Case Study

"But once installed, our systems are so reliable that our customers rarely need us."

Packaging Line Inspection Gets Performance Boost from INtime® RTOS Plus Windows*

Optel integrates inspection and control functions on a single PC, lowering costs without compromising real-time performance.

Manufacturing systems are becoming more advanced, incorporating capabilities like graphical user interfaces (GUIs), high-speed cameras, and real-time control on the same workload-consolidated hardware platform. To ensure support for these and other functions on the same PC without sacrificing performance or determinism, Optel Vision Systems* built a pharmaceutical production line inspection and control platform around the TenAsys® INtime® RTOS and Windows* OS.

tenAsys®

The pharmaceutical industry is huge, with the number of medications being mixed, molded, stamped, and packaged everyday in the millions and demand continuing to grow. Regardless of the amount, however, the margin for error never changes. If just one pill is put in the wrong packaging the error could be a life-or-death matter.

As demand has increased, so has the need for rapid processing of medications with very tight controls to prevent mistakes. The human factor has been decreased and replaced by high speed vision inspection systems. The stringent requirements imposed by the inspection process dictate the use of real-time software, particularly when vision inspection functions are combined with automated production line control.

Vision inspection systems not only inspect the individual pills, but bottles of pharmaceutical products as they are manufactured. The FDA mandates that 100% of these products must be inspected to ensure the right label is used and affixed properly, the right lot number and expiration date are printed, and the bottle cap is properly attached. Inspection systems also ensure that each tablet is the correct product for the bottle.

The same scrutiny applies to other drug manufacturing operations. In applications that use blister packs instead of bottles, similar 100% inspections are required. For vaccine vials, it is important to verify that 100% of the vials have aluminum crimps that are perfectly formed. In the case of syringes, 100% of the product must be inspected to make sure each one is perfectly assembled.

Since time is money, pharmaceutical manufacturers seek to automate the inspection process as much as possible, but the requirements for quality and safety are paramount. Such applications require very high-speed processing of high-resolution images, and quick decision-making and activation of controls. Some systems can perform up to 200,000 inspections per hour, making decisions within 30 ms.

Such was the challenge and opportunity for Optel* Vision Systems of Quebec City, Canada. Optel Vision delivers turnkey systems to the pharmaceutical industry that not only do inspection, but perform production line control functions, too. Because of the company's expertise in the field, they were contracted by a large pharmaceutical company to develop a new inspection and quality control system to upgrade a tablet processing line.

They built it on TenAsys® INtime® software.

Blueprints for Automated Packaging Line Inspection

The pharmaceutical company's processing line originally involved manual inspection of tablets and bottle labels to ensure the correct medicines are being packed in the correct bottles, that the tablet count per bottle is correct, and that no broken tablets are packaged. When a problem was detected, which could happen several times per hour, the entire line needed to be stopped while the bad product was removed, wasting valuable production time. The drug company wanted to automate the process of inspecting the tablets and bottles and rejecting bad products.

Optel Vision Systems responded to the customer's requirement by proposing an integrated computer system built around a board based on Intel* processors. Optel uses different single- or quad-core Intel processors for different applications depending on the performance requirements of the application. The processor is supported by a real-time I/O board of Optel Vision's own design that performs high-speed counting of things like the exposure cycle of the camera and connects to the Intel processor board over Ethernet.

Optel's system uses a camera to take a picture of each tablet as it passes a particular point on the line. Camera triggering is handled by circuitry on an I/O board interfaced to the computer and a rotary encoder attached to the tablet transport mechanism on the line. The image is processed using an algorithm that decides if the tablet is intact or not.

If the tablet is intact, the tablet is tracked through the system until it gets deposited into the bottle. If the tablet is missing, that "slot" on the production line is ignored. If the tablet is broken, the pieces are automatically ejected, avoiding line stoppages that plagued the previous version of the production line. Optel Vision's system also scans and tracks the progress of individual bottles by serial number

throughout the manufacturing, boxing, palletizing, and shipping process.

Image processing is done on a dedicated core of the main processor using Optel Vision's own proprietary algorithms. When an image is received, the algorithm compares it with a mathematical model of the correct product and then formulates a decision as to whether the image from the camera is a match. Optel Vision's library includes about 50 different vision algorithms capable of processing bottle, blister pack, or pill images at a rate of 2,000 per minute.

The tablet manufacturing line in question uses just two cameras and one computer, but Optel Vision has developed manufacturing inspection systems using as many as 12 cameras served by three or four image processing systems.

To control all the real-time processing, Optel Vision's system uses real-time operating system (RTOS) software. Optel Vision's engineers initially tried the embedded version of Windows* NT, but observed synchronization problems that caused product on the line to be missed, resulting in line stoppage. This occurred because Windows is primarily a human-directed operating system, designed to support the needs of servers and human users – not high-speed machines or vision systems. A critical piece of information from the I/O may be missed by the Windows software while it is performing unrelated tasks.

Optel's engineers searched for software that could be added to Windows to solve the real-time responsiveness problem. They evaluated some Windows I/O software drivers and then experimented with developing their own driver software. Next, they investigated implementing the entire system on a RTOS. All of these possible solutions were ruled out either because they didn't work reliably or were too complex.

Deterministic Control for Time-Critical Windows* Environments

What Optel wanted was an RTOS that worked alongside Windows and reliably handle all the high-speed I/O required by the system, while at the same time enabling Windows functionality for the system's operator interface and database management software. "In frustration, we went back to the Web and searched for a vendor that understands how to combine real-time and Windows functionality easily and reliably," said Louis Roy, President, Founder, and Owner of Optel Group. "This led us to INtime."

INtime provides deterministic control of time-critical I/O devices in the system while allowing Windows to control non-time-critical I/O. Unlike some software that attempts to add real-time functionality as a device driver to Windows (often an unreliable process), INtime is a separate software environment with its own task scheduler that ensures the processing of time-critical tasks is predictably accurate (Figure 1).

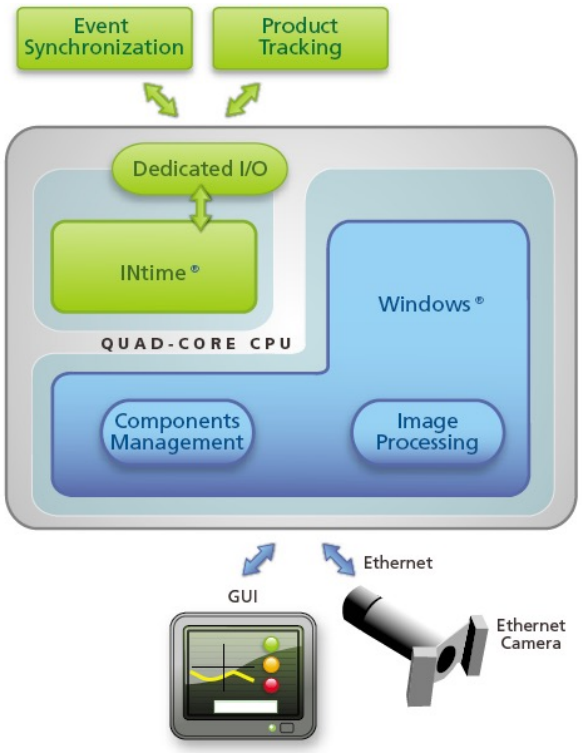

Figure 1. INtime® allows the real-time and Windows processing components of an application to run separately on their own cores, guaranteeing responsiveness.*

In the past, Optel needed to make modifications to their software to support each new version of Windows as it became available. But INtime is supported by a suite of monitoring and debugging tools that are highly integrated with the Microsoft* Visual Studio* development environment, enabling

the system's real-time and Windows application software to be developed using the same tools and context-sensitive help functions. Real-time Visual Studio wizards are also included to enable rapid prototyping and deployment of real-time systems.

"We used to have a lot of software on the real-time board that was hard to debug because it was a closed system," said Mathieu Gallant, Software Architect at Optel Vision. "Now with much of the real-time functionality moved to INtime, the software is easier to develop and maintain."

In this case, because the Windows human-machine interface (HMI) was maintained, training operators to use the upgraded packaging machine was straightforward, though some additional functions were added to the HMI to support machine diagnostics.

Due in large part to the ease of development using the Windows/INtime environment, the complicated Optel Vision system was tested, installed, and running within three months of project start. And the system has proven to be sufficiently reliable for the FDA to approve the automatic electronic inspections in lieu of manual ones.

With the ability to manage many more events at a higher speed, Optel Vision has a high-end platform that can be configured to support a much wider range of applications. For example, the company is currently working on a high-speed tablet inspection system for another pharmaceutical company that can inspect 10,000 tablets per minute and track them as they move through subsequent steps on the production line.

Workload Consolidation: Protect IP Investments and Realize Faster ROI

Because Optel standardized on a common I/O architecture for controlling the cameras in these applications, Optel is able to preserve its legacy system software IP as they migrate from one application to the next by consolidating the separate I/O board into a modular software workload that performs the same function running on INtime. The company expects to preserve the bulk of its investment in the future as it builds production line solutions that work with different types of tablets and filling machines.

Automating the inspection and reject elimination processes, Optel Vision's pharmaceutical customers now benefit from a much more efficient process. Eliminating frequent machine stoppages and enabling their customer's operator personnel to be used more efficiently has resulted in ROI on the upgrade of less than six months.

"We offer 24/7 support to our customers to deal with any problems that occur," said Roy. "But once installed, our systems are so reliable that our customers rarely need us."

A key lesson learned by the Optel Vision engineers along the way is that Windows, by itself, cannot be relied on to support the precise timing of applications that involve high-speed parts processing.

"It's critical to work with a company such as TenAsys, who has the expertise to reliably combine real-time and Windows processing," concludes Roy.

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