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Multispectral Imagery Explained: From Basics to Application

A COMPLETE GUIDE TO NAVIGATING DRONE BASED MULTISPECTRAL DATA COLLECTION

Contents

Multispectral imagery captures data across multiple light spectrums, unveiling data that can’t be seen with the naked eye.

What challenges does multispectral imagery solve?

Early detection of issues like diseases, water stress, pest infestation, nutrient deficiencies, and more.

Monitor chlorophyll concentrations and sediments in water, as well as plankton and algae blooms for in-depth research.

Reveals land use change, vegetation and agricultural production trends and cycles.

Utilise machine learning applications such as crop counting and advanced vegetation research.

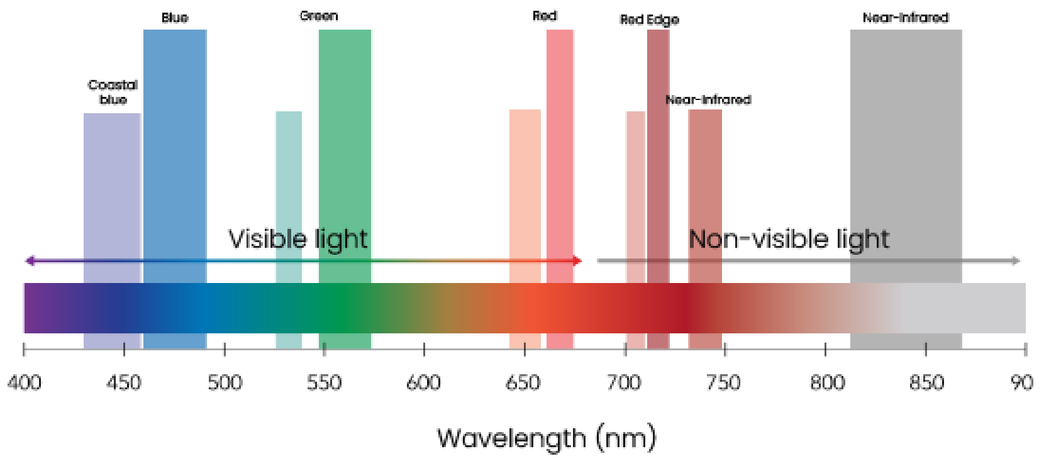
"Just one drone flight gave a 50% increase in the known number of archeological sites."

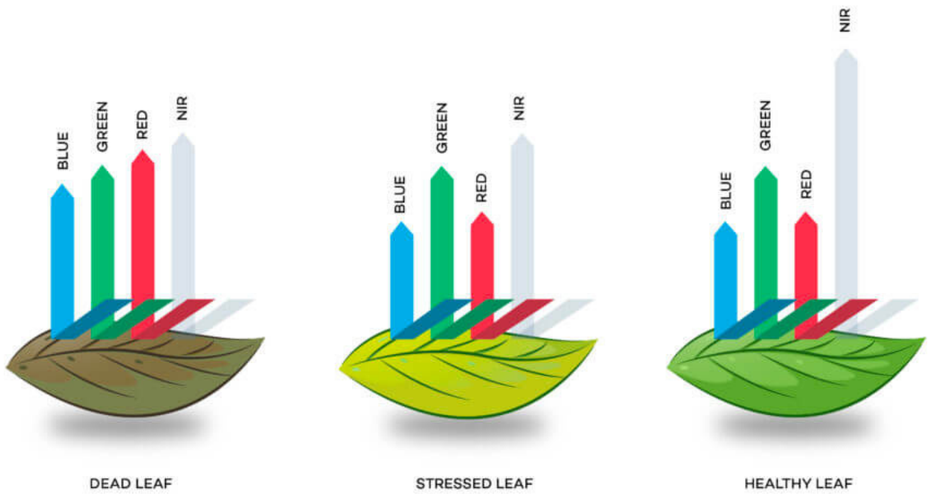
-Roger Doonan, Archeological Research Services

How does multispectral imagery work?

Visible light is just a small part of the electromagnetic spectrum.

Vegetation reflects and absorbs different wavelengths of light based on their health. Healthy plants reflect more near-infrared light due to higher chlorophyll levels, while changes in water content and cellular structure alter how they interact with infrared light, revealing their health status. Multispectral cameras can detect these wavelengths invisible to the naked eye and transfer them into visible light to colour code problems and deficiencies.





Multispectral Bands

Spectral bands refer to specific ranges of wavelengths in the electromagnetic spectrum. Each spectral band captures different types of information based on the way various surfaces or substances reflect or absorb energy at different wavelengths. These are the most common spectral bands that are built into drone sensors:

Band	Wave Length	Use
Red	600-700nm	Vegetative growth, crop type, humidity, and leaf area index
Near-infrared	700-900nm	Measure plant health and proctivity
Rededge	700-780nm	Crop stress, changes in chlorophyll content
Green	500-600nm	Measure canopy cover and weed growth
Blue	450-500nm	Detects water stress, disease, and big differences in plant health

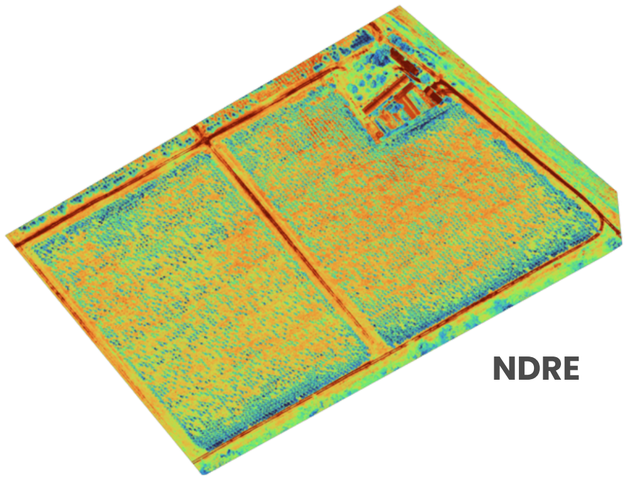
Multispectral Drone Data Types

Vegetation Indexes

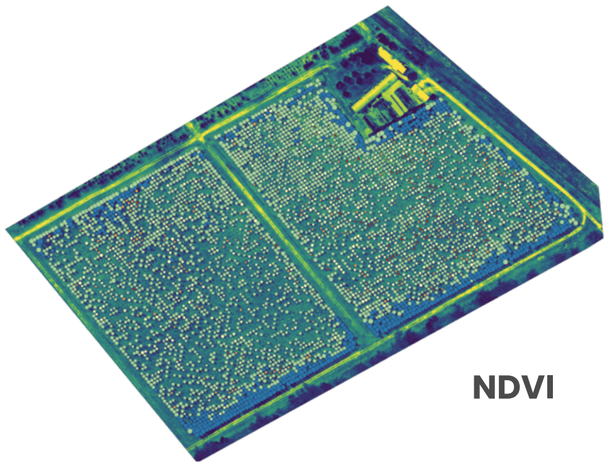
Capture a mix of different band combinations to learn about plant health - this is why some sensors will have different spectral bands depending on the use case

Maps

Maps with vegetation indexes like **NDVI and NDRE** aid in identifying weeds, disease, and more, allowing for the creation of drone flight paths for exact fertiliser and pesticide spraying.



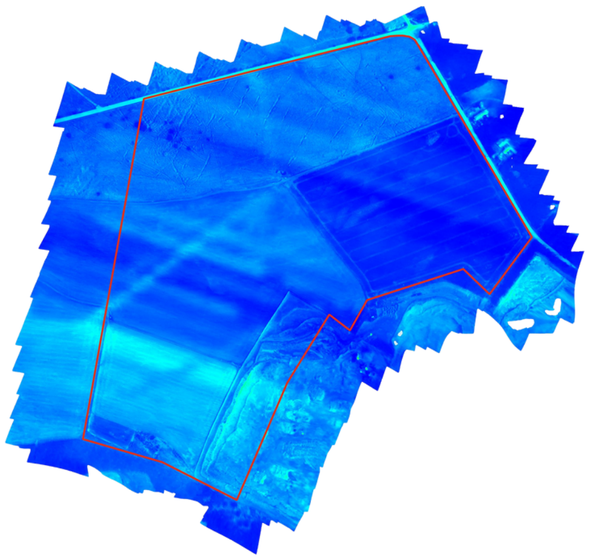
NDRE



NDVI

Archeology

Multispectral imagery helps uncover past human activities and settlements by detecting differences in vegetation growth and soil characteristics, which can indicate underlying structures or alterations in the landscape caused by historical human presence.



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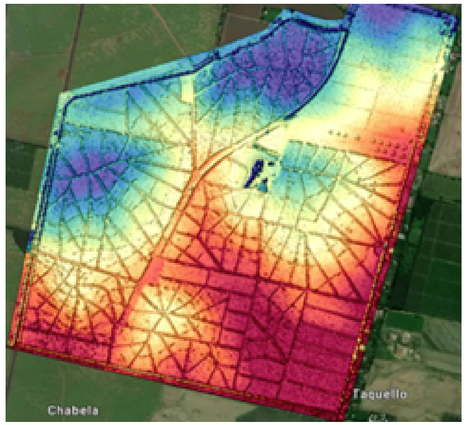
Map Types

*images from Wingtra

RGB (Visible light)

Records visible light that we can see too - this provides context to your multispectral data, helping you make descisions with clarity.



DSM (digital surface model)

Captures elevation changes in terrain, crop heights, and water flow patterns for management and planning.

False-colour band combinations

Combine different data from the spectrum using colours to show specific features, making complex information easier to understand.

Indexes

Indexes like NDVI, NDRE, OSAVI, Chlorophyll, Weeds, NIR, and CIR, reveal field issues by highlighting variations in factors like plant health and weeds.

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Vegetation Index Types

These index types show which spectral bands you use to create maps that you what you want to see, like the presence of weeds or stress.

Index	Insight	Use	Formula
NDVI	Shows chlorophyll content, revealing the greeness, density and health of plant	• Plant vigour • Yield potential • Nutrient content • Differences in soil water	(Nir-Red)/(Nir+Red)
NDRE	Indicates chlorophyll content in advanced crop growth, great for dense canopies.	• Leaf chlorophyll content • plant vigour • Stress • Nitrogen uptake • Fertiliser need	(Nir-RedEdge)/Nir+RedEdge)
OSAVI	Considers soil condition and chlorophyll content of crops in early growth stage	• See non-vegetated surfaces • Considers complex light interactions between soil and vegetation • Structural index in combined indices for chlorophyll detection	(Nir-Red)/(Nir+Red+0.16)
GNDVI	Uses green wave to calculate chlorophyll content, shown to be better than NDVI. Use for dense canopies and later development stages	• Nitrogen and water uptake in crops	(Nir-Green)/(Nir+Green)

Hardware

Drones equipped for multispectral imagery have become essential tools in precision agriculture, environmental monitoring, and resource management. Here's an introduction to the most popular and effective multispectral systems:

AgEagle Aerial Systems offers advanced multispectral imaging solutions, particularly through its MicaSense series, which includes sensors like the Altum-PT and RedEdge-P. These sensors are widely recognised for their capabilities in agriculture, environmental monitoring, forestry, land management, and research applications.

DJI offers advanced multispectral drone sensors designed for various applications, including precision agriculture and environmental monitoring. DJI has garnered a reputation as a leading drone manufacturer due to a combination of itss commitment to innovation, the quality and performance of its products, and its focus on customer satisfaction.

RedEdge-P™

The AgEagle RedEdge-P offers high-resolution RGB and multispectral imaging, covering five multispectral bands ((blue, green, red, red edge, and near-infrared). Equipped with a global shutter for distortion-free captures, RedEdge-P is designed for precision in data capture and supports a range of machine learning applications, such as plant counting.

- Plant counting
- Phenotyping
- Plant health mapping
- Fertiliser management
- Disease identification
- Species differentiation
- Crop scouting
- 3D point clouds

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Compatible with a wide range of drones through AgEagle Skyport, including DJI M350 and WingtraOne Gen II.

DJI MAVIC 3M

The DJI Mavic 3 Multispectral is a drone designed for precision agriculture and environmental monitoring. It features an RGB camera and four multispectral cameras capturing in the Green, Red, Red Edge, and Near Infrared bands, enabling detailed crop and environmental analysis. Equipped with an RTK module for precise positioning and a sunlight sensor for optimal image capture, it offers accurate and consistent data.

- Aerial surveying.
- DJI Terra / DJI SmartFarm Platform mapping.
- Generate 3D routes.
- Agricultural drone operation
- Intelligent field scouting
- Comes with RTK module

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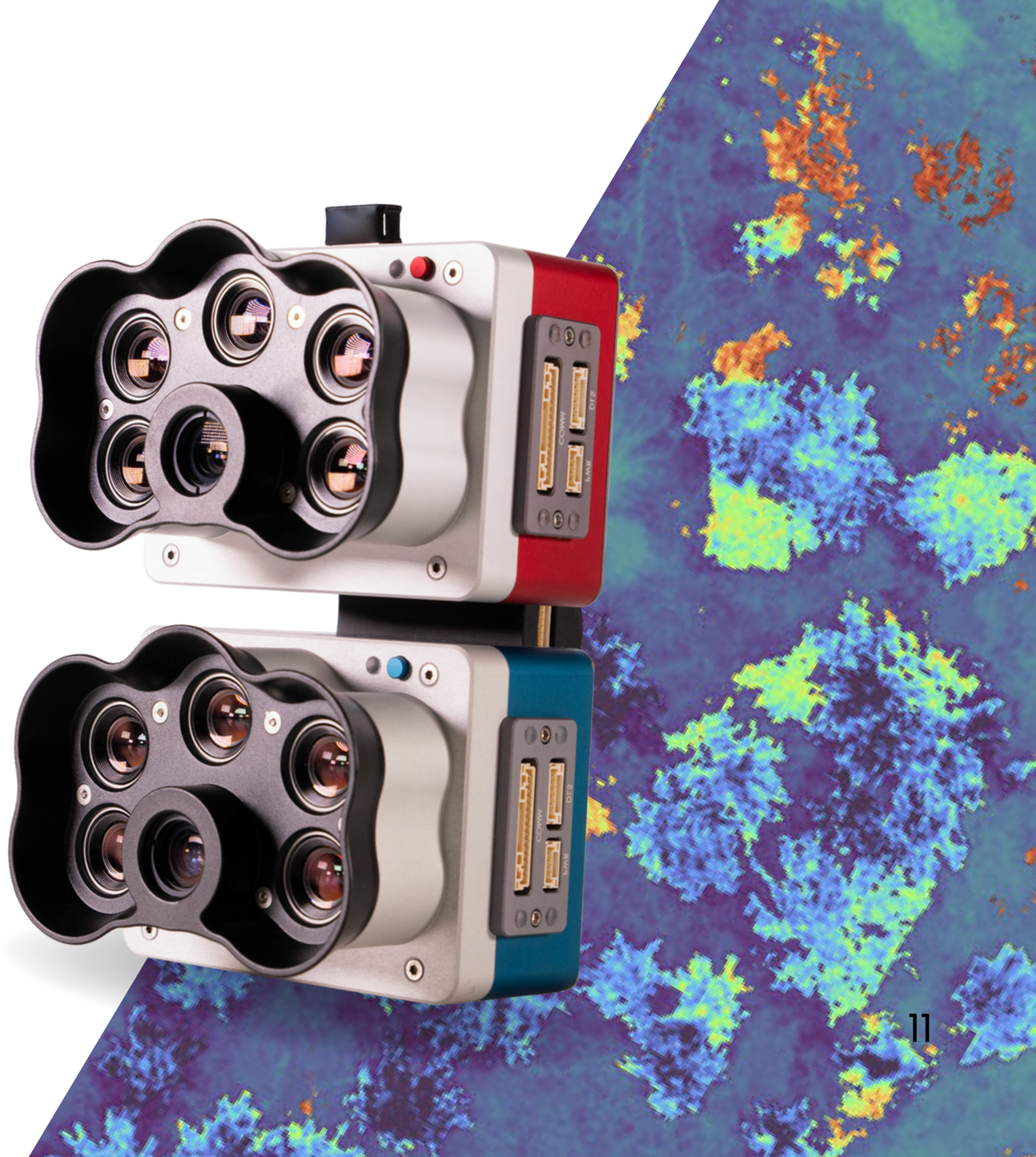
RedEdge-P™ *dual*

The AgEagle RedEdge-P dual provides ten spectral bands for enhanced data comparison with satellite imagery. These bands are carefully selected to align with the Landsat 8 and Sentinel-2 satellite bands. This kit includes both the RedEdge-P and the new RedEdge-P blue cameras, offering a unique coastal blue band for water vegetation analysis and weed identification in shallow water environments.

- Plant classification
- Weed identification
- Environmental research
- Conservation
- Vegetation analysis of water bodies
- RGB, NDVI, NDRE, OSAVI, NIT, CIR, DSM.



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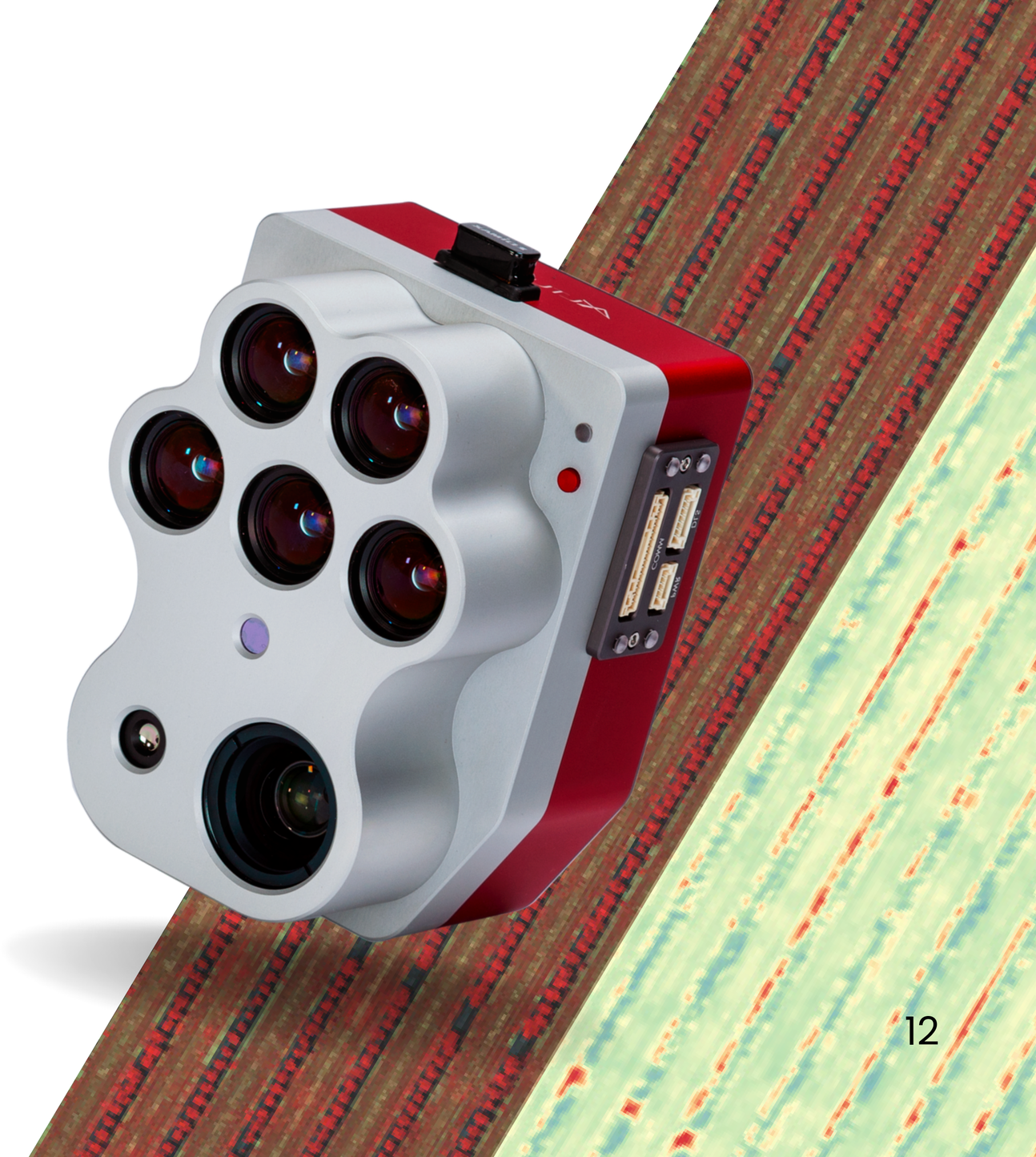
Compatible with a wide range of drones through AgEagle Skyport, including DJI M350 and WingtraOne Gen II.

ALTUM-PT™

The AgEagle Altum-PT sensor stands out for its high-resolution capabilities, combining thermal, multispectral, and RGB imagery. It's equipped with five multispectral bands (blue, green, red, red edge, and near-infrared) and a built-in thermal sensor. Altum-PT is designed for high accuracy and repeatability in data capture, supporting a variety of applications from crop counting to advanced vegetation research

- Irrigation scheduling
- Plant disease detection
- Plant phenotyping
- Fruit yield estimations
- Fruit maturity evaluation and bruise detection
- Water stress prediction
- Pressure issues and clogs detection in irrigation systems



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Compatible with a wide range of drones through AgEagle Skyport, including DJI M350 and WingtraOne Gen II.

Software

Multispectral imagery captured by drones needs to be processed to create the data for analysis. To do this, specialised software is required.

Pix4D is a Swiss company known for its advanced photogrammetry software, and has become a leader in drone mapping and 3D modelling software. Pix4D's software is known for its accuracy in converting images into georeferenced 2D maps and 3D models. It's used in a wide range of applications from agriculture (crop analysis, monitoring) to construction (site mapping, volume calculation), and environmental projects.

DJI offers advanced multispectral drone sensors designed for various applications, including precision agriculture and environmental monitoring. DJI has garnered a reputation as a leading drone manufacturer due to a combination of itss commitment to innovation, the quality and performance of its products, and its focus on customer satisfaction.

PIX4Dfields

15 Day FREE Trial

Agriculture mapping software for aerial crop analysis and digital farming.

- Create prescription maps
- Process your maps on-site
- Orthomosaics, elevation models, index maps, zones, and more

License Options:
Monthly Rental
Yearly Rental
Perpetual License

Compatible with all harware mentioned

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PIX4Dmapper

15 Day FREE Trial

Leading photogrammetry software for professional drone mapping that can interpret both RGB and multispectral imagery

- Photogrammetry
- Process your maps on-site
- 3D models
- Create accurate point clouds, DSMs and orthomosaics

License Options:

Monthly Rental
Yearly Rental
Perpetual License

Compatible with all harware mentioned

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DJI TERRA

15 Day FREE Trial

Capture, analyse and visualise your environment with this easy to use photogrammetry mapping software suitable for multispectral data.

- Photogrammetry
- Vegetation maps
- Prescription maps
- 2D & 3D models
- Mission planning

License Options:
Agriculture, 1 Year
(3 Devices)

Compatible with all harware mentioned

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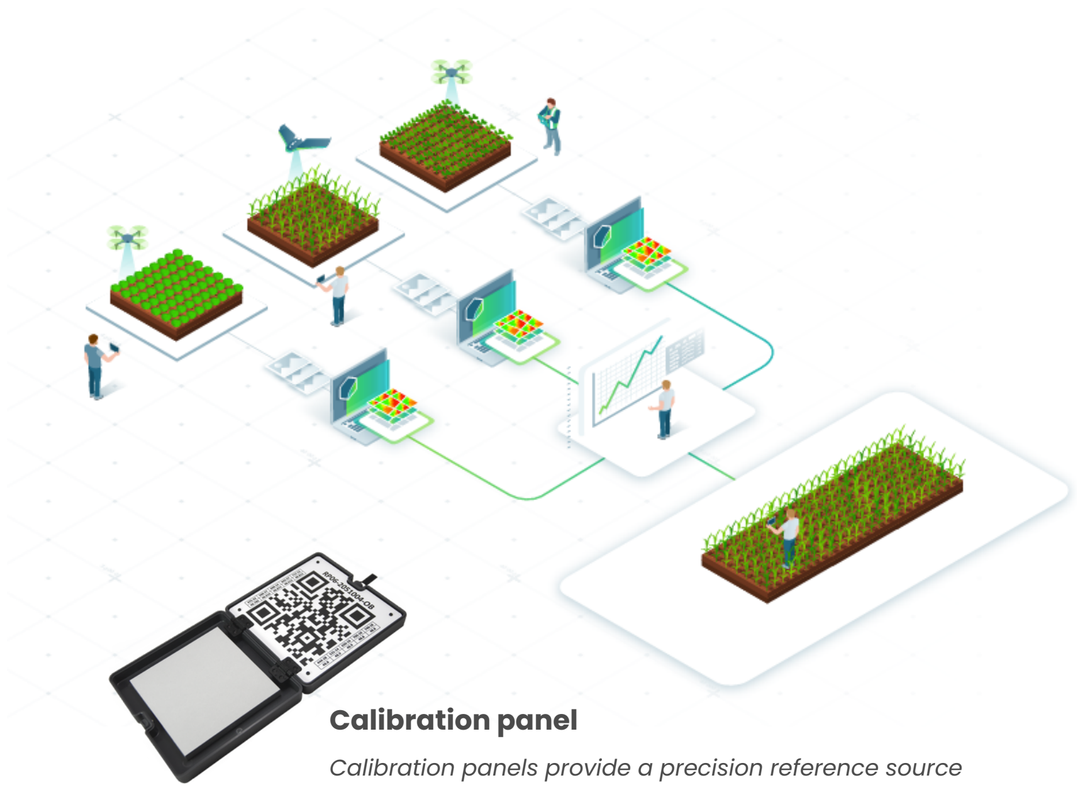
Start to Finish: Multispectral Drone Workflow



Calibration panel

Calibration panels provide a precision reference source for calibrating camera systems, ensuring accurate measurement and detection.

1. **Callibrate** your camera by turing on the drone and taking a picture of the callibration panel to capture the light conditions.
2. **Configure** the camera by connecting your device to the camera's Wi-Fi. It will then capture images at the programmed height and overlap.
3. **Plan** the mission in your given application and launch drone to complete autonomous flight.
4. **Process** the data anytime after you land using chosen software like DJI Terra, Pix4Dfields, Pix4Dmapper, or any other compatible choice.

*the pictures will be automatically georeferenced if your airframe has attached RTK or PPK (DJI M350 RTK, DJI M3M, WingtraOne Gen II, for example.)

- *The DJI Mavic 3M comes with a built-in sunlight sensor helps to calibrate the sensors in real time.*
- *Micasense sensors are radiometrically calibrated for data comparison with satellites.*

Uses of drones throughout the crop cycle

Multispectral imagery captured by drones needs to be processed to create the data for analysis. To do this, specialised software is required.

Planning Stage

When planning your crop planting, multispectral imagery can help strategise field utilisation to optimise efficiency.

Prescision Spraying

Using precision spraying methods based on prescription maps helps crops while minimising environmental pollution and local ecosystem harm.

Yield Estimations

How do you plan the yields of a crop? How can drones help estimate what your field will produce?

Crop Monitoring & Harvest

Monitor crops and fields with advanced techniques, measuring results beyond just visual inspection.

Crop Protection & Insurance

Drones quickly map fields for damage assessment, providing essential proof for insurance claims.

wingtra Use Case: Irrigation Management (Altum)

Problem

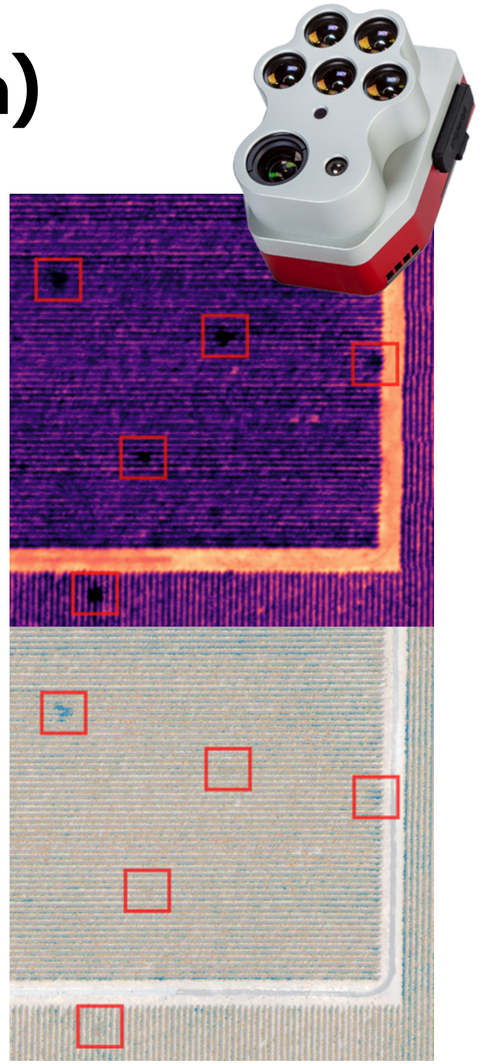
In vineyards, vines need to get stressed in order for them to produce better grapes. A water leakage can overwater causing the plants to produce more leaves and worse grapes. At the same time, higher water consumption costs more.

Solution

WingtraOne with a Micasense Altum camera can quickly detect broken pipes and determine which need to be fixed which will maximise yield and minimise input cost

Step by step

1.Acquire all aerial data in one flight
2. Process in Agisoft Metashape
3. Identify potential leakage location based on colder spots on thermal
4. Prioritise repair based on chlorophyll levels (NDRE), i.e. target which pipes have leaked longer



Camera: Altum AGL: 120m GSD: 5.2 cm / px multispectral Data deliverables: NDRE, thermal Area: 80 Ha

Use Case: Precision Agriculture (Mavic 3M)

Problem

Blackthorn Arable faced challenges in managing crop growth and controlling invasive weeds and pests. They struggled with uneven crop growth, with some areas lagging behind in growth while others were overgrowing. Additionally, they had issues with a high population of thistles, a type of weed, and the potential threat of wireworms, pests that can lead to complete crop failure.

Solution

The implementation of detailed drone insights enabled Blackthorn Arable to address these challenges effectively. By analysing drone imagery, such as the one titled “THISTLES”, they were able to identify zones with varying crop growth and weed infestation. This data allowed them to modify their crop inputs, like fertilisers, to balance the growth across different zones, promoting growth in underdeveloped areas and controlling overgrowth in flourishing ones.

wingtra Use Case: Eucalyptus Plant Counting (Altum)

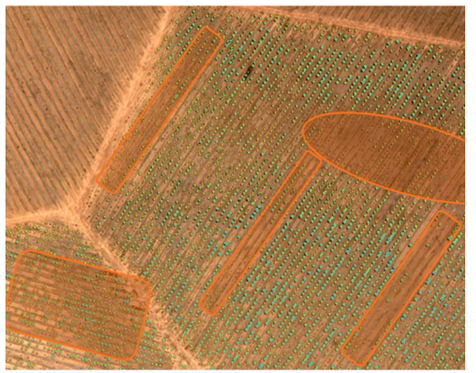
Problem

Replanting is crucial for maximising yield and minimising costs in cultivated areas, but it's challenging and time-consuming to plan accurately.

Solution

WingtraOne's multispectral data with Micasense Altum payload enables quick plantation overviews and effectively communicates the number of plants needing replantation, accurately quantifies replanting requirements, and assesses the need for additional tasks like ground movement or drainage.

Processed orthomosaics on GIS software to count plants



Areas and lines that need to be replanted

Step by step

1. Acquire all aerial data in one flight
2. Process in Pix4D
3. Work with the orthomosaics in GIS software to calculate NDVI for reliable automated plant counting algorithms
4. Identify problematic lines and areas by counting plants and determining their health
5. Calculate costs of replanting based on the information (NDVI) 6. Calculate if ground movement is needed.

Camera: Altum AGL: 250m GSD: 10 cm/px multispectral Data deliverables: NDVI, RGB Area: 530 Ha

wingtra Use Case: Bark Beetle - Forestry (Altum)

Problem

A multispectral map can identify trees stressed by bark beetle infestation before they become visibly detectable, helping to prevent the beetle's spread through the forest.

Solution

The WingtraOne, equipped with a Micasense Altum camera, identified problem areas and stressed trees. This data facilitated the calculation of stressed and dead tree percentages, problem analysis, and the development of preventive strategies.

Step by step

1. Acquire all aerial data in one flight
2. Process in Metashape or Pix4D
3. Identify anomalies
4. Detect canopy with problems
5. Decide which trees need insecticide or removal and calculate costs.

CIR map where the dark colours show dead and highly stressed trees. NDVI map shows in green the trees that are healthy

High Resolution RGB gives a photorealistically image to determine which trees need treatment

Camera: Altum AGL: 120m GSD: 5 cm/px multispectral Data deliverables: NDVI, NDRE, RGB Area: 150Ha

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