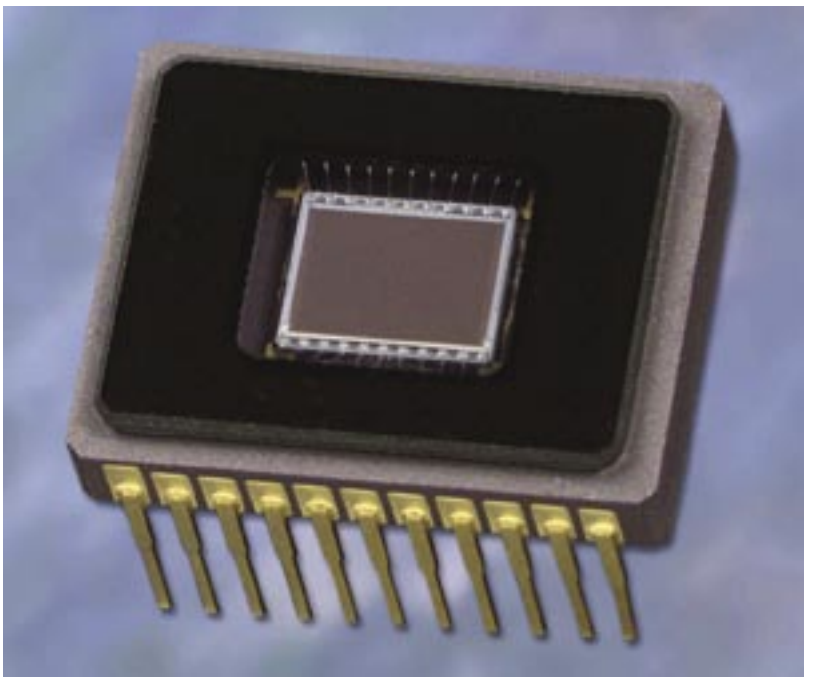
Image Sensors Speedup Automated Inspection

Increasing a system's throughput is a key requirement for today's manufacturers.

By Terry Guy



Kodak's high speed sensor, KAI-0340, is a 640 x 480, progressive scan, CCD image sensor. Image readout time is about 7 times faster with an image sensor such as this as compared to a standard RS-170 video camera. Photo: Image Sensor Solutions, Eastman Kodak Co.

Machine-vision systems use a combination of lighting, optics, cameras, computers and processing software to inspect manufactured items for quality control purposes and are used extensively in the semiconductor and electronics manufacturer markets — markets that require more inspection capabilities and faster throughput. Advances in sensor technology are improving a systems' capabilities to meet these users' needs.

Automated inspection systems are placed throughout the manufacturing process to help improve yield and quality. A key requirement and direction for automated inspection system suppliers is increased speed. Manufacturers measure speed as throughput or how many parts they can inspect per hour. This measure is important because automated inspection machines with higher throughput have faster payback times to their users, a key element in the sale of this equipment.

A typical inspection system is composed of two parts: a handling system for the item that is being inspected and a machine-vision system to determine if the item passes or fails the inspection. While there are several ways an automated inspection system supplier can increase the speed of their system, two key methods are to increase the speed of the handling system or to increase the speed of the machine-vision system.

The machine-vision system captures images of the item being inspected, and algorithms running in the computer determine if the item is good or bad. If the computer speed is increased or the algorithm optimized, an increase in speed from the machine-vision system can be accomplished. These improvements have occurred and will continue to occur as seen with increases in computer operating speeds.

SENSOR ADVANCEMENTS

However, there is another way to realize an increase in speed and that is by decreasing the time of the image capture. The cameras frame rate is a measure of the camera capture speed and is often specified in frequency as hertz (Hz) or in image readout time (1/frequency). For example, a camera that is specified at a frame rate of 30 Hz means the image is read out in 33 milliseconds. This is the time it takes to transfer the image from the camera to the vision system.

Decreasing the readout time of the image capture is accomplished by increasing the frame rate of the image sensor. Typical RS-170 video cameras operate at 30 frames per second with interlaced readout. In this readout mode, the image readout of the camera is broken into two pieces called an even field and an odd field. These two fields are read out at 30 Hz or (1/f) 33 milliseconds. This means that the vision system will get the image of the item it inspected 33 milliseconds after the image is taken. If the readout time can be decreased by increasing the frame rate (t=1/f) and all other factors remain the same, the result will be an increase in speed of the machine-vision system.

Advances in image-sensor technology have allowed camera makers to offer products that directly address this concept. Image sensors are now available that operate at 60 Hz and readout in a progressive scan fashion. With a 60 Hz frame rate, the image is read out in 1/60 second or 16.67 milliseconds. Again, with everything else equal, this translates into a twofold increase in speed as compared to a 30 Hz video camera.

IMAGE SENSOR SEES MORE DETAIL

Prior to the explosion of digital photography, scientists envisioned alternative ways for consumers and customers to store photographs, such as scanning and saving them as electronic files. In order to digitally convert photographs, a high-performance image sensor capable of "seeing" far more detail than the human eye would be necessary to scan the film negatives or photographic prints.

Image sensors manufactured much like mainstream semiconductor chips feature a matrix of tiny photodetectors (pixels) that convert light into an electrical signal that is read-out and converted to digital information. The digital image can then be stored, printed, displayed or transmitted. Kodak scientists realized that image sensors opened the door to a plethora of other applications. Thus began the advent of digital photography.

Kodak image sensors are used in a variety of applications from scanners, satellites, traffic cameras and copiers to professional digital cameras. And they are used in astronomy for high-resolution images of very distant objects. Image sensor technology is in use in NASA's current Mars Odyssey mission to photograph the Red Planet more extensively than ever before.

SOURCE: Kodak

However, there is another benefit. For example, with RS-170 video cameras, the image is read out in an interlaced fashion as an even and odd field. The two fields are actually half of the vertical resolution of the camera. In a typical 525 vertical line RS-170 camera, this means each field is approximately 262 lines. Most machine-vision systems using a RS-170 camera will typically use just one field resulting in using only half of the vertical resolution. This situation is remedied with a progressive scan image sensor. With a progressive scan sensor, the entire image is readout directly. In the case of a 60 Hz, 640 x 480 progressive scan image sensor, all 480 lines are read out in 1/60 second or 16.67 milliseconds. Not only is speed increased, but the amount of image resolution is also increased, providing more detail.

Further increases in image sensor frame rate are also available. For instance, one image sensor on the market is a 640 x 480, progressive scan, interline transfer CCD image sensor that can operate at 210 Hz full resolution or up to 3,000 Hz at partial resolution. At 210 Hz, the image is read out in 4.76 milliseconds, resulting in an increase of approximately seven times as compared to standard RS-170 video cameras.

Advances in image sensor technology have allowed camera makers to offer products that directly address this concept. Image sensors are now available that operate at 60 Hz and read out in a progressive scan fashion.

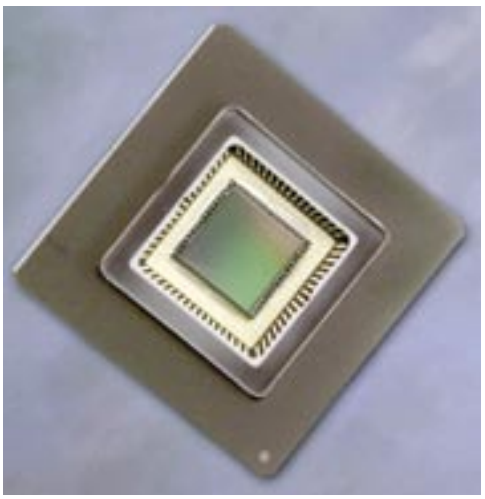
ANOTHER OPTION

Another way to increase the speed of the system is to decrease the time of the handling system. The handling system moves the item being inspected in and out of the camera's field of view. Typically, many images of the item being inspected are taken. This is needed because automated inspection systems often inspect small features on a large object. This process results in many images being taken to cover the item being inspected.

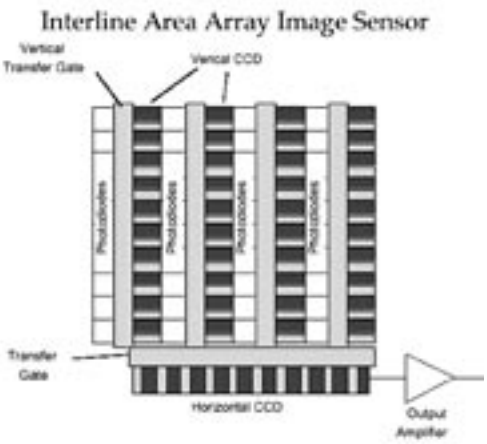
An additional increase in speed can be obtained by decreasing the number of images taken, resulting in less handling time. To accomplish this, some automated inspection system companies are using high-resolution cameras. These cameras have image sensors 1,024 x 1,024 or greater resolution and are used to increase the field of view of the camera resulting in fewer images taken.

There are many trade-offs when trying to increase the throughput of an automated inspection system. Two ways to do so is to increase the camera's frame rate to decrease the readout time, and increase the resolution of the camera to 1024 x 1024 or greater to decrease the number of images taken when scanning an item. Both techniques will provide increases in system throughput. Which one is best is determined by the requirements of the automated inspection system.

Terry Guy is the product marketing manager for Image Sensor Solutions, Eastman Kodak Co. (Rochester, NY). He has more than 20 years experience in the sensor market and has written numerous stories on the topic. For more information, contact Guy at terry.guy@kodak.com.



High resolution sensors, such as Kodak's KAI-1020, have a larger field of view and allows for fewer images to be taken. Photo: Image Sensor Solutions, Eastman Kodak Co.



Graphic of the interline sensor structure. Photo: Image Sensor Solutions, Eastman Kodak Co.