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Accurate Seal Inspection Problems Solved with Machine Vision

Four separate vision systems were integrated into one fully automated machine that inspects every surface of oil seals destined for shock absorbers. The machine operates with a cycle time of **under three seconds** in order to achieve the throughput expected by automotive manufacturers.

Background **Information**
Perfection is the norm in component manufacture for the automotive industry. The parts have to be supplied in huge numbers to precise deadlines, each being ready for installation with no faults or blemishes. As a result, quality checking is a key part of many production operations. It is little wonder, therefore, that this sector pioneered the use of machine vision systems to automate the inspection process and has always lead the way in adopting new developments in the technology.

Sunderland-based machine builder Phasor Ltd specializes in applying vision technology and has completed a state of the art inspection machine that checks every detail of every surface of shock absorber oil seals. The seals are basically rubber moldings, and they are checked for scratches, marks and surface blemishes; inclusions; and imperfections such as incomplete moldings.

"This machine will check literally thousands of seals every day, each getting a thorough going over," says Peter Hage, Phasor's Head of Design. "It would have been easy to design and build a machine had cost and cycle time not been part of the equation, but as they were key criteria, we knew we would have to come up with a radically new solution."

At the Design Stage
Knowing that Omron Electronics had some innovative low cost vision technology, Hage invited Malcolm Horner of Omron to a brainstorming session in which some concept designs would be developed and explored. "We had used Omron's F150 vision sensor in the past and were pleased with the results. This is an order of magnitude cheaper than a full blown vision system, but achieves fantastic results in those many applications where the operating environment is visually stable."

Until very recently, Phasor's requirements for high-speed 3D inspection would have required a top-flight vision system, but the brainstorming meeting proved to be a coup for Horner. He asked one simple question: Can you wait three months? And when Hage heard what would be coming available, the answer was an emphatic: "Yes!"

Horner explains the technology behind the F150: "Calling it a sensor is actually an understatement, as the F150 is a development of our already sophisticated pattern matching sensor, the F10, which does in a single unit what used to require a whole array of separate photo sensors. The F150 offers full vision system performance at commodity prices and with remarkably commendable simplicity of installation."

Application Solution

Horner was proposing the first use in the world of the new F150-3, the third generation enhancement of the F150, which has capabilities comparable to many visions systems that cost ten times as much, and which was due for launch in Autumn 2000. Most significant to Phasor is that the F150-3 includes a high performance surface defect algorithm.

Phasor's machine in its final form feeds individual seals along an input conveyor to a pneumatic arm that transfers them one at a time to a rotating spindle, which forms the first of two inspection stations. Here there are three F150-3 cameras, one focused on the main seal lip, one on the main body and one on the side of the seal. Each camera views a 30-degree segment of the seal while the spindle rotates around in discrete steps, so that the whole of the seal is viewed in a series of 12 images.

The F150-3 uses pixel comparison techniques to detect imperfections of the seal in each of the 36 different images. Each image analysis is executed in less than 110 milliseconds. After this, a second pneumatic transfer mechanism inverts the seal onto a further 12-step-rotating spindle. Here a single camera searches the underside of the seal for surface blemishes.

The machine is set so that both spindles are loaded and analyzing seals simultaneously, so a cycle time of less than 3 seconds per seal is achieved. However, this means that 48 different images have to be analyzed in under one and a half seconds. To complicate this already daunting task, images from the two spindles are generated virtually simultaneously, and therefore any sequence of 48 images actually refers to two or more seals rather that to a single one.

Hage was concerned about having to program the controlling software for the image analysis so that each seal was associated with the correct 48 images, but Horner was able to put his mind at rest. "Simultaneous with the launch of the F150-3, Omron introduced Vision Composer software that automatically marries images and objects no matter how complex the situation. It will save Phasor hours of programming time and de-bugging."

The four F150-3s are controlled by an Omron CPM1A micro controller and the image analysis data is fed from the cameras to an Omron CQM1H programmable logic controller which controls the safety switches and conveyor drives (again from Omron) and the pneumatics (which are all SMC). The CQM1A also controls the pneumatically powered reject gate, which flies open to divert any defective seals as identified by the image analysis to the recycle bin.

"Not only did Omron have just the right vision technology for our needs, but their control and automation equipment suited us, too," Hage said. "We are scheduled to make a series of these
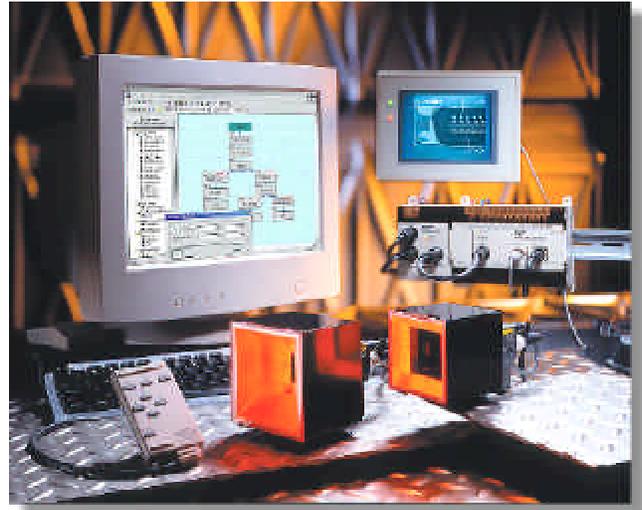
machines for installation around Europe and possibly elsewhere, so by specifying Omron through-out we can be confident that we will get technical support no matter where the machines are located."

Products Used:

F150-3 Machine Vision System
Vision Composer Software
NT2 HMI
CPM1A and CQM1H PLCs

Technology:

Multi-Camera On-Line Inspection

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