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Robots Paired With Machine Vision Create Automated and Efficient Motion, Leaving the Old Generation Behind

by Dan Hebert, PE, senior technical editor

ROBOTIC CAKE DECORATOR

Concept Systems (www.conceptsystemsinc.com) in Albany, Ore., provides integration services and automation products to machine builder OEMs. These systems typically consist of robotic workcells with integrated machine vision and 3-D laser scanning.

Doug Taylor, project engineer at Concept Systems, describes how a robot with vision is being used to decorate cakes, saying, "We supplied a 3-D vision system retrofit for a pair of robotic cake decorating lines for a large bakery, replacing a 2-D camera system that only provided the center point of the cake (X-Y), but offered no Z-axis information whatsoever," Taylor adds.

The new system scans cakes as they are conveyed into the robotic work cell and generates a 3-D model. "The model is used to generate a unique path for the robot to decorate the cake," Taylor adds. "It is a recipe-driven system, so the same robot can decorate many different cake styles with minimal changeover interactions."

The new system uses Hermary SL1880 scanners (two scanners and two robots per line) tied to a workstation PC communicating to the robot via an Ethernet connection. The four robots are Fanuc PCDK models.

"A Dell Alienware laptop PC on each line runs custom code written in Visual Studio 2012 which

Robots have been used for decades in industrial manufacturing applications to perform tasks such as welding, part picking and metal working. But without vision systems to guide robot movements and actions, these applications were limited to performing the same or very similar operations over and over on precisely located parts.

Consider an application where five similar, but not identical, sets of parts need to be welded. Without a vision system, five robot stations are required. Each part must be mounted in a costly high-precision fixture manually and then welded by a tool attached to a robot arm that moves with high accuracy and absolute repeatability.

When a vision system is paired with a robot, one welding station can weld all five part types, as well as other parts. Each part doesn't need to be manually and precisely mounted, but instead just needs to be securely attached to a servo-driven housing, with the vision system aligning the parts as required.

Vision systems free robots from the narrow restrictions of time and space, providing a host of advantages in a wide variety of manufacturing applications. These advantages enable more widespread use of robots by guiding their actions to closely fit ever-changing and more-demanding production requirements.

See It, Do It

When a robot can't see, the part on which it will perform an action must be precisely placed, requiring a very accurate fixture or positioning system and a high-precision robot. But with vision, close is good enough, as the robot can find its own way. "Vision systems make it possible to use a less precise and expensive robot for precise placement applications such as wafer alignment, part orientation or part presence," says Bob Fung, vice-president of engineering at Owens Design (www.owensdesign.com), Fremont, Calif., an automation services company that creates, designs and builds equipment for the semiconductor, disk drive, solar, flat-panel, LED, fuel cell and mobile electronics markets.

Chris White, project manager for automation at CMD (www.cmd-corp.com), Appleton, Wis., agrees. CMD built an automated packaging system based on a Yamaha robot and vision system that eliminates most of the problems with fixtures, part-positioning, orientation, part defects and product changeovers. "The vision system provides the robot with the position and orientation of the part, allowing the robot to pick and place the product as desired," he explains.

Matt Wicks, vice president of product development at Intelligrated, Mason, Ohio, (www.intelligrated.com), a materials handling specialist, says his company uses vision in applications when the material handling operations require more understanding about the environment, material or products. "We recently demonstrated a robotic de-palletizing application (Figure 1) that used 2-D and 3-D vision to determine the location and orientation of cases stacked on a pallet," Wicks says. "Then the robot was commanded to de-palletize the products onto a takeaway conveyor. This type of operation wouldn't be possible without the use of vision-guided robotics."

In some instances, seeing the parts and performing actions could be performed by sensors, but cameras are often a better solution. "As the price of vision systems drops, they're replacing sensors as they provide more functionality and flexibility," Fung adds. "For example, in the past we had to use multiple sensors or move the product past the sensors to determine the quantity and

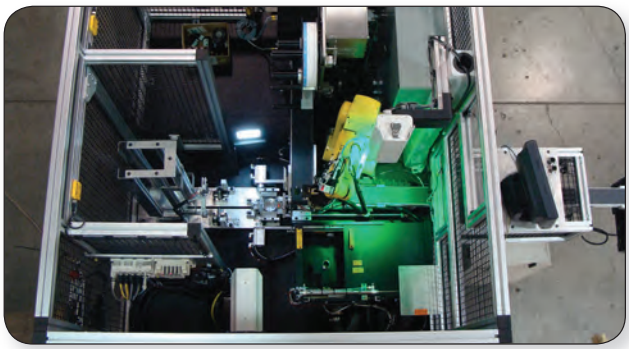
accesses the Fanuc PCDKs directly in .net code," Taylor explains. "The PC is the HMI, and it talks to the robots using the robot libraries. All four robots run Fanuc handling tool software, and the program is written in the TPP language."

Two separate but identical lines were retrofitted, allowing the bakery to process up to 40 cakes per minute. Taylor says the new system expanded the product offerings, increased the cake height envelope from plus or minus an eighth of an inch to plus or minus 5 inches, and increased overall throughput.

"We are expanding the system to include new R&D cake decoration designs," Taylor says. "The bakery sees the new 3-D scanner systems as a competitive advantage that will allow them to compete for work with a higher repeatability in the decorations at a much more competitive price point than they have been able to offer in the past."

orientation of parts in a carrier. A single camera now can do the same without moving the part, and it can support product changes without changing hardware."

A bakery used a 2-D vision system to guide cake-decorating robots until about a year ago. It upgraded to 3-D to improve flexibility and increase throughput. (See the "Robotic Cake Decorator" sidebar, p24.)



INTELLIGRATED

COST MAKES VISION LOOK BETTER

FIGURE 1: Vision is becoming a more viable option due to advances in software and hardware along with a corresponding drop in costs, making it more prevalent in applications like this layer de-palletizer.

How Hard Is It?

Adding vision to a robot isn't always easy. "There are challenges with the seamless integration of sophisticated vision, robotics and the accompanying automation systems," Wicks says. "This advanced level of integration requires a collaborative effort on the part of the vision systems providers, robotic arm manufacturers and robotic systems integrators because it requires in-depth knowledge of not only the vision piece, but also how it integrates with the robot and other automation equipment."

Fung says that most vision systems must be designed specifically to meet the requirements of the tool into which they are to be incorporated. "This increases the overall tool cost as well as the design time," he explains. "There's a lack of generic, industrial-quality vision systems that can be programmed easily to meet a variety of system requirements. Most vision systems are difficult and complex to operate. Much of the system complexity is due to the high image quality required for most applications, as well as challenges involved in accurately measuring parts that don't conform to regular shapes."

"While the software has become increasingly user-friendly, end users still need some proficiency with programming and setting up the cameras when they introduce a new product. Depending on the type of features the customer is looking for, this can be a tedious process."

Software and lighting pose problems, too. "We've seen advances in both software and lighting for vision systems, but there are many opportunities for further improvement," CMD's White says. "While the software has become increasingly user-friendly, end users still need some proficiency with programming and setting up the cameras when they introduce a new product. Depending on the type of features the customer is looking for, this can be a tedious process of adjusting the camera and lighting to show the intended features. Products have different patterns, colors, sheens and materials that can complicate setup."

Fung agrees and suggests improvements. "Lighting systems must be able to fit into the tool without adding excessively to tool size," he says. "Designers usually have to use very thin, industrial-grade backlighting, which is expensive and further increases overall system cost. Filtering to prevent stray light reflection is also a concern."

Most robot and vision vendors recognize the integration challenges and provide solutions. For example, White explains how Yamaha software helps, saying, "The software program in the Yamaha RCX controller is a modified form of BASIC. The commands are actually quite simple. For instance, a MOVEP command (move to position) tells the robot to move to a given X,Y,Z coordinate. The Yamaha firmware and hardware determine the most efficient path and control all the

ADVANTAGES OF USING VISION TO GUIDE ROBOTS

1. Automates manual steps and processes
2. One camera can replace multiple sensors
3. Speeds production and increases throughput
4. Greatly reduces programming effort to guide robot
5. Increases flexibility of the robot
6. Recipe-driven production reduces changeover times
7. Allows for less-precise positioning of parts
8. Less-expensive and more-precise robots can be used
9. Eliminates expensive fixtures
10. Allows a robot to perform multiple tasks