

ADVANCED IMAGING

SOLUTIONS FOR THE ELECTRONIC IMAGING PROFESSIONAL

The Wonderful World of Color

*When is it worthwhile to
purchase a color MV camera?*

**The Growth of
Thermal Imaging**

**Analytical
Instrumentation
Supplement**

The Wonderful World of Color

When is it worthwhile to purchase a color MV camera?



Color machine vision allows inspectors to check for ripeness and product quality. (Courtesy DALSA Corp.)

- Color machine vision
- 3CCD sensors
- Camera Link
- GigE

There is, seemingly, a manufacturer producing a quality camera, whether CCD or CMOS, for every application.

Imaging solutions are being found in almost every conceivable photonics area, from biomedical to military and aerospace, from the laboratory to homeland security.

While camera selection never has been greater and variable features such as speed, resolution and output requirements give the end user a wide variety of performance options from which to choose, one area is growing at a much slower pace. Color.

“While the machine vision industry has undergone some revolutionary changes in recent years, one area that continues to advance at a relatively slow pace is

that of color machine vision,” says Robert Howison, Project Leader (OEM Custom Projects) at DALSA Corp., (Montreal). One of the historical reasons for its slow adoption has been that solving a MV problem with color always required more money and processing power than an equivalent monochrome solution.”

That situation, however, is beginning to change, he says, because the cost of MV hardware and software has dropped drastically bringing both monochrome and color solutions within the reach of OEMs who, just a few years ago, would have laughed at an MV sales representative.

According to the Automated Imaging Association (AIA), only about one-third



Fig. 2: Single-chip area scan cameras use a single sensor that is covered by a color filter with a fixed, repetitive pattern. To reconstruct a complete color image the red, green and blue information is interpolated across several adjacent cells to determine the total color content of each individual cell. (Courtesy Toshiba Imaging Systems)

of all machine vision cameras sold in North America are color, however inroads are being made, primarily because of technological advances. For example, today's computers are able to process color's much larger data signals much faster, sensor technology has improved and sensors are less expensive. Finally, many new sophisticated software algorithms have been developed.

One of the technical changes spurring the market is the three-chip camera. Scientific imaging applications for use in diagnostic equipment are finding huge advantages with 3CCD technology, says Gary Pitre, Eastern Regional Sales Manager for Toshiba Imaging Systems Division (Irvine, Calif.). "The color information provides a tremendous amount of data that cannot be recognized with single-chip cameras," he says. "In the laboratory, for example, pathologists are viewing human cells and tissue with more color accuracy than ever before, giving them a new advantage in their work."

There are far fewer 3CCD camera manufacturers than there are single-chip suppliers in today's market. The technology is much more specialized and thus more expensive, even though the price has come down in recent years.

"Single-chip area scan cameras use a single sensor that is covered by a color filter with a fixed, repetitive pattern," Pitre explains. "To reconstruct a complete color image, an interpolation is needed. The red, green and blue information is interpolated across several adjacent cells to determine the total color content of each individual cell, therefore providing less color accuracy than 3CCD (Fig. 2).

Three-chip CCD cameras contain three separate image sensors and a prism that divides the incoming light rays into their red, green,

and blue components. Each chip then receives a single color at full resolution, providing the best color accuracy available (Fig. 3)."

Toshiba Imaging Systems Division has focused primarily on 3CCD cameras for the scientific imaging, broadcast, factory automation and industrial video markets. Although the applications requiring 3-chip color camera technology are far less demanding than the traditional single-chip cameras, they are gaining popularity in many vertical industries.

Toshiba's line of seven camera-link and analog 3-chip cameras include its latest, the IK-TF9C, which uses a camera-link interface. The model features a 2048 x 1536 pixel output resolution with a frame rate of 20 frames per second in full frame and 40fps in partial scan. Its IK-TU51 remote head camera has been integrated into Apollo Telemedicine's ASAP Imaging® telediagnostic medical imaging software, which allows a pathologist to look at real-time high-resolution images from under a microscope via internet streaming video.

DALSA expanded its Piranha family of line scan cameras to include a Piranha Color model. DALSA's tri-linear sensor technology uses three sensors on one die - one for each color,

red, green, and blue, and achieves three-pixel center-to-center line spacing. The Piranha Color has a camera-link interface and is available in 2k or 4k resolutions with line rates up to 33 kHz, allowing users to inspect more material in less time.

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A new entry in the 3CCD category is JAI's CV-M9 GE camera which, unlike others, has a GigE Vision interface. It also features programmable general purpose input/output ports (GPIO) and uses Cat5e or Cat6 cabling and doesn't require a dedicated frame grabber in the PC.

HOW TO CHOOSE

Color isn't necessary if you want to inspect your product for scratches or bumps on its color finish. Why? "In this instance the defects disrupt the evenness of a surface, which in turn affects the way light is reflected," says DALSA's Howison. "When you're grabbing images of a homogeneous surface (one that's perfect and has no discernable texture) all the pixels in the image will be about the same. But as soon as you grab an image of a scratch or a bump, suddenly light gets scattered in different directions. The scratches and bumps create areas of pixels that are darker and lighter, which means you don't need color."

When do you need color? "Any time you need to evaluate the presence or density of a color, its evenness of distribution or its similarity to some known reference," Howison says. One example is food. "Color allows us to determine ripeness and grade product quality. In the case of grains and legumes, color helps to grade product quality and distinguish foreign matter in a steady stream of product. In meat processing, color can be used to detect spoilage and discriminate areas of fat, bone and gristle for automatic trimming."

In the automotive industry, one might think of paint inspection, but car manufacturers have used automated paint systems for years without the need of automated visual inspection, Howison points out. "Today, the bulk of the effort goes into inspecting the fine visual details that make up the user interface. For example, making sure the consistency and evenness of the instrument-cluster light panel is important because the look and overall quality of that panel and the dashboard go a long way toward contributing to a driver's impression of the car's quality."

Another area where color is making inroads is sports television and the reality TV programming craze, says Toshiba's Pitre. "The broadcast market is seeking out 3CCD remote cameras for head-cam shots. They produce much better color fidelity over single-chip color cameras and the reproductions quality is essential for them. It's critical for the color imagery to look as close to the quality of the high-end broadcast cameras as possible when they switch."

Other applications include print inspection (quality and registration), CD and DVD labels, pharmaceutical inspection

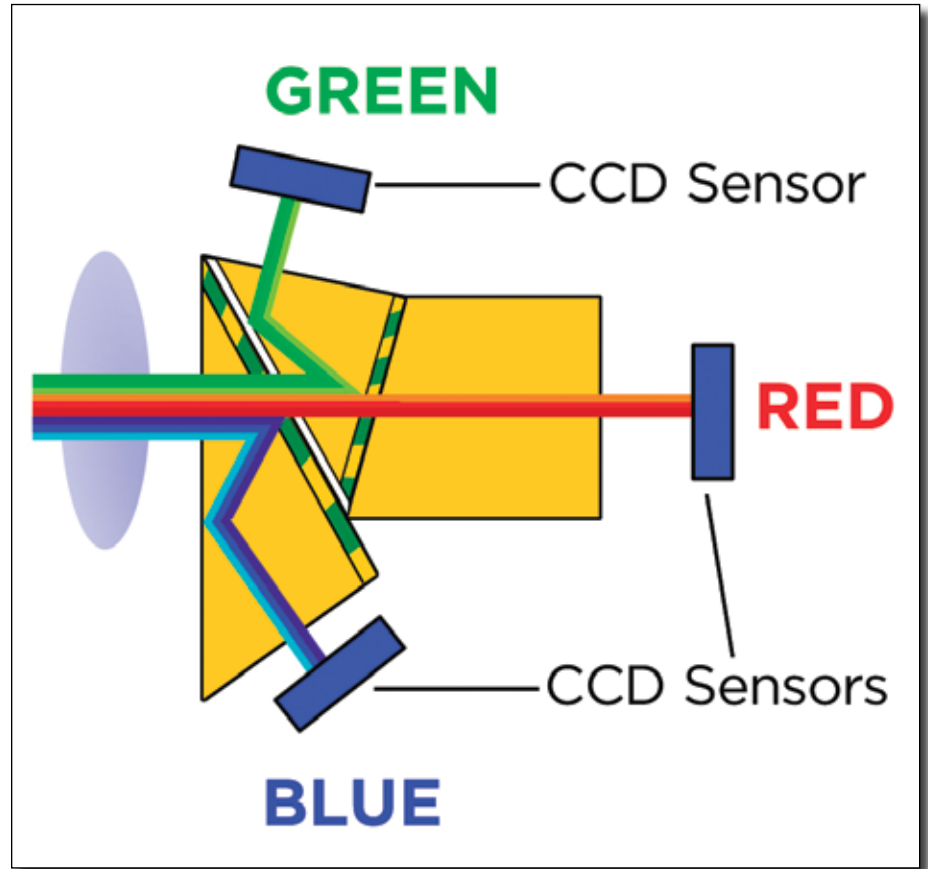


Fig. 3: 3CCD cameras contain three image sensors and a prism that divides the incoming light rays into their red, green, and blue components. Each chip then receives a single color at full resolution. (Courtesy Toshiba Imaging Systems)

tion (label verification), printed circuit board (PCB) inspection, and part presence and/or detection. In addition, there are numerous quality and grading applications that involve color and texture classification for things like wood, textiles and ceramic tile.

Some applications make the choice easy, but if there is any doubt, Howison says, ask yourself these questions:

- Is the object's color quality and consistency a key factor in the overall quality of your product?
- Can the object's color help you ascertain the relative quality of your product?
- Will color facilitate detection of the object?

If the answer to any of the three is yes, consider color machine vision. **AI**

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