Freeing high speed CMOS line scan cameras from the frame grabber

Lionel Touchart, Marketing Manager for Line Scan Cameras at Teledyne e2v

For some decades now, line scan cameras based on just one or two lines of pixel sensors have become well established in machine vision applications used for the high resolution image capture of objects moving at high speed. They are especially suited for installations in which a fixed camera is used to scan a continuous web of material, such as sheet metal, plastic or paper. However, there are also many applications where the camera is moved, such as the inspection of road surfaces or railway track.

In high speed applications, line scan cameras generally offer better performance than a frame camera that uses a two-dimensional area array of pixel sensors. The maximum rate at which the sensor can capture an image and transfer it for analysis is known as the 'line rate' given in kilohertz (kHz). The inspection speeds possible have greatly increased with the development of CMOS technology and are now in the 200kHz range.

There is an ever growing global trend in the machine vision sector to improve defect detection accuracy as well as colour analysis with the use of CMOS technology. This demands an even higher data throughput. Yet at the same time OEMs and their customers need to drive down the implementation cost of imaging systems to maintain their competitive advantage in a challenging market. This is driving the need for more simple and cost-effective designs with a reduced number of components. As a leader in the surface inspection sector Teledyne e2v has focused on eliminating one of the more complex and expensive items in the vision chain – the frame grabber.

Pictures taken by line scan cameras are analysed with image processing application software, specific to the relevant vision system and a frame grabber provides the interface between the image processing software and the camera. In a system comprised of many cameras, the image acquisition chain can become complicated.

The key to an efficient imaging system is simplicity, so adopting a frame grabber-less approach offers an interesting way to help reduce costs and technical complexity. In terms of interfaces, several options have been developed to address the throughput requirements when transferring images from the camera to the processing platform. However, these often pose

design or cost challenges, for example, line scan cameras with a GigE Vision interface meet frame grabber-less design and cost demands, but don't support the bandwidth required for the higher data throughput of colour images. Other frame grabber interface options, such as Camera Link, Camera Link HS, and CoaxPress, meet bandwidth demands but they are constrained by system and cabling costs.

Teledyne e2v's ELiiXA+, multi-line CMOS technology line scan camera offers 4.096 pixels resolution

The answer to the challenges of bandwidth requirements and cost demands for higher speed line scan applications lies in the fast emerging NBASE-T frame grabber-less interface.

The NBASE-T specification defines a new type of Ethernet protocol that boosts the speed of twisted pair cabling well beyond its designed limit of 1 Gbps to support 2.5, 5, and 10 Gbps speeds at distances up to 100 meters. Initially developed for telecommunication applications, NBASE-T technology offers a natural evolution for high performance imaging due to its bandwidth support, low cost cabling, and compatibility with the GigE Vision standard.

Teledyne e2v has partnered with Pleora Technologies to incorporate the new NBASE-T interface in its two families of line scan cameras (ELiiXA+ and UNiiQA+) that support any resolution from 0.5K to 16K, with Camera Link and CoaxPress interfaces.

Teledyne e2v's UNiiQA+, single line CMOS technology, in 4.096 pixels resolution

Relevance and possible applications for the machine vision industry

The high throughput of new NBASE-T cameras will enable high resolution and colour imaging in a frame grabber-less system. The extended reach, flexible, and field terminated cabling can be easily routed through systems to ease installation and maintenance when compared with more costly cabling required for Camera Link and CoaxPress interfaces. The GigE Vision standard, based on Ethernet technology, is independent to the hardware interface, that means existing GigE Vision software is fully compatible with this new NBASE-T technology. Furthermore, we estimate that the Network Interface Controller (NIC) for the NBASE-T solution will be approximately seven times less expensive than comparable Camera Link and CoaxPress solutions.

The view from a machine visions systems provider

Raoul Kimmelmann, Managing Director at Rauscher GmbH (a provider of machine vision solutions in Germany), says:

"We see applications for NBASE-T line scan cameras in food sorting and web inspection for print, film, and paper production. Here we've observed a trend towards higher line rates and colour imaging.

"As these inspection machines are usually large, a combination of high bandwidth and long cabling (beyond 10m, which can get difficult and/or expensive in Camera Link solutions) is necessary. In foil or paper production the width can go up to 8m, meaning multi camera setups are quite standard and the NBASE-T interface provides a big advantage for the network setup as we can reach up to 5 Gbps without changing the network."