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Harnessing the Power of Smart Cameras for Machine Vision Applications

Is the top on that bottle placed properly? Are those the correct parts in that tray?

Making the incidental check to determine accuracy of a part or product flow on a production line might be a simple task, but when those inspections and measurements need to be made at rapid-fire speed with unwavering precision, it's time to consider harnessing the capabilities of a smart camera. Packed with intelligence, optics, and the communication and processing power of a PC, today's smart camera brings sophisticated machine vision down to the point of inspection. Local intelligence allows the imaging, the decision, and the action to take place at the same location, translating a once multi-faceted job into fewer steps, fewer connections, fewer opportunities for error, and reduced overall system complexity.

Power and intelligence in one small package

Modern smart cameras bring many benefits. They are economically viable. They can be used for all the classical machine vision applications: inspection, gauging, location and placement, and identification. In most cases, the equipment is simple to install, implement, program, and use. If a manufacturer needs to make only one measurement, a single smart camera is virtually always a better option than installing a camera, computer, and vision board.

Jonathan Ludlow, product manager, Microscan, elaborates further on the evolution of smart camera technology and its growing impact on machine vision applications. Smart cameras have undergone marked advancements in recent years, notes Ludlow: "Initially, machine vision systems were large and bulky. Image data from the camera were sent by cable to a controller, PC, or specially outfitted computer, which performed the analysis and made a decision." As advancing technology yielded smaller and better devices, he adds, smart camera components followed suit, decreasing in size and adding functionality. Now all the intelligence resides within the camera.

Today's technology allows exceptional processing power to be placed in the same enclosure with the optics and still be reasonable in size and cost, points out Ludlow. In addition, such packaged applications are more focused, allowing each inspection site to have its own dedicated processor. "Earlier systems typically had many cameras linked back to one computer, which would perform decision-making tasks for numerous inspection sites. Today, one smart camera is dedicated to each task," Ludlow explains.

Currently, the typical standard smart camera consists of a lens, an image sensor and a processor (which is basically a small computer and a communication system in a single, compact enclosure). The process begins with the camera acquiring the image (using a lens, imager, and sensor), processing the image (using the computer—which incorporates memory, processor, and software), and then using a communication system to transmit results to other systems outside the camera (using a network or discrete signal to a PLC or other controller).

It is important to note that all imaging systems are not machine vision systems. Imaging systems take pictures and analyze the acquired data, but unless they are able to communicate those results for use by other systems to initiate action, they are not machine vision systems. "The differentiator between intelligent machine vision/smart cameras and, for example, scientific imaging systems," says Ludlow, "is the communications capability. Smart cameras use acquired information to take action. That action may be as simple as operating a switch that opens a valve or taking a defective part off a conveyor line, or as complex as controlling an entire production process."

Modern, feature-rich smart cameras are faster, offering typical speed capabilities up to 10 parts per second to encompass just about all middle-range applications and some higher-speed ones as well. "Even that limitation," stresses Ludlow, "is being removed as faster and faster processors are introduced." And although precision optics have changed little over the years—and vision systems do make use of the same technology as conventional cameras—the packaging and environmental protection of smart cameras have advanced. Most vendors now offer IP67-rated models that are waterproof, dust-proof, and suited for harsh environments. The ability to operate, in most cases, without a separate protective enclosure also reduces cost and installation complexity.

Wide-ranging applications: from packaging to automotive

The capabilities of smart cameras are well illustrated in two examples: a high-speed packaging line and an automotive inspection application. Both cases use Microscan HawkEye Model 1610TS smart cameras and a variety of lighting. (The HawkEye is also available in enhanced models, including the 1610TIS, a standard unit featuring IntelliFind patented software; the 1610TH, a standard high resolution unit; and the 1610TIH, a high-resolution unit featuring IntelliFind software.)

Providing support for the installations is HTE Inc., Auburn Hills, MI, an application engineering distributor that focuses on marking, reading, tracking, and machine vision. "Because of the technical nature of our business," explains Dan Reed, company president, "HTE maintains an engineering staff to provide installation support and perform feasibility evaluations on every proposal. Feasibility evaluations are a critical part of any machine vision application."

In the first example, a manufacturer of liquid packaging systems needed a system that would inspect the openings of juice cartons for proper geometry before allowing the cartons to proceed to the fill station. If a jam were to occur inside of the machine because of a damaged carton, a 4-hour downtime interruption would be needed to fully clean and re-sanitize the system. The HTE solution in this instance included one Microscan HawkEye smart camera on each line to inspect each carton. The line moves at a rate of 38 ips; each cycle takes approximately 50 ms from initial trigger to camera result. Using the technology, the manufacturer is able to conduct a robust and effective vision inspection on each carton, saving time and money.

Because the high-speed inspection occurs in a severe environment (temperatures in the machines reach 80 deg C), the cameras are protected in ventilated enclosures made of stainless steel and are splash- and water-proof. Ease of equipment installation allowed the company's engineering staff, working with HTE Inc. engineers, to integrate the system and achieve a successfully functioning installation.

In the second application, a large automotive supplier needed a system that could perform cam inspections. Requirements of the operation included checking the outside of each cam shaft for the presence of 5 holes, measuring the distance from the flange to the end of the cam, determining the presence of two grooves, and checking for broken tools in the end of the shaft.

The sophisticated inspection was especially complicated because the task had to be restricted to one camera and the position of the cam shaft was unknown. To thoroughly check the part, the camera had to perform multiple inspections as the part was rotated, carrying data from the prior inspections into each of the subsequent ones. The internal I/O architecture of the equipment—Microscan's Visionscape line of machine vision systems—allowed HTE Inc. to manage the multiple inspections required to successfully analyze the part. "Despite the complexity of the application," says Reed, "HTE was able to evaluate the proposal, obtain client approval, procure the required vision components, and have the system installed and running at the site in four days."

Spotlighting smart features

Microscan has played a major role in machine vision systems virtually since the inception of the technology. However, it expanded its machine vision/smart camera expertise significantly in 2008 with its acquisition of RVSI/Acuity/CiMatrix. The HawkEye 1610T smart camera was among its first product introductions following the acquisition. The line offers a range of features, important not only to the installations described above, but to those including tracking and traceability situations. Among these features are:

- *More than the average number of built-in discrete I/O points (up to seven outputs and five inputs).* The HawkEye smart cameras offer exceptional flexibility since four of the eight I/O points can act as an input or an output.
- *Ability to directly power illumination sources.* A number of lights may be plugged directly into a smart camera so that no separate wires are needed to provide power. For example, if a part needs to be illuminated for proper inspection, a light can be plugged into and linked to the camera so that the part is lighted automatically as it passes the unit. (Accessory lights for the Microscan smart cameras are supplied by NERLITE, a division of Microscan that specializes in machine vision lighting.)
- *Cross-platform software.* The software that runs on Microscan's PC based machine vision systems and which is used to develop and test an application—as well as the software that is used for its line of smart cameras—is one and the same. Technicians do not need to learn two systems, nor do those trained on one type need any re-training to work with the other type. More importantly, if an application is developed for a smart camera and then needs to run on a PC-based system, it may be easily migrated. No development investment is lost and no re-development costs are incurred.
- *Support of partial scanning in a range of resolutions.* If an application needs to focus on a portion of an image, the camera can be reset in a minimum amount of time to take only a portion of a frame at the same or greater speed.

Future smart camera system plans include the introduction of additional products that will harness the increasing functionality and features of this rapidly advancing technology.

For more information on smart cameras and machine vision applications, visit the Microscan Website at www.Microscan.com and the HTE Inc. Website at www.hte.net.

On September 15, 2008, Microscan purchased Siemens' Machine Vision Business and this reprint has been updated from the original editorial to reflect the change.

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