eoptis Sharper vision, better results.

Maia S2 and WV Multispectral Cameras Datasheet

The multispectral camera

Jointly developed with

SAL ENGINEERING

FONDAZIONE BRUNO KESSLER | CENTER FOR DIGITAL INDUSTRY

3DOM 3D OPTICAL METROLOGY

MAIA S2 and WV are the most advanced Multispectral Imaging Camera available today for civilian drones (UAVs), aircrafts and land vehicles.

The camera captures images in 9 VIS/NIR bands, ready for photogrammetric processing in precision farming and environmental monitoring applications.

The bands closely match those of Sentinel-2 and WorldView-2™ satellites, bridging the gap between low-resolution satellite and high-resolution UAV-based remote sensing data[1)].

The matched Incident Light Sensor (ILS) enables radiometric correction of the data, providing consistent results over time and under varying cloud conditions.

1) A.Revill et.al – Remote Sensing Journal – download the paper here

WorldView is a trademark of Maxar Technologies (formelly DigitalGlobe)

Key features

- 9 sensors at 1.2Mpix resolution with global shutter and 12 bits depth
- WorldView2- or Sentinel2-like satellite bands, covering the full VIS-NIR range
- Configuration and live image view over WiFi
- Plug-and-play for immediate use
- Factory lens distortion calibration
- Bundled scientific-grade image processing software
- A rich set of interfaces and full access to any camera setting for precise control
- Incident Light Sensor with matched bands for reflectance measurements with integrated GNSS

Main applications

Precision farming

- Vegetative index mapping
- Early detection of diseases
- Planning of water, pesticide and fertilizer supply
- Yield estimation

Industry

- Remote chemical imaging
- Industrial plant inspection
- Material sorting

Main applications

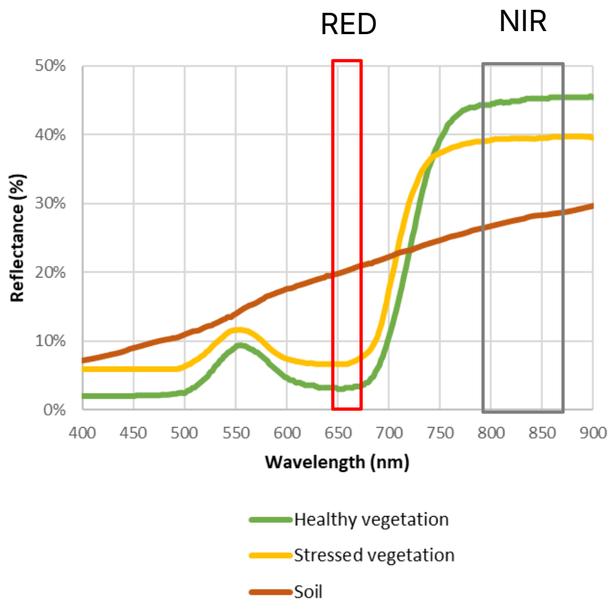
Environmental monitoring

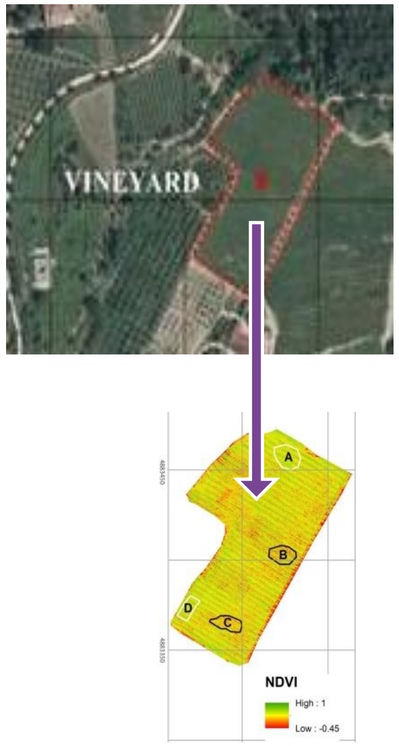
- Water resource monitoring
- Wildfire monitoring and post-fire assessment
- Soil erosion and land degradation
- Biomass mapping

Marine

- Shallow water bathymetry

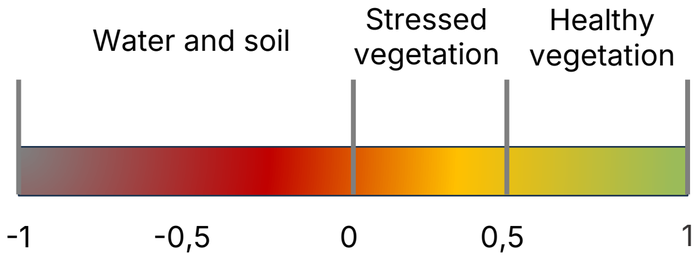
Application example: NDVI crop monitoring





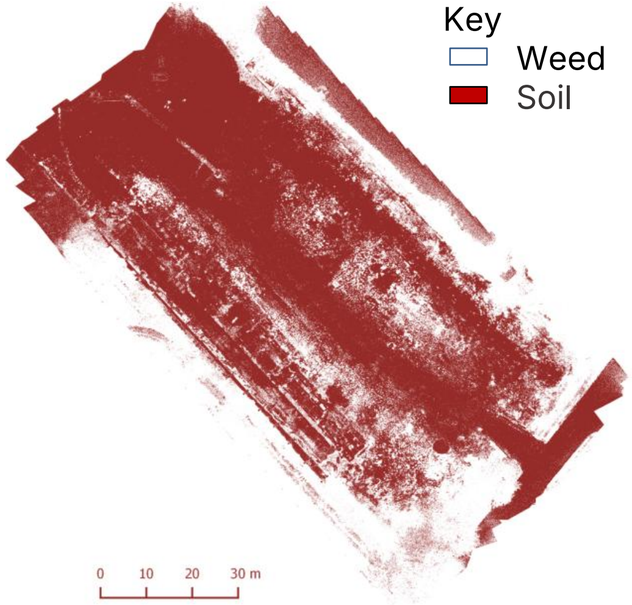
Normalized Difference Vegetation Index

NDVI is the most common vegetation index, effective in detecting live green plants or photosynthetic capacity. It also allows the identification of vegetated areas and the measurement of their health condition.



$$NDVI = \frac{NIR - RED}{NIR + RED}$$

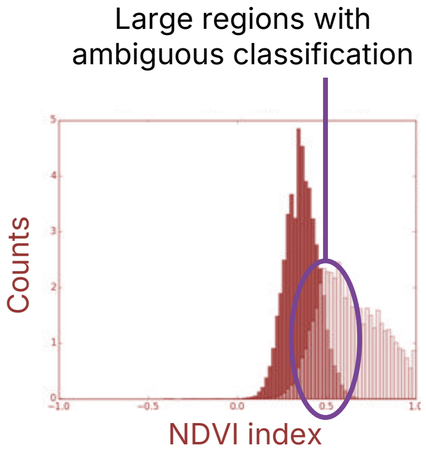
Application example: selective weeding



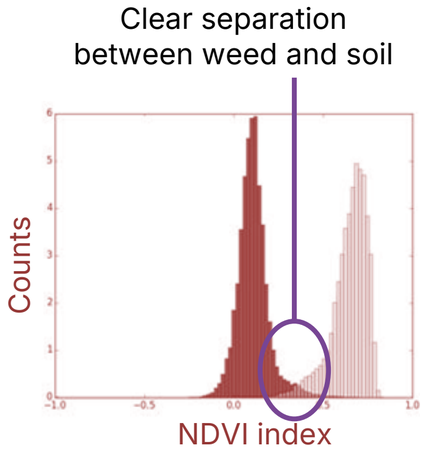
Map of a field affected by weed

Selective weeding

A cleaner environment also requires a drastic reduction of pesticide use. Smart spraying to selectively eradicate weed requires reliable data that the Maia camera can provide.



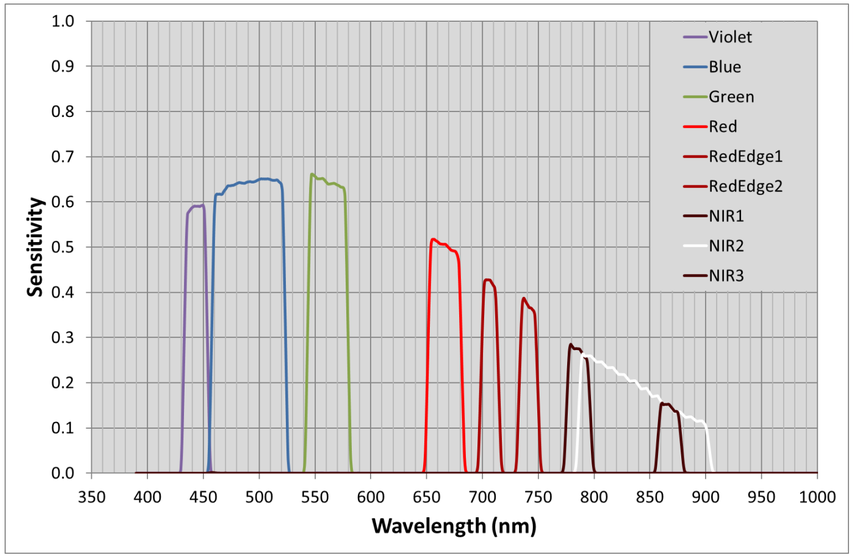
Other camera



Maia

Credits: M.Dubbini, L.Curzio – Universtity of Bologna

S2 spectral bands



Start	Stop	Center	Width	Region
433	453	443	20	Violet (Coastal)
458	523	490	65	Blue
525	575	560	35	Green
650	680	665	30	Red
698	713	705	15	Red Edge 1
733	748	740	15	Red Edge 2
773	793	783	20	NIR1
785	900	842	115	NIR2
855	875	865	20	NIR3

Units: nm
Data rounded to 1nm

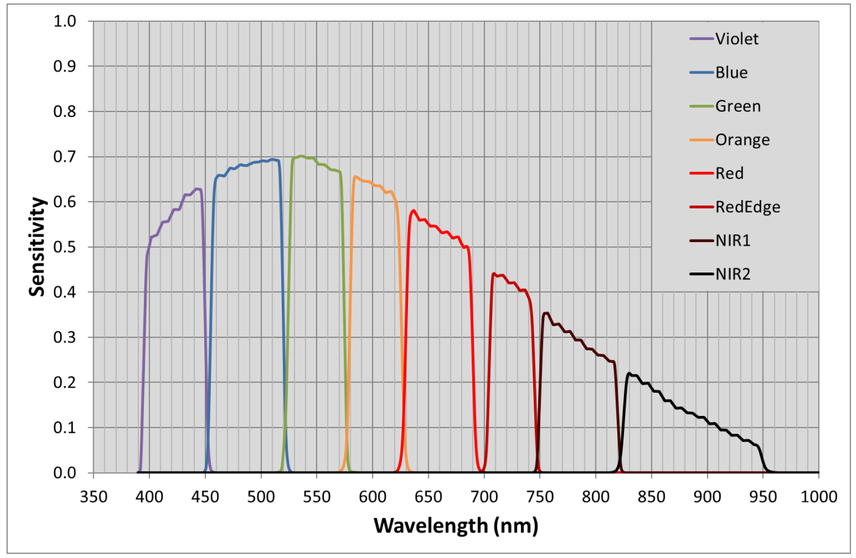
The 9 bands of MAIA S2 span the VIS/NIR spectrum, offering:

- All the bands offered by competitors.
- Additional extensive coverage of the blue/violet region.
- Dual red-edge and near-infrared region split in three bands for more detailed information.

The bands are very close to Sentinel2 satellite.

An RGB color image can be generated in post-processing.

WV spectral bands



Start	Stop	Center	Width	Region
395	450	423	55	Violet (Coastal)
455	520	488	65	Blue
525	575	550	50	Green
580	625	603	45	Orange
630	690	660	60	Red
705	745	725	40	Red Edge
750	820	785	70	NIR1
825	950	888	125	NIR2
-	-	-	-	Pachromatic

Units: nm
Data rounded to 1nm

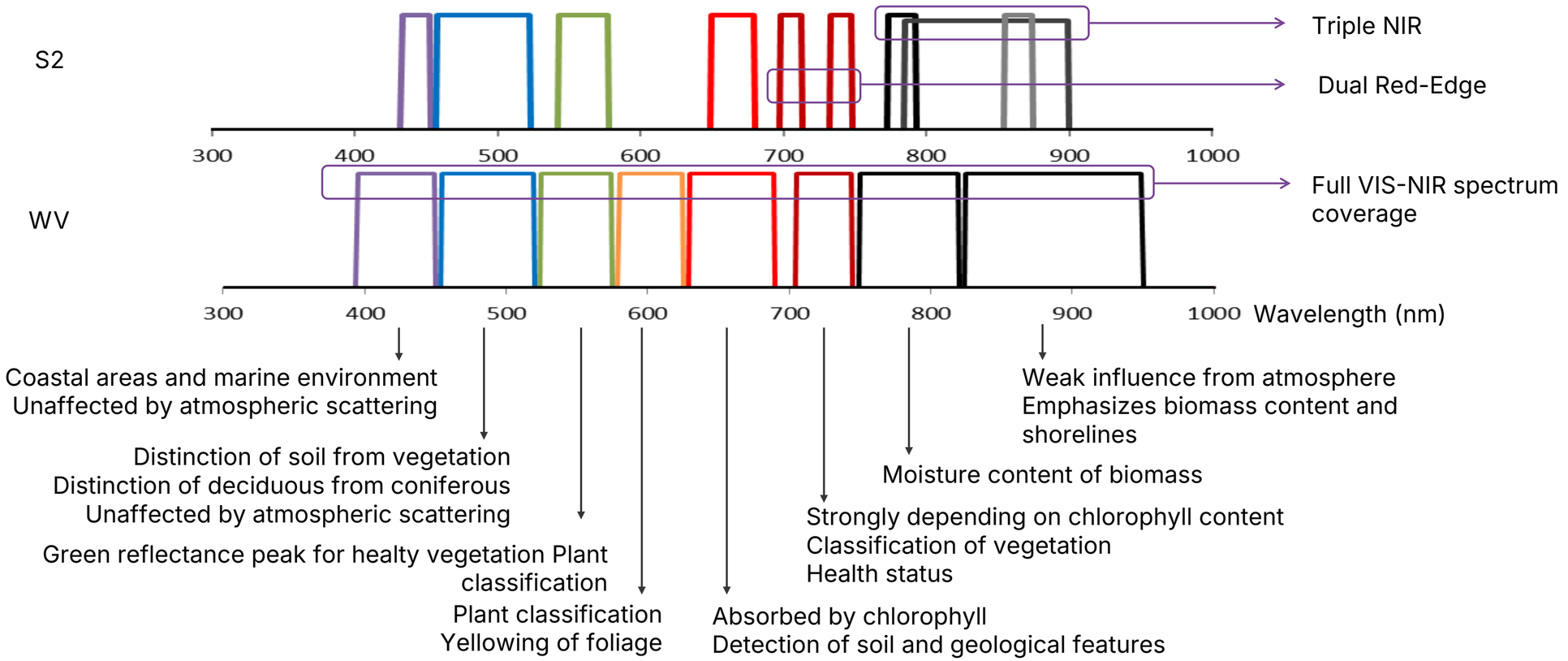
The 8 bands of MAIA WV span the full VIS/NIR spectrum, offering:

- All the bands offered by competitors.
- Additional extensive coverage of the blue/violet region.
- NIR region split in two bands for more detailed information.

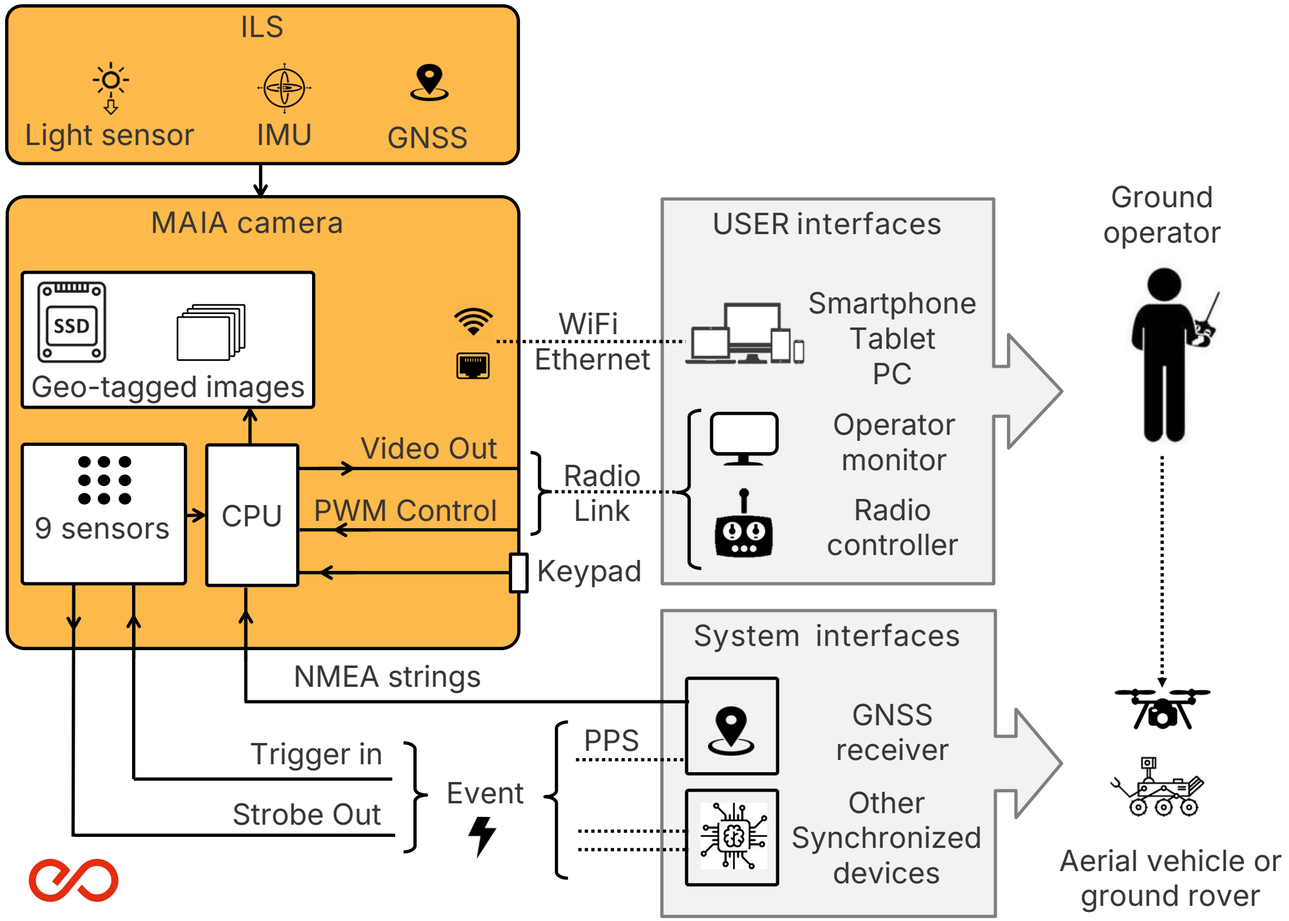
The bands are very close to WorldView2™ satellite.

In addition, a color image is available also live during capture.

Spectral bands features and applications



Camera integration



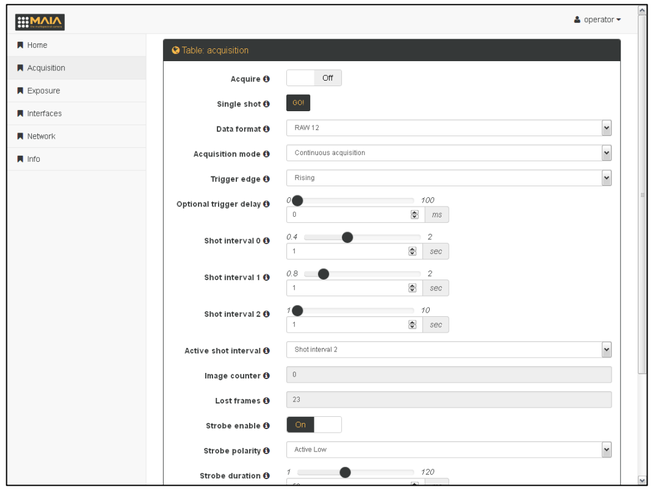
Flexible integration for every use scenario

The Maia camera features several interfaces for seamless integration with the vehicle and full operator control.

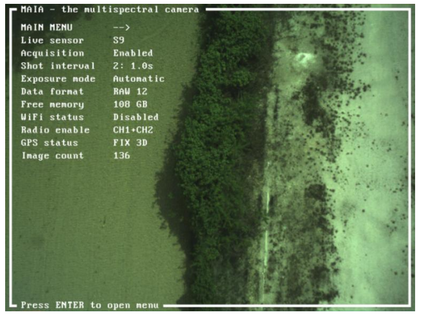
Multiple integration options are available to maximize the camera’s capabilities.

User interfaces

Web interface
Via WiFi before take-off



On-screen display
Via keypad before take-off
Via radio link during flight



Easy interaction before, during and after the survey

Connect to the camera web page with a smartphone or tablet to adjust all the system parameters before flight.

Use a Composite Video radio link with a monitor to display the image in real time and observe the survey's progression during flight.

Download and process the data after landing.

Additional harwdware is necessary.

Maia S2 and WV

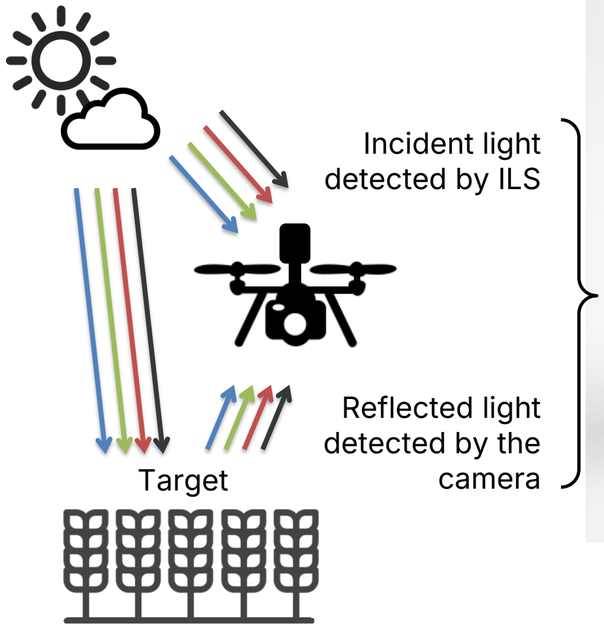
Hardware features

Key technical specifications	Features and benefits
9 sensors in two configurations: • 1 panchromatic (RGB) + 8 bands in the VIS-NIR range similar to the WorldView satellite. • 9 bands in the VIS-NIR range similar to the Sentinel-2 satellite.	An extensive band set covering the full spectrum including unique bands for environmental pollution detection, water supply planning and marine applications.
1.2Mpix CMOS sensor (1280 × 960) with global shutter. 8-10-12bits per pixel data depth and best-in-class sensitivity. Synchronous shot of all sensors up to 5fps.	Sharp and detailed images with no motion artifacts, even at fast UAV speed.
Factory-calibration for lens distortion of each band.	Data ready for scientific-grade data analysis and photogrammetric processing.
3cm ground sampling distance (GSD) with approx. 45×34m^2 field of view (FOV) at 75m flight altitude above ground.	Extremely detailed images with large area coverage for cost-effective data collection.
Full automatic or manual exposure mode, each sensor individually tunable.	Full control over exposure parameters for high-quality images.
Trigger input and strobe output sync signals.	Precise timing control of the image shot and sync of external devices.
250GB internal storage capability.	5 hours of acquisition at 8bits, 1fps / 1h at 3fps, 12bits.

Hardware features

Key technical specifications	Features and benefits
Built-in WiFi and GigE interface with web-based interface for configuration, live image view and access to stored data.	Wireless on-field access via smartphone, tablet or PC for image stream and configuration. Fast cable data download at home.
Input for external GPS serial port with NMEA strings detection.	Accurate geotagging of any image.
Remote controller input with event detection.	Easy control of key parameters during flight.
NTSC/PAL composite video output to stream live images of one band at choice via external radio link.	The operator can view live camera images.
Wide supply input (9-26VDC) and low power consumption (~7,5W).	Compatible with Li-Ion and Li-Po 3s to 6s battery packs, with limited impact on battery life. No external voltage converters are required.
Small size (99 × 128 × 46)mm^3. Lightweight (470g).	Fits fixed-wing and multi-rotor UAVs, with limited impact on other payloads.
Rugged design with no moving parts.	High reliability and long-term value.

Incident Light Sensor



Incident Light Sensor

The Incident Light Sensor (ILS) records the amount of the downwelling light for each spectral band. It enables radiometric correction of the data, ensuring accurate reflectance measurements and providing consistent results over time, even in case of light variations due to cloud coverage.

The ILS features an integrated GNSS receiver for precise image georeferencing. It is available with both standard-grade and centimeter-level accuracy, thanks to RTK technology. The ILS also embeds a pressure, temperature and humidity sensor (PTH) to have a complete overview of the environmental conditions during flight.

Image processing software

Calibration parameters of each lens and band are available on request if user wants to process raw images autonomously

MultiCam Pro

The camera comes with a Powerful image pre-processing software bundled. Designed by FBK's 3D Optical Metrology research unit - a group of leading experts in photogrammetry and remote sensing - it enables users without background in photogrammetry to generate scientific-grade data analyses.

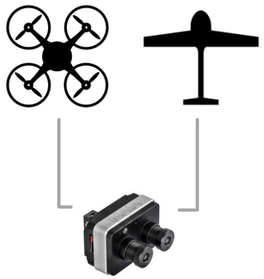
Raw data can be exported as-is in TIFF format if the user wants to process raw images with third-party software. The calibration parameters of each lens and band are available for this purpose.

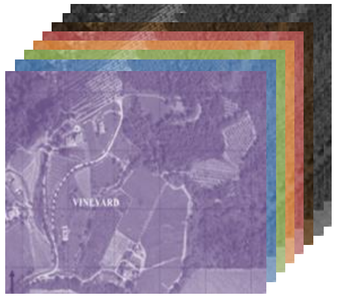
Software features

Key technical specifications	Features and benefits
Image undistortion and alignment (co-registration) with factory-calibration data and context-sensitive analysis.	Perfect overlapping of the multi-bands images, with sub-pixel accuracy and undistorted images.
2-modes of absolute radiometric correction for the bands: automatic or with reflectance target. Automatic relative radiometric correction (vignetting and black level compensation).	Accurate reflectance values for quantitative analysis.
Index computation and false-color image generation using standard indexes included in the bundled library (NDVI, GNDVI, SAVI, ...) and custom indexes defined by user.	Ready-to-use data for widespread analysis and flexibility to explore new application-specific indexes.
Preview of raw images and false-color index images.	Relevant information is immediately available.
Flow-driven user interface with full control of parameters and automatic processing option.	Processing is accessible to users without a background in photogrammetry as well as to experts who need scientific-grade analysis.
Algorithms optimized for the fast processing of very large datasets.	Data from surveys of large areas quickly available to user, even on-site!
Multi-layer and multi-band TIFF standard export formats.	Seamless integration with third-party environmental and photogrammetric processing software is possible.

Image processing flow

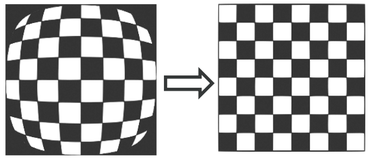
Survey of the area of interest





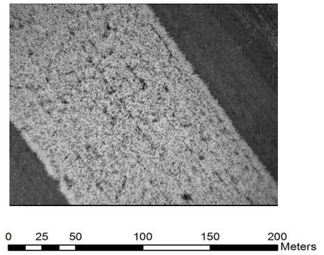
Captured images are multi-layer raw data.

Image undistortion and alignement (co-registration)



Thanks to factory-calibration lens parameters and parameters extracted from the images, the lens distortion is removed and each band of a multispectral capture is aligned with the others, resulting in multi-layer images with pixel-to-pixel matching features.

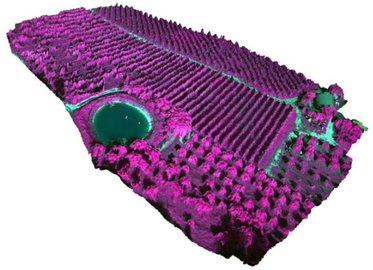
Radiometric correction

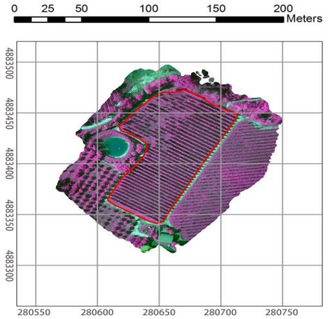


Images are radiometrically corrected to remove the effects of lens vignetting. By means of the capture of a reflectance panel, digital numbers proportional to the light hitting the target are converted into reflectance values of the target itself.

Image processing flow

Generation of georeferenced orthophotos and 3D models

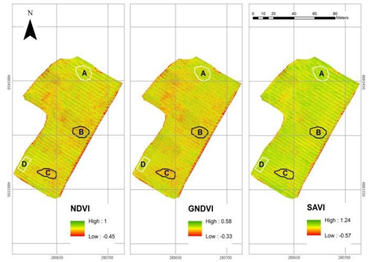




The captured images in the collected dataset can be stitched together to generate the orthophoto and the 3D model of the entire area.

This is an optional step that requires third-party software.

Computation of relevant indexes

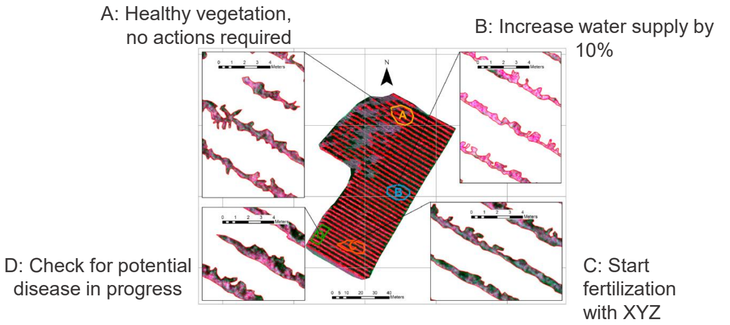


NDVI GNDVI
SAVI

A library of widely used indexes is embedded into the software and a generator of custom indexes is available. The acquired data are turned into a false color image that clearly highlights the features of interest.

NOTE: Computable indices depend on the actual bands configuration.

Analysis and actions



The result is analysed with the help of an application specialist (agronomist, geologist...) and the consequent actions to be taken are planned.

Technical specifications of the camera

Field	Value
Sensor	1.2Mpixel (1280×960) with global shutter
Pixel pitch	3.75µm
Sensitivity range	VIS-NIR: 390 nm to 950 nm
Lens	Fixed focus
Focal length	7.5 mm (nominal)
Aperture	f/#2.8
FOV	35° Horizontal 26° Vertical 43° Diagonal
Exposure mode	Manual Automatic Automatic with maximum exposure time limit
Exposure start	Simultaneous for all sensor
Exposure time	0.1 ms to 50 ms
Capture mode	Single shot Continuous with external trigger Continuous at fixed-time interval

Field	Value
Max. frame rate	3 frames/second with 10-bit and 12-bit RAW; 5 frames/second with 8-bit RAW
File format	8-bit RAW 10-bit RAW 12-bit RAW
Storage	Internal SSD with 210 GB net available image storage
Image size	11.8MB (for WV) / 10.7MB (for S2) in 8-bit 21.2MB in 12 bit
Image storage capaciy	~18000 (for WV) / ~20000 (for S2) in 8-bit ~10000 in 12 bit
Metadata	• Exposure time of each sensor • Timestamp at the shot time • Time, position, speed, GNSS fix status
Configuration	• Web interface via Ethernet or Wifi • Composite Video output with on-screen text + keyboard • PWM radio link input

Technical specifications of the camera

Field	
Interfaces	• Gigabit Ethernet • WiFi in Hot Spot by DHCP server • UART Serial for GNSS (3.3V LTTL – 5V tolerant) • Sync input – Trigger (5V CMOS) • Sync output – Strobe (5V CMOS) • Composite Video-output (NTSC/PAL) • Two-channel PWM input from radio link (5V CMOS) • 3 LEDs for events and status • 1 LED in sync with image exposure • Keyboard with eight function buttons
Size	99mm (W) x 129mm (H) x 47mm (D)
Weight	470g
Mount	4x M3×0.5 holes
Power supply	9-26VDC
Power consumption	~7.5W typ / 800mA at 9V (2A peak) Excluding power consumption of the ILS
Operating conditions	0°C to 40°C; 32°F to 104°F 20%-80%; non-condensing relative humidity

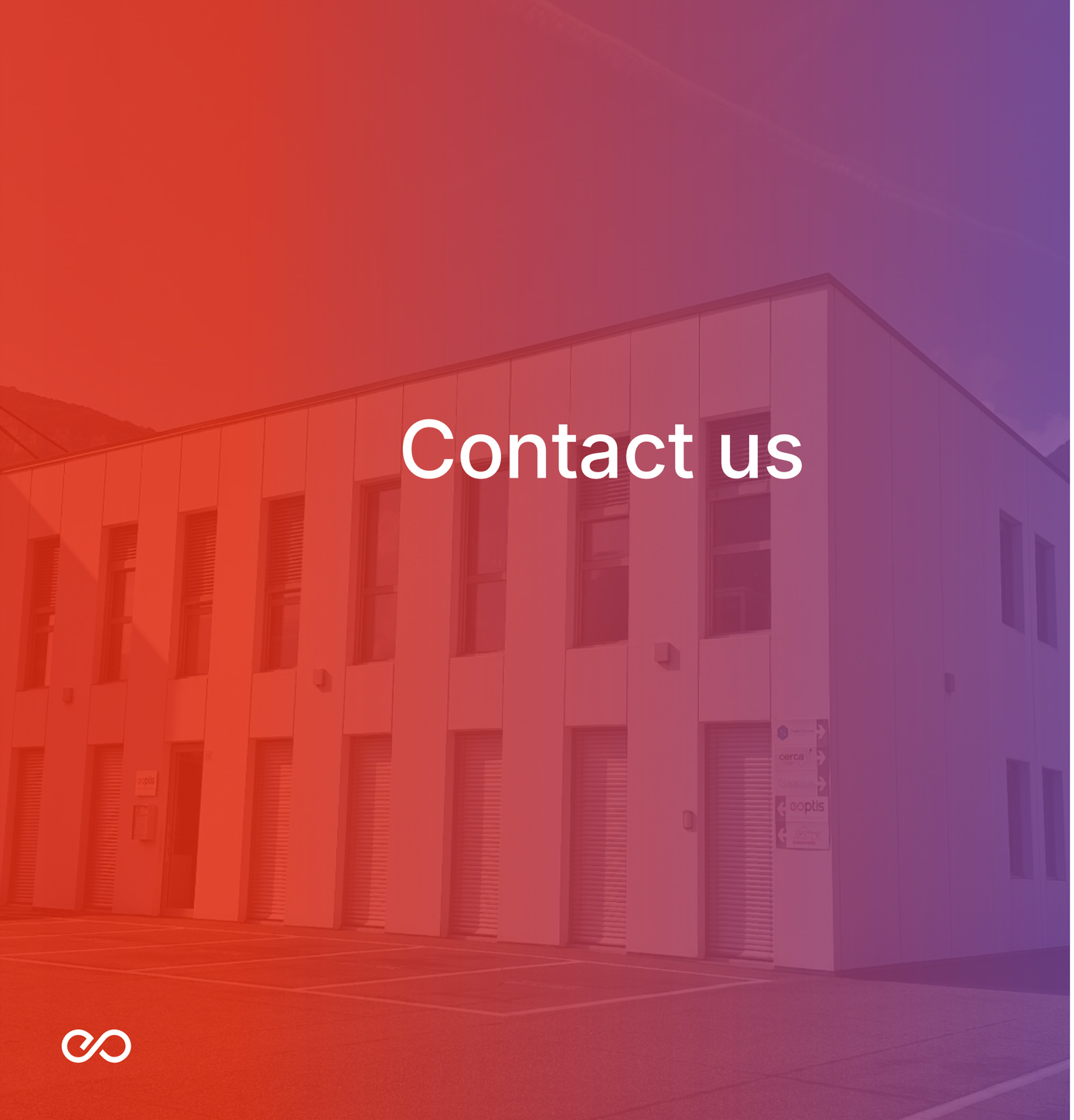
Field	Value
Image processing software features	• TIFF multi-layer extraction • Image distortion correction • Pixel-by-pixel alignment (co-registration) • Relative radiometric correction (vignetting, black level) • Absolute radiometric correction (ILS-based, manual, auto, white panel) • Index images creation (NDVI, GNDVI, SAVI, NDRE…) • Raster calculator • False-color images creation • Multichannel images creation • Monochromatic images creation • Preview of raw dataset • Crop TIFF multi-layer images • Exposure time export

Technical specifications of the ILS

Field	
Light sensor	• True cosine correction of incident light • Light level measured for each band of the MAIA camera, with matched spectra • Accurate irradiance measurement
GNSS receiver	• Standard precision receiver or high precision RTK • Concurrent reception of up to 2 GNSS (GPS, Galileo) • Navigation sensitivity of -165dBm • Better and faster positioning, supporting all satellite augmentation systems • Integrated passive antenna • SMA connector supporting active or passive external antenna
Gyroscope	±250°/s full-scale-range 0.1°/s resolution
Accelerometer	±4g full-scale-range pitch and roll angles with 0.1° resolution
Temperature sensor	0-60°C range ±1°C accuracy (*)

Field	Value
Pressure sensor	800-1100mbar range ±1mbar accuracy
Humidity sensor	0-100%RH range ±5%RH accuracy
Size	70mm (W) x 70mm (H) x 40mm (D)
Weight	160g
Mount	4x M3×0.5 holes
Power supply	4.5-9VDC with direct supply by the MAIA camera
Power consumption	~2.5W typ. / 450 mA at 5 V (700 mA peak)
Operating conditions	0°C to 40°C; 32°F to 104°F 20%-80%; non-condensing relative humidity

(*) The sensor measures the temperature inside the ILS case, which is, in general, higher than the ambient temperature due to several external factors, including the heating caused by the solar radiation and the power dissipation.



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