For most machine vision camera manufacturers interlaced cameras serve only as legacy products, for the customers that need replacement cameras for long-serving systems. However, there are new interlaced cameras using new sensor technology. This Tech Tip explores the reasons behind this apparently retrograde step and examines the advantages that interlacing can bring to some applications.

► Interlacing?

Interlacing was developed for the television market as a way to increase the apparent frame-rate of a camera without increasing the required bandwidth for the transmission. It works by dividing an image into lines and exposing odd lines first, then even lines. This gives the appearance of doubling the frame-rate whereas in fact only half of the sensor is exposed at any time. Figure 1 illustrates this.

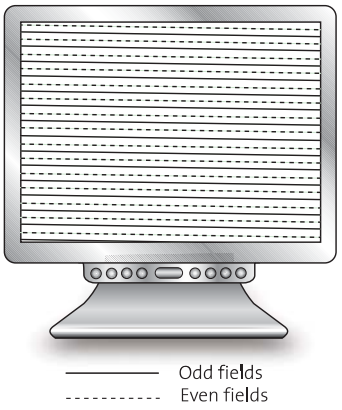


Figure 1 – An illustration of the odd and even 'fields' in an interlaced system.

This system is still used in analogue broadcast television systems, because the eye is sensitive to flickering upto around 40Hz and (in European systems) this gives 25 frames (actually 50 fields) per second.

However, the major problem is that when an image is frozen it can appear to be torn if any of the objects in the image are moving, as shown in Figure 2.

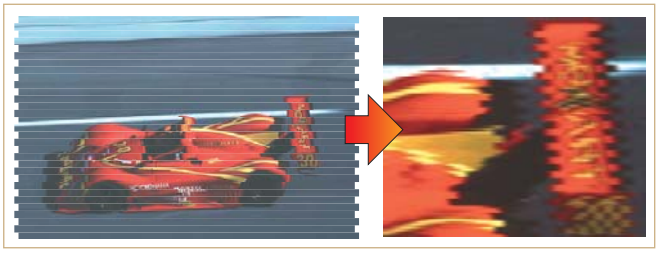


Figure 2 – An example of interlaced artefacts on moving objects

This is the reason that most new machine vision cameras are now progressive scan – outputting a single field with a global shutter to freeze motion in a way that gives better still images.

However, there are still good reasons to use interlaced cameras. As these cameras usually output standard video (i.e. one of the television standards) there is a huge market for the sensor manufacturers in the worlds of security and broadcast television. So while interlaced cameras are considered old technology in machine vision, development still continues and for much larger markets. As an illustration of the demand for interlaced sensors, Sony offer 12 progressive scan CCDs and 52 interlaced sensor models at the time of writing. The huge market for CCTV cameras demands TV standard outputs and high sensitivity. There is also a call for sensors that are sensitive to near infra-red. The developments that were driven by the security sector can be used in machine vision cameras as long as the disadvantages of interlacing are taken into account.

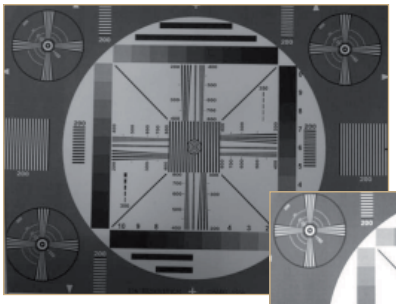
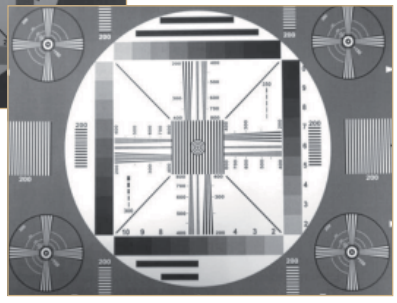


Figure 3 – Comparative images from a progressive scan AVT Guppy F-046B and ....

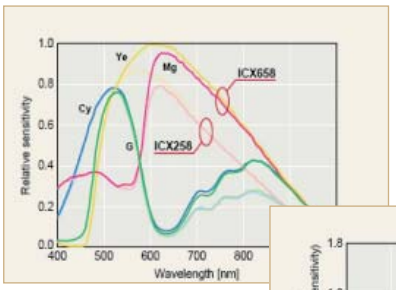


... an interlaced AVT Guppy F-044B NIR.

It is possible for interlaced cameras to be more sensitive as the shift register for interlaced sensors can be simpler and made smaller, allowing a greater fill-factor, although this is not always the case. Figure 3 shows comparative images from two AVT Guppy cameras – one with a Sony progressive scan sensor, the other with a Sony interlaced sensor. Note how much brighter (more sensitive) the interlaced image appears.

► Continuation: Interlacing?

Sony's most sensitive sensors use Sony's EXview HAD technology to improve response at near infra red wavelengths. Due to the markets available for these sensors, there are ten interlaced CCDs with this technology currently available but only one progressive scan sensor (available in colour or monochrome). Figure 4 shows two graphs of relative response against wavelength for one of the Sony EXview interlaced sensors (ICX658) and a conventional Sony interlaced sensor (ICX258). The first graph shows the sensitivity of the two sensors and also the wavelengths allowed through the mosaic filters (discussed later). The second graph shows the difference in sensitivity between the two sensors against wavelength. Human response to light stops at around 780nm, so we define anything above this as infra red. Note that the EXview sensor is still usefully sensitive well into the near IR region.



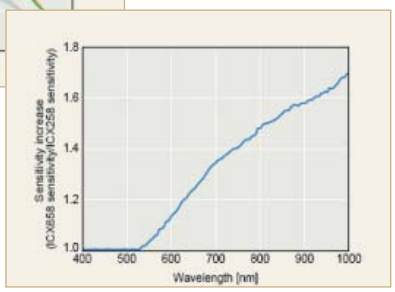
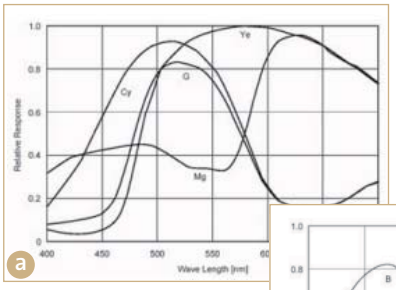


Figure 4 – A graph of relative sensitivity for two Sony interlaced sensors – one with EXview HAD technology (ICX658) and one without (ICX258).

The second graph shows the difference in sensitivity between the two sensors.

Around 50% of existing machine vision applications employ cameras with interlaced sensors. This means that there are a number of specialised applications with specially-designed illumination and trigger methods. New interlaced cameras can be used as 'slot-in' replacements in these systems with the bonus of better sensitivity from newer CCD designs.

A single chip colour camera uses a coloured mosaic filter positioned over the pixels. For colour applications it is relatively easy in interlaced sensors to use complementary colours (cyan, yellow, magenta and green) instead of the usual red, green and blue ('Bayer' filter). In general, Bayer filters give better colour resolution, but complementary filters allow more light through, improving the sensitivity yet further.



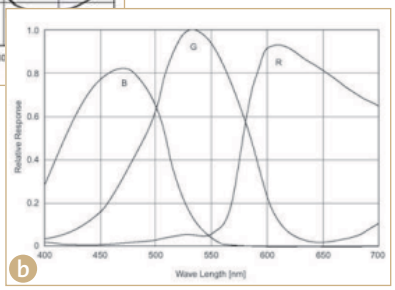


Figure 5 – A comparison of a) complementary and b) Bayer colour filters. The area underneath the colour filters (added together) gives an idea of light transmission.

Generally more light is transmitted through a complementary filter than a Bayer filter.

There are a number of new interlaced models from AVT in their miniature Guppy range that output image data over FireWire. These cover EIA and CCIR standards and 1/3" and 1/2" sensor formats. There are models using the EXview sensors that are specifically targeted at near-IR applications. AVT have also used interlaced sensors for very high resolution Oscar range, which also outputs data over FireWire. These do not use standard video outputs, but two or even three fields. Often it is necessary to 'de-interlace' the image in a PC to use both fields to create a frame. AVT's interlaced cameras allow this to be carried out within the camera so that a frame is output rather than fields.

Figure 6- AVT Guppy (left) and ...

... Oscar (right). All Oscars and some Guppy cameras use interlaced CCDs.

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