Solution Brief

intel EDGE INSIGHTS FOR INDUSTRIAL

Kontron and Intel Develop Advanced AI-based Visual Inspection that Boosts Quality Assurance for Manufacturers with Small but Broad Product Line

Artificial Intelligence and Machine Vision deliver a powerful platform for improving manufacturing quality while lowering costs.

"This project has shown that with the help of cutting-edge technology and a relatively simple setup, it is possible to boost quality assurance and control costs in a small lot production environment."

— **Thomas Dreyer,** Director of R&D Kontron

Kontron Has a Vision for AI

Machine vision and Artificial Intelligence (AI) continue to play an increasingly prominent role in improving product consistency and quality within the manufacturing sector. Object recognition systems can detect tiny errors, imperfections, and inconsistencies not easily caught by human inspection. These systems automate time and labor-intensive tasks while boosting product quality.

According to research firm Markets and Markets, the machine vision market will reach US $15.5 billion by 2026[1]. Machine vision is especially valuable when used with small lots and discreet manufacturing, which can incorporate a variety of designs and product variations. Machine vision removes the need for a human to check each unit individually, a task that can prove complicated, time-consuming, and costly.

Harnessing the power of machine vision makes sense for Kontron, a leading manufacturer of high-performance industrial computer systems. Kontron's systems deliver state-of-the-art functionality that incorporates Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT).

Organizations, primarily OEMs, purchase Kontron computers with highly customized components and configurations. For Kontron, ensuring that systems are configured and assembled properly was a time-intensive and expensive task. It required comparing each product to its specification to verify that each had been built correctly.

In response to these challenges, Kontron worked with Intel to implement a sophisticated AI machine vision inspection solution using Intel® Edge Insights for Industrial (EII), which runs atop the OpenVINO™ toolkit microservices development architecture. Using standard video cameras and an existing IT and PC infrastructure, the German company changed the way it approaches quality assurance (QA).

The AI-based visual inspection solution delivered immediate and tangible benefits. "This project has shown that with the help of cutting-edge technology and a relatively simple setup, it is possible to boost quality assurance and control costs in a small lot production environment," explains Thomas Dreyer, director of R&D at Kontron.

Kontron Recognizes a Need to Speed up Inspection through Automation

Kontron customers order custom-built systems with specific ports and connectors to meet their requirements. In many cases, customers also require optional functionality and customized mechanical configurations. Before any system can go out the door, Kontron must conduct a thorough inspection to confirm the correct combination of multiple unique attributes. In the past, humans had to manually inspect each computer before it could be shipped.

That task is further complicated by the fact that Kontron's product portfolio offers computer systems in many different combinations and configurations. As a result, inspectors had to constantly switch gears – double-checking exact specifications from design sheets – before a system could be approved to ship.

Manually inspecting all these units was tedious and time-consuming. It also was easy to overlook an issue – such as a misconfigured USB port or even a screw at the wrong angle – especially when inspectors became fatigued. Such inefficiencies add to the cost of production and slow delivery, resulting in lower quality assurance satisfaction scores from customers.

In October 2021, Kontron turned to Intel to figure out how to construct an advanced AI-based visual inspection platform. The company wanted to ratchet up inspection efficiency and improve overall quality assurance. "We recognized that object recognition technology was an ideal fit for our computer assembly process. It introduced features and capabilities that could potentially transform Kontron", Dreyer says.

Intel AI Powers Advanced Machine Vision

From the start, project leaders at Kontron knew they wanted to create an AI solution that would be fast and simple to implement yet deliver critical features and capabilities that provided practical benefits. Plus, they didn't want to invest large sums of money into highly specialized hardware and cameras if it wasn't necessary.

They discovered that Intel offered a robust set of technologies to meet their needs:

- Intel® Edge Insights for Industrial (EII) software – an open and flexible microservices architecture that speeds up development tasks while optimizing performance,
- Intel® OpenVINO™ toolkit with built-in deep learning reference algorithms; and
- Industrial PCs (IPCs) based on 11th Gen Intel® Core™ processors.

This powerful yet affordable technology foundation was able to accomplish advanced AI-based machine inspection using only the Intel® Core™ processors without the addition of expensive and power-consuming GPUs or hardware accelerators.

"The platform is appealing because it delivers the processing power and tools to build a machine vision system quickly, effectively, and affordably," Dreyer explains. "We couldn't afford to devote a great deal of time building a solution, and it couldn't interrupt our current production environment. Intel's EII and OpenVINO™ toolkit delivered the crucial capabilities that we needed."

Kontron and Intel Tame Complexity through Advanced AI

The company also had specific requirements in mind for the visual inspection solution. A top priority was that all AI inference should take place at the edge—closer to data sources – in order to boost speed and deliver cost savings. To reach this goal, the system had to handle video ingestion, storage, and analytics within a single software package. It also had to support a highly flexible microservices framework.

The AI visual inspection powered by Intel EII offers the following:

- The ability to process streaming video, extract specific still images, and accommodate on-premises analysis within a low latency framework. Employees couldn't wait minutes for the visual inspection system to generate the required images. Everything had to take place in real-time.
- A highly flexible and customizable framework. Because Kontron offers its customers a broad choice of configuration options for PCs, the object recognition system had to be extremely adaptable.
- Higher inference performance. A faster video frame rate analysis was achieved with the OpenVINO™ toolkit.
- The ability to use 11th Gen Intel® Core™ processors without needing to add specialized hardware, such as discrete GPUs. The x86 technology enabled Kontron to tap its existing hardware resources along with leading-edge graphics and wireless capabilities that Intel provides to speed up the process and keep costs down.
- The ability to construct an open and modular platform using Docker containers.
- An opportunity to use low-cost USB web cameras, representing a significant saving over the cost of industrial-grade cameras, to capture video streams and break them into individual images.

Kontron Transforms the Vision into a Sophisticated but Affordable Visual Inspection Solution

The first step in building the machine learning model was to mount six cameras around the area set up for visual inspection. The webcams capture streaming image data from different angles and perspectives, including above, below, and along the sides of the systems. The image data created a simultaneous multi-dimensional view of each computer.

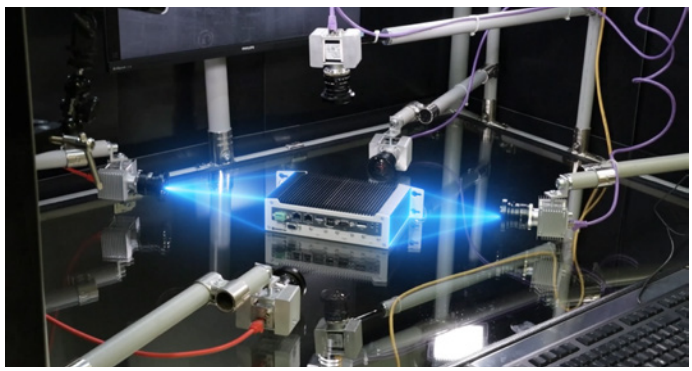

Figure 1. Kontron's visual inspection setup uses six webcams to capture streaming image data from different angles of the PC.

Kontron initially used about 535 images of 160 different computer configurations of two different computer types to train the machine learning system. The images included details such as screw positions, label positions, holes, and mounting angles from all six angles—top, bottom, and four sides.

The team labeled objects of interest to generate a representative dataset of images for each type of PC, including components and missing or defective parts. The task wasn't without challenges. For example, the team had to find a way to filter out reflections and other lighting issues that could lead to machine vision errors. Consequently, the team annotated images and fine-tuned the system to ensure that it was highly accurate.

"In order to increase the accuracy of the model, i.e., how well an object is recognized, we used techniques such as augmentation—rotating images a few degrees, using different brightness values, cropping, and padding, as well as even mirroring techniques," Dreyer explains. They also had to augment the data set to obtain a sufficiently large number of distributed objects and experiment with different learning models and methods, like transfer learning using models from the OpenVINO Model Zoo, to determine what would work best.

Figure 2. Objects of interest were labeled to generate a representative dataset of images for each type of PC, including components and missing or defective parts.

After finding the best augmentation methods and the optimal set of labeled objects, the team used more than 12000 different images and 30 labeled objects to train the final model in a public cloud using GPUs. The AI model was then transferred to the OpenVINO™ toolkit to run within the Intel EII framework.

"Once the AI training was set up in the cloud, labeling the new images took only two days, and training the model with the new images took just one day!" Maik Pertermann, Kontron AIS.

An Eye on Quality with AI

After launching the machine vision system, Kontron continued to explore ways to improve performance. One key gain resulted after the team experimented with consumer-grade USB cameras. Kontron had initially relied on specialized high-end industrial Gigabit Ethernet cameras with additional hardware requirements to capture images. However, they found that off-the-shelf USB video cameras provided sharper images with more detail due to the included automatic focusing function and the advantage of connecting directly without needing additional hardware.

Another advance took place as the team refined the training process. "We increased object detection accuracy by fine-tuning the AI model training parameters. In addition, labeling similar looking objects, such as different types of screws that were not of immediate interest, had a large impact on the recognition rate", Kontron's data scientist Maik Pertermann pointed out. "This helped us achieve rates approaching above 90% of most components."

The AI solution analyzes computing systems by comparing real-time image views against the trained model. The solution assesses all predefined objects from the specification with corresponding detected objects to a human operator, who can then examine the product and verify any issues. The operator can also comment on the inspection results allowing Kontron to perform further investigation along with the automatically stored records and either incorporate the data into the AI model or ignore it if there's a false positive.

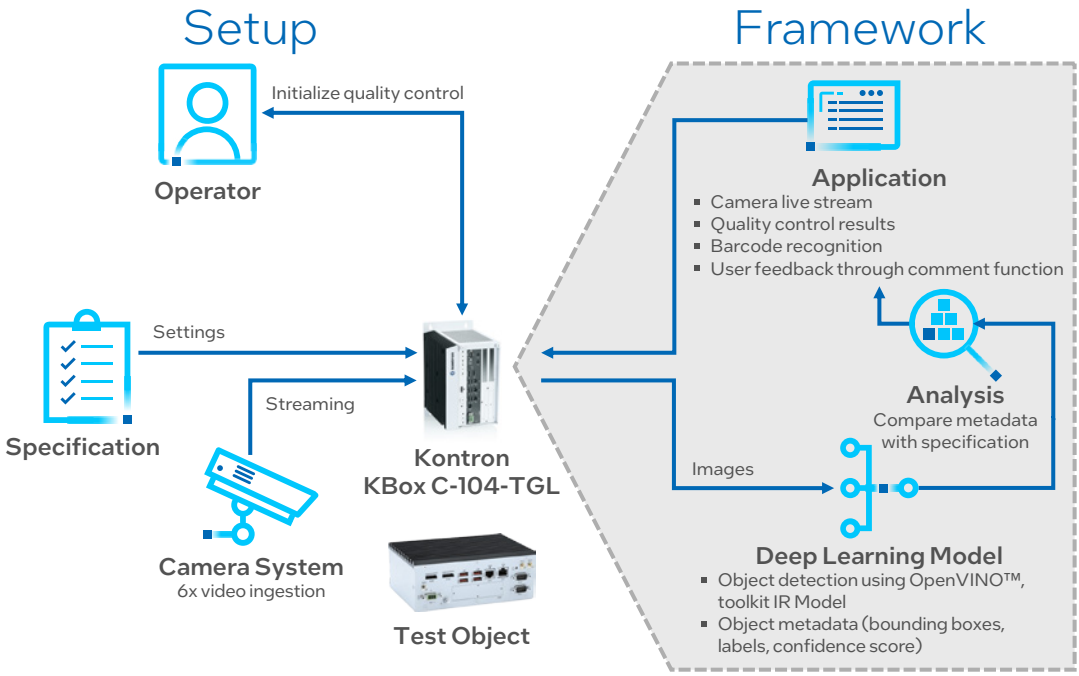

Figure 3. Schematic of Kontron's visual inspection solution.

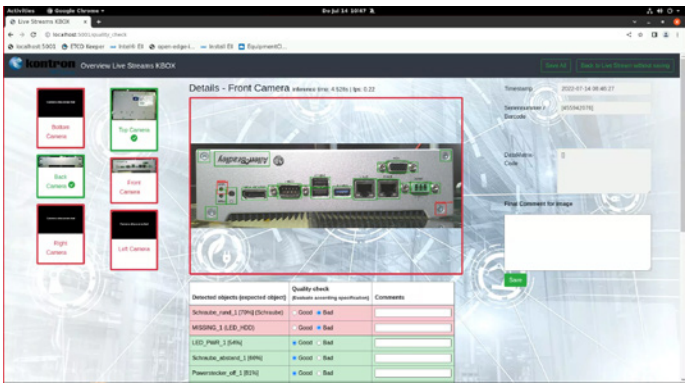

Figure 4. The visual inspection solution provides a human operator with an assessment of whether (green highlighted) or not (red highlighted) the detected objects match the specification, who can verify any issues.

According to Dreyer, the system has proved its value on the production line. For one thing, inspectors can work more strategically—and reduce configuration errors that customers detect upon delivery. For another, machine vision minimizes the possibility of worker fatigue that contributes to errors.

About Kontron

Kontron has established itself as a global leader in advanced computing systems. Companies in fields such as industrial automation, avionics, telecommunications, defense, energy, healthcare, transportation, and manufacturing use Kontron computers. These systems require both compute power and specialized features.

Kontron creates value through a combined portfolio of hardware, software, and engineering services. The manufacturer offers standard and individually engineered solutions for highly specialized needs in areas such as the Internet of Things (IoT) and Industry 4.0.

Organizations relying on Kontron computers benefit from accelerated time to market, a lower total cost of ownership (TCO), extended product lifecycles, and fully integrated applications.

Moreover, the inspection technology and process are highly flexible and expandable. Kontron will introduce new and different inspection features in the future. With the hardware infrastructure and AI foundation in place, simply adding specific training data is all that's needed. "We have an extremely versatile and valuable object recognition solution that will effectively support our efforts now and in the future," Dreyer explains.

AI Changes Quality Assurance at Kontron

The combination of Intel and Kontron technologies has introduced revolutionary AI-based visual inspection. Kontron's machine vision solution is helping the high-performance industrial computer manufacturer embrace the future—and better serve its customers.

The result is improved quality control at a lower total cost and the ability to deploy technical staff strategically. This project has shown that with a relatively simple set-up and the help of Intel Edge Insights for Industrial software, it is possible to quickly support quality assurance in a production environment so that more manufacturers can benefit from machine vision in the new era of AI.

Learn More

Explore how your organization can eliminate time-consuming and manual inspection processes – including in small lot manufacturing – through a machine vision and AI framework that is powerful yet intuitive.

- **Kontron**
- **Intel OpenVINO™ toolkit**
- **Intel® Core™ processor family**
- **Intel® Xeon® processor family**
- **Intel® Edge Insights for Industrial**

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[1] https://www.marketsandmarkets.com/PressReleases/industrial-machine-vision.asp.

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