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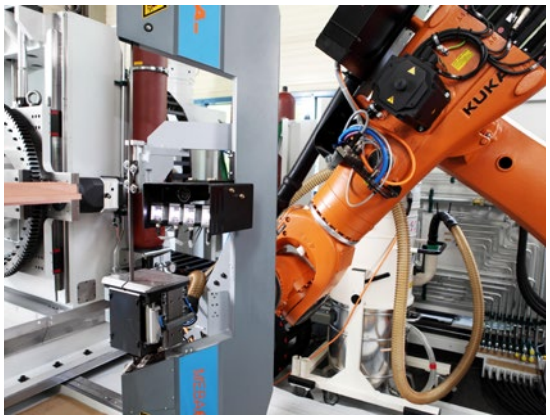
ROBOTICS AND MACHINE VISION: AN UNBEATABLE TEAM



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Combining robotics and machine vision to form a team.

Eight application examples by VDMA member companies illustrate the contribution robotics paired with machine vision can make to efficient production in various industrial sectors.

By Nikolaus Fecht

Machine vision systems have a huge range of talents: they check quality, guide machines, control processes, identify components, read codes and supply valuable data on optimizing production. All this helps to automate robots reliably, safely and precisely, thus improving their overall performance. But first, two different systems have to be combined to form a team.

Kuka Roboter GmbH chose a software platform to do this. The experts describe it as flexible and multi-talented, because it is equally suited for stationary cameras as well as for cameras integrated directly into the robot. The onboard solution works on every Kuka robot without requiring separate hardware. This reduces additional effort and expense, as there is no need for an external machine vision program. The system makes it possible to detect the position of randomly-arranged parts (pick and place), as well as reading codes and fonts.

“Seeing robotics” for a wide audience

“We have developed this solution for small robots in particular,” says Sirko Prüfer, Product Manager for robot vision. “The user can operate our technology intuitively without extensive prior knowledge.” The ease of use is all thanks to an integrated electronic support, which also assists the user in programming the robot – a process known as teach-in.

With the system for 2D functions, the Augsburg-based company is now making seeing robots available to a wider audience. “The use of an industrial camera is particularly useful for applications in small-scale robotics,” emphasizes Prüfer. Cells and plants that use small robots require greater flexibility and shorter set-up times for the production of new parts. This allows production to cater to the increasing demand for individualization.

The system is used in electronics manufacturing (inspection and position detection), the food industry (quality control, position detection, bar code reading, separating products), the automotive industry (position detection) and machine tools (quality control, position detection, measuring tasks). Seeing robots make it easier for integrators in production technology to start operating machine tools, for example, and help them to automate manual tasks such as product handling by means of position detection.

Camera system monitors bulk goods

An innovation by Denso Robotics Europe (Denso Europe B. V.) in Mörfelden-Walldorf is designed for a wide range of tasks such as pick and place. The feeding system with an integrated robot, a camera and its own software delivers components via a bulk material transporter. “As soon as the parts have been placed on the conveyor, they are within the coverage area of the machine vision system,” explains software engineer Stephan Steneberg. “The vision system decides what the next steps should be. If the components are well-positioned and ready for collection, it transmits the coordinates to the robot’s controller so that the robot can pick up a product.”

When it encounters poorly-positioned products, the system reports that they must be separated or turned so that the robot can pick them up. The machine vision system which is integrated in the robot controller also detects when there are not enough parts remining on the conveyor and tells the feeder what it should do. In total, the system is able to move parts with a length of up to 250 millimeters and a maximum mass of up to 300 grams. According to Steneberg, the system is primarily characterized by its ease of use, because “anyone who has basic knowledge of vision-controlled applications can operate it with just a brief introduction”.

Yaskawa Europe GmbH in Allershausen has addressed a very demanding challenge. Welded components for vehicle emission systems have to satisfy the toughest standards with regard to dimensional accuracy and leakproofness. This makes quality control very important and complex. After all, measuring all the necessary parameters completely requires a measurement laboratory with tactile measuring equipment, and takes around 15 minutes.

Inspection within the cycle time of the welding robots

A fully automatic inspection solution for an automotive supplier is just as precise, but significantly faster. Within seconds, the system identifies the component via a lasered data matrix code, performs 3D measurement of geometric characteristics in the vehicle coordinate system and carries out a leak test of complex components. As a result, inspections can proceed exactly within the cycle time of the welding robots.

This system is a fully integrated and self-contained special inspection machine. It performs the 100-percent measurement of the components to correspond exactly with the production cycle of the robot-based welding systems (approx. 40 seconds per component). The components to be inspected run through the inspection cell on a conveyor system with component-specific workpiece carriers equipped with RFID tags.

Robot-controlled 3D measurement

At the first position, 3D measurement is carried out by a stereo camera head. Each of the two cameras, calibrated to each other, takes a picture of the same feature. A six-axis robot ensures that the cameras can reliably reach every point of the component. Mounted in a hanging position, the extremely flexible articulated manipulator rotates completely around the component. In total, the robot approaches 20 specific features of the component so that the corresponding measuring points can be recorded by the cameras with a resolution of 0.05 millimeters.

“Our handling robot is a key element in the solution. It ensures that the camera head can reliably reach every measuring point. The system is already designed to accomodate future modifications and expansions,” explains Jürgen Riedinger, Sales GI Robots & Products at Yaskawa.

Adhesive processes are on the way

A solution sometimes depends on a customized sensor. The lightweight materials used today are making adhesive processes an increasingly important part of automobile construction. The adhesive seams are usually applied by an industrial robot. Dr. Stefan Gehlen, Managing Director of VMT Bildverarbeitungssysteme GmbH in Mannheim, explains: “Checking the adhesive beads applied is absolutely vital in order to ensure that the adhesive seam is of high quality.”

To meet this demand, the subsidiary of Pepperl+Fuchs GmbH, Mannheim, has developed an online adhesive bead sensor for direct use on the robot. It features two integrated laser sensors, which the robot guides along the adhesive beads together with the applicator. The captured pictures are used by a machine vision system to create a real, high-resolution, three-dimensional image of the adhesive bead, which is then analyzed for defects. “By the use of the provided system software the adhesive bead is inspected in real time for all possible defects, including geometry, volume, and position. The software reports quality deviations immediately,” says Gehlen.

Checked adhesive bead

The sensor head consists of one fixed and one rotating module. The laser units are installed in the rotating module, while the fixed module is connected to the applicator. Integrated into the sensor head and separately controllable, the rotational axis always guides the rotating measuring unit along the adhesive bead in the best possible way, independent of the robot or application jet movement. This makes it possible to check the adhesive bead application even in radii and corners.

Pfaff Industriesysteme und Maschinen GmbH Branch Office KSL in Lorch is proud of the world's first unattended, fully automatic robot sewing system for stitching cuffs in shirt production. In this joint project with the subsidiary Dürkopp Adler AG in Bielefeld, a robot transports the sewing material. It takes cuffs out of a magazine and lays them on a camera system for measuring, in order to then feed them into the sewing system with the edge in the perfect place. If the camera reports that a cuff is not within the specified tolerances, it is automatically discharged.

Fully automated sewing

"The system sets new standards in automated textile production, because it shortens production cycles, avoids shutdowns and significantly increases productivity," says Product Manager Veit Mückenmüller-Ammon from Pfaff. "With the fully automated production of cuffs we implement new manufacturing options for the clothing industry." The intelligent handling system enables highly precise, operator-free working in clothing production for the first time. Thanks to this switch from manual workplaces to the automated plant, the users can now produce shirts in reproducible quality and large batches, he continues.

How a machine vison system and a robot complement one another in an ideal case is shown by an application from the automotive industry. "Robots and machine vision systems have been working with high process reliability at an automotive supplier since 2013," says Tillmann Zoller, Project Engineer at i-mation GmbH in Rottweil. "The company decided to automate the handling of brake discs, because the weight of the components – up to 20 kilograms – was putting too much physical strain on employees."

The answer is a fully automated inspection and handling system with an articulated robot and a machine vision system. A mobile smart camera with integrated lighting installed on the robot determines the position of the components. A line scan camera installed in a fixed position uses Optical Character Recognition (OCR) to read the brake discs' type designation. This is a challenge, as the dotted and roughened type designation is applied to the metal via needle embossing.

The software learns to read

"The writing looks a bit chaotic and difficult to read at first," says Zoller. "We teach our OCR software how to read the individual letters." Based on the type identification, the controller of the machine vision system then decides whether the component is the right blank brake disc which is to be processed.

If the brake disc passes inspection, the robot knows exactly how to pick up the component thanks to the coordinate information from the mobile camera. It uses magnets to grasp the brake discs and moves it to the processing stations. Using a position cross, the camera also identifies the position of wooden boards, which the robot then picks up with vacuum grippers and places between the brake discs in a pallet cage as protective intermediate layers. "The pallet cage is filled layer-by-layer with brake discs and wood panels," says Zoller.

"The main task of machine vision technology is to make automated production processes more flexible," explains Holger Wirth, Vice President R&D Industrial Automation at Isra Vision AG in Darmstadt. A plug & automate sensor series of Isra provides the means for quick, sustainable and cost-efficient implementation of flexible automation. "The easy installation ensures short set-up times and a great deal of versatility. Extended maintenance intervals and the robust and space-saving design provide for undisturbed processes," says Wirth. The technology focuses on the gripping processes which link two production steps. Their flexible and cost-efficient usability make the sensors suitable for organizing organizational trends such as a "lean production".

Easy to install and operate

The easy installation and operation do not require any specific skills. The sensors enable a high degree of automation and the software that comes with it provides a lot of "built-in" automation knowledge. "This allows companies to benefit from the opportunities provided by digitization easily and cost-efficiently and to support their production and quality inspection with maximum flexibility in the best possible way," the Vice President explains.

With the easy-to-install series, Isra Vision makes the profitable use of optical systems possible even for production facilities with smaller lot sizes. The sensors require neither complex programming nor extensive training. Using guided workflows and an intuitive menu, they ensure a correct and convenient set-up, preventing delays caused by programming errors. Short set-up times support the stability of the production processes and prevent downtimes.

Wheel inspection via x-ray vision

The development of a fully automated x-ray system to inspect aluminum wheels for automobiles brought Erhardt + Abt Automatisierungstechnik GmbH in Kuchen together with the Fraunhofer Development Center for X-ray Technology (EZRT) in Fürth. The EZRT supplied the image evaluation software and x-ray detector.

“Every wheel has to be x-rayed,” says Michael Frieß, Technical Director at Erhardt + Abt. “We were successful in combining traditional automation with technical x-ray technology.” A 6-axis robot is used to position the wheel in virtually any position between the x-ray tube and the detector. This makes it possible for the system to screen the wheel from every viewpoint that is important for assessing the quality. “Hitting the best possible angle at all times is crucial,” says Frieß.

“Teaching” during ongoing operations

The fitter teaches the robot how it needs to position the wheel by remotely parameterizing the movement patterns and saving them in the control unit. “This teaching can take place while the system is in operation,” Frieß explains. A degradation-free detector makes it even easier for users to employ the system. In contrast to other systems commonly used, this system produces a consistent image quality. This eliminates the need for adjusting the image parameters and follow-up teaching. “As a result, it makes no difference which one of the machines the customer uses to inspect the wheels,” says Frieß. ■

Further Information

Machine Vision | Denso Robotics Europe | i-mation | Isra vision | Kuka Robotics | KSL | Erhardt-Abt | VMT | Yaskawa

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