**Image sensor**

An **image sensor** is a device that converts an optical image into an [electronic signal](http://en.wikipedia.org/wiki/Signal_(electronics)). It is used mostly in [digital cameras](http://en.wikipedia.org/wiki/Digital_camera) and other imaging devices. Early sensors were [video camera tubes](http://en.wikipedia.org/wiki/Video_camera_tube) but a modern one is typically a [charge-coupled device](http://en.wikipedia.org/wiki/Charge-coupled_device) (CCD) or a complementary metal–oxide–semiconductor ([CMOS](http://en.wikipedia.org/wiki/CMOS)) [active pixel sensor](http://en.wikipedia.org/wiki/Active_pixel_sensor).

## CCD vs CMOS

Today, most digital still cameras use either a CCD image sensor or a CMOS sensor. Both types of sensor accomplish the same task of capturing light and converting it into electrical signals.

A [CCD](http://en.wikipedia.org/wiki/Charge-coupled_device) image sensor is an analog device. When light strikes the chip it is held as a small electrical charge in each photo sensor. The charges are converted to voltage one pixel at a time as they are read from the chip. Additional circuitry in the camera converts the voltage into digital information.

A CMOS imaging chip is a type of [active pixel sensor](http://en.wikipedia.org/wiki/Active_pixel_sensor) made using the [CMOS](http://en.wikipedia.org/wiki/CMOS) semiconductor process. Extra circuitry next to each photo sensor converts the light energy to a voltage. Additional circuitry on the chip may be included to convert the voltage to digital data.

Neither technology has a clear advantage in image quality. On one hand, CCD sensors are more susceptible to vertical smear from bright light sources when the sensor is overloaded; high-end [frame transfer CCDs](http://en.wikipedia.org/wiki/Charge-coupled_device) in turn do not suffer from this problem. On the other hand, CMOS sensors are susceptible to undesired effects that come as a result of [rolling shutter](http://en.wikipedia.org/wiki/Rolling_shutter).

CMOS can potentially be implemented with fewer components, use less power, and/or provide faster readout than CCDs. CCD is a more [mature technology](http://en.wikipedia.org/wiki/Mature_technology) and is in most respects the equal of CMOS.[[1]](http://en.wikipedia.org/wiki/Image_sensor#cite_note-test1-0)[[2]](http://en.wikipedia.org/wiki/Image_sensor#cite_note-test2-1) CMOS sensors are less expensive to manufacture than CCD sensors.

Another hybrid CCD/CMOS architecture, sold under the name "sCMOS", consists of CMOS readout integrated circuits (ROICs) that are bump bonded to a CCD imaging substrate – a technology that was developed for infrared [staring arrays](http://en.wikipedia.org/wiki/Staring_array) and now adapted to silicon-based detector technology.[[3]](http://en.wikipedia.org/wiki/Image_sensor#cite_note-test3-2) Another approach is to utilize the very fine dimensions available in modern CMOS technology to implement a CCD like structure entirely in CMOS technology. This can be achieved by separating individual poly-silicon gates by a very small gap. These hybrid sensors are still in the research phase, and can potentially harness the benefits of both the CCDs and the CMOS imagers.[[4]](http://en.wikipedia.org/wiki/Image_sensor#cite_note-test4-3)

An **active-pixel sensor (APS)**, also commonly written **active pixel sensor**, is an [image sensor](http://en.wikipedia.org/wiki/Image_sensor) consisting of an [integrated circuit](http://en.wikipedia.org/wiki/Integrated_circuit) containing an array of pixel sensors, each pixel containing a [photodetector](http://en.wikipedia.org/wiki/Photodetector" \o "Photodetector) and an active amplifier. There are many types of active pixel sensors including the CMOS APS used most commonly in [cell phone cameras](http://en.wikipedia.org/wiki/Camera_phone),[web cameras](http://en.wikipedia.org/wiki/Web_camera" \o "Web camera) and in some [DSLRs](http://en.wikipedia.org/wiki/Digital_single-lens_reflex_camera). Such an image sensor is produced by a [CMOS](http://en.wikipedia.org/wiki/CMOS) process (and is hence also known as a **CMOS sensor**), and has emerged as an alternative to [charge-coupled device](http://en.wikipedia.org/wiki/Charge-coupled_device) (CCD) imager sensors.

The term *active pixel sensor* is also used to refer to the individual pixel sensor itself, as opposed to the image sensor;[[1]](http://en.wikipedia.org/wiki/Active_pixel_sensor#cite_note-0) in that case the image sensor is sometimes called an *active pixel sensor imager*,[[2]](http://en.wikipedia.org/wiki/Active_pixel_sensor#cite_note-1) *active-pixel image sensor*,[[3]](http://en.wikipedia.org/wiki/Active_pixel_sensor#cite_note-2) or *active-pixel-sensor (APS) imager*.

**Line-scan camera systems**

A line-scan camera is a camera device containing a line-scan [image sensor](http://en.wikipedia.org/wiki/Image_sensor) chip, and a focusing mechanism. These cameras are almost solely used in industrial settings to capture an image of a constant stream of moving material. Unlike video cameras, line-scan cameras use a single array of [pixel sensors](http://en.wikipedia.org/wiki/Active_pixel_sensor), instead of a matrix of them. Data coming from the line-scan camera has a frequency, where the camera scans a line, waits, and repeats. **The data coming from the line-scan camera is commonly processed by a computer, to collect the one-dimensional line data and to create a two-dimensional image. The collected two-dimensional image data is then processed by image-processing methods for industrial purposes.**

Line-scan technology is capable of capturing data extremely fast, and at very high image resolutions. Usually under these conditions, resulting collected image data can quickly exceed 100 MB in a fraction of a second. Line-scan-camera–based integrated systems, therefore are usually designed to streamline the camera's output in order to meet the system's objective, using computer technology which is also affordable.

Line-scan cameras intended for the parcel handling industry can integrate adaptive focusing mechanisms to scan six sides of any rectangular parcel in focus, regardless of angle, and size. The resulting 2-D captured images could contain, but are not limited to 1D and 2D barcodes, address information, and any pattern that can be processed via image processing methods. Since the images are 2-D, they are also [human-readable](http://en.wikipedia.org/wiki/Human-readable) and can be viewable on a computer screen. Advanced integrated systems include[video coding](http://en.wikipedia.org/wiki/Video_coding), [optical character recognition](http://en.wikipedia.org/wiki/Optical_character_recognition) (OCR) and finish-line cameras for high speed sports.