

Advantage of the CMOS Sensor

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View-DR

Exmor™

IPELA

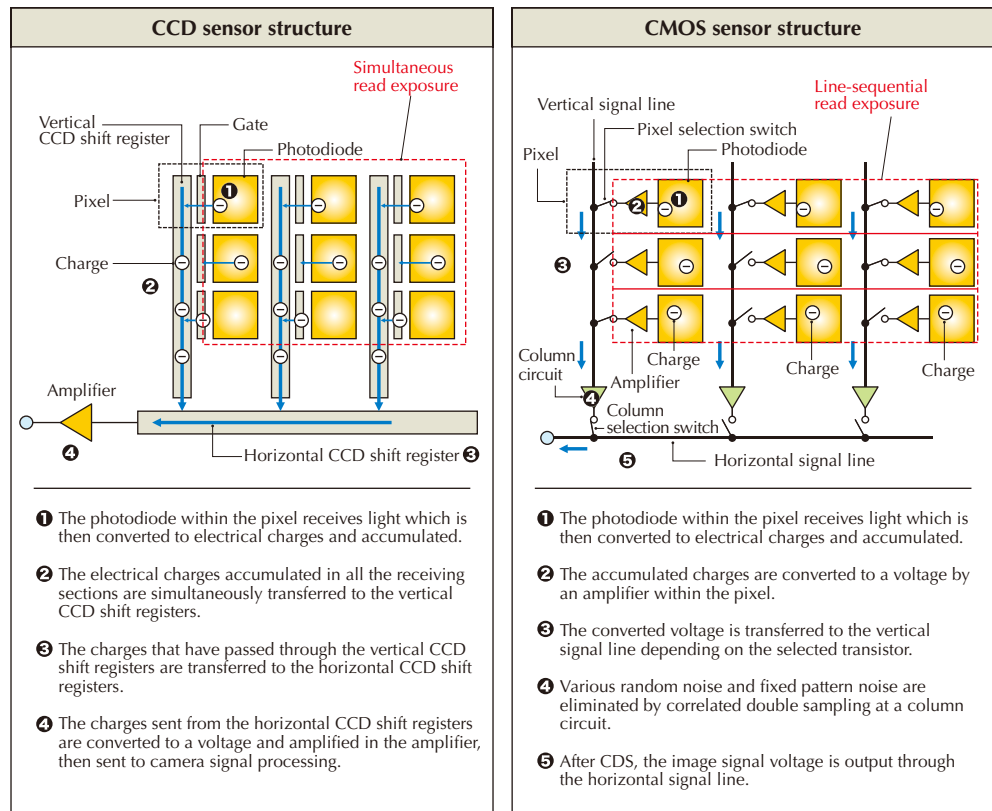
1. Introduction

Existing mainstream analog security surveillance cameras have been using analog signals with a video format that can then be sent through a single BNC cable using a TV format (NTSC, PAL). Today's typical imager is the CCD sensor in analog security surveillance cameras. Until a few years ago, the other type of imager, the CMOS sensor (mainly VGA) had been used in web cameras and some imaging devices.

2. Comparing CCD & CMOS

Although both image sensors act as capture devices for a camera, the latest CCD and CMOS sensors are very different in structure. Figure 1 describes these structures.

Fig.1: How to read out signals



To use CCDs in video applications, it is necessary for all the vertical and horizontal shift registers to constantly relay received image data as electronic signals. As a result, there is a limit to achieving high resolutions and increasing speed. Additionally, power consumption becomes comparatively high. On the other hand, CMOS sensors only need to move one readout column of circuitry, so power consumption is low and it's easy to increase speed.

3. CMOS Sensor “Exmor”

In recent years, with growing interest in small HD-resolution camcorders, there has been significant development of CMOS sensors which are low power consumption devices with high-speed image readout capabilities. In the field of security surveillance, this development is accompanied by the increasing prevalence of IP networking, which in turn builds demand for HD resolution, as the digital of the network surveillance camera signal does not depend on a conventional TV format.

Because of these growing needs, Sony has amassed its image quality knowledge accumulated in CCDs, and dedicated this to creating new, more advantageous high-speed, high-resolution CMOS sensors. The result is a CMOS sensor with an entirely new structure: the “Exmor”.

Both CCD and CMOS sensors have the same part that converts light into electricity (a key element of image quality). With the “Exmor”, however, Sony uses high image quality pixel technology accumulated in CCD development to enlarge as much as possible the light-receiving section of the photodiode.

Tables 1 and 2 show specifications and Image Sensor Characteristics for the “Exmor” CMOS, CMOS and CCD sensors.

(Table 1) Specifications

Item	IMX035	IMX012	ICX445
Sensor type	“Exmor” CMOS	CMOS	CCD
Image size	Diagonal 6.08 mm (1/3 type)	Diagonal 4.7 mm (1/3.8 type)	Diagonal 6.0 mm (1/3 type)
Transfer method	All-pixel	All-pixel	Interline
Total number of pixels	approx. 1.49M pixels 1384 (H) x 1076 (V)	approx. 1.33M pixels 1304 (H) x 1017 (V)	approx. 1.32M pixels 1348 (H) x 976 (V)
Number of effective pixels	approx. 1.39M pixels 1329 (H) x 1049 (V)	approx. 1.28M pixels 1296 (H) x 985 (V)	approx. 1.25M pixels 1296 (H) x 966 (V)
Chip size	7.64 mm (H) x 7.64 mm (V)	6.452 mm (H) x 6.402 mm (V)	6.26 mm (H) x 5.01 mm (V)
Unit cell size	3.63 μm (H) x 3.63 μm (V)	2.925 μm (H) x 2.925 μm (V)	3.75 μm (H) x 3.75 μm (V)

(Table 2) Image Sensor Characteristics

Item	IMX035	IMX012	ICX445	Remarks	
Sensitivity (F5.6)	Typical value	460 mV	290 mV	460 mV	3200K, 706 cd/m ² (Exposure time: 1/30 s)
Saturation signal	Minimum value	830 mV	550 mV	350 mV	T _j = 60 °C

Another major element that determines image quality is noise reduction. In “Exmor” CMOS sensors, noise on the analog part is eliminated by the built-in Correlated Double Sampling (CDS) circuit. Other new structural elements drastically also decrease the noise-contamination level.

Figure 2 and Figure 3 describe these structures.

- The A/D conversion conventionally done just before signal readout is now performed immediately after the light-to-electricity conversion, and is performed for each column. This helps to reduce noise because the analog circuit is made shorter, and the frequency lower.
- Noise-elimination circuits (CDS circuit) are equipped in the digital domain in addition to in the analog domain.

Fig.2

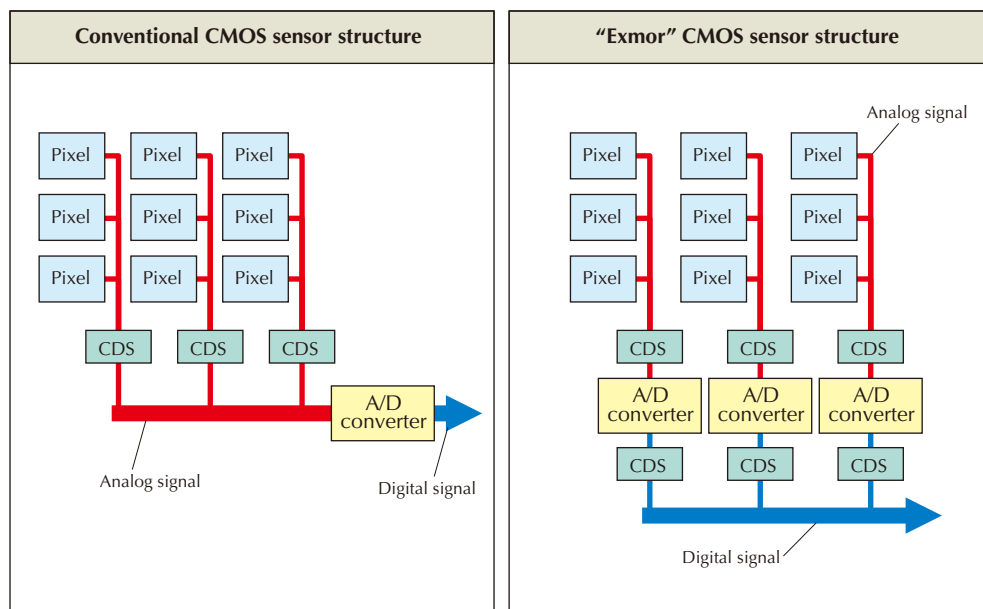
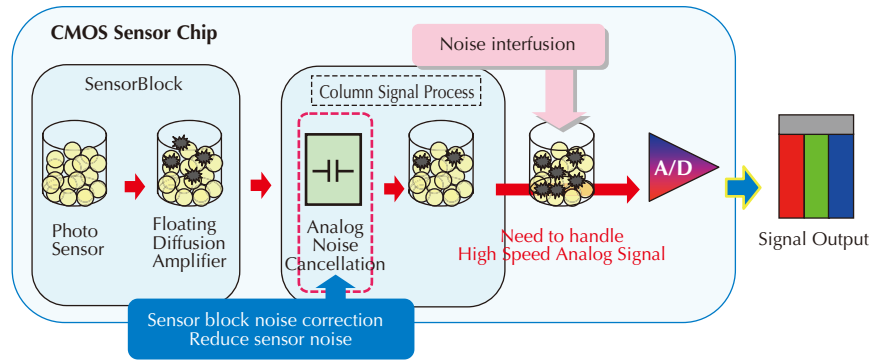
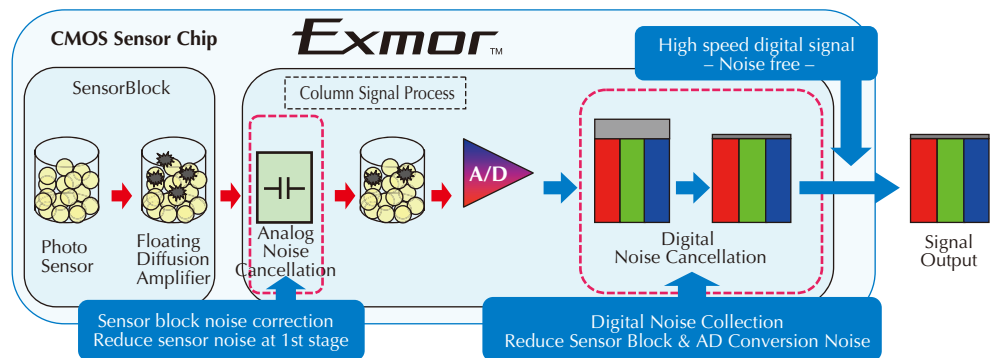


Fig.3: How to reduce noise

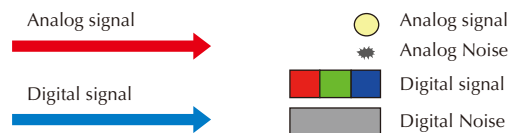
Conventional CMOS Sensor



“Exmor” CMOS Sensor



Realize Low Noise Process with Dual Noise Reduction



Through these methods, rapid improvements have been made in CMOS sensor image quality, achieving the same performance level as CCD sensors.

Taking the example of recent, typical Sony IP cameras, the minimum object luminance specifications for cameras equipped with either a CCD or an “Exmor” CMOS sensor are as follows:

- Sony CCD network surveillance camera SNC-CM120: 1.3M CCD equipped 0.8 lx
- Sony CMOS network surveillance camera SNC-CH140: 1.3M CMOS equipped 0.2 lx

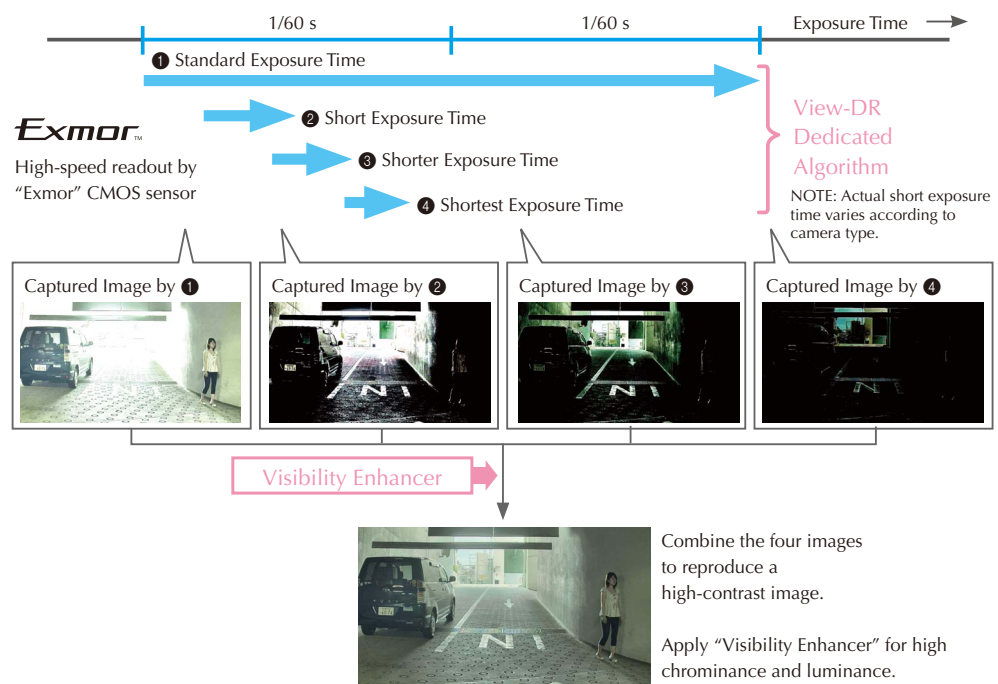
4. New Wide-D Technology – Using High-speed Readout of the CMOS Sensor (View-DR)

When comparing the newly developed “Exmor” CMOS sensor with the CCD sensor, not only has the sensitivity improved, but now data (image) readout is dramatically faster. Using these high-speed readout capabilities, Sony’s IP cameras are equipped with a newly-developed Wide-D technology (called the View-DR function).

With a CCD sensor, the user is restricted to taking successive 1/60-second images or 1/30 second images and combining the two. In View-DR, the user can take one 1/30-second image at long exposure, and take other images over the same period at short exposure, and then image process them in real-time to achieve an industry-best wide dynamic range.

Figure 4 shows the structure of this industry-best Wide-D (View-DR function) as used by the “Exmor” CMOS sensor:

Fig.4: Structure of View-DR function



5. Future Developments

For security surveillance applications that require improvements in visibility and image analysis for advanced image processing, and to meet customer demand for greater sharpness and improved detail, it is inevitable that the advance towards HD/ Full HD will continue.

The high resolution and high image quality required for HD, especially in surveillance applications, means a drastic increase in the volume of image data that the image sensor must read out. As a result, CMOS sensors, which readout data at higher speeds than CCD sensors, are becoming mainstream in the security industry and soon in general.

Already Sony is developing further solutions. It has created a yet more sensitive CMOS sensor called the “back-illuminated high-sensitivity CMOS image sensor”, now available in video camcorders and digital still cameras.

No doubt the future for the CMOS sensor is bright indeed, as it has succeeded in delivering both sensitivity improvements and noise reduction – the key contributors to high image quality – in a small sensor design. Equipped with this sensor, Sony’s surveillance cameras are a testament to quality and innovation in the industry.

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