Solution Brief

Computer Vision

# Improved Manufacturing Efficiency with High-Accuracy Automated Optical Inspection

**The ADLINK Automated Optical Inspection (AOI) solution, enabled with Intel CPU, GPUs and AI models optimized by OpenVINO toolkit, provides highly accurate visual inference at scale to reduce overhead costs of quality assurance in manufacturing.**

Human vision and attention are poorly matched to the needs of visual product inspection on manufacturing lines. Accuracy and reliability deteriorate as people make these high-speed, repetitive judgments. Augmenting human workflows with computer vision has been successful at reducing fatigue and increasing accuracy and productivity for years. Advances in AI now improve further on this model, with automated optical inspection (AOI) based on neural networks reducing the burden on human inspectors.

AOI systems use camera sensors to capture images of products on the manufacturing line and then analyze those images algorithmically to identify defects and abnormalities. These processes are useful across various manufacturing industries, with the potential to improve quality control and reduce costs. As a result, the global market segment is expected to grow by 12.3% through 2032.[1]

As manufacturing businesses plan their approaches to deploying AI — including for AOI — many are challenged by the technology's complexity and computational requirements. Projects may be delayed or fail entirely due to missteps and the scarcity of critical expertise. ADLINK helps customers overcome those obstacles with a highly accurate AOI solution that is easy to implement, helping deliver fast time to market and low total cost of ownership, with flexibility across production use cases.

## ADLINK AOI solution for manufacturing

As a proof of concept on its own manufacturing line, ADLINK has deployed its AOI solution to automate final inspection of embedded computers. The solution uses six cameras to capture product images from all sides, as illustrated in Figure 1. The frames are analyzed using neural networks on an ADLINK MVP-5200 Series compact industrial computer. Featuring the Intel® Core™ i7-12700E processor and ADLINK MXM-AXe GPU module based on Intel® Arc™ Graphics, the system offers a flexible combination of CPU, integrated GPU, and discrete GPU resources for neural network models of varying complexity.

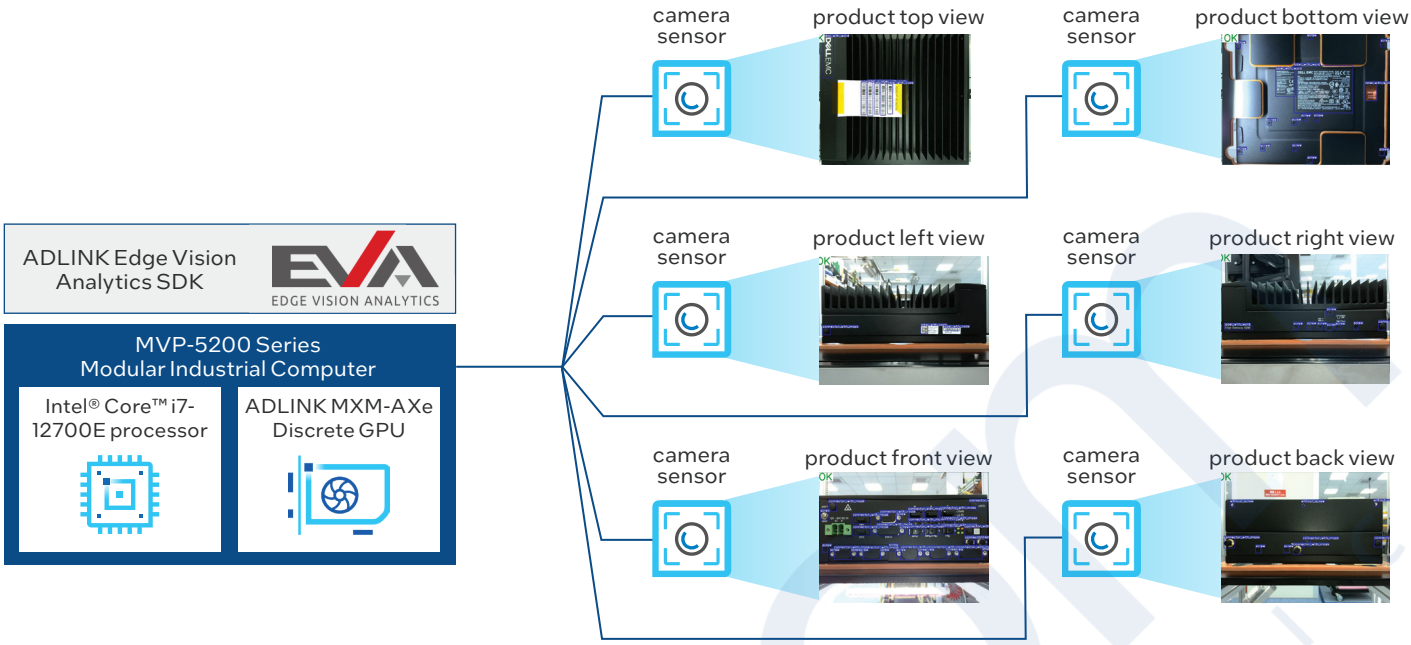


**Figure 1.** ADLINK automated optical inspection (AOI) solution for manufacturing.

The accuracy of visual inference made by the solution is the most critical key performance indicator (KPI). Initial measurements by ADLINK's Advanced Manufacturing Technology Center found that the average human inspector was capable of checking products at a rate of about one every 20 seconds with an accuracy of about 98%, depending on the individual. With improving on that result as a primary goal, the team reports that the AOI solution succeeds by inspecting each product in just one second with an accuracy of 98.8%.[2] This outcome demonstrates substantial potential ability to save on overhead hours for inspectors in manufacturing processes.

The ADLINK MVP-5200 series series computer featuring the 12th Generation Intel Core processor is built with ADLINK's embedded systems engineering expertise. Its rugged, fanless design is targeted to operate at the edge, running industrial compute and AI applications in either Linux or Windows. In addition to the CPU and its powerful integrated graphics, the system offers scale-up inference capacity with Intel Arc Graphics on the ADLINK MXM-AXe GPU module. Table 1 summarizes the hardware resources available for AI compute on this platform. They include special instructions in the CPU (AVX-512, VNNI) and GPU (DP4a) to accelerate vector and integer computations, and dedicated engines (XMX) on discrete GPU for matrix multiplication.

**Figure 2.** The ADLINK MVP-5200-MXM computer and MXM-AXe GPU module.

**Table 1.** Hardware acceleration of neural network computations on ADLINK MVP-5200 series computer.

| Ingredient | | AI Acceleration |
|---|---|---|
| CPU | 12th Generation Intel® Core™ i7 Processor | AVX-512 and VNNI |
| Integrated GPU | Intel UHD Graphics 770 | DP4a |
| Discrete GPU | Intel Arc A350M/370M GPU | DP4a, XMX |

Hyper Compute, which is part of Intel Deep Link technology, intelligently balances compute workloads across CPU and GPU resources. This underlying mechanism enables applications to harness availability and maximize utilization of Intel hardware capabilities to speed up computations. Similarly, the Intel® OpenVINO™ inference engine is capable of combining CPU, integrated GPU, and discrete GPU resources available on an Intel platform such as the ADLINK MVP-5200 series computer to support AI workloads. The OpenVINO solution stack features an open, non-proprietary programming model and draws on the unmatched Intel ecosystem of hardware and software building blocks.

## Streamlined integration using ADLINK Edge Vision Analytics SDK

To accelerate the development and deployment of machine vision applications, ADLINK embeds the Edge Vision Analytics (EVA) SDK in its AI vision products. Key features are shown in Figure 3. EVA provides both a runtime and integrated development environment (IDE) for simple and intuitive operation, with support for Windows, Linux and Docker containers. It also includes code samples and technical support.

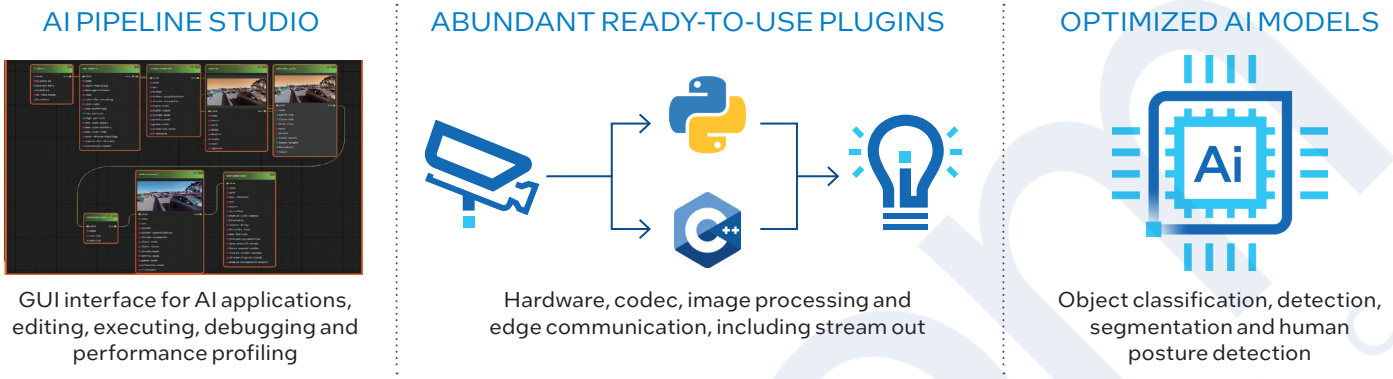


**Figure 3.** Key EVA SDK features for edge AI vision applications.

This service-ready software platform provides ready-to-use open source plugins that support each stage of the workflow from image capture and processing to AI inference, post-processing and analytics. EVA also supports the creation of new plugins using Python that run smoothly alongside the provided C-based plugins. Field-ready support for more than ten camera protocols and a low-code/no-code GUI enable developers to quickly create proofs of concept that validate project plans with enhanced control over investments in time and budget.

Foundational to the EVA SDK is the open source GStreamer media framework which enables use of hardware resources for media processing in the application pipeline. The EVA SDK makes GStreamer more capable and reduces the complexity of edge AI vision development. This feature provides ready support for complex pipelines, with high development efficiency. Implementation teams construct applications by dragging and dropping functional components to create processing pipelines. EVA supports multiple inference engines, including OpenVINO which optimizes for Intel hardware.

## Fast, accurate deep learning results, powered by OpenVINO

The Intel Distribution of OpenVINO™ toolkit — which is included with the EVA SDK — facilitates and simplifies creation of fast and accurate deep learning pipeline in ADLINK's AOI solution. The ADLINK team takes advantage of the toolkit's streamlined development workflow, freeing up precious team resources. Using OpenVINO's write-once, deploy-anywhere model, algorithms can be deployed across the hardware platform, including on the CPU, integrated GPU and discrete GPU. Rapid conversion and optimization of edge-optimized models for Intel architecture improves the accuracy of inference while accelerating development.

The solution's design specifications call for the capture and analysis of inputs at a rate of 20 frames per second for a robust data-ingress stream. To meet this performance threshold, the ADLINK team assesses many neural network models to determine the suitability of each one. The OpenVINO toolkit includes a large and growing number of models optimized for Intel architecture. This enables consideration of a larger number of models than would otherwise be practical, with the effect of improving the quality of the solution while reducing development effort.

ADLINK's AOI development team experienced additional benefits in developing with OpenVINO, including ease of installation, compatibility with multiple model formats and data types and GUI tools for low-code development. These benefits combine to improve development efficiency, flexibility and accuracy.

> *"Developing with OpenVINO saved ADLINK dramatically on engineering resources.... OpenVINO's extensive model support in particular helped our team bring a high-quality AOI solution to market faster and more cost-effectively than would otherwise have been possible."*
>
> **– Fencer Kao, Software R&D Manager, ADLINK Technology, Inc.**

## Conclusion

The openness and extensibility of the platform and programming model of ADLINK's Edge Vision Analytic Platform make it an ideal point of departure for broader implementations of AI in manufacturing. For example, additional visual computing workloads can support worker safety monitoring, such as tracking proximity to hazardous equipment and proper use of personal protective equipment.

As robotics and other automated systems, coupled with AI techniques, play increasing roles on the factory floor, this mode of development is critical to the future of the manufacturing industry. By building efficiency and cost savings into every aspect of production, the future is ripe for improved profitability from AI innovation.

## More Information

Contact ADLINK sales

ADLINK MVP-5200 series

MXM-AXe embedded MXM GPU module

Intel Core i7-12700E processor

Intel Arc Graphics for the Edge

Solution provided by:

intel + ADLINK

[1] Emergen Research, April 2023. "Automatic Visual Inspection Systems Market, By Type (2D Systems and 3D System), By Application (Surface Inspection and Measurement), By Component (Hardware and Software), By End-use, and By Region Forecast to 2032." https://www.emergenresearch.com/industry-report/automatic-visual-inspection-systems-market.

[2] Reported by ADLINK, August 2023.

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