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On the cover:
New high definition television (HDTV) cameras are being integrated into industrial environments to assist in the inspection of a variety of manufactured products these days. For more information, see the applications article on page 3a.

(*Image courtesy of Dage-MTI*)

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Applying HDTV Imaging Technology To Industrial Applications

New high definition (HD) television cameras are being integrated into industrial environments to assist in the inspection of a variety of manufactured products. HDTV technology is reaching areas of application far outside the broadcast or entertainment markets, in part because of the capability of perfectly matching the cameras' HD resolution, pixel to pixel, to high definition LCD and LED monitors, making these systems ideal for real-time, live viewing inspection.

Quality Control Inspection

One application utilizing the newest HD camera system involves the quality control (QC) inspection of circuit boards at an industrial manufacturing plant. The original QC process involved three inspection stations with the line inspectors looking through the eyepieces of stereo microscopes with typical magnification of 7x to 40x. Because the employees were required to wear safety glasses, this made viewing images through the microscopes even more difficult and often resulted in eye fatigue. The decision was made to remove the three microscope stations on the inspection line and replace them with the newest single-chip CMOS camera technology, e.g. a high definition, real-time camera system for each station, all connected to high definition monitors (Figure 1). Since the cameras and lenses are much smaller than the microscopes, they can be placed higher, allowing for more working space for the inspectors. The monitor can also be mounted slightly higher to keep it out of the way, and it can be shared with a local computer, if needed (Figure 2).

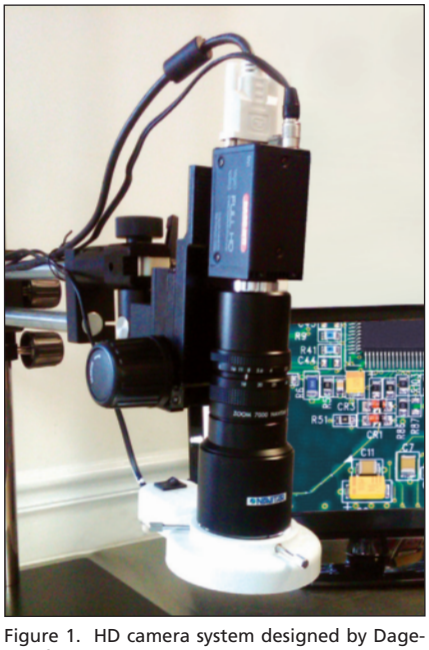

Figure 1. HD camera system designed by Dage-MTI for a circuit board inspection application.

In addition to eye fatigue, which was remedied with the use of a high def monitor, alignment of a microscope system with its many parts (e.g., eyepieces, condenser, and lighting) can be difficult. Use of the HD camera system with one main component eliminates misalignment of the image.

Vibrations, which also present a challenge, are often caused by the weight of the microscope and/or the technician looking into it. Because the lightweight camera creates no vibration on the mount and the technician views the image on a monitor, these issues are also resolved with the HD system. Enabling the inspectors to view the live HD images on the HD monitors has improved the quality of the inspection dramatically.

The inspector's physical comfort (not having to lean over to view through the microscope eyepieces) and the monitor being visible to everyone in the vicinity, sometimes even several lines away, has also contributed to an increase in quality control on the circuit board inspection stations. Further, the technician could easily point to a defect on the screen to a colleague, if collaboration was required. In this ongoing inspection process, the experienced inspection technicians are also using the HD system to "visually" train new personnel with live, real-time demonstrations on how to detect circuit board defects.

The circuit board manufacturer has employed the Dage-MTI HD-210D high definition single-chip CMOS camera, with a Navitar Zoom 7000 Macro-Zoom lens, a Schott-Fostec annular fiber optic ring light with polarizer, and a high definition monitor. The illuminator provided a uniform light source which eliminated the unwanted shadows from the circuit board while the polarizer used on the light source and camera lens prevented bright reflections from the solder pads and wire elements.

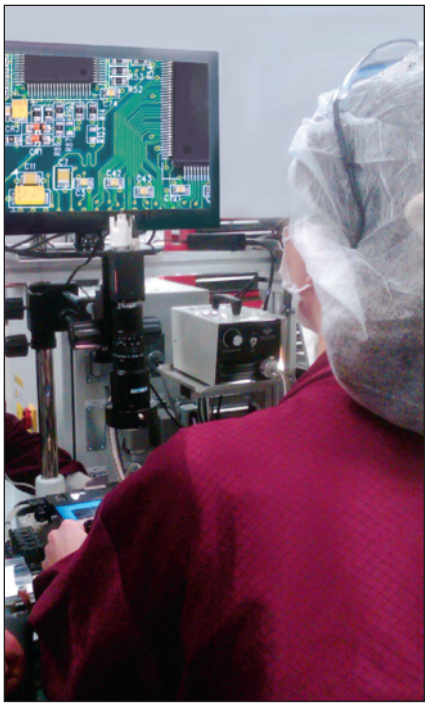

Figure 2. Circuit board inspection line utilizing the new HD-210D imaging system.

The solution for simple HD image archiving is achieved in this application by using the RV-DR capture device. One click of the mouse automatically labels and saves images to a USB memory stick, and a scroll of the wheel allows instant review of all the captured HD images.

Resolution

Recent innovations in real time, full screen HD video provide the user with true 1920 (H) × 1080 (V) resolution, for use in industrial inspection tasks. The high definition color cameras provide a simple solution to viewing highly detailed images in a real-time, live mode, and provides a 6.75x increase in resolution over the standard format real-time CCD cameras [640 (H) × 480 (V)]. There is no programming, software, or computer needed to achieve the HD image.

Older camera technology has permitted color adjustments to only three primary colors: red, green and blue (RGB). Newer high definition 3-chip CCD and single-chip CMOS cameras have the

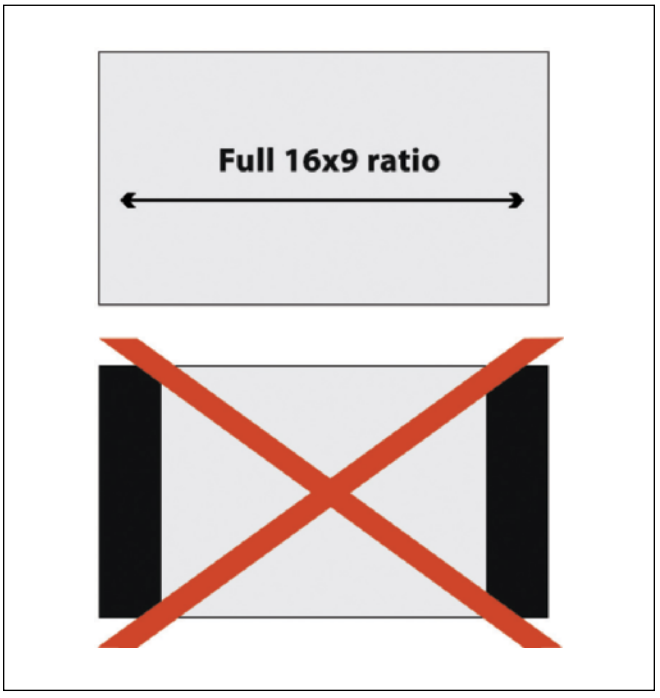

Figure 3. (Top) Illustrates full screen output with a true 16 x 9 aspect ratio that is provided by the high definition (1920 x 1080) camera system. (Bottom) Illustrates what can happen to the image with 3MP or higher resolution.

capability of reproducing perfect color because they can be calibrated to auto-adjust more colors: yellow, cyan, green, magenta, red, and blue. In addition, the 2.1 megapixel CMOS high resolution camera used for circuit board inspection utilizes a pattern of filters which cover the image sensor. Each pixel is measured with the amount of incoming light through the corresponding filter to produce outstanding color clarity and color reproduction. Certainly there are cameras with much higher resolution such as those with 3 megapixels, 5 megapixels or higher. However, these cameras do not operate in real time.

Megapixels

It is also important to point out that the 3MP and 5MP cameras have an aspect ratio of 4 × 3 as opposed to the HD images which have a 16 × 9 aspect ratio. If you attempt to display any of the 3MP, 5MP or high resolution images on a large screen LCD or new LED monitors, one of two things will occur. The image will be squeezed vertically to fit the large screen monitor with its 16 x 9 aspect ratio, producing wide black vertical stripes on either side of the image. Conversely, if you stretch the image to fill the entire width of the monitor screen then you truncate or lose the top and bottom parts of the image (Figure 3).

In either case, there is another, more significant problem. On the 3MP and 5MP or higher resolution cameras, the display has to interpolate or compress the horizontal and vertical resolution of each image in order to be viewed on the large screen monitors. This interpolation causes aliasing of all high resolution images, which essentially distorts the image. The higher the resolution the more this distortion affects the image.

For optimal resolution and viewing, HD cameras should match exactly the pixel to pixel resolution of the LCD and LED monitors. Because the aspect ratio of the HD images is 16 x 9, no vertical black stripes are present on the HD monitor. Especially important for inspection tasks, there is no vertical compression of the image to make it fit the HD monitor display and there is no horizontal stretching of the image to make it fit the width of the screen. This eliminates aliasing caused by interpolation or compression of the large images to make them fit the large screen monitor.

In addition to industrial applications for inspection the new HD technology is becoming more prevalent in microscope cameras that can provide smooth motion plus a sharp, true color, full screen HD image, due to the high frame rate of 60 frames per second. Utilizing the new instrumentation in settings such as tumor boards, clinical rounds, pathology labs, and classrooms, the HD camera systems, in conjunction with large, flat screen HD monitors, are enabling more effective and accurate teaching methods.

Inspection methods are becoming ever more sophisticated with advanced technologies, allowing for vast improvements in manufacturing and training. As we have seen, the use of high definition television imaging has major applications in industrial quality inspection, personnel training, and documentation of defects.

This article was written by John Bogan, Director of Imaging, Dage-MTI (Michigan City, IN), with contributions from Mark Blanton, Microscope Solutions (Raleigh, NC). ***For more information, contact Mr. Bogan at jbogan@dagemti.com, or visit http://info.hotims.com/34456-201.***