Refining Defect Detection Algorithms for More Accurate, Effective PCB Quality Inspection

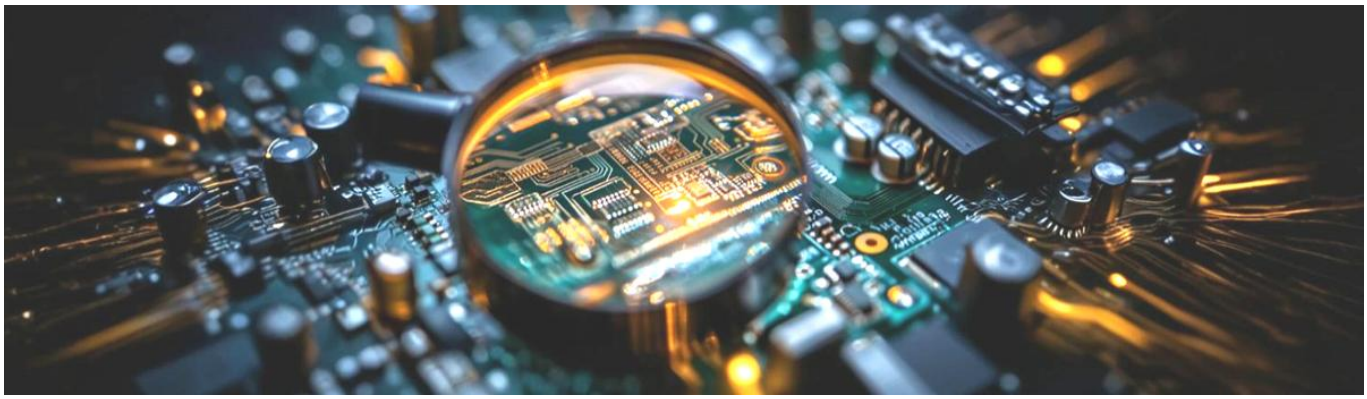
Introduction

The effectiveness of printed circuit board (PCB) quality inspection solutions can be broken down to three facets - automated Optical Inspection (AOI) systems that are used to acquire images of PCB components, inferencing software used to detect defects, and hardware connecting the two. The latter of these is responsible for processing data obtained from the AOI system and running defect detection models, typically via its GPU, to perform key tasks within the quality inspection solution as a whole.

This is why one vendor chose to incorporate AAEON's new MAXER-2100 as an edge server when building their quality inspection system, the Hawkeye. The company developed cutting-edge software to identify defects in PCBs. They then deployed the MAXER-2100 to process image data from an AOI device and run their AI inferencing models via the MAXER-2100's GPUs to quickly and accurately detect defects during the manufacturing process.

This comprehensive quality inspection process instilled such confidence that AAEON consequently chose to deploy it in its own factories, using an AOI device to obtain data and the MAXER-2100 to run the vendor's defect detection models to determine whether various components passed or failed. This reduced AAEON's reliance on manual inspection and increased the accuracy and speed of its PCB assembly line's quality inspection process.

Defect Detection Difficulties



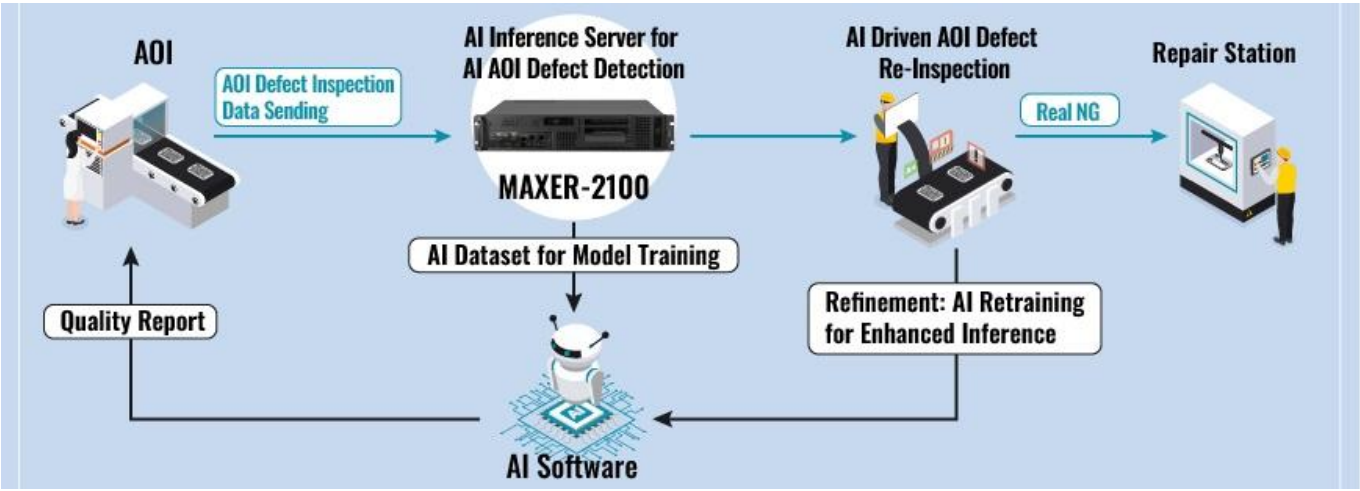
Companies encounter a range of difficulties when it comes to maintaining a strict quality assurance process, many of which are difficult to account for due to the number of variables involved. In traditional manufacturing environments, human error is unavoidable. Further, employees require time and experience to develop the skills necessary to meet high standards.

As demand grows, companies have the choice of either increasing staff headcounts or risking a lower rate of production due to the time it takes for personnel to manually inspect each component of a PCB, which typically takes between two and three seconds per photograph.

A second challenge is faced by software providers and systems integrators seeking to offer complete quality inspection utilizing AI inferencing. When instituting an AI-assisted AOI process, the efficiency and effectiveness of inference models relies on the hardware deployed to run them. These factors highlight a need for hardware that can handle and accelerate complex AI algorithms without sacrificing accuracy. A process that consists of image data acquisition, defect detection, followed by manual inspection and repair is no longer competitive.

In the MAXER-2100, the vendor found the ideal platform for their software, running their inferencing model to rapidly identify defects in PCB components, but the crucial thing that the MAXER-2100 brought to the quality inspection ecosystem was its use of using deep learning to refine the client's inferencing model as it received and processed a greater volume of data, resulting in a faster and more accurate quality inspection process overall.

AOI Architecture



The Hawkeye solution acquired images of components, solder joints, traces, and other features of the PCBs via an AOI device.

Once captured, these images were transmitted to the MAXER-2100, powered by 13th Generation Intel® Core™ LGA 1700 socket-type processors. With NVIDIA® GPU cards installed via PCIe slots, the MAXER-2100 was able to run the vendor's AI inferencing model to determine the pass/fail status of each component image.

These algorithms leveraged deep learning through approximately 30 photographs per component at an inference rate of 0.03s, with which a baseline was established to assess components against. The acceleration provided by the installation of additional GPUs in the MAXER-2100 worked to enhance the efficiency of these AI algorithms, shortening the time needed to detect defects to just 0.05s per photograph.

Once defects were detected, detected defects were recorded in quality assurance reports generated by the system. This report detailed visual data determining the location and nature of the defect on a given component, so that manufacturers could take corrective action.

The key benefit of the MAXER-2100 as part of the solution as a whole was that once quality reports had been generated, it could retrain and optimize the vendor's software model through deep learning due to having more data with which to ascertain deviation from components that passed, and those that failed quality inspection.

How AAEON's Edge Server Offered MAXimum Impact

Using AAEON's MAXER-2100 as part of the vendor's Hawkeye quality inspection process provided a range of advantages:

Enhanced Efficiency

With its support for both 12th and 13th Generation Intel® Core™ processors, the MAXER-2100 delivered could concurrently process high quantities of data, streamlining the inspection process and reducing the judgment time to 0.05s per photograph, compared to between 2 and 3 seconds per photograph required for manual inspection.

Improved Accuracy

The MAXER-2100's GPUs provided the ideal platform to run the vendor's defect detection algorithm. As a consequence, the success rate of the application as a whole was over 99%, improving on the estimated 95% accuracy rate offered by manual inspection.

Continual Improvement

Utilizing machine learning as data was received from the application's AOI device, the MAXER-2100 helped to refine the vendor's inferencing model. Consequently, as the system analyzed components and PCB defect reports were created, the model had a greater volume of data with which to determine variations in components.

The MAXER-2100's impact on the vendor's Hawkeye AOI system represents a leap forward in the field of quality control, increasing both the efficiency of the manufacturing process and the precision and reliability of AI-assisted quality inspection.

By taking advantage of both the acceleration and processing offered by the edge server, the vendor's model acquired more and more detailed examples with which to distinguish between PBCs with defects and those that reached quality standards, creating a continual improvement loop that enhanced the validity of the generated reports, while also showcasing the exceptional value of AI integration.

About AAEON

Established in 1992, AAEON is one of the leading designers and manufacturers of industrial IoT and AI Edge solutions. With continual innovation as a core value, AAEON provides reliable, high-quality computing platforms including industrial motherboards and systems, rugged tablets, embedded AI Edge systems, uCPE network appliances, and LoRaWAN/WWAN solutions. AAEON also provides industry-leading experience and knowledge to provide OEM/ODM services worldwide. AAEON works closely with premier chip designers to deliver stable, reliable platforms. For an introduction to AAEON's expansive line of products and services, visit www.aaeon.com.