

Unleashing Next-Gen Artificial Intelligence (AI)-Based Automated Optical Inspection (AOI) Workload Consolidation Solution

Introducing the next-level AI AOI solution enabled by ASRock Industrial* iEP-9020E Robust Edge AIoT Platform¹ with 13th Gen Intel® Core™ Processor², Intel® Edge Insights for Industrial³, and Intel® Distribution of OpenVINO™ Toolkit⁴.

Table of Contents:

- Introduction 1
- Solution Proposal 2
- Microsoft* EFLOW: The Best of Both Worlds 2
- Intel® Tech & Software Ingredients 2
- Putting the Solution to the Test: Pilot Run in Detail 3
- Deciphering the Metrics of Transformation: Understanding Accuracy, Efficiency, and Beyond . . . 3
- Envisioned Industrial Applications 5
- Conclusion 5
- Learn More 5
- References and Sources 5

Enhancing Processes Through iEP-9020E Robust Edge AIoT Platform

Manual	AI AOI	Gain
Bar Code Scanning + Human Inspection + Image Capturing	Bar Code Scanning + AI Detection + Image Capturing	258.8% Increase in Operational Efficiency
2 Operators	1 Operator	50% Reduction in Labor Cost
Accuracy: 97.5%	Under Rejection: 0%	Review Rate: 2.5%

Note: The aforementioned outcomes were derived from a pilot implementation by ASRock Industrial utilizing the iEP-9020E Robust Edge AIoT Platform.

Introduction

The existing landscape of product defect inspection operations finds itself grappling with a trifecta of challenges: subpar accuracy rates, operational inefficiencies, and a scarcity of proficient labor. The prevalent manual inspection methodologies, while once regarded as new and smart solutions, are now very close to becoming obsolete. These dated approaches have a problem simply because humans make mistakes, manifesting themselves as errors that ripple across the production line. The harmful effects of inconsistent judgments – When different inspectors find different problems at different times, it creates a mess that makes work and quality suffer.

Also, the manual way of inspecting things is inefficient and time-consuming. Consequently, it depletes financial resources and places a burden on the workforce's capacity. Conventional Automated Optical Inspection (AOI) systems encounter their tribulations in the modern industrial arena. These venerable systems, which rely on optical sensors for their core function, suffer from image analysis challenges. These challenges often materialize within AOI systems, where the determination of pass-or-fail outcomes hinges on the finesse of optical sensors. Regrettably, these AOI systems have a hard time adapting, struggling to detect new defects without undergoing a substantial reprogramming exercise.

Compounding is a serious problem in the manufacturing industry – an experienced workforce is on the brink of retirement, leaving a void in their wake, and there are not enough young people interested in taking their place. This causes a big gap in skilled workers. This mix of problems makes things like how much we can make, how well we can make it, and how much it costs to make it all get worse. This is a big concern because if we do not solve these problems, it will hurt the economy and the new ideas we have in the manufacturing industry.


“ Our partnership with Intel® to implement an advanced AI AOI workload consolidation solution within our OEM factory signifies a momentous stride forward in the realm of defect inspection. Leveraging the capabilities inherent in our iEP-9020E Robust Edge AIoT Platform¹, in synergy with 13th Gen Intel® Core™ Processor² and cutting-edge AI technologies, we have attained an outstanding level of precision and operational efficiency. This accomplishment sets the stage for a groundbreaking era of manufacturing excellence.
– James Lee
President of ASRock Industrial. ”

In the relentless pursuit of a paradigm shift in industrial inspection, a beacon of innovation emerges through the symbiotic partnership of Intel® and ASRock Industrial*. Their brainchild: the trailblazing next-generation Artificial Intelligence (AI)-Based AOI Workload Consolidation, powered by the computational prowess of ASRock Industrial's iEP-9020E Robust Edge AIoT Platform¹ with the 13th Gen Intel® Core™ Processor². This case study embarks on an expedition into the annals of this revolutionary pilot run, highlighting how important the roles are played by Intel® Edge Insights for Industrial (EII)³ and Microsoft* Azure Internet of Things (IoT) Edge for Linux on Windows (EFLOW)⁵. The goal is to unlock a never-before-seen level of precision, efficiency, and cost-effectiveness that defies convention and reshapes the trajectory of manufacturing product quality inspection.

Solution Proposal

The ASRock Industrial iEP-9020E Robust Edge AIoT Platform¹ introduces an all-encompassing solution powered by Next-Gen AI-enabled AOI Workload Consolidation. This groundbreaking paradigm leverages the convergence of Linux*-based AI workloads and Windows* GUI applications seamlessly orchestrated through Microsoft EFLOW⁵, all encapsulated within a singular, high-performance iEP-9020E with 13th Gen Intel® Core™ Processor².

This pioneering approach brings together the strong abilities of inference and real-time data analytics, making solving problems better and everything works smoother. The integration of these cutting-edge components marks a transformative milestone in the realm of industrial innovation, accentuating ASRock Industrial's and Intel's commitment to pushing the boundaries of possibility.

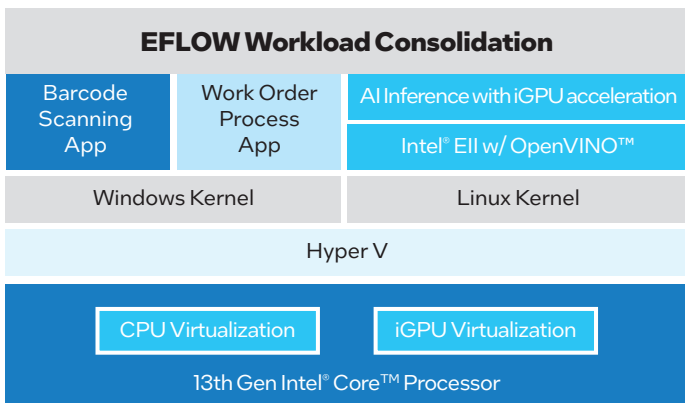
Pain Points: PCBA Board Defect Detection in Factory	Solution: AI AOI Workload Consolidation with ASRock Industrial iEP-9020E
<ul style="list-style-type: none"> ▪ Quality labour shortage ▪ Inconsistency Inspection Accuracy ▪ Low Manual Inspection Efficiency ▪ Operation Cost 	<ul style="list-style-type: none"> ▪ 13th Gen Intel® Core™ Processor ▪ Intel® Edge Insights for Industrial ▪ Intel® Geti (DL model training) ▪ Intel® iGPU for AI Inference acceleration on Microsoft EFLOW 

Microsoft EFLOW⁵: The Best of Both Worlds

Microsoft EFLOW, or Azure IoT Edge for Linux on Windows, provides a platform for deploying Linux IoT workloads on Windows IoT devices.

Currently, most industrial computers still operate in a Windows environment. Nevertheless, businesses may sometimes choose to implement their custom modules using the Linux distribution of their choice to address specific business requirements. Traditionally, Linux-based cloud-native workloads were not able to run on a Windows-based system. With the introduction of EFLOW, the conventional barrier became a thing of the past, as integration between the two allows AOI applications to leverage the strengths of both Windows IoT and Linux environments.

By enabling the coexistence of different workloads, EFLOW offers the potential to save substantial development time and reduce time-to-market.



To find out more, kindly refer to the white paper on Microsoft EFLOW at <https://www.intel.sg/content/www/xa/en/internet-of-things/industrial-iot/modernize-aoi-with-eflow.html>.

Intel® Tech & Software Ingredients

In the initial deployment phase, the solution adeptly utilizes Intel's forefront technologies and software stack, encompassing a spectrum of innovative elements that substantially enhance its operational prowess. These elements encompass:

13th Gen Intel® Core™ Processor²

The 13th Gen Intel® Core™ Processor for IoT offers more cores and memory for compute-intensive edge use cases. With a hybrid architecture and up to 24 cores and 32 threads, this generation achieves up to 1.04x faster² single-thread performance, up to 1.34x faster² multi-thread performance, and up to 1.25x faster² in CPU image classification inference performance.

The high-functioning 13th Gen Intel® Core™ Processor boasts the following key features, all of which are ideal for a seamless deep learning AI inference environment:

- **Integrated GPU (iGPU)²:** As hardware accelerator for AI workload.
- **Manageability:** Simplifies device management and maintenance.
- **Hardware Security:** Protects sensitive data through advanced security features.
- **Virtualization:** Enables efficient resource utilization and workload isolation.

Intel® GETI⁶ – for AI Model Training

Intel® GETI offers tailored computer vision AI model training for various industries. With active learning and AI-assisted labeling, it provides an intuitive user experience to simplify the AI model training process and ensure that AOI models are reliable and accurate.

In short, Intel® GETI enhances data connectivity and processing capabilities with sped-up model-training time.

Intel® Distribution of OpenVINO™ Toolkit⁴ – for AI Inference

Intel® Distribution of OpenVINO™ Toolkit enables optimized AI AOI inference. It is designed to optimize deep learning models for faster inference on Intel® hardware platforms, including CPUs, GPUs, and FPGAs.

Besides providing flexible deployment options (e.g., on-premises and cloud deployments), OpenVINO™ is cross-platform compatible, supporting a vast range of deep learning frameworks. OpenVINO™ enables model conversion from different frameworks (e.g., TensorFlow, PyTorch, MXNet, ONNX, and Caffe) into a standardized Intermediate Representation (IR), which can then be accessibly deployed on any Intel® hardware architecture.

To summarize, ‘write once, deploy anywhere’ – OpenVINO™ optimizes AI inference for improved accuracy and speed.

Intel® Edge Insights for Industrial (EII)³ – for AI Inference

Intel® EII provides an Intel-optimized edge analytics software reference design that extends Intel® Distribution of OpenVINO™ Toolkit⁴ inference capabilities. Simply put, it supports AOI solutions to run on Intel® hardware, including CPUs, GPUs, and FPGAs.

Intel® EII also offers flexible deployment options. Depending on the specific needs of organizations, deployment of AOI solutions can be on-premises, cloud, or hybrid.

To sum up, Intel® EII eases data exchange between systems, enabling efficient data analysis with low latency at the edge.

Intel® iGPU Driver⁷ – as AI Accelerator

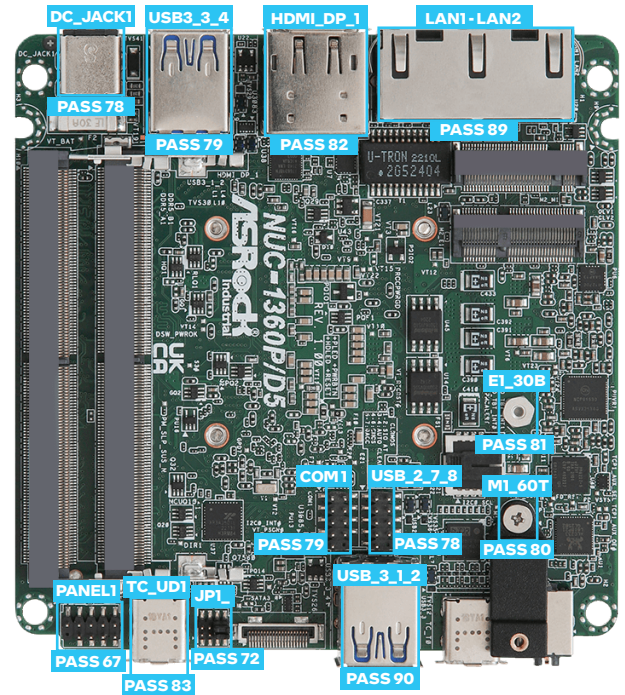
As its role suggests, the Intel® iGPU driver enables the use of iGPU for accelerating AI functions in AOI applications within the Linux environment, significantly improving the performance of inference computing.

The driver is compatible with various Intel® hardware platforms, including CPUs, GPUs, and FPGAs. It also supports numerous Application Programming Interfaces (APIs), including DirectX, OpenGL, Vulkan, and OpenCL.

Notably, the Intel® iGPU driver is easy to install with the assistance of the Intel® Driver & Support Assistant.

Putting the Solution to the Test: Pilot Run in Detail

ASRock Industrial's Original Equipment Manufacturer (OEM) factory becomes the testing ground for the pilot run. The iEP-9020E¹ undergoes rigorous evaluation, with a Printed Circuit Board Assembly (PCBA) comprising 12 components, namely DC Jack, HDMI/DP, USB3, LAN, Type C, Header (Panel, COM, USB2), Jumper, Pillar, Screw, and Label (see following figure).



Deciphering the Metrics of Transformation: Understanding Accuracy, Efficiency, and Beyond

The pilot run concludes with impressive and praiseworthy outcomes, showcasing the synergy between technological innovation and operational efficiency. This segment will delve into the salient positive outcomes derived from the pilot run conducted within the precincts of ASRock Industrial's cutting-edge OEM facility.

Faultless Barcode Decoding Proficiency

In the everyday operations of ASRock Industrial's OEM factory, barcode scanning is conducted through manual process. In other words, an operator is stationed at the designated location along the production line and in charge of scanning the barcodes on PCBAs manually using a barcode scanner. Such a tedious arrangement not only opens up the operation to human errors but may also affect efficiency and production flow, not to mention tying up valuable resources that could otherwise be utilized in other parts of the production line.

Taking advantage of the AI AOI solution, implementing an automated barcode reading process is made available. And the results from the pilot run are overwhelming. The system managed to achieve 100% accuracy, producing 198 out of 198 barcode readings without a hitch.

This feat is made possible by Intel® Hyper-Threading Technology (Intel® HT Technology), which allows more efficient use of processor resources, enabling multiple thread runs on each core. Moreover, the computing power of the iGPU⁷ is utilized for AI AOI Inference, which entirely accomplishes the workload balance to increase productivity.

Elevated Precision

Before the implementation of the AI AOI solution, the OEM factory encountered notable fluctuations in its inspection accuracy, leading to operational challenges. However, following the strategic deployment of AI AOI Workload Consolidation driven by the advanced iEP-9020E platform¹, the initial trial exhibited a remarkable upswing, achieving an exceptional accuracy rate of 97.5% in AI AOI inference. Among the 198 PCBAs subjected to scrutiny in this exercise, a noteworthy 193 PCBAs are positively identified and classified with utmost precision. This groundbreaking outcome underscores the efficacy of the integrated solution in significantly mitigating inspection discrepancies and enhancing production quality.

Optimized Efficiency

Apart from increased accuracy, the AI AOI solution managed to boost operational efficiency by 258.8%, thanks to AI-based vision analysis, quick decision-making, and streamlined processes.

To put things in perspective or more specifically, the required time for the complete check of a 12-component PCBA, both done manually or through the AI AOI process.

To manually inspect a 12-component PCBA, one operator needs 7 seconds to complete the task. Subsequently, another operator requires 37 seconds to take 2 pictures of the PCBA (Top & Bottom) for the production log. And that sums up a total of 44 seconds for only one PCBA.

What about the AI AOI process? A mere 17 seconds. What is more, it involves a much simpler process, as the picture logs and AI inference are carried out in one single step by one operator. The operator needs only to place the PCBA on the inspection compartment/stand, and later, flip the PCBA over from its top face to its bottom face. With just a few clicks on the operating computer, the device practically takes over from there on, from image capturing and defect inspection to documentation.

If we are to factor in human fatigue and eye strain from prolonged manual inspection, the productivity and efficiency differences between the conventional method and the AI AOI solution may very well be even more apparent.

The following figures provide a general idea of the workflow for an AI AOI process from start to end.


1. Image Capturing & AI Inference

Please put the board
FACE UP
Place on stand and press OK (spacebar)

The program will automatically scan the Barcode
And automatically take picture after the countdown is completed

OK

Work order completed!!



3. 'Fail' → Servicing/Rectification

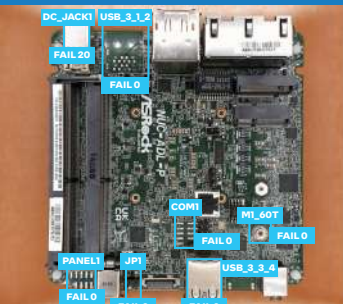
Please check the following parts:	The AI inspection result is:
DC_JACK1	<div style="background-color: #FF0000; color: white; padding: 5px; font-weight: bold; font-size: 1.2em;">Fail</div>
PANEL1	
COM1	
JP1	
M1_60T	
USB3_1_2	
USB3_3_4	

If your inspection result is Fail
Please click Fail with the mouse
And send the board to the repair center

Fail

If your inspection result is Pass
Please make sure the reverse side is facing up
Then press Pass to proceed to picture taking

Pass



2. 'Pass'

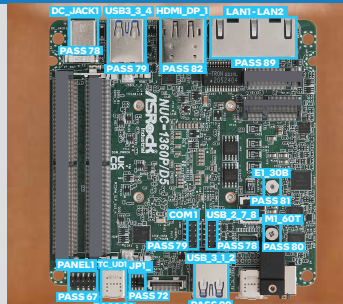
Pass

Please make sure the reverse side is facing up

Then press Pass to proceed to picture taking

Fail

Pass




4. Data uploading

Data is being uploaded
Please be patient

T8S-EA000100017

Total number 300
No. of Pass: 299/ No. of Fail: 1

Upload progress: 299/300



As shown in the figures, the operator is given clear instructions as to how to operate the entire AOI process and what are the 'next' steps to take after each preceding one.

Diminished Labor Expenditure

Enhanced efficiency often comes with reduced labor costs, and the pilot run showed no exception. By automating defect inspection and reducing reliance on manual labor, labor costs along the production line are projected to be reduced by an astounding 50%.

A major plus to this outcome would be the leeway to redirect available human resources to more value-added tasks, benefiting all stakeholders.

Digital Traceability Advancement

As mentioned earlier, the work solution conveniently uploads the data and results onto the cloud upon task completion, forgoing any manual recording and uploading. Besides saving precious time and labor, such workflow provides a comprehensive traceability system for the production line.

By digitizing defect data and enabling seamless traceability, constant root-cause analyses and continuous process improvement are made possible.

Furthermore, digitizing inspection data also indicates the absence of manual documentation, which translates into reduced resources, and yet again, more cost-saving for the corporation.

Envisioned Industrial Applications

The ASRock Industrial iEP-9020E¹ and the AI AOI Workload Consolidation Solution can be utilized in numerous applications in various industries with system integrator's support, streamlining complex defect detection and quality control processes. To name a few:

- Telecommunication industry
- Electronic industry
- Automotive industry
- Food industry
- Pharmaceutical industry
- Contract Engineering and Manufacturing (CEM) factories
- OEM factories

At a glance, the AI AOI Workload Consolidation Solution provides several common benefits for said organizations, such as improved quality assurance and control, increased efficiency, optimized production workflows, enhanced data analysis and continuous improvement, and cost and labor savings.

Nevertheless, it is noteworthy that one prominent strength of the AI AOI Workload Consolidation Solution is its scalability. AI-based AOI solutions are designed to be scalable, allowing them to handle small or large volumes of products, with the flexibility to adapt to changing production demands. Such a feature ensures that the inspection process can keep up with the pace of production across numerous industries and institutions.

In addition, AI-based AOI solutions can be integrated with existing facilities on the assembly line. This would mean seamless implementation without significant disruptions to the production process, as well as not needing total equipment and facility replacement.

Conclusion

The ASRock Industrial iEP-9020E¹ with Next Gen AI AOI Workload Consolidation Solution stands as a game-changer in defect inspection. By harnessing the power of 13th Gen Intel® Core™ Processor² and AI technologies through Linux & Windows workload consolidation, this solution addresses the challenges of accuracy, efficiency, and labor shortage, paving the way for a new era of manufacturing excellence.

Learn More

Contact ASRock Industrial to discover more about the iEP-9020E at <https://www.asrockind.com/iEP-9020E>

Watch the video of the AI AOI pilot run at <https://www.youtube.com/watch?v=6bbjlb3SR0k>

References and Sources

1. ASRock Industrial iEP-9020E Robust Edge AIoT Platform
<https://www.asrockind.com/en-gb/iEP-9020E>
<https://www.youtube.com/watch?v=6bbjlb3SR0k>
2. 13th Gen Intel® Core™ Processor for IoT
<https://www.intel.com/content/www/us/en/products/details/embedded-processors/core/13thgen.html>
3. Intel® Edge Insights for Industrial
<https://www.intel.com/content/www/us/en/internet-of-things/industrial-iiot/edge-insights-industrial.html>
4. Intel® Distribution of OpenVINO™ Toolkit
<https://www.intel.com/content/www/us/en/developer/tools/opencvino-toolkit/overview.html>
5. Azure IoT Edge for Linux on Windows (EFLOW)
<https://learn.microsoft.com/en-us/azure/iot-edge/iot-edge-for-linux-on-windows?view=iotedge-1.4>
<https://techcommunity.microsoft.com/t5/internet-of-things-blog/meet-the-azure-iiot-edge-for-linux-on-windows-eflow-team-at-build/ba-p/2370352>
6. Intel® GETI
<https://geti.intel.com/>
7. Intel® iGPU Driver
<https://www.intel.com/content/www/us/en/artificial-intelligence/hardware.html>
<https://www.intel.com/content/www/us/en/support/articles/000005524/graphics.html>



Performance varies by use, configuration and other factors. Learn more on the Performance Index site.

Performance results are based on testing as of dates shown in configurations and may not reflect all publicly available updates. See backup for configuration details.

No product or component can be absolutely secure.

Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy.

All versions of the Intel vPro® platform require an eligible Intel® Core™ processor, a supported operating system, Intel LAN and/or WLAN silicon, firmware enhancements, and other hardware and software necessary to deliver the manageability use cases, security features, system performance and stability that define the platform. See intel.com/performance-vpro for details.

Your costs and results may vary.

Intel technologies may require enabled hardware, software or service activation.

© Intel Corporation. Intel, the Intel logo, and other Intel marks are trademarks of Intel Corporation or its subsidiaries.

Other names and brands may be claimed as the property of others.