Application: Vision-Guided Robot System

Industry: **Precision-Machined Automotive Components**

Products Used: **FANUC Robotics M-16*i*B Robot**
FANUC Integrated Vision System
TM 200 Video Camera
LED Red LED Ring Light
Matrox 4sightII Computer
End-of-arm Tool (EOAT)

An Intelligent robot equipped with a FANUC vision sensor ideal for bin picking.

Challenges:

This company wanted to reduce labor costs and increase throughput by automating its manufacturing processes. To find a solution, FANUC Robotics America, Inc. needed a way to unload or depalletize randomly-placed transmission gears from a plastic bin.

In addition to unloading the gears onto an exit conveyor, the robot needed to transfer a plastic board that divides each gear layer. To meet the throughput requirements of the workcell, the vision-guided robot had to reach an average cycle time of 4.5 seconds per part, including the removal of the plastic divider sheets. In addition, the vision system needed to calibrate so it could calculate the feature scaling and robot position in a 2-D environment.

Solution:

To address these challenges, FANUC Robotics designed a work cell incorporating a FANUC M-16iB robot coupled with a FANUC integrated vision system for robot guidance. The system relies on an advanced integrated vision system to take a snapshot of the gears and coordinate subsequent manufacturing steps. The vision hardware includes a Pulnix (Sunnyvale, CA) TM-200 video camera, Advanced Illumination, Inc. (Rochester, VT) RL36120 red LED ring light, high flex camera power cable, high flex camera coaxial cable, and power supply, and a Matrox (Quebec, Canada) 4sightII computer. The Matrox computer includes an “Orion PC104+ Frame Grabber,” which is used to capture visual input. A generic flat panel monitor, keyboard and mouse complete the user-interface to the vision system. Other major components include a custom designed and built end-of-arm-tool (EOAT), pneumatics package, robot riser, two-part rack locators, divider sheet storage rack, interface panel and safety fence.

Solution *(cont.)*

Robots are trained using FANUC Robotics' Windows-based vision program. The use of a dedicated computer provides easy access to the vision system. FANUC Robotics' system has the immediate ability to program new parts and troubleshoot vision issues using the dedicated computer hardware versus an external interface method such as a laptop. Parts are "trained" to provide a reference to compare images taken during automatic operations. The trained parts are found by vision using FANUC Robotics' geometric pattern matching algorithm. The part is trained at the same height that the robot searches for parts; this provides the best opportunity to find parts, since the size and contrast will be most accurate.

The information from visual calculations that is provided to the robot is the x and y location of the center of the gear with respect to the trained nominal position. Both parts are symmetrical, and radial orientation is not required. The vision system interfaces directly to the robot via Ethernet through the FANUC Robotics' robot server. The offset data from the vision system is placed into position and registers on the robot.

The key parameters used in this application are size and contrast. The size and contrast are combined to create an overall "score" that is used to determine if a part has been found or not found. Utilizing the size characteristic, the vision system can determine if the tested part is on the current layer or one layer lower (a condition that exists along bin walls). Contrast can be used to differentiate between an actual part and an oil ring from a part that has been removed. During testing, the vision system identified phantom parts that were caused by oil rings on the plastic board. The vision system recognized the oil ring as an actual part. The problem was solved utilizing the contrast locator parameter. On a contrast scale of 1 to 100, the oil ring scored a contrast value of 44 versus a contrast value above 95 for "real" parts. Phantom part finds were eliminated by adjusting the vision recognition system.

The vision system also located gears that were one level lower than the robot was unloading. The parts were on the outer ring and the plastic board allowed enough of the part to be "seen" so that the vision system identified it as a "found" part. The problem was resolved using the "size" locator parameter to ignore parts that were not at least 95% of the trained part size.

After the system was installed, the customer requested that FANUC Robotics add part orientation detection. Any gears that enter the machining center upside down cause damage and downtime to the tool. Using a clockwise pointing part feature, the vision program was able to identify upside down parts and load them into a reject chute. The parts are then manually loaded to the tool. FANUC also provided upgrades to the vision display tools that show the operator the edges the vision system was using to locate a part. FANUC responded by adding red and green indicators on the image in the vision interface. The green light helps show a positive edge find and the red edges indicate where an edge was expected, but not found.

"The system has proven to be a success. The combination of robotic reliability, and the latest advances in visual recognition technology have met all customer requirements," said Richard Meyer, Vision System Designs. "After four months of operation the FANUC Robotics vision/robot cell increased production throughput by five percent, and decreased labor costs by 30 percent with a system uptime above 90 percent."