Machine Vision Helps Syringe Assembly System Double Productivity

Cognex Corp.

Often, in order to provide customers with the best quality products, companies are forced to sacrifice high productivity and competitive pricing. However, one company's innovations in syringe manufacturing technology have proven that quality can be achieved efficiently, at a low cost.

One of AVTEX's Inspection Stations

Syringe manufacturers need to maintain high levels of quality in order to ensure the safety of patients and caregivers, while maximizing productivity to deliver their product at a competitive price. AVTEX Machine Vision Inspection Stations, customized specifically for a two-machine syringe assembly process coupled with a packaging system built by Arthur G. Russell Company (AGR), meet both of those goals. The machine vision system performs a series of inspection operations, such as ensuring the presence and location of components, in as little as 50 milliseconds.

"The key to maintaining AVTEX's Inspection Station's accuracy at ultra-high levels of speed is incorporating Cognex [1] VisionPro software, which includes vision tools with the intelligence to ignore non-critical variations in appearance while focusing

on the critical features that determine a product's acceptability," said Mark Granahan, President of AVTEX.

Established in 1995, AVTEX is dedicated to machine vision and is headquartered in Burlington, Connecticut, near Hartford, with an engineering branch in Bristol, CT, at The A.G. Russell Co. (AGR). AVTEX's clients include North American and European manufacturers and machine assemblers in all industries ranging from consumer products to medical, automotive, aerospace and electronics.

Since its founding in 1945, AGR has been an innovator in the field of automatic assembly equipment. AGR has built hundreds of large scale machines and thousands of precision feed systems for the assembly of medical products such as syringes and blood collection tubes. The company has extensive experience in high-speed assembly of all types of medical products, and thorough understanding of the Food & Drug Administration requirements for medical product assembly.

"We used Cognex VisionPro software to develop six machine vision inspection stations for this machine," said David Baker, AVTEX engineer. The VisionPro tool library offers a wide range of powerful tools that provide accuracy and repeatability under the most challenging conditions and can be used to perform just about any machine vision application.

Machine Produces 480 Syringes Per Minute

AGR's syringe-producing process requires two machines and 17 individual stations. The first machine indexes every two seconds and processes 16 syringes during each cycle for a total production rate of 480 syringes per minute. The needles, or cannula, are loaded into the first station of the machine. The needles are then picked up from a hopper by a vacuum gripper and the point end is inserted into a wheel. At the bottom of the wheel, needles are transferred to a belt to be presented to a vacuum pickup head. At Station #2, the needles are picked up and rotated 90 degrees and inserted into plastic hubs. Each hub includes a protector that is applied to the needle after it has been used to prevent accidents. Adhesive is applied to each hub-needle assembly in Station #3 and cured with ultraviolet light in Station #4.

The needles could appear in the pallet at the first station of the machine at any angle. A machine vision system at Station #5 determines the angle of the needle. This operation occurs during the index of the machine which constitutes 660

milliseconds of the cycle, leaving only 41 milliseconds for each needle to be inspected. AVTEX engineers created a custom /lens light and selected a Sony XC-HR50 camera and Cognex VisionPro software to perform this inspection operation. The VisionPro PatMax pattern-matching tool was used to locate the part and report its orientation to the machine control system.

Three-Step Geometric Measurement Process

The programmers provide examples of good needles for training models used by the Cognex software PatMax. PatMax uses geometric information in place of pixel grid-based correlation by applying a three-step geometric measurement process to an object. For example, it interprets a square as four line segments and a football as two arcs. PatMax identifies and isolates the key individual features within an object image and measures characteristics such as shape, dimensions, angle, arcs, and shading. It then correlates the spatial relationships between the key features of the trained image to the runtime image, encompassing both distance and relative angle. By analyzing the geometric information from both the features and spatial relationships, PatMax is able to precisely and repeatably determine the object's position without regard to the object's angle, size, or appearance.

Station #6 uses a gripper arm driven by a servo motor to rotate the needle into the proper orientation for subsequent processing steps. This servo driven assembly provides extremely accurate and high speed handling of the needles. Station #7 is another machine vision station that verifies the needle orientation using the same camera and AVTEX software as Station #5. Stations #5 and #7 are run on the same personal computer.

Station #8 uses Cognex VisionPro software to inspect the assembly to ensure that the hub has been securely fastened to the needle. Two Sony XC-HR50 cameras look at the assembly from the top and side views. The VisionPro software analyzes both images to determine whether or not a sufficient amount of adhesive has been applied in the right location. These two cameras are also controlled by the same personal computer that controls stations #5 and #7.

Blob Tool Needle Check

Station #8 uses two perpendicular Sony XC-HR50 cameras and a Cognex VisionPro edge tool to measure the angle of the needle relative to the hub. At this point the needle is moving on tracks with the needle bevel facing in the direction of motion. At station #9, another vision application backlights the pointed tip of the needle and checks to make sure it is intact. This station uses VisionPro’s grayscale blob

tool to inspect the height and angle of the tip of the needle to check for problems such as the tip being folded over. The grayscale blob tool provides highly repeatable measurements of connectivity, area, size, and shape of objects.

At Station #10, a servo-driven gripper inserts shields over the tips of syringes that have passed all of the previous inspections. Station #11 is an unloading station, in which a vacuum operated gripper head picks up the syringes that have passed inspection and puts them on a conveyor. The gripper head has 16 pockets and individual pockets can be turned on and off depending on the inspection results.

The conveyor carries the syringes to a second machine that indexes every second. Station #1 of this machine is used for loading the needle/hub assembly into the machine from the conveyor. Station #2 uses a gripper driven by an AC motor to screw the syringe onto the needle-hub assembly. The motor has a clutch that breaks away once the proper torque limit is reached. In Station #3, a gripper picks up the syringe and places it into a plastic blister pack that holds ten units.

Inspecting the Packaging

Station #4 is an inspection station where two XC-HR70 cameras look at the blister pack. They use the PatMax pattern matching tool to check that each pocket holds a syringe and that all of the major components of the syringe such as needle, hub, shield and protector are present. “We use the PatMax tool for this station because the syringe could be located anywhere within the blister pack pocket and PatMax is very good at locating things when you do not know in advance where they will be,” Granahan said. This inspection station works during the stationary part of the cycle which occupies approximately 660 milliseconds but the actual inspection operation only takes about 50 to 60 milliseconds.

Station #5 applies a paper backing to the blister packs that have passed inspection. Station #6 separates the packages that passed from those that failed the inspection. Only packages that pass inspection are loaded into boxes. Those that fail are placed into a bad parts bin for reworking.

“These machines provide the customer with the ability to produce syringes at a rate of approximately twice the level that was possible in the past,” and with twice the accuracy Granahan said. “A key to their success is the use of machine vision systems that operate at the high production rates of the machines while providing 100% inspection that ensures the quality of every unit.”

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