Hyperspectral Camera

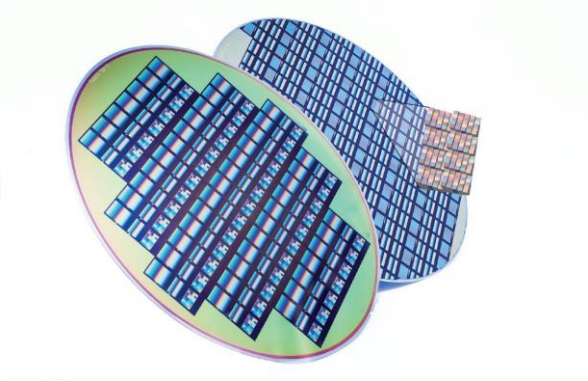
초분광 카메라

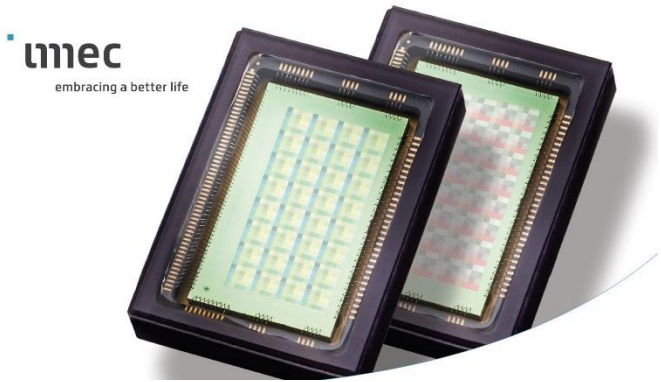
Camera types

- Snapshot – 스냅샷
- Snapscan – 스냅샷 + 라인스캔
- Linescan – 라인스캔
- Mobile – 휴대형
- Drone – 드론 시스템

Snapshot Spectral Camera

- 반도체 공정을 활용한 filter patterned on chip 초분광 센서
- One-shot 촬영 방식
- 가볍고 컴팩트한 구조





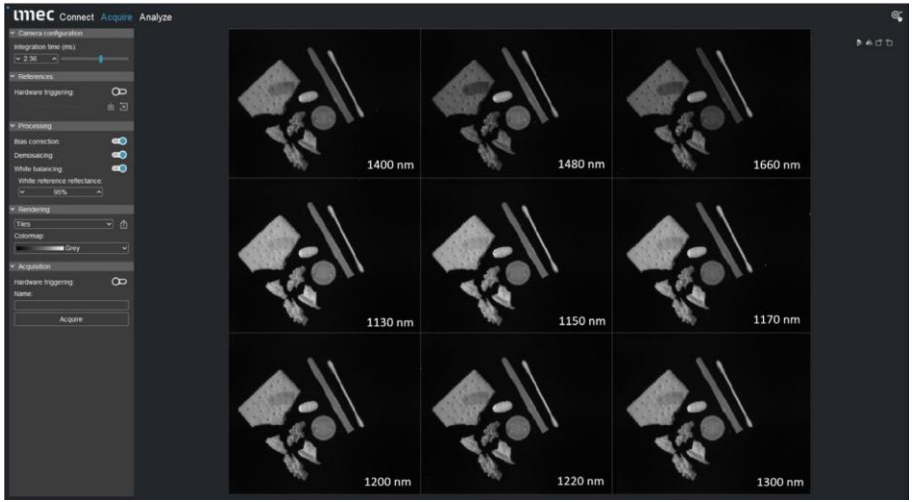
Snapshot – VIS / NIR

	Snapshot VIS	Snapshot NIR
공간 해상도	2048 x 1088 픽셀 (after reconstruction)	
분광 밴드	16 밴드	25 밴드
파장 범위	460 ~ 600nm	665 ~ 960nm
FWHM	< 15nm collimated	< 15nm collimated
측정 속도	최대 120 hyperspectral cubes/sec	
Bit depth	10 bit	
수광부	16 / 25 / 35 / 50mm, F2.0, C마운트	
광학 보정	Software corrected	
통신 인터페이스	USB3.0 + GPIO	
크기(mm)	31(L) x 26(W) x 26(H)	31(L) x 26(W) x 26(H)
무게	32g (렌즈 제외시)	32g (렌즈 제외시)

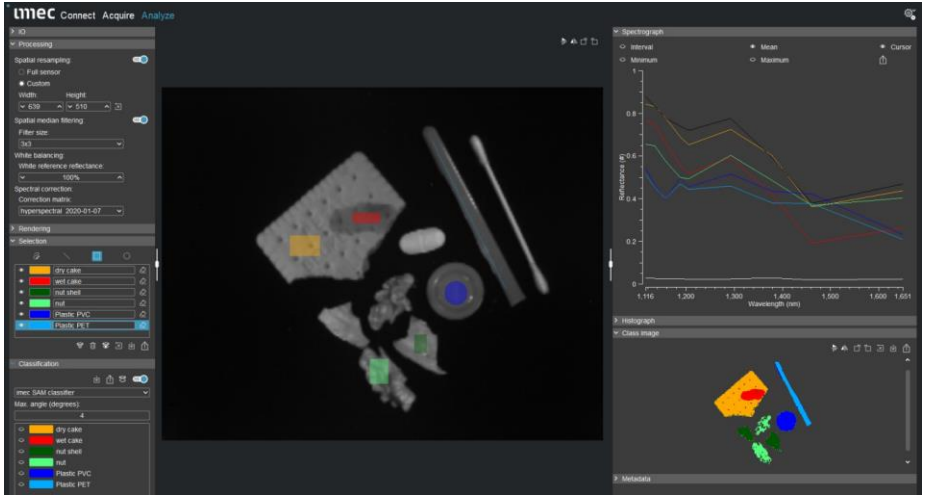
Snapshot – SWIR

	Snapshot SWIR
공간 해상도	640 x 512 픽셀
분광 밴드	9 밴드
파장 범위	1100 ~ 1650nm
FWHM	< 10 ~ 15nm
측정 속도	최대 120 hyperspectral cubes/sec
Bit depth	13 bit
수광부	16 / 25 / 35 / 50mm, F2.8, SWIR C마운트
이미지 센서	InGaAs based 640 sensor with TEC cooler electronic
픽셀 크기	15㎛ pixels
통신 인터페이스	USB3.0 + GPIO
크기(mm)	130(L) x 65(W) x 65(H)
무게	680g (렌즈 제외시)

Snapshot – HSI Mosaic software



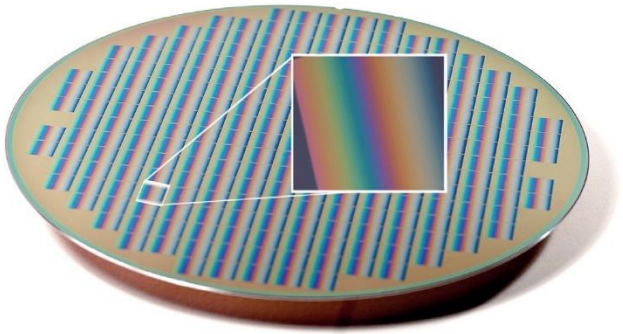
Single band images

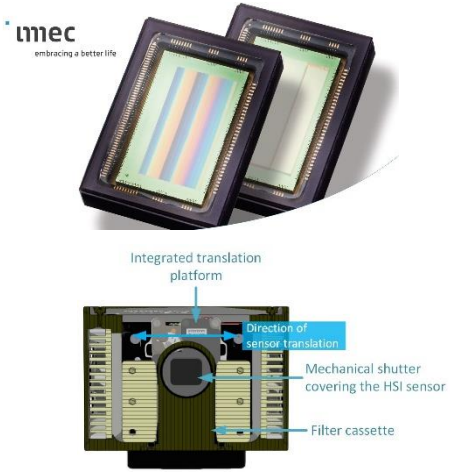


SAM classification

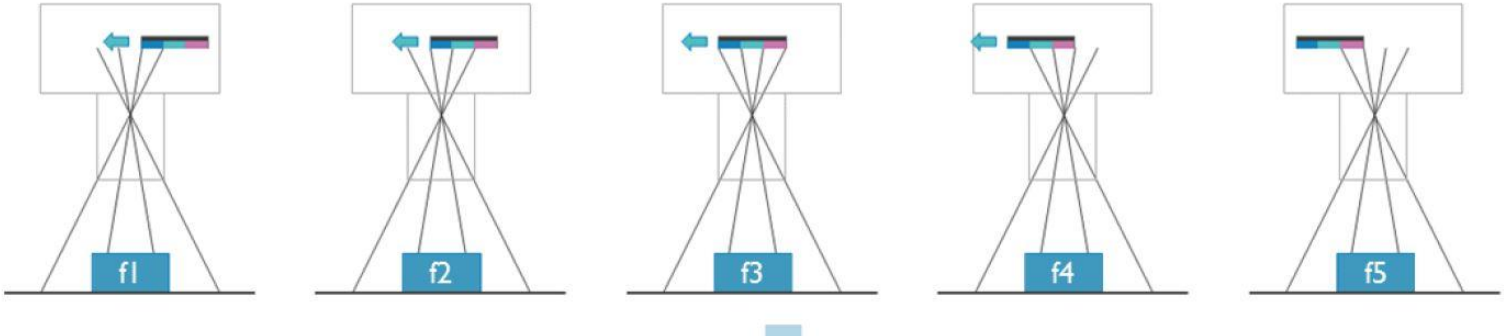
Snapscan Hyperspectral Camera

- 반도체 공정을 활용한 filter patterned on chip 초분광 센서
- 내부 스캔 촬영 방식
- 고해상도의 full spectrum 이미지

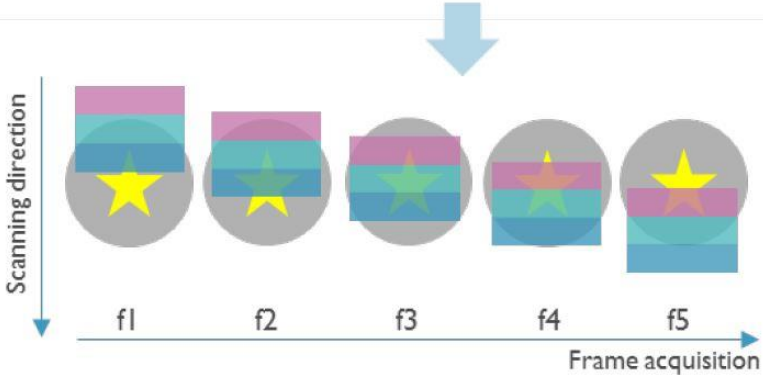


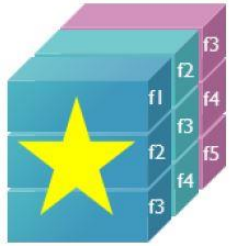


Snapscan Hyperspectral Camera



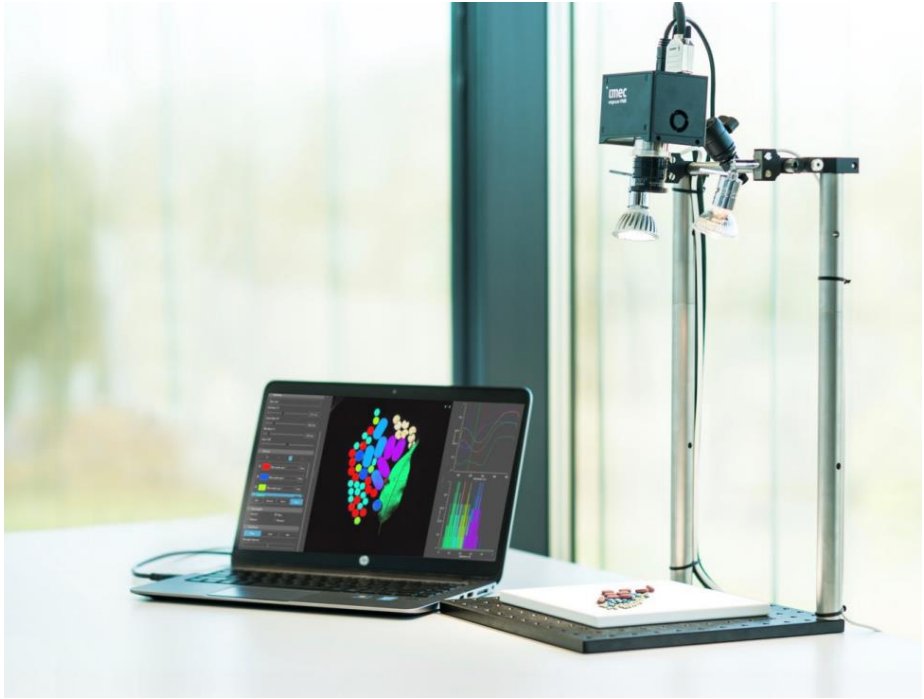
Both the object and the camera remain stationary. The sensor inside the camera moves to acquire the complete hyperspectral data.





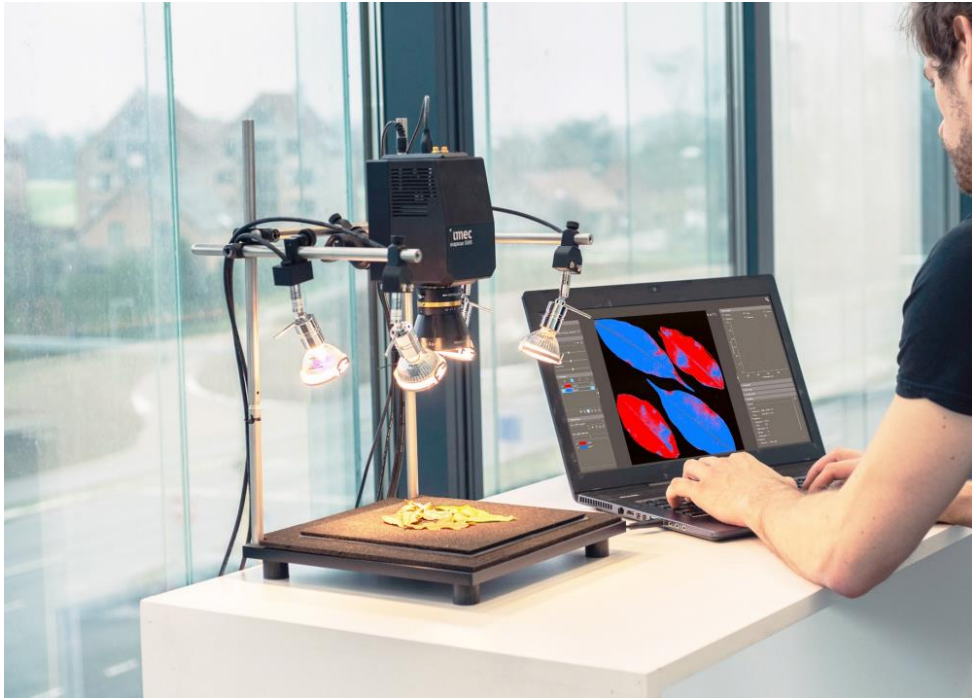
Assembly of data from individual frames to construct the hyperspectral data cube

Snapscan – VNIR / NIR



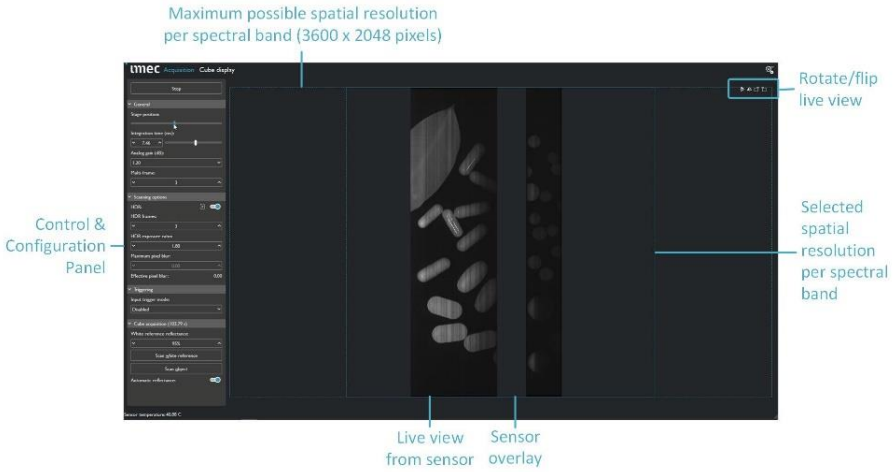
	SNAPSCAN VNIR	SNAPSCAN NIR
공간 해상도	최대 3600 x 2048 픽셀	
분광 밴드	150 밴드	100 밴드
파장 범위	470 ~ 900nm	600 ~ 970nm
FWHM	< 10 ~ 15nm	
측정 속도	2s ~ 20s (depends on acquisition parameters)	
스캔 시스템	내장형 piezo scanning platform	
Bit depth	10 bit	
수광부	20 / 24 / 35 / 50mm, F2.0, C마운트	
냉각 방식	fan based + TE cooling electronics	
셔터	자동 영점 조정을 위한 기계식 셔터 내장	
SNR	> 100 ~ 200	
통신 인터페이스	USB3.0 + GPIO	
크기(mm)	100(L) x 70(W) x 70(H)	
무게	645g (렌즈 제외시)	

Snapscan – SWIR



	SNAPSCAN SWIR
공간 해상도	최대 1200 x 640 픽셀
분광 밴드	100 밴드
파장 범위	1100 ~ 1700nm
FWHM	< 5 ~ 10nm
측정 속도	2s ~ 10s (depends on acquisition parameters)
스캔 시스템	내장형 piezo scanning platform
Bit depth	13 bit
수광부	16 / 25 / 50mm available based upon request
냉각 방식	fan based + TE cooling electronics
셔터	자동 영점 조정을 위한 기계식 셔터 내장
SNR	최대 600 : 1
통신 인터페이스	USB3.0 + GPIO
크기(mm)	90(L) x 90(W) x 130(H)
무게	1072g (렌즈 제외시)

Snapscan – HSI Snapscan software



Live view display for acquisition mode

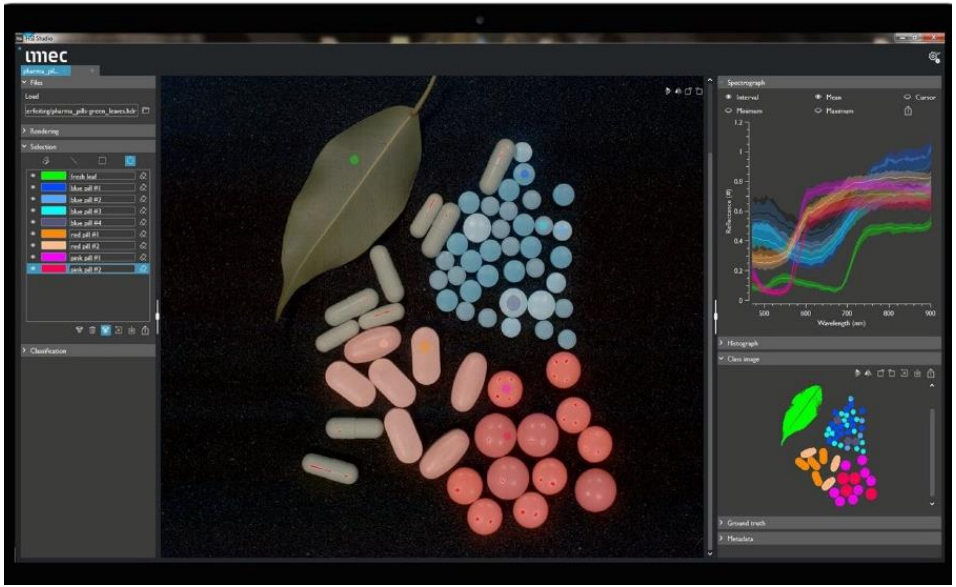
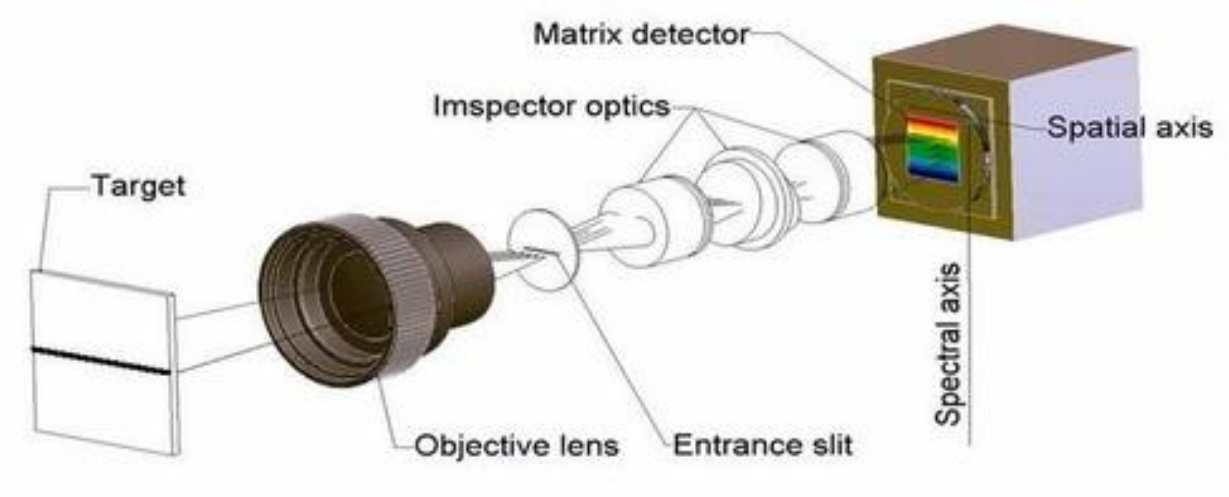


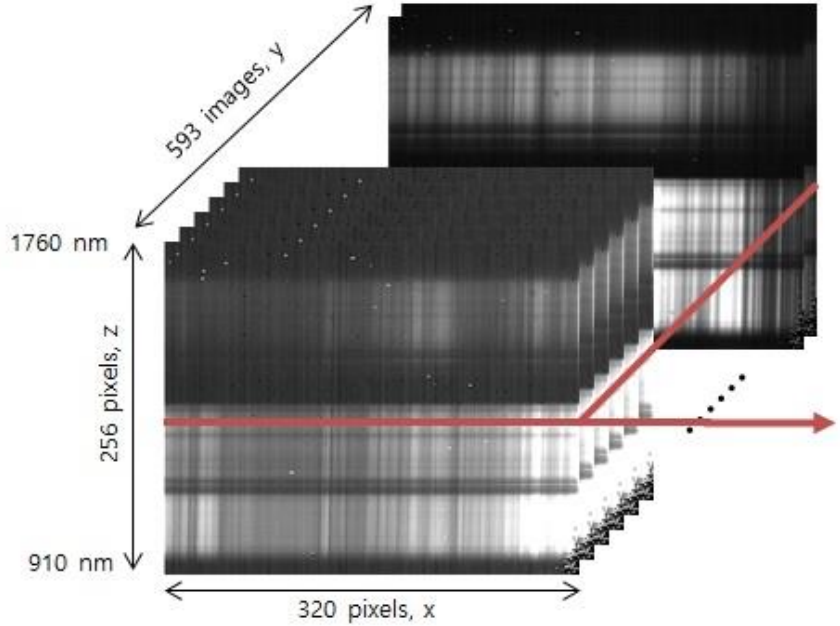
Image analysis and classification in cube display mode

Linescan Hyperspectral Camera

- 투과형 분광 광학계
- 라인 스캔 촬영 방식
- 고해상도의 full spectrum 이미지



Linescan Hyperspectral Camera



Visualization in 1290 nm

Linescan Hyperspectral Camera

Linescan – FX camera

Spectral Range	400 – 1000 nm
Spectral Bands	224
Spectral FWHM	5.5 nm
Spatial Sampling	1024 px
Frame Rate	330 FPS full frame 9900 with 1 band selected
FOV	38˚
F-number	F/1.7
Camera SNR (Peak)	600:1
Camera Interface	GigE Vision or CameraLink
Dimensions	150 x 85 x 71 mm
Weight	1.26 kg

Integrated shutter and order blocking filter

Linescan – FX camera

Spectral Range	900 – 1700 nm *
Spectral Bands	224
Spectral FWHM	8 nm
Spatial Sampling	640 px
Frame Rate	670 FPS full frame 15 000 FPS with 4 bands selected
FOV	38˚
F-number	F/1.7
Camera SNR (Peak)	1000:1
Camera Interface	GigE Vision or CameraLink
Dimensions	150 x 85 x 75 mm
Weight	1.56 kg
Integrated shutter	

Linescan – FX camera

Spectral Range	2.7 – 5.3 µm
Spectral Bands	154
Spectral FWHM	35 nm
Spatial Sampling	640 px
Frame Rate	380 FPS (Full image with default binning)
FOV	24° / 45° / 60°
F-number	F/2.0
Camera SNR (Peak)	1600:1 (Dynamic range with 1.5 ms integration time)
Camera Interface	GigE Vision or Custom ethernet
Dimensions	280 x 202 x 169 mm
Weight	7 kg
Integrated shutter	

Linescan – SWIR

OPTICAL CHARACTERISTICS	TYPICAL SPECIFICATIONS
Spectral range	1 000 - 2 500 nm
Spectral resolution FWHM	12 nm (30 µm slit)
Spectral sampling	5.6 nm
Spatial resolution	rms spot radius < 15 µm
F/#	F/2.0
Slith width	30 µm (50 or 80 µm optional)
Effective slit length	9.2 mm
ELECTRICAL CHARACTERISTICS	
Detector	Cryogenically cooled MCT detector
Spatial pixels	384
Spectral bands	288
Pixel size	24 x 24 µm
Detector cooling	Stirling, 25 000 h MTTF
Optics temperature stabilization	Yes
Camera output	16 bits CL
SNR	1 050:1 (at max. signal level)
Data cable	Length 5 meters
Frame grabber	National Instruments NI 1427
Camera control	USB / RS232
Frame rate	450 fps (maximum full frame)
Exposure time range	0.1 - 20 ms
Power consumption	Nominal < 50 W
Input voltage	Wide 24 V

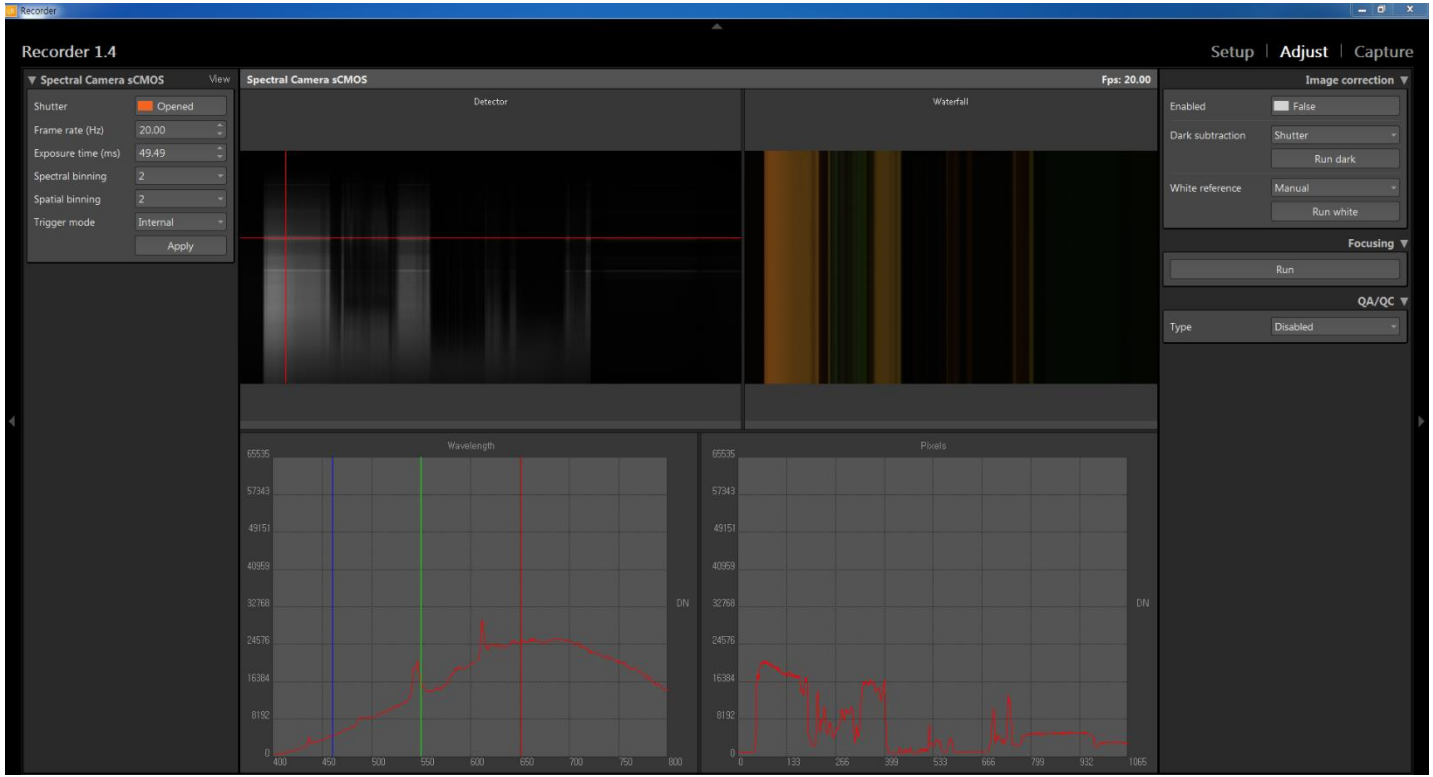
Linescan – FENIX

	VNIR			SWIR
Camera specifications				
Spectrograph	High efficiency transmissive imaging spectrograph			
Spectral range	380 - 970 nm			970 - 2 500 nm
Spectral resolution	3.5 nm			12 nm
F/#	F/2.4			
Smile / Keystone	< 0.2 pixels			
Polarization sensitivity	Throughput practically independent of polarization			
Signal-to-noise ratio (peak)	600 - 1 000:1 *			1 050:1
Spatial resolution	384 pixels			
Frame rate	Up to 100 Hz			
Integration time	Adjustable within frame period			
FOV	32.3°			
IFOV	0.084°			
Swath width	0.58 x altitude			
Altitude for 1m pixel size	660 m			
Electro mechanical shutter	Yes			
Detector	CMOS			Stirling cooled MCT
Spectral binning options	2x	4x	8x	-
Number of spectral bands	348	174	87	274
Spectral sampling / band	1.7 nm	3.4 nm	6.8 nm	5.7 nm
Data interface	CameraLink 12-bit			CameraLink 16-bit
Typical power consumption **	150 W			
Maximum power consumption **	500 W			
Environmental characteristics				
Storage temperature	- 20 ... +50 ºC			
Operating temperature	+ 5 ... +40 ºC, non-condensing			

Linescan – LWIR

SPECTRAL CAMERA LWIR	OWL	HS
Optical characteristics		
Spectral range	8 - 12 µm	8 - 12 µm
Spectral bands	84	30
Spectral resolution	100 nm**	400 nm
Spectral sampling/band	48 nm	150 nm
Spatial pixels	384 pixels	
Field of view	With fore lens L43***: 24° With fore lens L32***: 32.2°	With fore lens L41*** 32.2°
Spatial sampling	L43 0.063° / L32 0.084°	0.084 °
Aberrations	Insignificant astigmatism, smile or keystone < 0.1 pixels	
Optics temperature	Stabilized	Uncooled
Electrical characteristics		
Detector	MCT	LWIR uncooled microbolometers
Numerical aperture	F/2.0	F/1.0
Pixel size	24 x 24 µm	25 x 25 µm
Cooling	Stirling-cycle cooler	Uncooled
Camera output	14-bit LVDS	GigE Pleora
Frame grabber	NI-PCI 1422 or 1424 National Instruments	-
Frame rate	up to 100 fps	60 fps
Shutter/internal calibration	Yes / Optional	No
Power consumption	< 200 W + 400 W (calibrator)	3 - 5 W
SNR	Target 300 K * 8 µm **450** * **10 µm 580** * **12 µm** 230	Target 400 K * 8 µm **240** * **10 µm 210** * **12 µm** 180
NESR (mW/m2srµm)	* 8 µm **21** * 10 µm 18 * **12 µm 40**	* 8 µm **270** * 10 µm 310 * **12 µm 800**
NETD/ spectral pixel	0.2K	1K

Linescan – LUMO data acquisition software



Mobile Hyperspectral Camera

- 디지털 카메라 방식의 휴대형 초분광 카메라
- 측정에서 분석까지 자율적 운용 가능
- 내장 GPS를 활용한 측정데이터의 위치정보 기록
- USB연결 또는 WIFI를 통신을 이용한 원격 제어

Mobile Hyperspectral Camera

Feature	Value
Spectral camera	VNIR 400~1000 nm (CMOS)
Viewfinder camera	5 Mpix
User interface SW	By Specim
Storage	SD card max 32 GB
Data Format	Specim Dataset with ENVI compatible data files
Battery	5200 mAh Li-Ion (Type 26650)
Operational time	Appx. 100 measurements with one SD card and battery
Display & keyboard	4.3 " touch screen + 13 physical buttons
Camera interface	USB Type-C
Size	207 x 91 x 74 mm (depth with lens 125,5 mm)
Weight	1.3 kg
F/number	1.7
Wavelength band	400~1000 nm
Spectral resolution FWHM	7 nm
Spatial Sampling	512 pix
Spectral bands	204

Mobile Hyperspectral Camera – High resolution

MOBILE SNAPSCAN SYSTEM PRODUCT SPECIFICATION

Spatial resolution	up to 3650 x 2048 px (7Mpx RAW per band)
Spectral resolution	100+ bands (NIR version) or 150+ bands (VNIR version)
Spectral range	600 – 970 nm (NIR version) or 470 – 900 nm (VNIR version)
FWHM	~ 10 – 15 nm (collimated)
Acquisition speed	~ 200ms - 20 seconds, depending on acquisition parameters, lighting and object)
SNR	> 100 - 200, flat SNR over spectral range
SW scanning modes	Digital TDI (x5-8 stages max) Multi-exposures HDR (high-dynamic-range) Digital binning (2x2, 3x3, 4x4) Spectral ROI - Region of Interest (1 to 8 bands max) Spatial ROI - Region of Interest (2048 x custom scanning length)
Dynamic range	8/10 bit
Optics	20/24/35/50 mm lenses – F2.0 – C-mount
Smile & keystone	Software corrected
Interface	USB3.0 + GPIO + I/O for triggering
Powering	USB-C powering via compatible laptop and / or battery pack
Cooling	Passive & active cooling (fan based + TEC)
Temperature	35°C to 45°C (operation), 5°C to 50°C (transport)
Mechanical	Integrated mechanical shutter for automatic dark-counts, Tripod mount (¼"-20) + side mounting M5 holes
Dimensions (LxWxH)	13 x 9 x 7 cm
Weight	780 g (without optic)

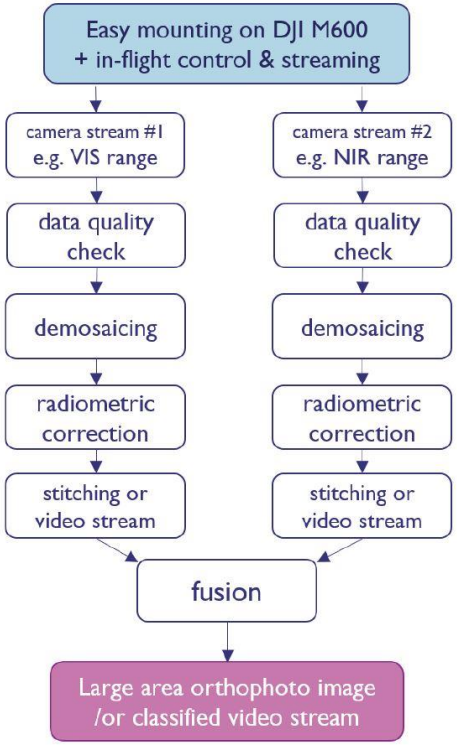
Drone Hyperspectral Camera – Linescan

- Push-broom 방식
- GPS/IMU 통합형 센서
- 다양한 플랫폼 호환

항목	특징
Sensor Type	Push-broom Line Imaging Spectrometer
Detector Type	CCD/CMOS hybrid 1408 spatial pixels
Focal Length / FOV	16mm / 29.5degrees
Spectral Range	400 ~ 1,000nm
Spectral Bands	155 bands (2bin)
Spatial Pixels	704 pixels (2bin)
INS	GPS + Mems IMU
Size / Weight	13.7 x 8.8 x 7.1cm / 680g

Drone Hyperspectral Camera – Snapshot

- One-shot 촬영 방식
- GPS/IMU 통합형 센서
- VIS / RedNIR / NIR / SWIR의 다양한 파장대역 대응



Drone Hyperspectral Camera – Snapshot

UAV PLATFORM CONFIGURATION POSSIBILITIES

Spatial resolution	2,048 x 1,088 px (VIS, RedNIR, NIR sensors) with 5.5 um pixel pitch 640 x 480 px (SWIR sensor) with 15 um pixel pitch
Spectral resolution & range	30+ bands in 450 – 875 nm range (VIS + RedNIR configuration) 40+ bands in 470 – 970 nm range (VIS + NIR configuration) 40+ bands in 675 – 1650 nm range (NIR + SWIR configuration) custom configurations possible – please contact us for more info
FWHM	~ 10 – 15 nm
Acquisition speed	90 FPS max for single sensor, 40 FPS max for dual-sensor camera
SW acquisition & processing pipeline	On-board (Linux based) processing capabilities : - RAW frames acquisition to local storage at video-rate - Saturation detection - Focus & elevation stability detection - De-mosaicing & radiometric corrections - Real-time classification with built-in classifiers On-computer (PC, window based) processing pipeline : - Stitching for orthophoto images - Fusion of two camera orthophoto images Output format = ENVI compatible file
Embedded HW	nVidia Jetson GPU, 2TB local storage, geo-tagging of each spectral image with access from GPS/RTK & IMU data from DJI Matrice 600 drone. Remote control connectivity fully integrated with DJI Matrice 600 HW & SW environment
Dynamic range	8 / 10 bit (VIS to NIR range sensors) and 13 bit (SWIR range sensors)
Optics	9 / 12 / 16 / 24 / 35 / 50 mm lenses – F2.0 – C-mount
Mechanical	Fully compatible with Gremsy Pixy U and MavLink industry standards
Dimensions (LxWxH)	10 x 7 x 6.5 cm
Weight	450 g (without optics)

THANK YOU

KISlab

Korea Imaging Spectroscopy Laboratory