Specification

Multispectral Drone Camera for Agriculture

MSDC-AGRI-1-A

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Background Information

Trademarks

Spectral Devices Inc., MSC2,MS2-AGRI-1-A, MSDC-AGRI-1-A

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1. Description

The multispectral drone camera is a turnkey multispectral imaging solution for easy integration into drones with PixHawk flight controllers enabling capture of geotagged aerial images for further analysis in data mapping software.

Each MSDC-AGRI-1-A includes a snapshot multispectral camera (MSC2-AGRI-1-A), a lens, a vision computer, and a high-performance 3-axis gimbal (optional). System is compatible with common drone platforms. The system is energy-efficient, lightweight, and comes fully configured with camera control and image capture software. Images can be saved to SD card at up to 10 FPS. Start and stop buttons control image capture on demand. A live multispectral video feed is available for downlink.

The MSC2 RGB-NIR multispectral camera incorporates a high performance 4MP CMOS sensor that is modified with Spectral Devices proprietary multispectral filter array technology.

This miniature multispectral snapshot camera simultaneously captures images at 4 distinct bands (spaced between 580 nm and 820 nm) at 178 frames per second in full frame mode. There is no requirement for additional filters, filter wheels, or tunable filters.

2. Key Features

- Snapshot Operation (capture spectral images simultaneously)
- Captures 4 Bands (580, 660, 735, 820 nm)
- Anti-X-Talk™ Technology (enhances contrast and spectral performance)
- High Frame Rate (up to 178 FPS)
- High Performance (4MP Global Shutter 1-inch CMOS Sensor)
- Lens Mount C-mount
- Interface USB3.0
- Camera weight 55 g, computer weight 140 g, gimbal weight 465 g
- Real-time HDMI output of multispectral images
- Power: 5V/4A input
- Input Voltage UBEX 14 – 52 V
- Input Voltage Gimbal 12V / 5A
- Connection USB, CAN, UART, HDMI
- Pan Range +/- 330 degrees
- Tilt Range -45 degree / +135 degree
- Roll Range -90 degree / +45 degree

3. Applications

The camera is suitable for remote sensing in agriculture. The 580 nm band is known as chlorophyll reflectance peak in the visible light spectrum. The Red, Red Edge and NIR bands can

be used to assess plant health, detect diseases early, and optimize crop yields using such metrics as Normalized Difference Vegetation Index (NDVI) and Normalized Difference Red Edge Index (NDRE). Table 3.1. lists example metrics that can be used for multispectral analysis using MSC2-AGRI-1-A.

Combined with Spectral Devices SBC-1 miniature vision computer, the MSC2-AGRI-1-A offers an easy-to-use lightweight and modular imaging solution for UAV users.

Table 3.1. Example metrics for multispectral analysis using MSC2-AGRI-1-A camera

METRIC	FULL NAME	BANDS	EQUATION	INTERPRETATION
NDRE	Normalized Difference Red Edge Index	NIR, Red Edge	$NDRE = (NIR - RedEdge) / (NIR + RedEdge)$	Range from -1 to +1. A higher NDRE indicates greater plant health, reflecting denser and greener vegetation. This is crucial for assessing crop vitality and identifying areas needing attention. This metric performs better in crops at late stages of growth.
EVI	Enhanced Vegetation Index	NIR, Red, Blue	$EVI = G*((NIR - Red) / (NIR + C_1*Red - C_2*Blue + L))$, where C_1 and C_2 are coefficients for atmospheric resistance, L - value to adjust for canopy background	Range from -1 to +1. Higher EVI values generally indicate healthier and more vigorous vegetation, while negative values may indicate non-vegetated surfaces or water bodies. This metric corrects for atmospheric conditions and canopy background noise. Compared to previously listed metrics it is more sensitive in areas with dense vegetation and to canopy structural variations such as leaf size and canopy type.
MSAVI2	Modified Soil Adjusted Vegetation Index	NIR, Red	$MSAVI2 = (2*NIR+1-SQRT((2 NIR+1)-8(NIR- Red))$	Ranges from -1 to +1. Higher MSAVI values generally indicate healthier and more vigorous vegetation, while negative values may indicate non-vegetated surfaces or soil. Used when a lot of soil is present, in early crop development stages.

Figure 3.1 shows example images obtained with MSC2-AGRI-1-A. The camera produces 4 greyscale co-registered images corresponding to 580, 660, 735 and 800 nm bands. The red (660 nm) and NIR (800nm) bands are shown in Fig.3.1a and b, respectively. Healthy vegetation is known to reflect more NIR light compared to other spectral bands. For example, the Normalized

Difference Vegetation Index (NDVI) (Fig.3c) can be used to assess plant health. Higher NDVI indicates greater plant health (between values of 0-1), reflected by the higher chlorophyll content in the vegetation. Low NDVI values (0 - -1) indicate presence of water, rocks or man made objects.

(a) Red image	(b) NIR	(c) NDVI
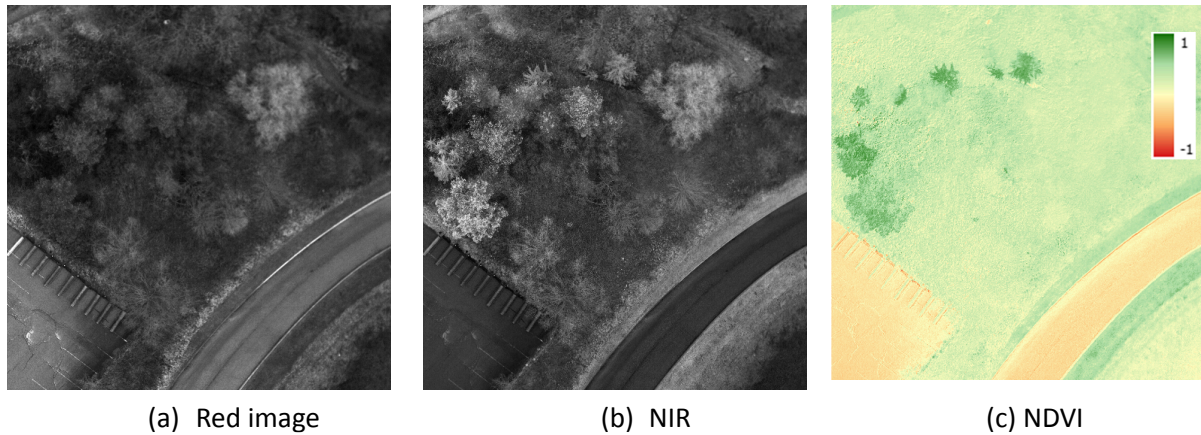
Figure 3.1. Example of images obtained with MSC2-AGRI-1-A camera. (a) Red band image, (b) NIR band image, (c) Normalized Difference Vegetation Index (NDVI) calculated as NDVI = (NIR - Red) / (NIR + Red).

4. Sensor and its Spectral Characteristics

The MSC2-AGRI-1-A camera has 4 distinct bands centered at 580, 660, 735, 820 nm (FWHM ~70 nm). The sensor of the camera is covered with a multispectral filter array providing each sensor element (pixel) its own spectral response (Fig.4.1a). Spectral response of the MSC2-AGRI-1-A camera sensor is displayed in Fig.4.1b.

(a)	(b)
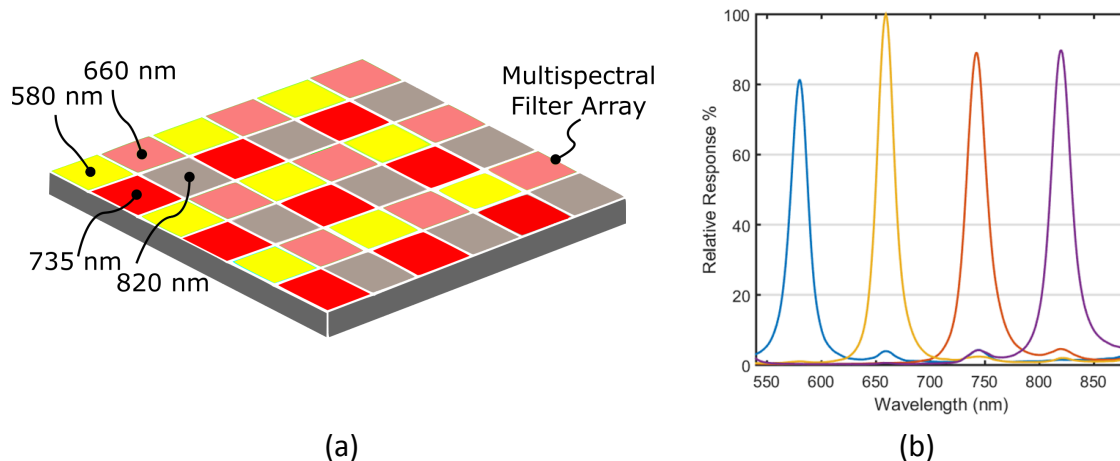
Figure 4.1. (a) Example of MSC2-AGRI-1-A multispectral filter array structure (note: band arrangement can vary between cameras) (b) Spectral response of the MSC2-AGRI-1-A camera.

5. Anti-X-Talk™ Technology

Anti-X-Talk™ technology is an unique Spectral Devices Inc. on-chip technology working at the filter level and preventing light leakage between individual filters. Without Anti-X-Talk™ technology, stray light between spectral channels is significant, often exceeding the light leakage due to spectral overlap between adjacent filters. As a result images suffer from low contrast and spectral ambiguity.

Spectral Devices invented Anti-X-Talk™ technology to overcome these problems. It works by blocking stray light between adjacent filters, making the pixel response more predictable and directly related to the actual spectral response of the overlying pixelated filter. The result is multispectral images with better spectral discrimination and higher contrast.

Furthermore, high quality image data from the MSC2-AGRI-1-A can be used as is without the need for proprietary post-processing algorithms and the camera can be used with a wide range of lens types even at large apertures (e.g. f/2).

6. Specifications

Lens Mount	C-mount
Sensor Type	CMOS
Sensor Model	AMS CMV4000
Sensor Format	1-inch
Number of Spectral Channels	4
Image Pixels Per Spectral Channel	512 x 512 (1024 x 1024 after debayering)
Effective Pixel Size (H x V)	5.5 µm x 5.5 µm
Capture Method	Area
Spectral Channels	450, 550, 650, 800 nm
Spectral Bandwidth (FWHM)	~70 nm
On-chip Spectral Enhancement	Anti-X-Talk™ Technology
Shutter Type	Global
Exposure time	22 µs to 16.77 seconds (Default: 11,116.0 µs)
Auto Exposure	Supported
Interface	USB3.0
Weight	Camera 55g, computer 140g, gimbal 465g, total 660g
Power	5V/4A input
Input Voltage	UBEX 14 – 52 V, Gimbal 12V / 5A
Connection	USB, CAN, UART, HDMI
Pan Range	+/- 330 degrees
Tilt Range	-45 degree / +135 degree
Roll Range	-90 degree / +45 degree

7. Camera Mechanical Drawings
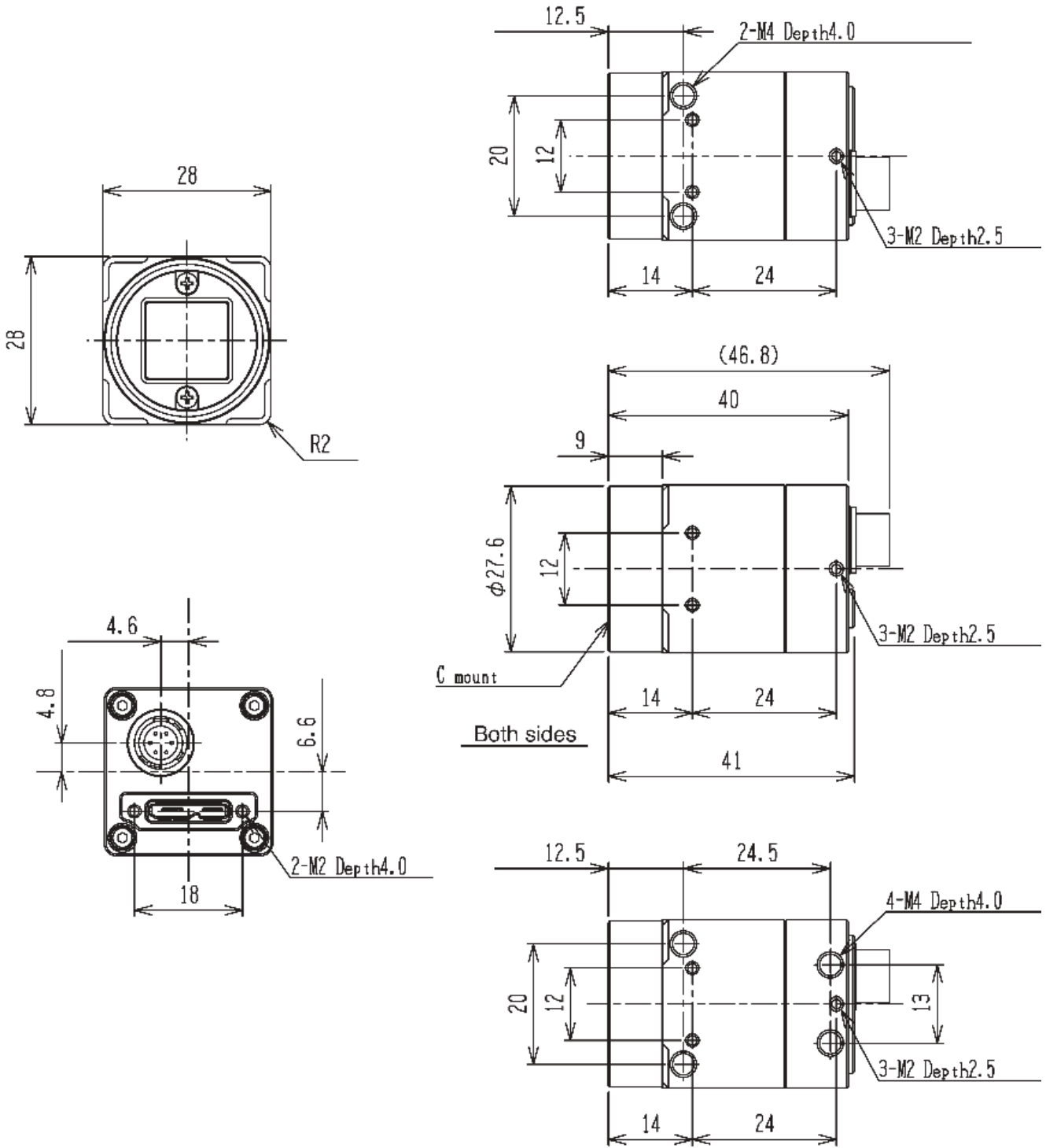
8. Package Contents

The MSDC is shipped with several items including a multispectral camera integrated with a vision computer, lockable ruggedized lens, 128 GB microSD card with microSD adaptor, a Pixy U Gremsy Gimbal (optional), Camera and Vision Computer Cables to the camera gimbal end, Camera Trigger IN/OUT from the QR gimbal end to Pixhawk, gimbal other accessories, power adaptor, a country specific power cord, and a USB Wi-Fi dongle. All accessories come in a waterproof case.