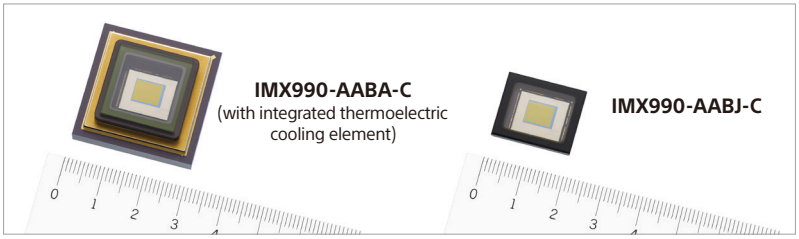
SONY

SWIR image sensor

IMX990 1/2-inch type (8.2 mm diagonal)
approx. 1.34 effective megapixel SWIR image sensor
IMX991 1/4-inch type (4.1 mm diagonal)
approx. 0.34 effective megapixel SWIR image sensor

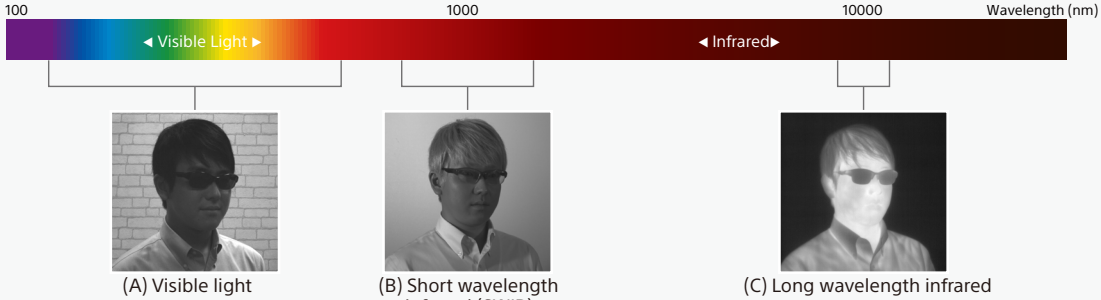


In industrial applications, we can now find cameras that capture visible light and non-visible light. This allows for new applications and previously difficult computer vision tasks to be challenged. Let us introduce our new SWIR (Short Wavelength Infra-Red) image sensor that can support these opportunities.

What is SWIR?

Generally, light with a wavelength of 400 to 780 nm is called visible light, and light with a wavelength of 780 to 10^6 nm is called infra-red light. Among the infra-red rays, the light located just next to visible light is called SWIR. Sony's SWIR image sensor can capture the SWIR band from visible light to 1,700 nm.
[Photo 1] is a comparison of images taken with visible light and infra-red light of the same subject. In contrast to the visible light image (A) that we are accustomed to, the infra-red image (C), which has a long wavelength, cannot capture the characteristics of a person. On the other hand, although the SWIR image (B) looks like visible light because their wavelengths are close, unique information which is different from the visible light image can be captured under SWIR light.

[Photo 1]



(A) Visible light
(B) Short wavelength infrared (SWIR)
(C) Long wavelength infrared

Images (B) and (C) are captured in the environment under the invisible light environment.

SenSWIR

SenSWIR is a wide-band and high-sensitivity SWIR image sensor technology implemented by the combination of compound semiconductor InGaAs photodiodes and Si readout circuits through Cu-Cu connection.

Summary of application of SWIR technology

Visualizing water

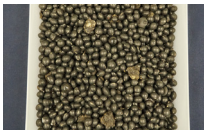
Smartphone camera image

Detecting moisture in the dents on the apple skin

Under visible light | Under SWIR (1,450 nm)

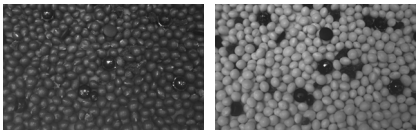
Water becomes black in an image taken with a camera set at the wavelength of 1,450 nm because water absorbs the light at this wavelength. This attribute can be leveraged for detecting moisture in objects.

Sorting materials



Smartphone camera image

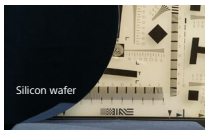
Detecting plastic and metal pieces in a pile of black beans



Under visible light | Under SWIR (1,300 nm)

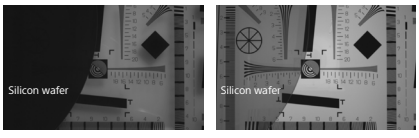
Infrared reflectance and absorptance vary at different wavelengths from one material to another. Utilizing this attribute, a specific material can be singled out among other materials, such as plastics, that may look very similar to one another under visible light.

Transmission observation



Smartphone camera image

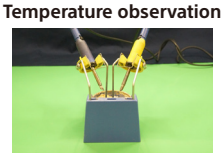
Inspection of silicon wafer



Under visible light | Under SWIR (1,550 nm)

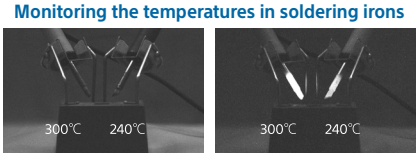
SWIR includes a spectrum that penetrates certain materials, and this has been leveraged in manufacturing, such as a transmission inspection for semiconductors.

Temperature observation



Smartphone camera image

Monitoring the temperatures in soldering irons



Under visible light | Under SWIR (1,550 nm)

Some image sensors can convert heat into luminosity information. SWIR image sensors are suitable for the observation of heat over 250°C.

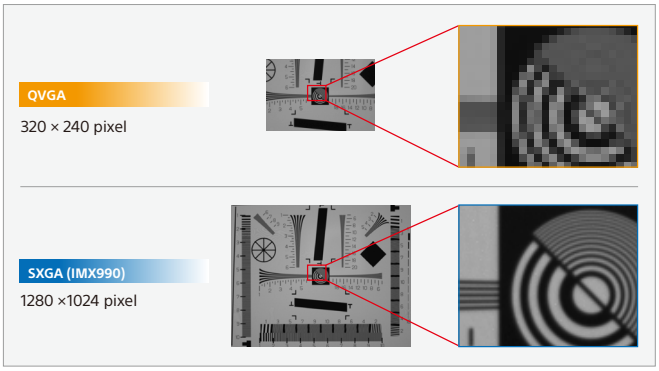
Features of image sensors with SenSWIR technology

Smaller system realized by the industry's smallest* pixel at 5µm

The pixel size of the IMX990/IMX991 is the industry's smallest 5µm. Despite their small size, they achieve high image quality of SXGA. This feature can increase flexibility for camera positioning and enhance accuracy for inspections, expanding the applications of SWIR sensing. (see Photo 2)

* Among the SWIR image sensors based on a compound semiconductor using InGaAs (indium gallium arsenide). Source: Sony (as of May 2020)

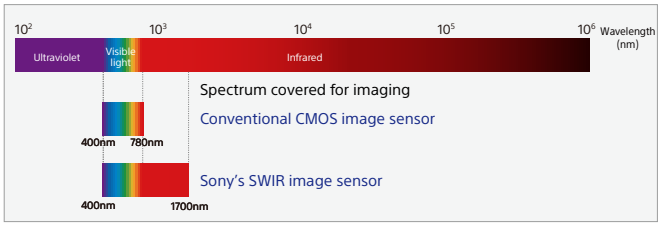
[Photo 2] Image quality of IMX990 (parallel to SXGA)
SXGA has a wide field of view and high resolution.



Two functions in one image sensor

The image sensors with SenSWIR technology are compatible both with the SWIR spectrum and a wide band of 400 to 1,700 nm wavelengths, which includes the visible light spectrum. Inspections that previously required two cameras, one for visible light imaging and the other for SWIR, can now be carried out with one that integrates both functions. This not only widens the scope of items and purposes of inspection, but also helps to reduce system cost and accelerate image processing, improving throughput. Also, one camera means the captured images in two modes are identical to the pixel level, avoiding image shift. (see Fig. 1)

[Fig. 1]



Digital output ready for efficient camera design

In general, most SWIR image sensors output analog signals only. This means camera manufacturers need to add digital conversion circuit in camera side before developing the camera functionality. Sony's SWIR image sensors of this series incorporate digital conversion circuit, eliminating the needs of such an extra work. This will allow camera manufacturers to make a quick start to develop versatile functions of cameras as they wish more easily and efficiently.

Specifications

Device structure

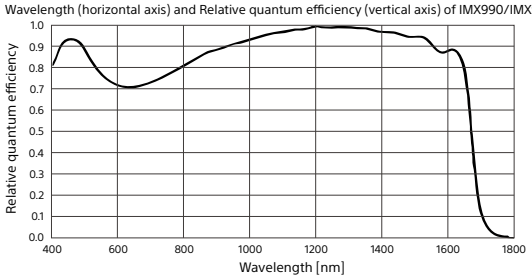
Item		IMX990-AABA-C	IMX990-AABJ-C	IMX991-AABA-C	IMX991-AABJ-C
Image size		8.2 mm diagonal (1/2-inch type)		4.1 mm diagonal (1/4-inch type)	
Effective pixels		1,296 (H) × 1,032 (V), approx. 1.34 megapixels		656 (H) × 520 (V), approx. 0.34 megapixels	
Unit cell size		5µm (H) × 5µm (V)			
Optical black	Horizontal direction	Front 0 pixels, rear 96 pixels			
	Vertical direction	front 12 pixels, rear 0 pixels			
Input drive frequency		37.125MHz/74.25MHz/54MHz			
Power supply	Pixel	2.2V, 1.2V			
	Analog	3.3V, 2.2V			
	Digital	1.2V			
	Interface	1.8V			
Shutter mode		Global shutter			
Output interface		SLVS (2ch/4ch)			
Package	Thermoelectric cooling element	Included	-	Included	-
	Dimensions	30.0mm (H) × 30.0mm (V)	20.0mm (H) × 16.8mm (V)	30.0mm (H) × 30.0mm (V)	20.0mm (H) × 16.8mm (V)

Imaging characteristics

Item	IMX990	IMX991	Notes
Sensitivity	121mV	121mV	F8, 1/30 sec. accumulation
Saturation signal	360mV	360mV	
Quantum efficiency	>75%	>75%	λ=1200nm
Operability*1	>99.5%	>99.5%	

*Measurement conditions: Tj = 15 C, all-pixel readout mode.
*1: Operability: percentage of pixels free of defects

Wavelength (horizontal axis) and Relative quantum efficiency (vertical axis) of IMX990/IMX991



Data may vary depending on conditions and the environment.

Basic drive mode

Model	Drive mode	Recommended recording pixels	ADC [bit]	Frame rate (max.) [frame/s]
IMX990	All-pixel readout	1280 (H) × 1024 (V) Approx. 1.31 megapixels	8	130
			10	120
			12	70
IMX991	All-pixel readout	640 (H) × 512 (V) Approx. 0.33 megapixels	8	250
			10	240
			12	130

URL for the dedicated SenSWIR technology webpage:
https://www.sony.net/swir-tech

Please inquire from the URL below or the QR code, to the right, for detailed information of Sony's SWIR image sensors or evaluation data samples:
https://info.sony-semicon.co.jp/en/inquiry-form0001pr