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PHOTONICS SPECTRA

Interline CCDs Serve Machine Vision Applications

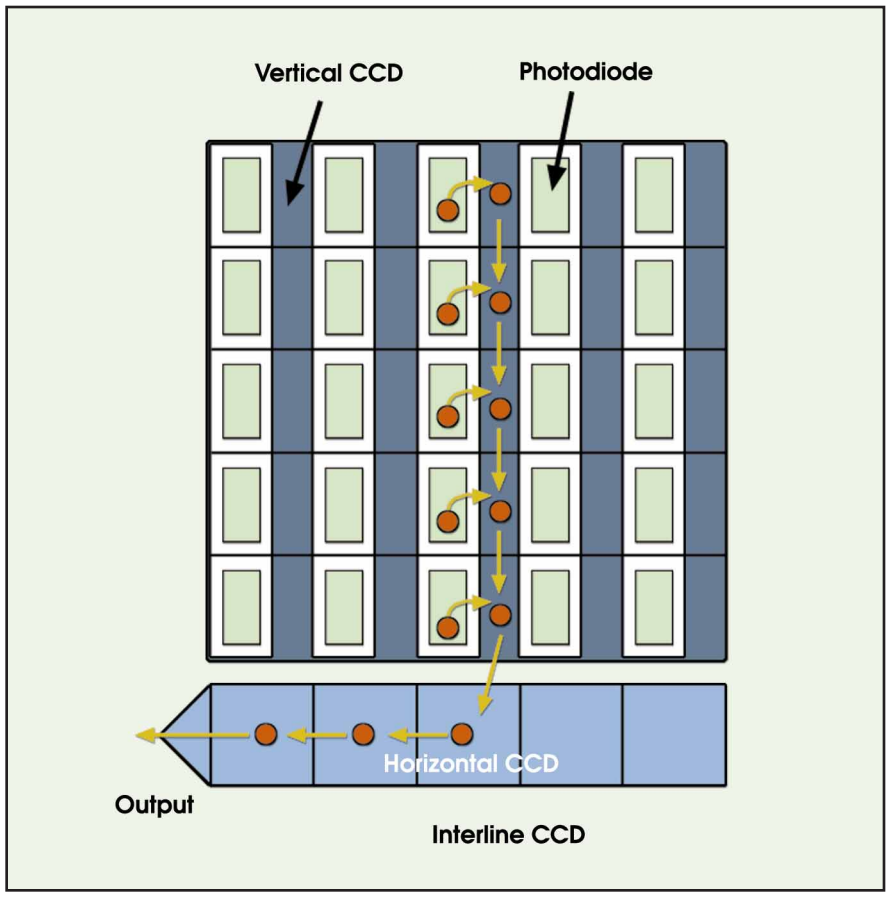
Fast readout, good peak quantum efficiency and antiblooming facilitate high-speed inspection in less-than-optimum environments.

by Terry Guy, Eastman Kodak Co.

Many industrial manufacturers use machine vision systems to control the quality of their products. Such systems can measure the product's size, position and color, the location of key components or other characteristics that determine whether an item should be passed or failed. A key to successful inspection is the choice of image sensor and its ability to capture images quickly and with enough detail to determine whether a product meets specifications.

For this reason, many machine vision applications rely on interline CCD imagers. This sensor type has an array of image-sensing sites (pixels), each of which has a light-sensitive portion to form the image. The other area of the pixel is covered by a metal layer (to block light) and becomes the storage region, called the vertical CCD (see figure). The image that is formed is transferred from the light-sensitive area to the vertical CCD after an exposure. As a result, while one image is being exposed, the previous image can be safely transferred out of the sensor. Interline image sensors can operate in a progressive-scan fashion, where the entire image is read out one line after another.

With these design features, interline CCDs can be clocked at high frequencies to provide fast frame rates. Unlike full-frame CCD imagers, they do not require external shutter capability. Storage of an image after exposure and before being fed to the readout register serves an electronic shutter function, varying the effective integration time of each group of pixels. Unlike mechanical shutters, electronic shutters do not have limited lifetime problems.



Engineers have boosted the speed of interline CCD image sensor chips to 210 fps, an increase by a factor of four over conventional interline technology.

Increasing frame rates

End users should expect to see continued, incremental performance improvements in this sensor type. For example, where a conventional interline CCD may offer around 60-fps readout, 210 fps is possible with an interline transfer CCD image sensor, such as the Kodak KAI-0340M, which has resolution of 640 × 480 pixels and a 1/3-in. optical format.

In addition, it is possible to read out a central portion of the image array to provide up to 3500 fps with resolution of 244 × 60 pixels. Other key features of this sensor type that allow flexible imaging in diverse machine vision applications include antiblooming (which keeps reflected light from shiny areas from corrupting the image), excellent sensitivity and resolution ranging from 640 × 480 pixels to megapixels.

Many cameras designed to take photos use a full-frame CCD, where the imaging sensor is an area array that uses CCDs both to collect photo-generated charge and to transport it. To capture the extremely fast dynamic motion, systems often use interline CCDs.

High quantum efficiency

Although the specifics of machine vision applications vary, users in general look for faster frame rates, to increase system throughput; higher quantum efficiency, to provide better sensitivity; and larger dynamic range, so that relevant details can be seen in both the brighter and darker parts of the image.

Besides ever-increasing pixel counts, much recent work has focused on increasing the quantum efficiency of these CCDs. By adding a microlens on top of the pixel array, light from nonphotosensitive areas can be focused onto the sensitive area, increasing the total amount of collected light. This and other developments have resulted in sensors with peak quantum efficiencies in the range of 55 to 65 percent.

Complementary metal oxide semiconductor (CMOS) image sensors will find use in machine vision applications as this technology matures. Although CMOS designs allow any portion of the imaging array to be read out independently, the requirements of an electronic shutter and restricted image quality limit the acceptance of these sensors for machine vision applications at this time. □

Meet the author

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