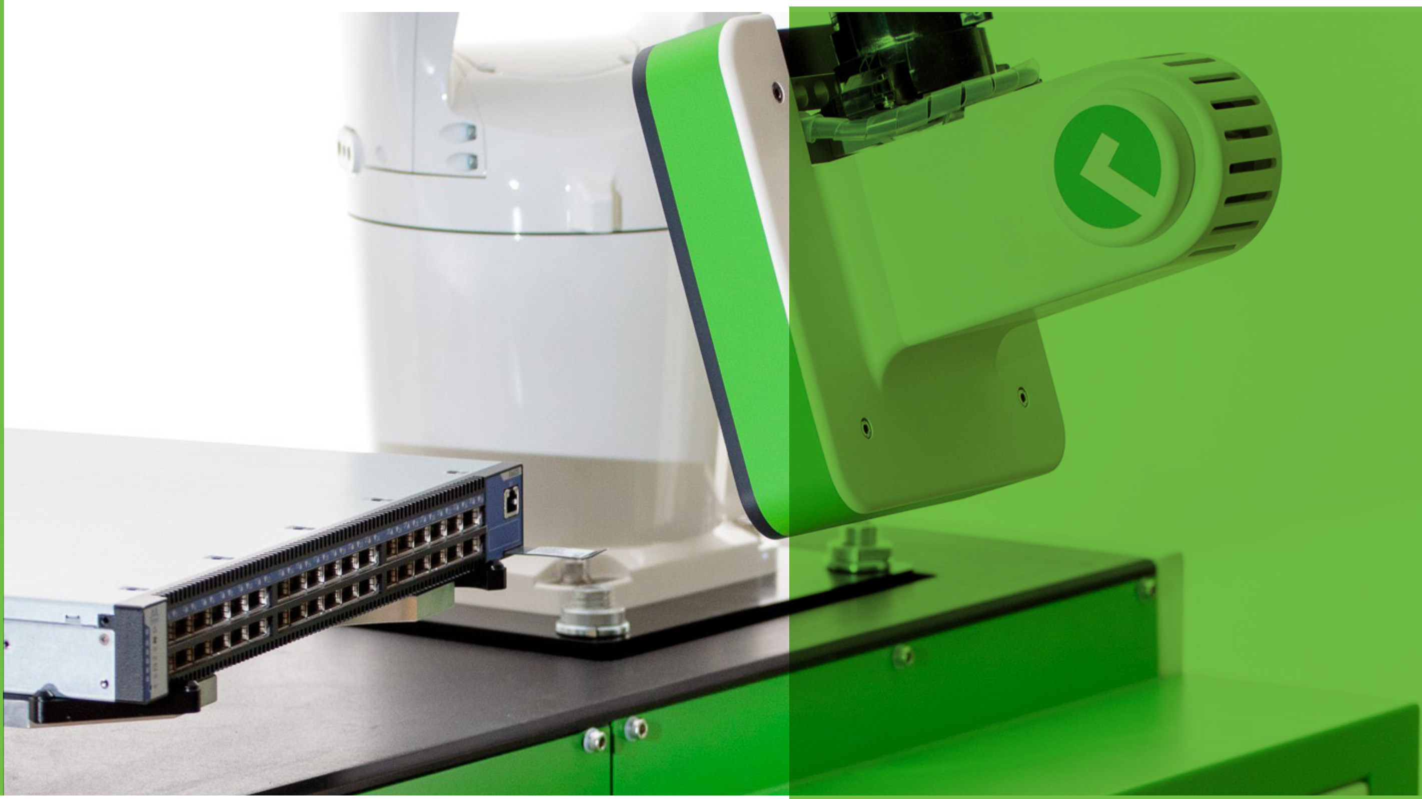
HYBRID VISION SYSTEM INSPECTS HIGHLY VARIABLE ELECTRONIC PRODUCT MIX

Deep learning, 3D imaging, traditional machine vision, and intelligent robotic planning team up to inspect hundreds of server and switch models.



KITOV.ai

HIGH-END SERVER AND SWITCH manufacturers must visually inspect components not only for cosmetic defects such as scratches, dents, and shade variations but also for functional defects like bent pins on ports and connectors, untightened screws, missing components, and wrong barcodes. Defects like these cost manufacturers time and money, not to mention brand reputation and customer satisfaction. Fortunately for those in the industry, advanced machine vision and automation technologies offer a more effective, accurate, and cost-efficient method for automated visual inspection than manual alternatives.

Manual Inspection Mishap

Prior to deploying machine vision technologies, a leading supplier of end-to-end communication solutions, storage, and hyperconverged infrastructure used manual visual inspection on the manufacturing line. Training and certifying employees to be quality inspectors involved a major investment of time and money. The visual inspection process covered many quality areas, including:

- Surface inspection of all six sides — ensuring no scratches or dents
- Silkscreen and PAD printing quality
- Edge inspection — ensuring that edges were sharp and clean, without any defects
- Light-pipe indicator quality and existence
- Screw quality and existence
- Label location, edges, and print quality
- Communication port housing and pin defects (on up to 48 ports)

In addition, the manufacturer assembled more than 200 different products and models, making any customized automatic inspection solution impractical due to cost consideration and implementation time. In 2016, the manufacturer learned the hard way that manual visual inspection was too error prone for this level of detail, as the company shipped out a large batch of defective communication servers and switches after a ramp-up in production due to growing product demand. Regrettably for the manufacturer, the defective products were discovered after installation, and the cost implication was significant, involving product repacking and repair, impacting logistics and inventory, and of course reflecting on the company's reputation. With this in mind, the manufacturer sought an automated solution that more precisely detects defects.

Flexibility for Production Variance

Machine vision and automation systems help many OEMs keep up with customer demands, but certain situations move beyond the scope of traditional robot, machine vision, and motion-control technologies. Production processes that require mass customization and personalization also increase production environment variance, which can throw a wrench into traditional machine vision processes.

Quality inspection procedures for such variations may include multiple algorithms applied in a specific sequence to extract useful information from captured images. Traditional rules-based algorithms define defects using mathematical values and logic rules, but using such algorithms to create an accurate and reliable inspection routine — free of extensive false negatives and false positives — can take hours or days, depending on the product and the programmer's skill level. Multiply that time requirement by hundreds of product variants and quality inspection becomes unfeasible.

Even further, defining complex assemblies and shapes using mathematic values results in a rigid rule set that may not offer the best solution for modern product lines. If a system inspects electronic connectors to verify pin presence, for example, changing lighting conditions could make a pin appear to be crooked or missing and the vision system might then fail the entire connector. If the connector is a critical system component and the OEM must catch 100% of defective connectors regardless of waste, the manufacturer may have to scrap 10%, 20%, or 30% of its production to meet customer specifications, resulting in unnecessary waste and costs. Manufacturers require not just automated inspection systems but also flexible inspection technology that adapts as products, processes, and environmental conditions change.

A Hybrid, Standalone Approach

Seeking an automated visual inspection system that could suit its unique needs, the customer gave the nod to Kitov.ai to develop its system. The company's standalone deep learning product inspection station comes standard with several pretrained neural networks for locating and inspecting screws, surfaces, labels, and data ports, and it also performs optical character recognition. Kitov.ai constantly develops and adds new pretrained neural networks, referred to as semantic detectors, that help more customers in a wider variety of industries solve their most perplexing inspection tasks.

Inspecting highly variable finished products like the one the manufacturer offers presents a significant machine vision challenge. Traditional, rules-based systems can produce unacceptably high false-negative and false-positive rates. Using only deep learning to solve the problem involves training the system to recognize every component in an assembly and then combine the components into a single assembly for the final quality inspection step. In this case, achieving acceptable false-negative rates without allowing too many defective products to escape the quality check often proves difficult, even for experienced vision system designers.

Kitov.ai's system combines traditional machine vision algorithms with deep learning capabilities to enable the inspection of complex assembles and to continually adapt to changing conditions. It essentially allows the system to learn what makes good and bad parts during production runs, and not just during the training phase of system development, placing automated continuous improvement of industrial processes within reach.

Intelligent Software for Complex Needs

The smart visual inspection system uses an off-the-shelf CMOS camera with multiple brightfield and darkfield lighting elements in a photometric inspection configuration to capture 2D images. The software then combines these images into a single 3D image. Because the technology uses common semantic terms ("screw," "port," "label," "barcode," "surface") rather than machine vision programming terms ("blob," "threshold," "pixel," "contrast"), nonexperts can learn how to modify or create new inspection plans in a short time.

Deep learning software classifies potential defects discovered by the traditional machine vision 3D algorithms, and the software's intelligent robot planner uses mathematical algorithms to automatically maneuver a robot with an optical head without the need for operator input. The algorithms decide where to move the camera, choose an illumination condition from a set of onboard lighting elements, and dictate how many images to capture for each test point. Additionally, the software instructs the robot how to move optimally from point to point during inspection.

Rapid ROI, Deployment at Scale

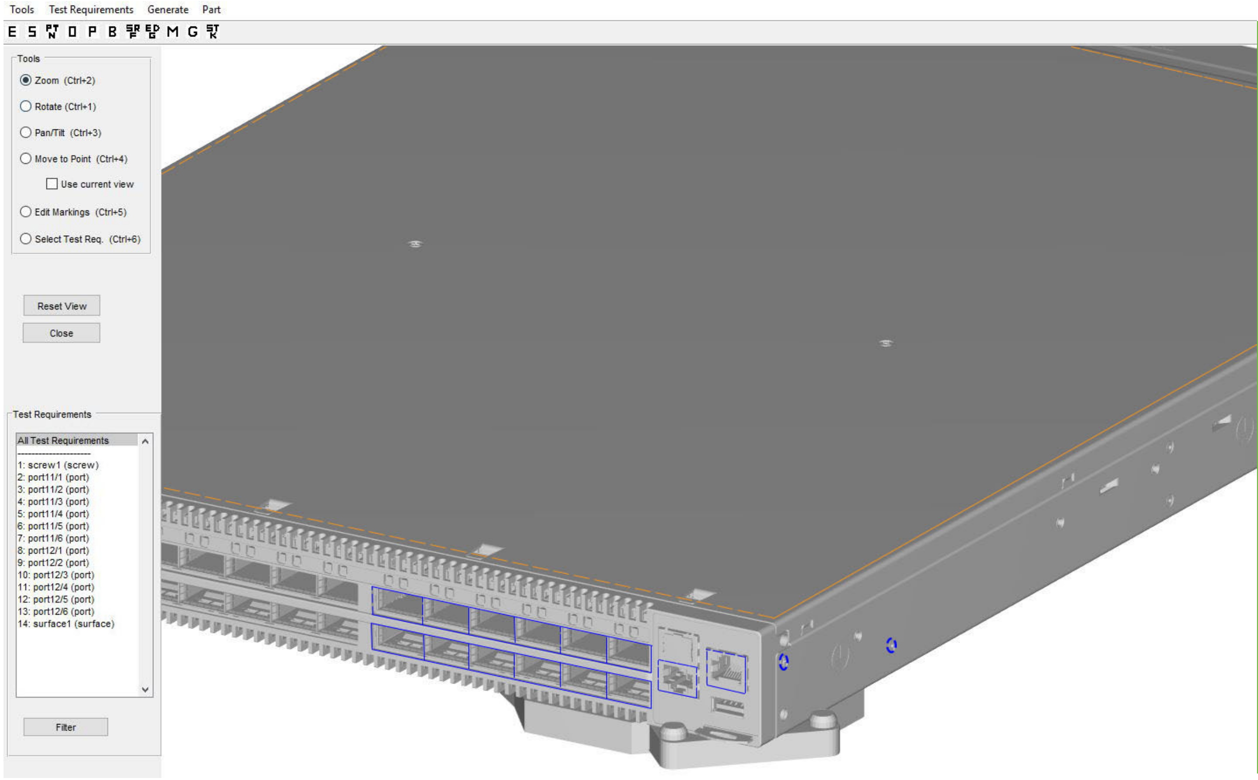
Using the smart visual inspection platform, the customer successfully created more than 100 different inspection plans in a few months.

As mixed models make their way through the manufacturing process, the system seamlessly switches between the different inspection requirements based on the product model and manufacturer needs. Using a 6-axis robot and rotating table, the system scans products up to 850 mm by 420 mm in size — inspecting for all test requirements such as surface, communication ports (housing and pins), labels, and screws — covering the customer's full product range.

With the new system, the manufacturer also collects valuable inspection data to drive manufacturing process improvement. Return on investment took less than six months, and the customer also adopted Kitov's smart visual inspection platform across its manufacturing facilities on a global scale.

"Kitov's system is the only out-of-the box solution on the market that can inspect such complex products," concluded the manufacturer after deployment.

Bent pins inside computer I/O ports are among the most common reasons electronic products are returned to the manufacturer as defective. However, inspecting fine wires at the bottom of cavities with reliability and accuracy requires a 3D inspection system, often with additional capabilities, such as deep learning defect analysis. This programming interface begins with the system designer loading a CAD file (shown here) or "golden part" image. The designer can then draw regions of interest around important inspection points. Advanced hybrid solutions evaluate each region on the product to determine the right combination of traditional and deep learning algorithms for inspection.



Kitov.ai solutions are implemented in disparate applications in various market segments. Please contact Kitov.ai via the company website **(www.kitov.ai/contact)** or **Corey Merchant at: corey.merchant@kitov.ai.**

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