technology

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HP Imaging Electronics CMOS Image Sensors

Image Sensor Technology: CMOS vs. CCD

For the past 25 years, charge-coupled devices (CCDs) represented the only technology available for capturing images in an electronic form. Although this technology requires a significant investment in specialized fabrication and manufacturing processes, CCDs nevertheless yield a high-quality image that makes them suited for digital and PC cameras, toys, and other emerging electronic devices.

In 1993, researchers at NASA's Jet Propulsion Laboratory invented a method for using Complementary Metal Oxide Semiconductor (CMOS) technology to produce high-quality image capture devices that were competitive with CCD-based products. As the technology used for all modern microprocessors, memory chips, and Application Specific Integrated Circuits (ASIC's), CMOS components are fabricated in mainstream silicon foundries, resulting in significant cost reductions, process line improvements, and a higher level of circuit integration on the chip.

This on-chip circuitry enables CMOS image sensors to achieve a significant advantage in functionality over CCDs. The result? A more compact system that decreases defects, increases reliability and reduces the need for peripheral support chip packaging and assembly, further reducing cost.

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Next Page

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A question of power

Stated simply, CMOS sensors consume much less power than that of similar CCD sensors–at least 10 times less, in fact. This advantage is particularly important for applications such as digital cameras, PC videocameras, laptop computers, cellular phones and toys.

Unlike CMOS components, CCD systems require multiple 5-15 V power supply levels and voltage regulators for operation. CMOS typically uses a single, 3.3 volt (or 5 volt supply), increasing power supply efficiency.

Higher System Integration

With CMOS, signal processing can be integrated directly on the chip. On-chip analog-to-digital conversion (ADC) facilitates driving high-speed signals off-chip. Digital output is less sensitive to pickup and crosstalk, and more convenient for the system designer to use as it facilitates computer and digital controller interfacing while increasing system robustness. Timing control can be integrated onto the sensor chip. Digital Signal Processing (DSP) functions can also be realized, from color encoding, image stabilization and compression to motion tracking, video conferencing and wireless control. In addition, standard camera functions such as Automatic Gain Control (AGC), color balance, and automatic exposure and focus control are possible on a single chip.

Lower Cost

Because CMOS is used for many different types of integrated circuits, it has the advantage of manufacturing economies of scale that drive down defect density and production costs. Higher yields and less susceptibility to defects make CMOS a lower cost technology than CCD for image sensors. Fewer parts, a smaller form factor, and higher reliability in the end product system mean cost savings to the systems manufacturer.

A better image

CCDs rely on a process that can leak charge to adjacent pixels when the CCD register overflows; thus bright lights “bloom” and cause unwanted streaks in the image. CMOS architecture is inherently less sensitive to this effect. CMOS has the ability to embed the analog components thus introducing less noise into the signal and therefore better preserving the signal integrity between the sensor and the final digital output. In addition, smear–caused by charge transfer in the CCD under illumination–is non-existent with CMOS.

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