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Tech-Tip

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Very High Resolution Imaging

This Tech Tip discusses very high resolution imaging and the various ways it can be achieved.

Linescan

Linescan cameras, in their simplest forms, use a sensor with a single line of pixels. Typical resolutions vary from 512x1 pixels upto 16384x1 pixels, see Figure 1. Linescan cameras work in a similar way to a flatbed scanner, fax machine or laptop fingerprint scanner by building up an 'area image' from multiple lines. In a machine vision camera this typically happens in a framegrabber. As only the width of the resulting image is fixed, it allows a very high resolution image to be created and also means that images of different aspect ratios can be created. Typically areascan sensors have an aspect ratio of 4:3, 16:9 or 1:1, but linescan images are not limited to this and can closely match the target. Even with a 4:3 ratio a 16k linescan camera would allow either a 358 megapixel or 201 megapixel image, depending on the orientation. With long line-lengths there is a requirement for large format lenses also. For some applications, particularly those with a relatively short working distance, it may make sense to use multiple cameras and stitch the images. This is far easier than for areascan cameras, since any lens distortion is only in one direction, rather than two.

Figure 1 – Teledyne DALSA Piranha3 16k, a very high resolution, high-speed CMOS linescan camera.

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Areascan

The limitation of linescan is that it requires that there is movement past the sensor to build up an image and this is not always possible. With areascan sensors the pixel count is also always increasing. In recent years it has become affordable to use 10 megapixel CMOS sensors, for example in the IDS UI-1490 range of cameras, see Figure 2. This uses a rolling shutter design that can cause image artefacts if the target is moving at a significant speed. DALSA's range of global shutter CMOS sensors range from VGA to an upcoming 8 megapixel version. These offer high-speed as well as high-resolution and good signal to noise ratios.

Figure 2 – left: IDS UI-1490ME (10 megapixels, CMOS rolling shutter), right: Teledyne DALSA Falcon 4M60 (4 megapixels, CMOS global shutter).

In the world of CCD sensors, increasing pixel count has been shown by several manufacturers. Sony has released a 2/3" 5 megapixel CCD that can be found, for example, in the JAI BM500GE, see Figure 3. Meanwhile Kodak has a series of four-tap CCDs including a soon-to-be-released 28.8 megapixel sensor that will be integrated into the AVT Prosilica GX range to create the GX6600, see Figure 3.

Figure 3 – left: JAI BM 500GE (5 megapixel GigE camera), right: AVT GX6600 (28.8 megapixel camera using two aggregated GigE links for double bandwidth)

Novel ways to increase resolution

STEMMER IMAGING has recently started selling the CVC Ultra cameras, see Figure 4. These use a 5 megapixel Sony sensor with ‘pixel shift’ technology to create 125 megapixel mono images or 45 megapixel colour images.

Figure 4, CVC Ultra 45 megapixel colour camera or 125 megapixel monochrome camera using pixel shift technology with cameralink base output

By moving the sensor with piezo-actuators, 3 horizontal and 3 vertical positions are used to create 45 megapixel images or 5 x 5 positions to create 125 megapixel images. For the colour version the Bayer mosaic version of the Sony sensor is used. The piezo-actuators can be used in two ways:

1) To create a 45 megapixel Bayer colour image (so the pixel shift effectively multiplies the resolution of the Sony sensor by 9)
2) In a 5 megapixel ‘3 CCD mode’. Here the four elements of the square Bayer mosaic (red, green, green, blue) are shifted so that each pixel position of the 5 megapixel image is exposed with a red, green, green and blue pixel. The effect is similar to that of a 3 CCD sensor in that there is no interpolation to create colour information for each pixel. This means that there is not the colour-fringing that can occur in Bayer colour images.

There is, of course, a time-shift between these positions and their exposures, so it is necessary that there is not significant movement of the camera or target over the acquisition time. However, this technology allows for a massive increase in resolution without a requirement for large format lenses.

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