technologytrends

Andrew Wilson, Editor, andyw@pennwell.com

INDUSTRIAL INSPECTION

Smart cameras check bottles at high-speed

In today's manufacturing environments, products are being produced at increasing rates. This is especially true in the beverage industry where bottles are filled, capped and inspected. Cap inspection, tamper band and printed date code must be performed quickly to keep up with demand. The systems that perform these tasks must be designed so that wash-down and sterilization can be completed rapidly.

This was the task faced by EPIC Systems (St. Louis, MO, USA; www.epicmachinevision.com) when a major producer of soft drinks approached the company to develop a system to inspect 6oz plastic bottles of fruit juice at speeds of up to *continued on page 6*

FORESTRY AUTOMATION

Vision system speeds log volume analysis

To remain competitive, lumber mill operators must accurately determine the amount of wood that is produced from their timber suppliers. In the lumber industry, this is determined by measuring the length and diameter of logs and then calculating how many one inch thick boards can be fabricated from them – a figure known as board feet measure.

After trees are felled, they are de-limbed and cut to a specific length after which the diameter of each one must be measured. "In the past," says Greg Hilbert, President of eSolutions (Lafayette, IN, USA; www.teamesolutions.com), "measuring the diameter of each log was performed manually – a process that was labor intensive, time consuming and not consistently accurate.

Based on the success eSolutions had shown in the development of a vision-based wood trimming system, Pike Lumber (Akron, IN, USA; www.pikelumber.com) tasked Hilbert and his colleagues with the development of a vision-based system to automatically perform log diameter measurement.

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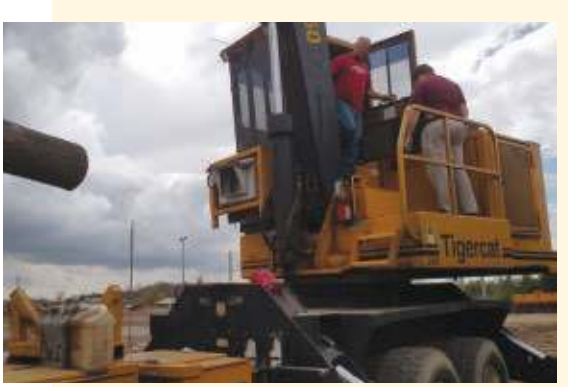


Mounted to the front of a Tigercat 240B loader, a vision system from eSolutions allows the operator to automatically determine the width of timber logs without leaving the cabin.

AUTOMOTIVE ANALYSIS

Conoscopic holography makes engine measurements more accurate

To ensure the high performance required by today's automotive engines, automotive manufacturers must ensure that engines are manufactured with close tolerances. This entails inspecting the engine block to make certain that machined features such as bore holes meet the correct specifications.

"In the past," says Dr. Xavier Savin, President of Groupe Visionic (Saint-Aubin-lès-Elbeuf, France; www.visionic.fr), "such tasks were accomplished using coordinate measurement machines that used mechanical probes to make such measurements." Although effective, such systems are less accurate that those that employ non-contact optical measurement techniques.

One such highly accurate optical method for performing such non-contact measurement is that of conoscopic holography, a technique that has been used by Groupe Visionic in the development of an automated machine to measure features of engine blocks such as the depth and width of bore holes.

After engine blocks are manufactured, they are robotically placed on a stage under two ConoPoint-3 laser distance sensors from Optimet (North Andover, MA, USA; www.optimet.com) that are mounted on an X-Y-Z gantry. To measure the geometric charac- *continued on page 8*

900 units per minute.

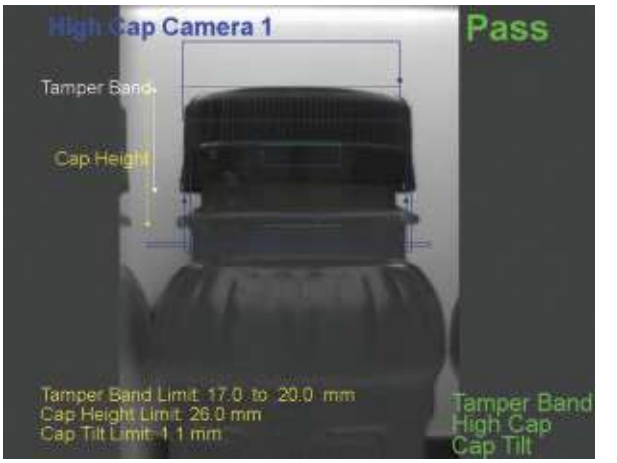
The bottle inspection system was placed after the company's filler and capper machine. It was engineered to ensure the correct cap position, perform tamper band verification and check whether a printed date code was present on the top of the cap. To perform this task, EPIC Systems' vision system uses three In-Sight 5600 smart cameras from Cognex (Natick, MA, USA; www.cognex.com), each of which captures a 120° segment of the exterior surface of the containers.

Fitted with 16mm focal length Fujinon lenses from Fujifilm (Minato, Tokyo; www.fujifilmusa.com), the cameras are placed approximately 8in from the bottles as they pass along a 4in wide conveyor. Another In-Sight 5600 smart camera views the top of the bottle cap through a DLPW 300 x 300mm flat dome light from Smart Vision Lights (Muskegon, MI, USA; www.smartvision-lights.com). All four cameras were interfaced over Ethernet to a Control Logix PLC from Allen-Bradley (Milwaukee, WI, USA; www.ab.rockwellautomation.com).

To ensure wash down and sterilization can be performed, each of the cameras is mounted in a rugged enclosure from Allison Park Group (APG, Allison Park, PA, USA; www.apgvision.com). Likewise, since the DLPW 300 x 300mm flat dome light is enclosed in a stainless steel housing, it can withstand the harsh environmental conditions demanded by washdown procedures.

"In the design of the vision system, it was necessary to evenly illuminate the sides and the top of the containers as they move through the bottle inspection station," says Chris Walker, Project Manager with EPIC Systems. "Rather than place LED lighting around the three cameras to illuminate the sides of the containers, simple white back reflectors were placed opposite each camera. This reflected the light from the flat dome illuminator to back-light the bottles. In addition, the light indirectly illuminates the front of the bottles,

EPIC Systems has developed a system to inspect 6oz plastic bottles of fruit juice at speeds of up to 900 units per minute.



Measurements such as the distance from the cap shoulder to the tamper band (or pull-up), cap height measurement and the cap height are determined using Cognex's In-Sight Explorer software.

allowing for an accurate tamper band inspection measurement. Thus, a single light is used to produce a top indirect illumination, indirect front lighting and backlighting from the reflectors to distinguish the bottle's outer-edge features."

The bottles are tracked by an incremental encoder as they move along the conveyor at 900 bottles per minute. The encoder is fitted to the conveyor belt shaft and interfaced to the PLC. An optical switch is also interfaced to the PLC and triggers each camera, to capture an image at a 150µs exposure time.

Walker and his colleagues used Cognex's

In-Sight Explorer software to analyze whether the cap and tamper band was correctly placed, and the printed date code was present on the top of the cap.

"To check the placement of the cap and tamper band," says Walker, "it is necessary to accurately locate the position of the bottle in the field of view of the image." To do so, edge detection tools are first used to determine the position of the top and shoulder of the bottle. Once this is determined, regions of interest (ROI) are automatically placed around specific areas in the image where the cap and tamper band are located. Measurements such as the distance from the cap shoulder to the tamper band (or pull-up), cap height measurement and the cap height can then be determined. These measurements are performed on all three images captured from the three In-Sight 5600 smart cameras to provide a 360° inspection of the container.

To check whether printed characters are present on the top of the container, captured images are first thresholded and a morphology operator is used to dilate the black pixels within the image. An edge detector can then be used to place a ROI around the text and the percentage of black pixels within the bounding box counted.

"In this way," says Walker," bottle inspection systems can determine whether the correct amount of ink has been placed on the top of the bottle cap." Should a cap, tamper band or cap inspection fail these inspections, an output from the PLC is used to trigger a pneumatic rejection mechanism from Filtec (Torrance, CA, USA; www.filtec.com), that ejects the container from the conveyor.

To allow the operator to visualize the images as they are captured, the system uses a PanelView graphic terminal from Allen-Bradley that is interfaced to the Control Logix PLC. Running Cognex's Vision View software in conjunction with Allen-Bradley's Factory Talk View software allows the operator to visualize images and control the system from a single HMI.

EPIC Systems has installed more than 100 bottle inspection vision systems of various types and designs at bottling and canning facilities worldwide.

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teristics of the face of the engine the first laser scanner is used to make multiple distance measurements of known reference points on the engine block.

"Since the engine will not be placed in such a manner that all the bore holes will be perpendicular, data from the first laser scanner can be used to calculate its position in x-y-z space," says Savin. Once this is known, the scanner can be repositioned in x-y-z space to make an accurate measurement of the depth of each hole.

To measure the inside diameter of each of these holes, a second ConoPoint-3 laser distance sensor is fitted with a periscopic probe custom designed by Groupe Visionic. By fitting the laser sensor with the periscope probe, laser light from the sensor is then redirected at right angles from the periscope.

Using engine orientation data previously computed, this probe can then be placed at the correct angle within the bore hole. To make measurements of the diameter, the probe is then lowered into the hole at a depth of usually between 25-35mm and the ConoPoint-3 laser distance sensor fitted with the periscope automatically rotated. In this way, reflected laser light from the 360° circumference within the hole can be captured.

"Because the ConoPoint-3 laser distance sensors use the principle of conoscopic holography, an accuracy of between 20-50µm can be attained," says Savin. In the system developed by Groupe Visionic, the laser sensor is first positioned at a known distance of between 3-50mm from the part to be measured.

Monochromatic eye-safe laser light from the sensor is then focused onto the part to be measured using an objective lens. Reflected light from the part is then polarized into two orthogonal polarizations which then pass through a uniaxial crystal in the sensor. In such crystals, the refractive index of one crystal axis is different from the other such that light with one polarization will travels at a different speed than one that is polarized differently. Thus, the two rays that emerge from the crystal have distinct relative phase and cross-polarization angles.

By placing a second polarizer after the crystal, the direction of the electrical field of the rays is then recovered with the result that the phase delay between them will result in an interference pattern at the output. Because this pattern varies with the distance the laser scanner is from the object under test, signal processing algorithms can be used to retrieve the distance information from measured fringe pattern data.

Groupe Visionic has developed an automated machine to measure features of engine blocks such as the depth and width of bore holes using laser distance sensors.