Unique Visual Inspection Solutions in Applied R&D

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"Standard" is a relative term. What is standard today in terms of manufacturing or fabrication might have been unusual or even cutting-edge a few years ago. But standard doesn't mean old or antiquated; it could simply mean the most common use right now. Commercial vision systems and sensors are developed to provide a wide range of inspection capabilities. These systems have standard vision functions built right in, so even those new to visual inspection can quickly assemble and create a line-ready inspection solution. Usually in applied R&D, a commercially hardened and supported product is desired, but new or unique use of the product requires features not yet available. Engineering and technology exploitation combine to pave the way for an unusual application to become standard.

Commercial Standard

Commercial vision systems and even vision plug-ins for IDEs (integrated development environments) provide a set of existing functions that perform the most common inspection tasks. This includes pattern matching and feature measurement capabilities. Pattern matching is an image processing routine where images of parts are compared to the ideal part or master pattern. Another common image processing task is gauging or feature measurement. Vision systems are calibrated to know the relationship between one pixel and a real-world measurement. Once calibrated, items that come into view can be measured to extreme precision, with resolutions depending on the camera and field of view. In short, commercial options are plentiful and provide a large amount of image processing intelligence to solve many standard applications. They have evolved to this standard by the continual application of their use and the feedback from users who want their system to have not yet available features.

Unique Applications

EWI has been working with and innovating upon the latest manufacturing and process technologies, and this is especially true for inspection and vision systems. One of the more challenging solutions we have delivered involved automated inspection and repair of aerospace components, a notoriously high-mix, low volume part landscape. We started by applying commercial vision systems to the inspection of a part, but found that the standard vision functions could not be directly applied. Figure 1 shows an example of an automotive part with a standard gauging and masking routines applied. This straightforward approach could not be used for our aerospace application because the features we are looking for are not known in advance. We did not have a master or ideal part to use as the pattern because each aerospace component to be inspected was different. This meant that the pattern-matching routine was dynamic, and had to be created on the fly. In this case, we constantly came up against a limitation such as number of image processing masks to be used simultaneously, so we turned to programming loops, adjustable equation variables and other methods to adapt the inspection algorithm in real time. Custom filtering and lighting techniques were also needed to permit the correct imaging of parts due to different part finishes. This challenging vision application for inspection was delivered and is in use today.

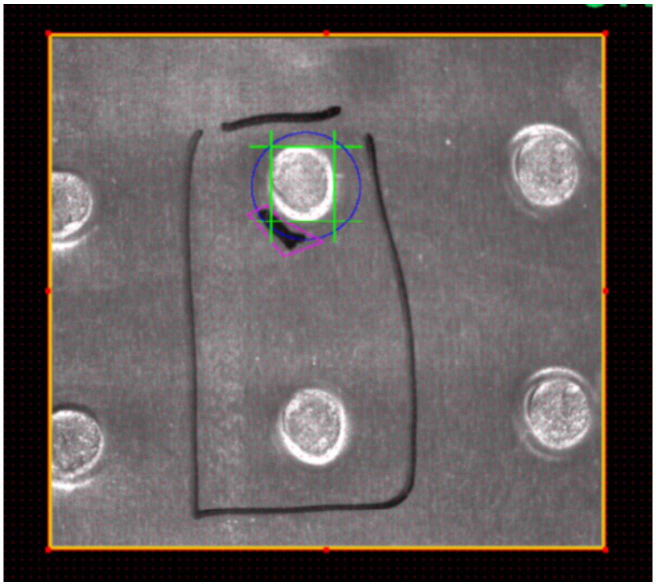

Figure 1. One-off or high-mix part features cannot always be predetermined within the vision processing routine. Standard image processing routines like gauging and masking, shown in this image, must be adapted for on the fly aerospace parts.

Another non-standard application involved modification of both the sensor hardware and its controller. A traditional arc welding robot needed to access a narrowing and winding joint path. Commercial seam-tracking laser vision sensors are readily available and work well especially when integrated with robots. In this application, however, we could not physically fit our sensor into the location, so we employed mirrors and optical geometry to bend the light and redirect it. Figure 2 shows an example of a seam tracker in a narrow joint, reorienting the laser line. This required an add-on modification to the laser sensor and additional processing of the vision data. This same application also required more measurement data than the sensor was designed to provide. We worked with the sensor manufacturer to modify their controller, giving us access to the information needed to provide the solution. In this case, both add-on hardware, custom software and sensor controller firmware was modified, yet the system was still commercially supported.

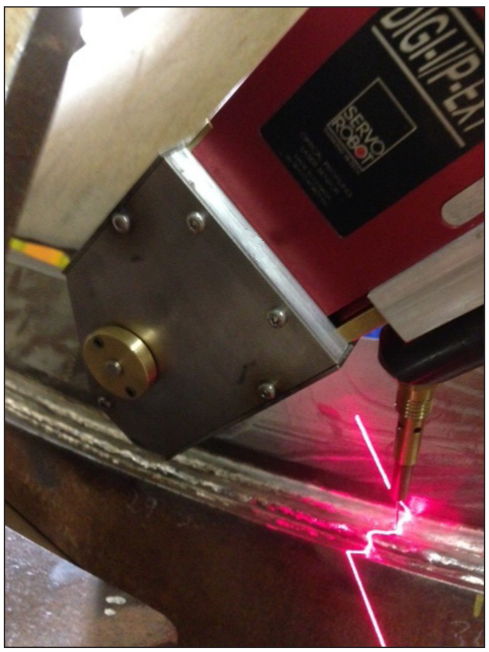

Figure 2. Laser seam-tracking sensor was modified to divert laser beam and to provide surface profile data.

Additive manufacturing (AM) is one of the processes in which EWI is currenting applying its vision system expertise. An example is the use of camera and laser-based vision to laser powder bed-fed (L-PBF) AM process to inspect the powder layers and fused layers within the build. Commercial laser profilometer technology worked well in our initial research (Figures 3, 4), but industry requirements are pushing the envelope for faster inspection speeds and wider inspection areas. Mirrors, lensing and other tricks to engineer solutions are being considered and tested to optimize vision inspection for AM applications.

Figure 3. A commercial laser vision system will need to be modified or developed to be commercially viable for real-time surface inspection in a laser powder bed AM process.

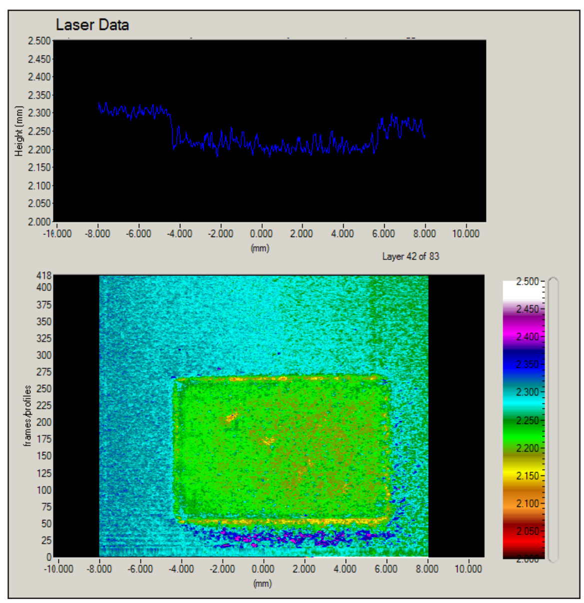

Figure 4. A single line of surface topology from the laser profilometer (top graph) and accumulated surface profiles over one of many layers in an AM build (bottom, color depth plot), identify defects in the current layer of a small AM part, in process.

Integration between the sensor and the motion controls of the processing system is helping to make intelligent decisions about when to trigger the sensor so that measurement resolution and measurement speed can be maximized. Engineering around the current technology limitations and the requirements of the application is part of the process in applied R&D.

With persistent understanding of the latest in manufacturing and dedication to continually utilizing and improving upon commercial options, we can effectively raise the standards for tomorrow's higher quality visual systems. Working with existing technology and pushing its boundaries is as vital to innovation as the innovation itself.

***Connie Reichert LaMorte**, Principal Engineer for Design, Controls & Automation, is an expert in the areas of laser-based vision, control systems and adaptive welding. She has developed inspection and control solutions in a range of industries with an emphasis on weld-related defect detection and has published papers on corrosion detection, weld inspection, and adaptive welding. Connie has been an EWI associate since 1996.*