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Maia M2 Multispectral Camera Datasheet

The multispectral camera

Jointly developed with

SAL ENGINEERING

CENTER FOR DIGITAL INDUSTRY
FONDAZIONE BRUNO KESSLER
3DOM 3D OPTICAL METROLOGY

MAIA M2 is a low-cost modular Multispectral Imaging Camera for civilian drones (UAVs), aircrafts and land vehicles.

The camera captures images in 2 VIS/NIR bands, ready for photogrammetric processing in precision farming and environmental monitoring applications.

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

The camera can be scaled up at any time to build compact arrays of up to 3 cameras, allowing for the computation of a large set of the most well-known multispectral indices.

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

WorldView is a trademark of Maxar Technologies (formelly DigitalGlobe)

Key features

- 2 sensors at 1.2Mpix resolution with global shutter and 8 or 12 bits depth
- Several configurations available, based on the WolrdView2- or Sentinel2-like satellite bands, covering the full VIS-NIR range
- Designed to be arranged in arrays of up to 3 cameras to increase the detectable indices
- Plug-and-play for immediate use
- Weighing 59g only, it fits low-payload drones
- Factory lens distortion calibration
- Bundled scientific-grade image processing software

Main applications

Precision farming

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

Industry

- Remote chemical imaging
- Industrial plant inspection
- Material sorting

Main applications

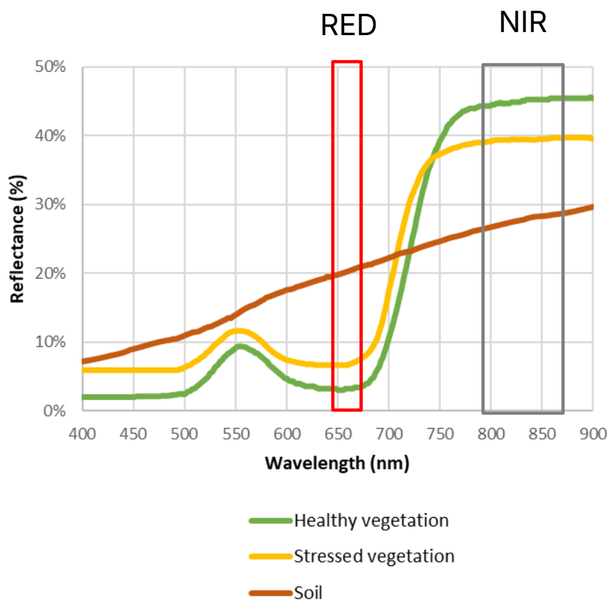
Environmental monitoring

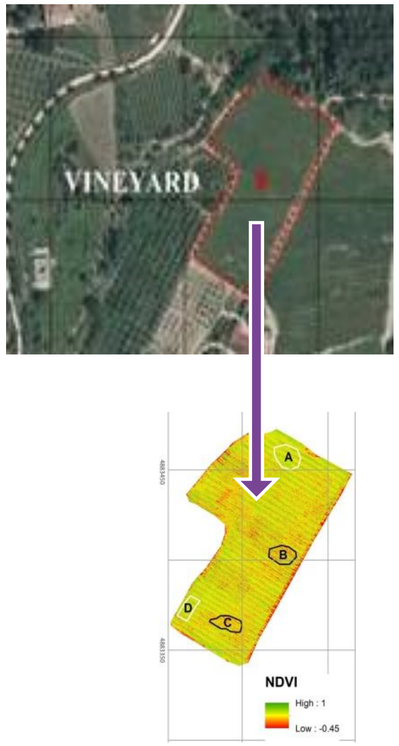
- Water resource monitoring
- Wildfire monitoring and post-fire assessment
- Soil erosion and land degradation
- Biomass mapping

Marine

- Shallow water bathymetry

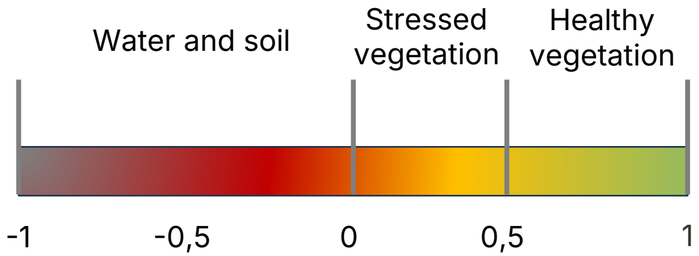
Application example: NDVI crop monitoring





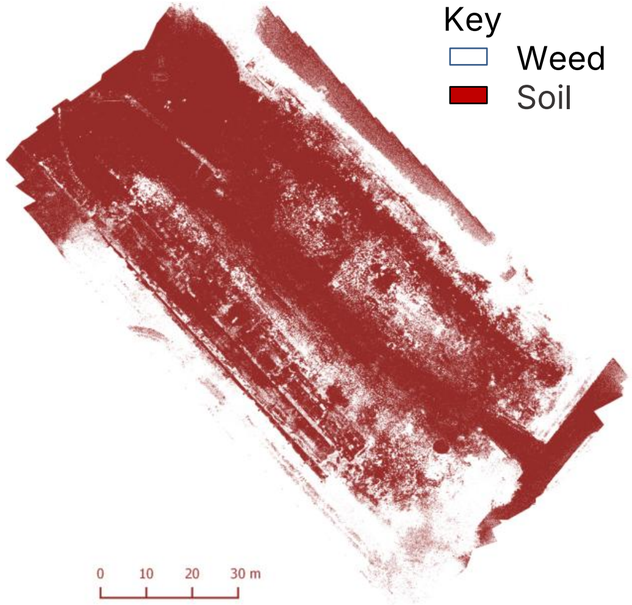
Normalized Difference Vegetation Index

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 their health condition.



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

Application example: selective weeding

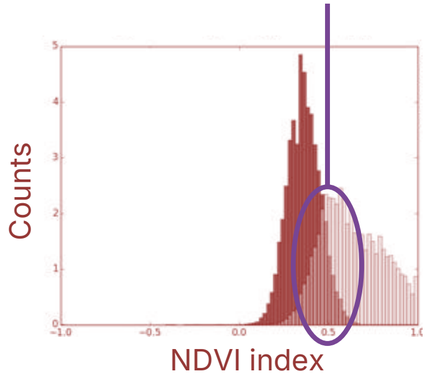


Map of a field affected by weed

Selective weeding

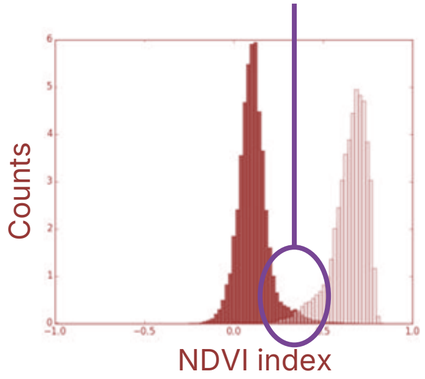
A cleaner environment also requires a drastic reduction of pesticide use. Smart spraying to selectively eradicate weed requires reliable data that the Maia camera can provide.

Large regions with ambiguous classification



Other camera

Clear separation between weed and soil

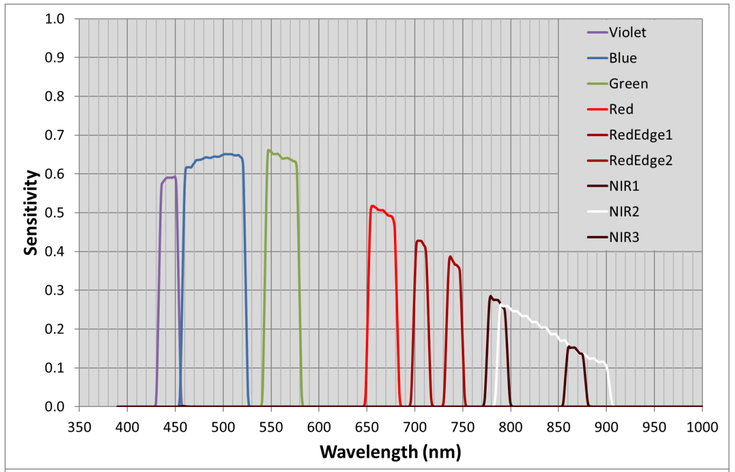


Maia

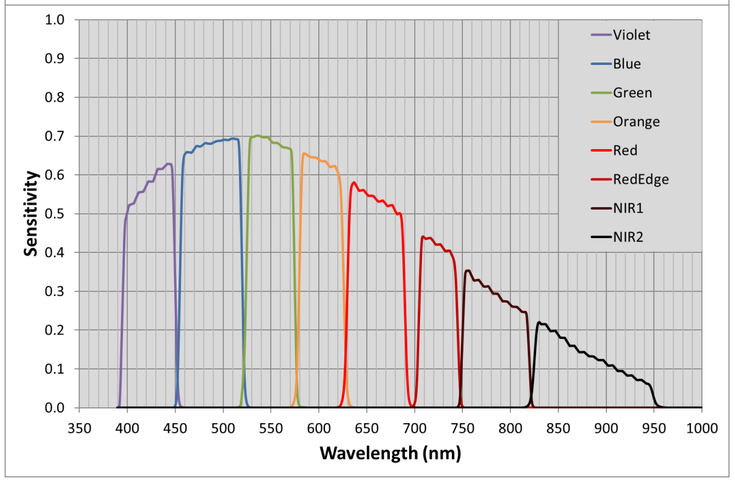
Credits: M.Dubbini, L.Curzio – Universtity of Bologna

Spectral bands portfolio

Sentinel2



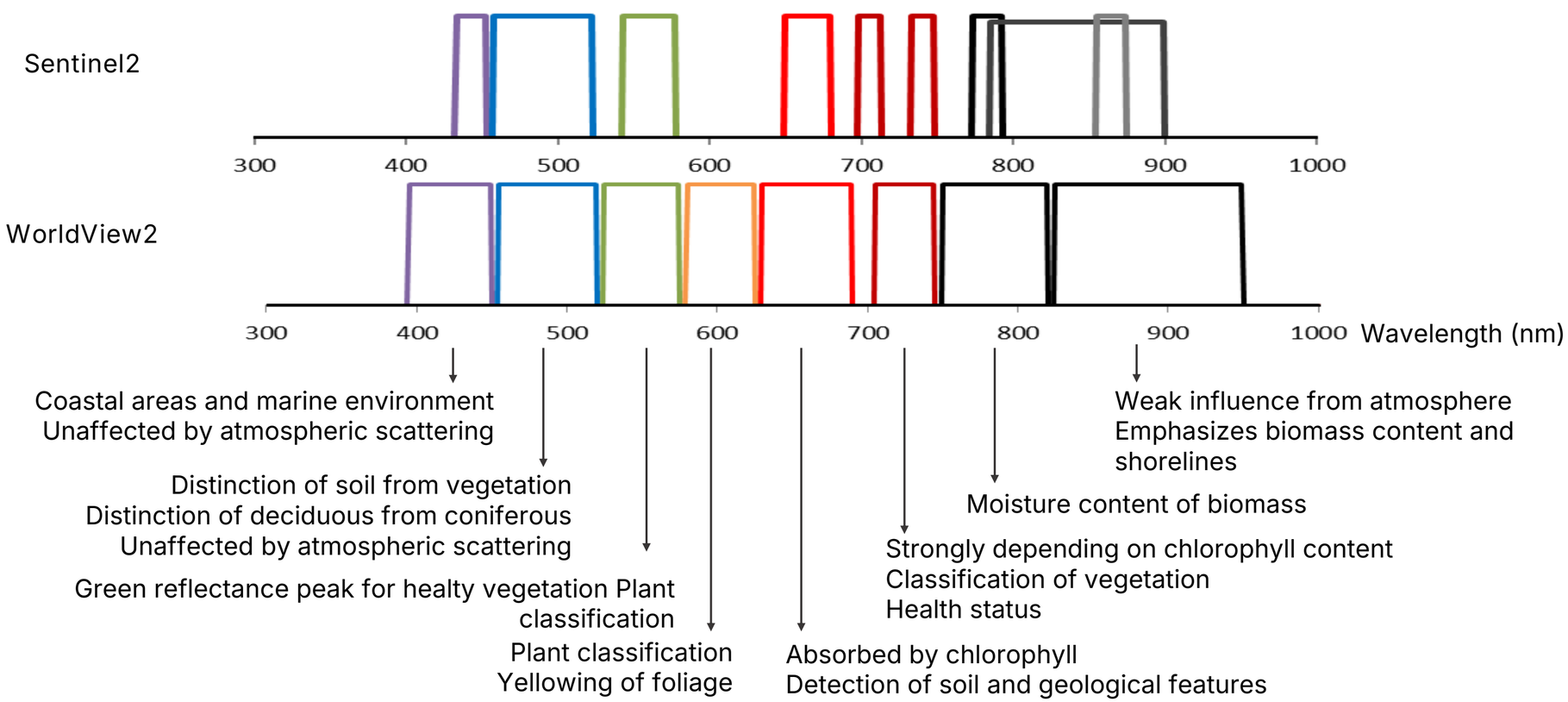
WorldView2



	Band	Start	Stop	Center	Width	Region	Satellite
	B1	395	450	423	55	Violet (coastal)	WorldView2
	B2	433	453	443	20	Narrow Violet (coastal)	Sentinel2
	B3	455	520	488	65	Blue	WorldView2
	B4	458	523	490	65	S2 Blue	Sentinel2
	B5	525	575	550	50	Green	WorldView2
	B6	54	577.5	560	35	Narrow Green	Sentinel2
	B7	580	625	603	45	Yellow	WorldView2
	B8	630	690	660	60	Red	WorldView2
	B9	650	680	665	30	Narrow Red	Sentinel2
	B10	698	713	705	15	High RedEdge	Sentinel2
	B11	705	745	725	40	RedEdge	WorldView2
	B12	733	748	740	15	Low RedEdge	Sentinel2
	B13	773	793	783	20	High Narrow NIR	Sentinel2
	B14	750	820	785	70	High NIR	WorldView2
	B15	785	900	842	115	Wide NIR	Sentinel2
	B16	855	875	865	20	Low Narrow NIR	Sentinel2
	B17	825	950	887.5	125	Low NIR	WorldView2
	PAN	-	-	-	-	Panchromatic	

Units: nm
Data rounded to 1nm

Spectral bands features and applications



Available models

Version	Bands			Main index		Other computable indices
V01		B1	B5	PPR	Plant Pigment Ratio	CTR6
V02		B1	B8	NPCI	Normalized Pigment Chlorophyll Index	IO, CTR1, LIC2, SRPI
V03		B1	B11	WV-BI	Worldview Built-Up Index	WV-NHFD
V04		B1	B15	BWDRVI	Blue-Wide Dynamic Range Vegetation Index	WV-VI
V05		B3	B5	PRI	Photochemical Reflectance Index	BGI, CRI1
V06		B3	B8	BRI	Blue Red Pigment Index	IOR
V07		B3	B11	CRI2	Carotenoid Reflectance Index 2	
V08		B3	B15	BNDVI	Blue Normalized Difference Vegetation Index	PSSRC1, PSSRC2, PSNDC1
V09		B5	B8	PVR	Photosynthetic Vigour Ratio	NGRDI, DSWI-4, GI
V10		B5	B11	ARI	Anthocyanin Reflectance Index	
V11		B5	B15	GNDVI	Green Normalized Difference Vegetation Index	PBI, GOSAVI, GSAVI, RARS, GRVI, GCI
V12		B7	B15	CTR3	Simple Ratio Carter 3	
V13		B8	B11	NDVIRE	Normalized Difference Vegetation Index Red Edge	FR, FR2, CTR4
V14		B8	B15	NDVI	Normalized Difference Vegetation Index	RDVI, TDVI, WDVI, WDRVI
V15		B11	B15	NDRE	Normalized Difference Red Edge Index	NDCHL, RRI
V16		PAN	B15	NDVI, GNDVI, BNDVI, SAVI	Indices with broad-band Red/Green/Blue bands Ready-to-use Color image	

Many models, covering almost any application

16 models of the M2 cameras are available, each optimized for the computation of specific indices.

Other custom models can be made by drawing on the bands' portfolio. Minimum orderable quantities apply.

Array built on a combination of models

2-camera array	Bands			Main indices	Other computable indices
V05 V14		B3 B8	B15 B5	NDVI, GNDVI, BNDVI Narrow-band color image	PRI, PVR, BRI, BGI, CRI1, IOR, PSSRC1, PSSRC2, PSNDC1, NGRDI, DSWI-4, GI, PBI, GOSAVI, GSAVI, RARS, GRVI, GCI, RDVI, TDVI, WDVI, WDRVI
V10 V14		B5 B8	B11 B15	NDVI, GNDVI, NDRE	PVR, ARI, NDVIRedEdge, NGRDI, DSWI-4, GI, PBI, GOSAVI, GSAVI, RARS, GRVI, GCI, FR, FR2, CTR4, RDVI, TDVI, WDVI, WDRVI, NDCHL, RRI

3-camera array	Bands			Main indices	Other computable indices
V01 V06 V15		B1 B3 B11	B5 B8 B15	NDVI, GNDVI, BNDVI, NDRE, PPR, PRI, BRI, ARI, CRI2 Narrow-band colour image	NDVIRE, WV-BI, PVR, NPCI, BWDRVI, CTR6, IO, CTR1, LIC2, SRPI, WV-NHFD, WV-VI, BGI, CRI1, IOR, PSSRC1, PSSRC2, PSNDC1, NGRDI, DSWI-4, GI, PBI, GOSAVI, GSAVI, RARS, GRVI, GCI, FR, FR2, CTR4, RDVI, TDVI, WDVI, WDRVI, NDCHL, RRI

Multiple cameras can be merged to increase detectable indices.

The camera is designed to be arranged in an array, allowing for computation of a larger set of indices and expanding the possible applications.

Some combinations of 2 and 3 cameras are shown here.

Maia M2

Hardware features

Key technical specifications	Features and benefits
2 sensors in two configurations: • 1 panchromatic (RGB) + 1 bands in the VIS-NIR range. • 2 bands in the VIS-NIR range.	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 exposure mode, adjustable on 3 levels.	Images always correctly exposed.
Trigger input (PPS) and strobe output sync signals.	Precise timing control of the image shot and sync of external devices.
Removable Micro-SD up to 32GB storage.	Acquisition lasts 3+ hours at 8bits, 1fps. Memory card is easily replaced once full.

Hardware features

Key technical specifications	Features and benefits
USB interface for data download without SD removal.	Easy field operations.
Wide supply input (5-9VDC) and low power consumption (~7,5W).	Compatible with USB and Li-Ion and Li-Po 2s battery packs, with limited impact on battery life. No external voltage converters are required.
Small size (49 × 34 × 46)mm^3. Lightweight (59g).	Fits fixed-wing and multi-rotor UAVs, even those with minimal payload capacity.
Rugged design with no moving parts.	High reliability and long-term value.

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.

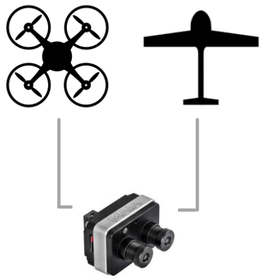
Raw data can be exported as-is in TIFF format if the user wants to process raw images with third-party software. The calibration parameters of each lens and band are available for this purpose.

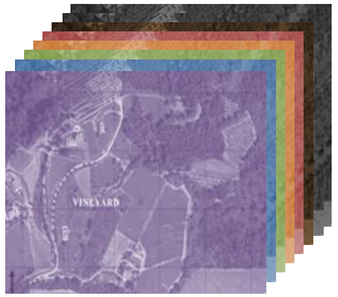
Software features

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

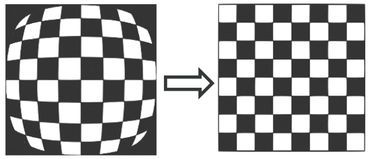
Survey of the area of interest





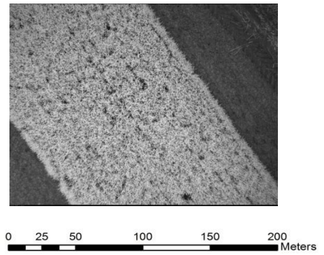
Captured images are multi-layer raw data.

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.

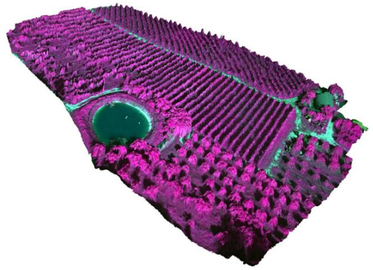
Radiometric correction

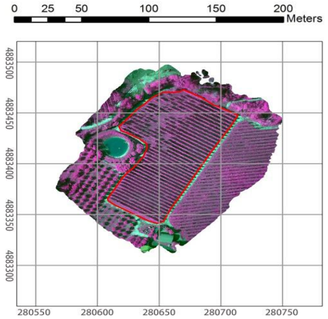


Images are radiometrically corrected to remove the effects of lens vignetting. By means of the capture of a reflectance panel, digital numbers proportional to the light hitting the target are converted into reflectance values of the target itself.

Image processing flow

Generation of georeferenced orthophotos and 3D models

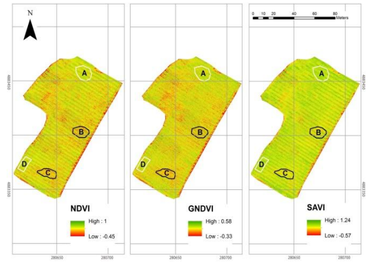




The captured images in the collected dataset can be stitched together to generate the orthophoto and the 3D model of the entire area.

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

Computation of relevant indexes

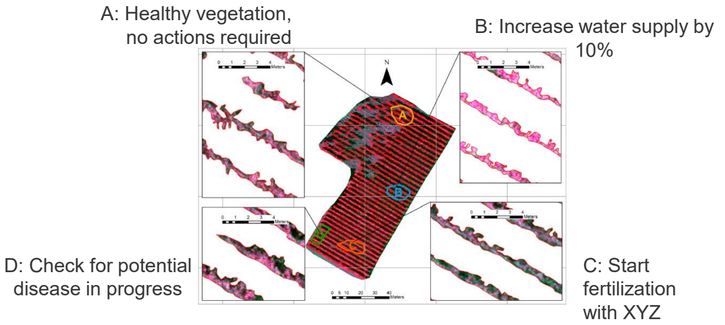


NDVI GNDVI
SAVI

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 band 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

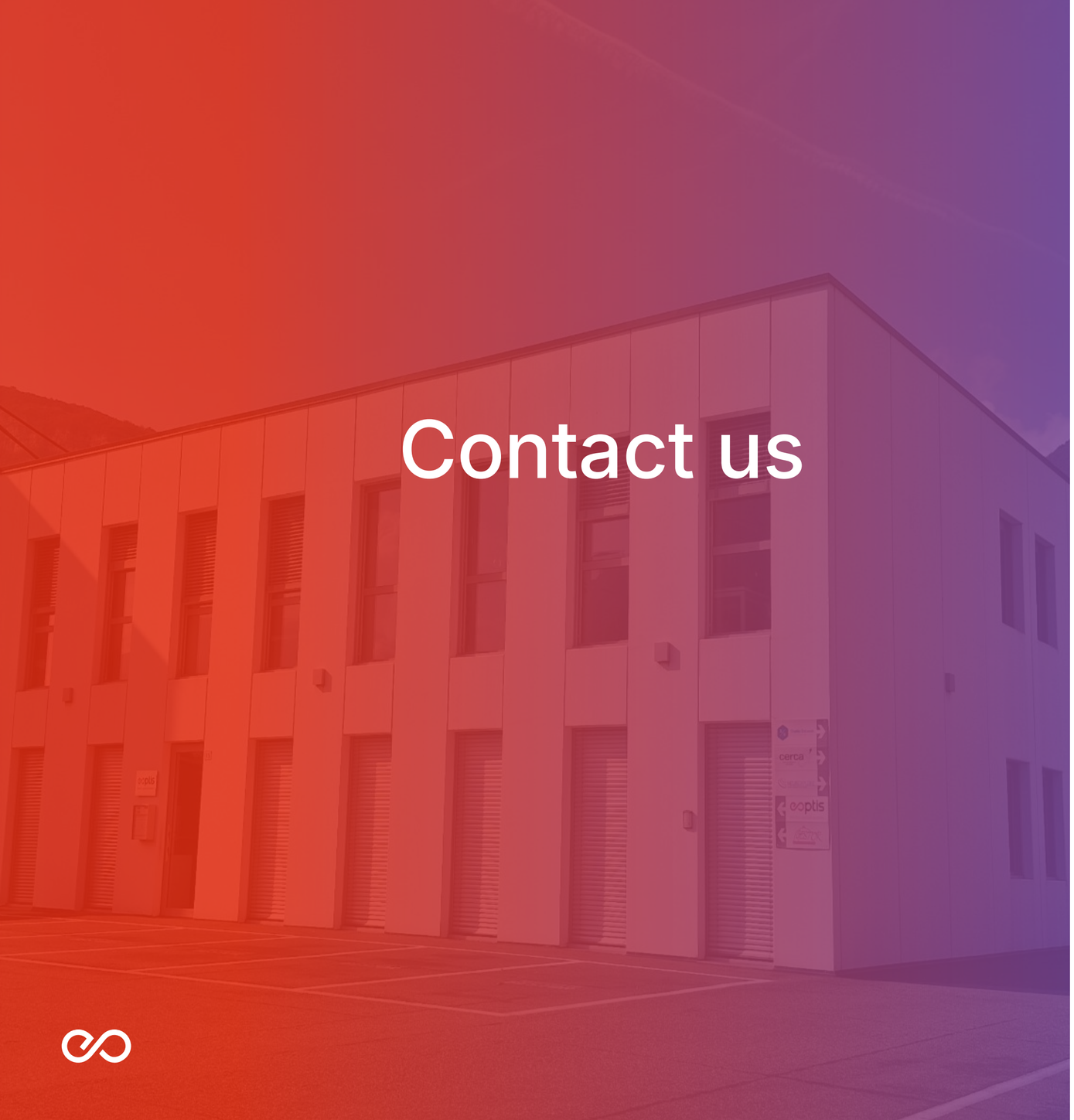
Field	Value
Sensor	1.2Mpixel (1280×960) with global shutter
Pixel pitch	3.75μm
Sensitivity range	VIS-NIR: 390 nm to 950 nm
Lens	Fixed focus
Focal length	8 mm (nominal)
Aperture	f/#2
FOV	36° Horizontal 27° Vertical 44° Diagonal
Exposure mode	Automatic with 3-step adjustable exposure target
Exposure start	Simultaneous for all sensor
Capture mode	Single shot Continuous with external trigger (up to 1 fps) Continuous at fixed-time intervals (at 1 fps)

Field	Value
Max. frame rate	1 frames/second with 8-, 10- and 12-bit RAW;
File format	8-bit RAW 12-bit RAW
Storage	Micro-SD class 10 U3 up to 32GB
Image size	2.5MB in 8-bit 4.8MB in 12 bit
Image storage capaciy	Up to ~12.000 images, corresponding to more than 3h of operations
Interfaces	• USB2.0 interface for data download • Trigger input and Strobe output sync signals • Key switch or digital input pin to start/stop the acquisition • Key switch to set image bit depth and brightness • Serial port for advanced control

Technical specifications of the camera

Field	
Size	49mm (W) x 34mm (H) x 23mm (D) body only Depth ~46mm including lens and connector
Weight	59g
Mount	2x M3×0.5 holes
Power supply	5-9VDC
Power consumption	~2.5W typ / 500mA at 5V (1A peak)
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 undistortion • Pixel-by-pixel alignement • Relative radiometric correction (vignetting, black level) • Absolute radiometric correction (manual, auto, white) • 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



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better results.