Machine learning-supported robots provide flexibility in quality control for automotive manufacturing

To keep pace with rapid technological advancement and increasing customer expectations, manufacturers must modify production lines more and more frequently and on much shorter notice. Considering this situation, the BMW Group is using a flexible solution on a production line at its plant in Dingolfing, Germany. The solution combines reprogrammable, lightweight industrial robots, computer vision, and AI-based learning models. This has increased flexibility and optimized quality control.

The challenge: Controlling the quality of different components on the same production line

AI-based image processing is now a standard method of visual quality control for industrial components. Since technology is always improving, the components of production lines are also changing at an increasing rate. Any change in components has traditionally been accompanied by labor- and time-intensive modifications to the production line which can, in turn, affect revenue. Today's customers demand shorter turnaround times but are unwilling to compromise on quality or cost.

This raised the question of how best to retrofit modifications to a production line in order to keep pace with all challenges while also satisfying a wide range of application requirements. The goal was to find a solution that was both generic and flexible enough to dovetail easily with a rapidly changing global market. First, the production line needed to be modularly designed with manufacturing units that can be modified quickly and frequently. Second, image capturing needs to be relocated to mobile units that can be integrated into the modular design. Lastly, smooth and sound performance hinges on the modules being able to exchange sensor data and actuator commands swiftly and securely.

The solution: Improving quality assurance with cameras and programmable robots

Collaborative, lightweight robots are being used to complement human flexibility on production lines in numerous plants. To ensure their future viability, modern industrial robots can be reprogrammed and equipped with additional components, such as cameras, as the manufacturing scenario dictates. Advances in robotics have ushered in a new era of no-code implementation, because teaching industrial robots no longer calls for expert knowledge.

Dresden-based start-up, Wandelbots GmbH, developed a no-code software platform that records the movements of a handheld input device—the TracePen—and translates it into the relevant, robot-specific programming language. In this way, the software makes it possible to simultaneously teach and reprogram multiple robots and make the data available to other robots. Using the no-code approach, production companies can react quickly to shifts in manufacturing requirements, while equipping the robots with cameras enables them to gather

images for automated quality control based on computer vision. The movements of the robotic arms can be tailored to capture images relating to a specific component or application scenario. This approach delivers images of a higher quality by ensuring nothing blocks the camera's view and by fine-tuning the detection angle for an optimum perspective. Higher-quality images enhance the accuracy of the AI-based evaluation and, in turn, the efficiency of the plant's quality assurance.

Creating AI models is faster with the cloud

To determine whether a manufactured component meets quality assurance standards, the robots use the evaluation of the images they gathered using AI models. These models can be created quickly and easily because the robots are connected to the Realtime Computer Vision (RCV) software platform developed by Robotron Datenbank-Software GmbH, a digitalization specialist also based in Dresden. Robotron uses Microsoft Azure Machine Learning Operations (MLOps) to automate both the determination of relevant information and the RCV workflow, encompassing image annotation, AI model training, deployment, and the inference infrastructure for visual quality control.

MLOps provides the company's data scientists with the considerable graphics processing unit (GPU) computing power required for the iterative training of the machine learning models. It also offers the dynamic scalability typical of the cloud, because Robotron's GPU requirements can increase tenfold on short notice. The data scientists' value this rapidly scalable computing power just as much as the fact that MLOps covers the entire lifecycle of the machine learning models, while also offering interfaces for third-party systems.

"The end-to-end pipeline has all the features needed to develop and maintain machine learning models throughout their lifecycles," explains Dr. Deepa Kasinathan, Product Manager & Group Leader at Robotron Datenbank-Software GmbH. "We actually use our own machine learning training pipeline, which we can connect via interfaces to the Azure MLOps release pipeline to map the entire machine learning lifecycle."

This provides a time-saving way of training the models and putting them into operation with just a few clicks. MLOps satisfies regulatory requirements by automatically creating an audit trail and safeguarding the integrity of the assets. Microsoft Azure Active Directory provides the ideal concept for permissions and roles to ensure seamless collaboration among the IT, DevOps, and data science teams—even if these roles are not within the same company.

Meanwhile, the technology for the robots themselves is rapidly evolving. As an AI specialist, Robotron was an early adopter of Microsoft AI and Machine Learning innovations and participated in the relevant closed beta tests. The company is currently working on expanding its concept for fast-learning robots to include other applications. Over at Wandelbots, the company's no-code programming also supports a wide range of use cases—visual quality control is only one of many. Waldelbots is therefore working on scalable models that are designed to work with Azure Marketplace.

Because they can perform a multitude of tasks, reprogrammable lightweight robots are the best option for modular, flexible production lines. They provide a flexible platform for production stages, including visual quality assurance using AI-based computer vision underpinned by machine learning models. For training, deployment, and auditing, Microsoft Azure Machine Learning offers a reliable, dynamically scalable, cloud environment that covers the entire machine learning lifecycle. By pioneering these solutions, the BMW Group has furnished its Dingolfing plant with a production solution that is as efficient as it is agile. The solution can be easily transferred to other production lines, bringing new momentum to the automotive industry. At the same time, the technologies involved are paving the way for agile industrial manufacturing across all sectors.

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