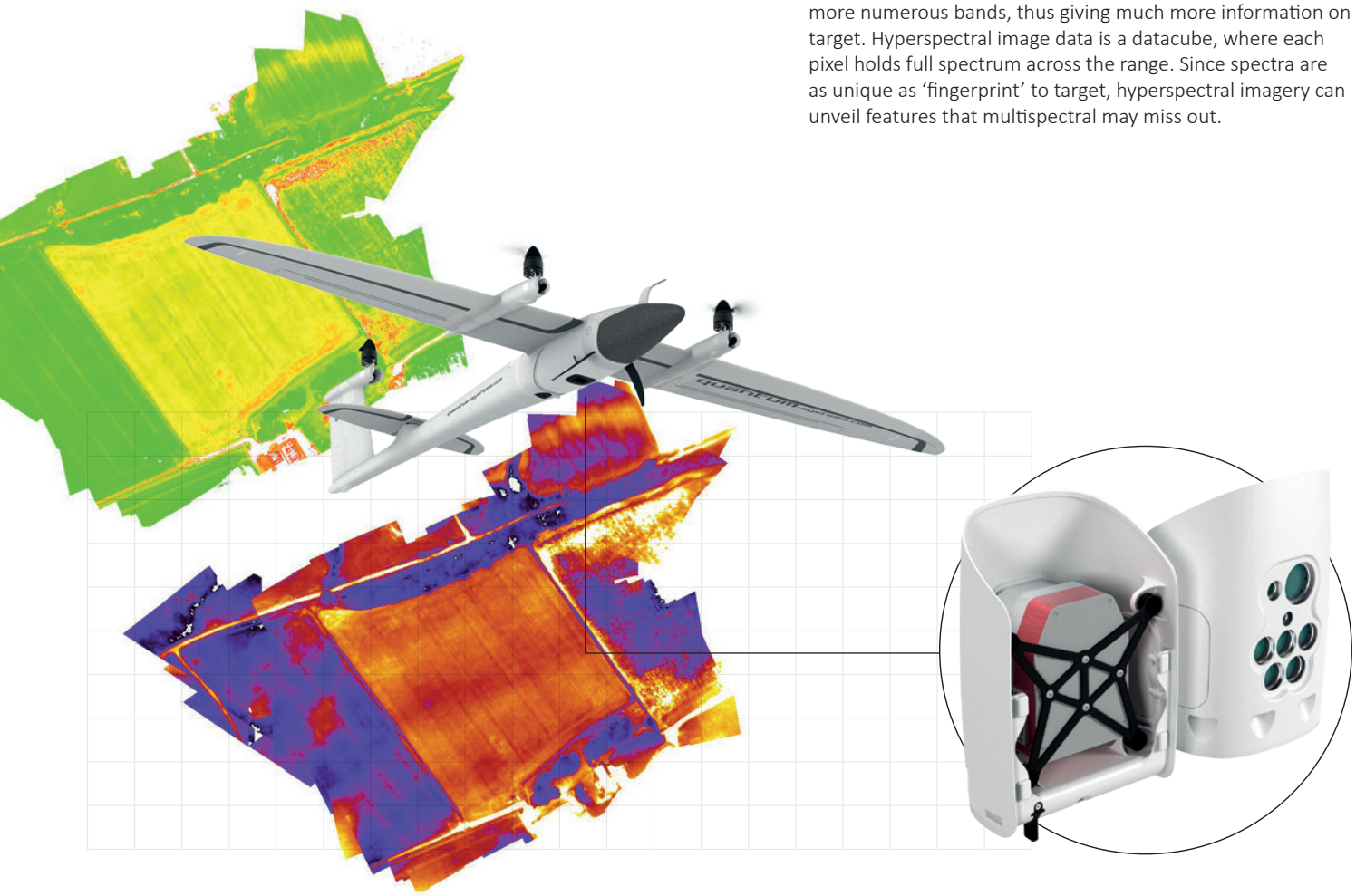
The advantage of multi-spectral imaging is that it extends human sight sensitivity beyond visible spectrum. Some wavelengths that are widely recognized for particular applications, such as normalized difference vegetative index (NDVI), can be deployed into multi-spectral imaging. Nonetheless, it has been proven to be very useful in many other fields, greatly empowering advancement of agriculture. And the adoption of UAV has made it possible to make large-scale mapping and thus better agricultural management.

Agri-EPI Centre has invested MicaSense Altum sensor covering RGB, NIR, Red Edge and LWIR, which can be operated easily on VTOL UAV platform.

With this multi-spectral imaging system, several important vegetation indexes such as red edge, NDVI, can be quickly collected and mapped across survey fields.

Hyperspectral Imaging

Hyperspectral imaging captures images at hundreds of wavelengths, creating a detailed spectral signature of objects and materials. Compared to multispectral imagery, hyperspectral imagery measures energy in narrower and more numerous bands, thus giving much more information on target. Hyperspectral image data is a datacube, where each pixel holds full spectrum across the range. Since spectra are as unique as ‘fingerprint’ to target, hyperspectral imagery can unveil features that multispectral may miss out.



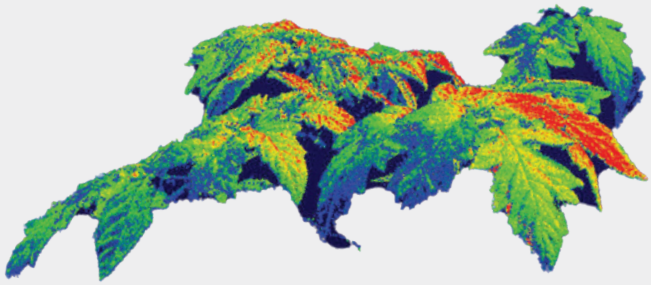
Agri-EPI Centre has invested in a range of hyperspectral imaging systems:

> Lab-based

The Hyperspectral SWIR 3.0 camera is a multi-purpose imaging instrument, collecting hyperspectral data in the short-wave infrared range (1000 to 2500nm). 384 spatial pixels achieve image rates of up to 400 frames per second. Its temperature-stabilised optics provide the stability and sensitivity required in the most challenging imaging applications.

> Gantry system in glasshouse

Glasshouse-based sensor platform for use in pilot scale growth trials and phenotyping, as well as novel sensor development to investigate and quantify the impact of different factors on plant physiology and biochemistry.



> UAV-mounted

The coaligned VNIR and SWIR cameras create high-quality hyperspectral data cube, covering the spectral range from 400- 2500 nm, double resolution data in the VNIR range is always readily available.

> Others

The Nano HP™ is a small and lightweight VNIR hyperspectral sensor ideal for airborne hyperspectral imaging applications. It's UAV attachable, and perfect for environmental monitoring and precision agriculture applications.

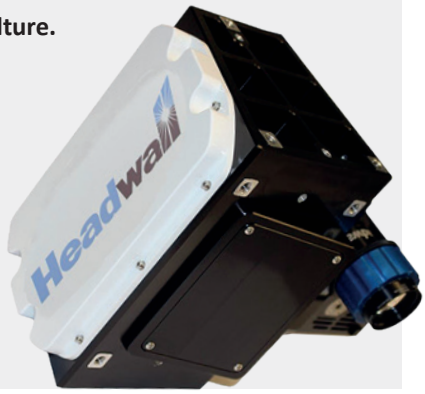
Hyperspectral imaging has a wide range of applications in agriculture, including crop health monitoring, disease detection and prevention, soil analysis, and yield prediction.

Developers can also benefit from hyperspectral imaging, such as creating masks or models for image annotations, calibrating machine learning models created from other technologies, and extracting pixel-wise spectral information, etc.

> SIF

Remote sensing of solar-induced fluorescence (SIF) is rapidly advancing as a technique in agricultural and environmental science, although it is founded upon decades of research, applications, and sensor developments in active and passive sensing of chlorophyll fluorescence. The extremely weak yet distinct SIF signal can be assessed remotely using a very high-resolution spectral sensor in tandem with state-of-the-art algorithms to distinguish the emission from reflected and/or scattered ambient light.

Agri-EPI Centre has been leading the utilisation of UAV-based SIF application in agriculture.



Headwall's SIF imaging sensor excels at collecting data present in the Oxygen-A and Oxygen-B bands where weak but valuable fluorescence signals are found. With this data, environmental scientists can gain a better understanding of plant physiology and stress.

This system can detect solar-induced fluorescence as a proxy measurement of photosynthetic activity, which specific applications areas may include:

- Stress detection (e.g., plant diseases, water stress, herbicide stress)
- Estimation of photosynthesis and GPP (Gross Primary Productivity)
- Tracking of temporal and phenological changes in different vegetation types

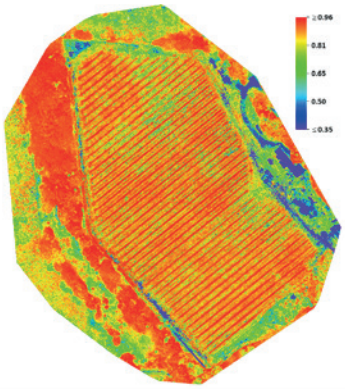
ENVI Processing Software

Agri-EPI Centre has onboard ENVI software for spectral image processing and data analysis, which can help to understand the data requirement and provide technical advice.

Case Study 1:

Crop Health Indication

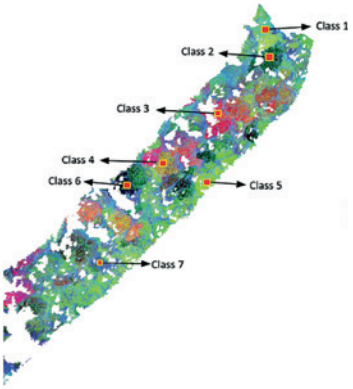
Hyperspectral imaging can be used to identify various Multispectral imaging is capable to calculate NDVI (Normalised Difference Vegetation Index) directly by utilising NIR and RED bands. NDVI is a standardized way to measure healthy vegetation. Higher NDVI values, which are indicated as red color, represent healthier vegetation. Lower NDVI, which are indicated as blue color, represent less or no vegetation.

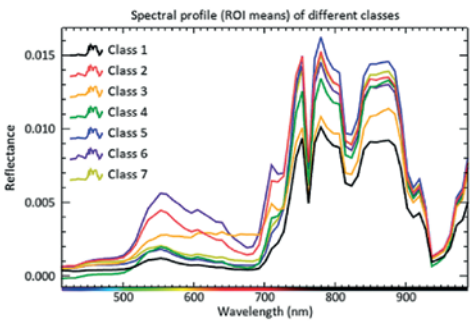


Case Study 2:

Tree Species Classification

Hyperspectral imaging can be used for tree species classification in mixed-species forest, for precise monitoring of disease development. PCA was used for species classification, with pixels in same colour calculated as the same class (likely belong to one tree species). Spectra analysis showed that different classes present varied spectral profiles.





Agri-EPI Centre can provide end-to-end service from requirements analysis, to data collection to delivery and analysis if required. Please get in touch for more details.

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