

## **Pushing AI Vision to the Edge: Axiomtek's AI Starter Kit**

## Axiomtek's AI Starter Kit Extends Vision Intelligence to the Edge

As Artificial Intelligence (AI) continues to evolve, manufacturers across multiple industries – from printed circuit board (PCB) assemblers identifying defective solder points to food processing companies checking for broken seals – are increasingly relying on machine vision and edge intelligence technologies to drive product quality. They need a highly efficient, AI-driven solution with advanced vision capabilities to boost inspection speed and accuracy, while still being able to keep costs under control. Deep learning, a set of specialized algorithms designed to teach computers how to see and understand visual inputs such as images and videos, is particularly suited for developing AI vision analytics to add intelligence to the production line. It can be deployed on machines to give them the ability to detect flaws, guide robots, and control manufacturing processes, becoming an appealing option for businesses striving to achieve the highest level of quality assurance for their products.

Axiomtek's AI Starter Kit offers an easy-to-use developer's toolkit that integrates computer vision and deep learning tools to facilitate the development of AI-enabled object detection and classification in manufacturing facilities. This proof-of-concept kit combines dedicated hardware and software ingredients needed to perform deep learning training and inference workloads on the industrial equipment. It allows engineers to quickly get started with their deep learning projects, validate their AI systems to ensure desirable performance, and eventually be able to implement optimal AI vision solutions for diverse industrial usages.

### What's Inside the AI Starter Kit:

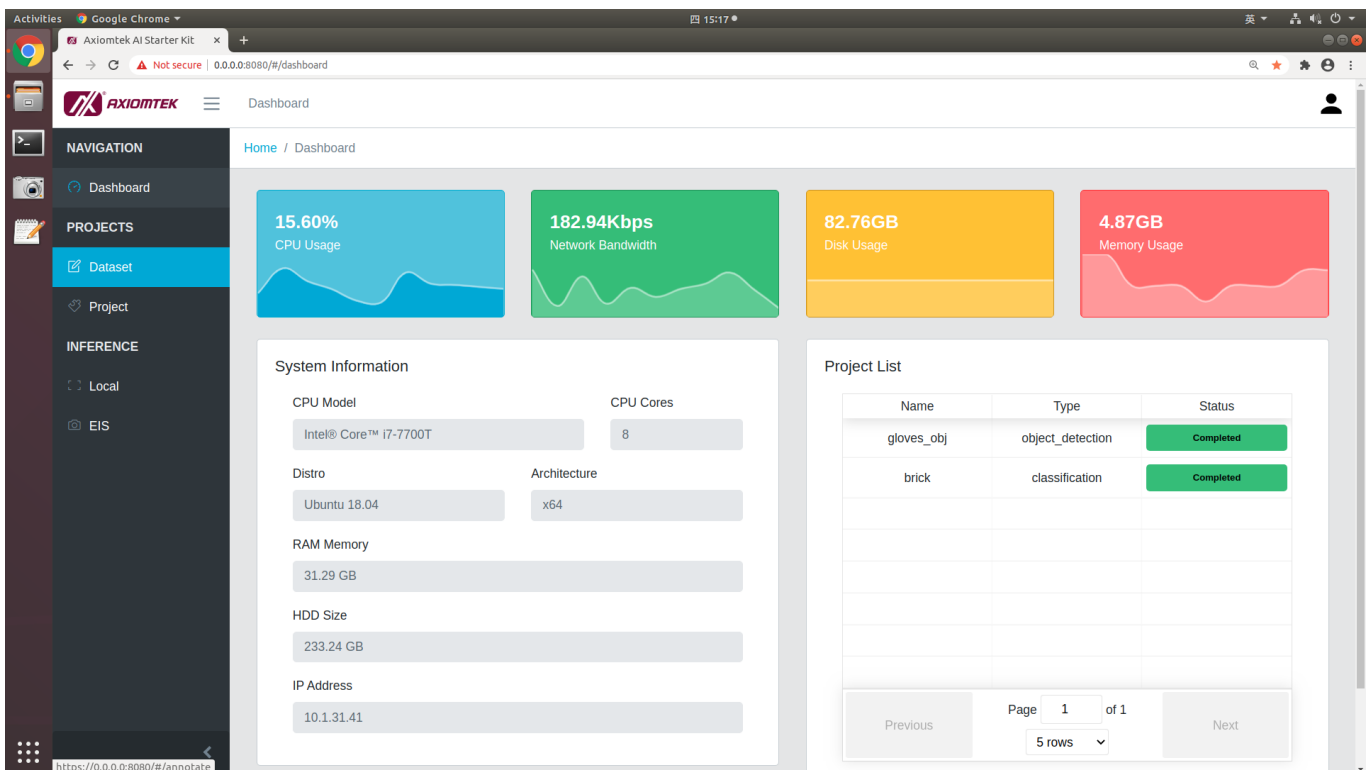
- Axiomtek's IPC962-511-FL, a high-performance Intel® Core™-based edge AI system with GPU/VPU accelerator support for visual computing.
- A high-resolution web camera for video feeding.
- Axiomtek AI Suite (AIS): a built-in training and inference software toolkit based on Tensorflow Framework, Intel® Edge Insights for Industrial, and Intel® OpenVINO™, providing one-stop software resources for training and running deep learning models for different inference tasks. The Axiomtek AI Suite is designed with remarkable interoperability to be used across a wide range of hardware platforms based on the Intel® CPU architecture.



## Axiomtek AI Suite (AIS)

The Axiomtek AI Suite (AIS), an end-to-end deep learning toolkit designed based on the framework of Intel® Edge Insights for Industrial, enables all-in-one deep learning workloads – from image labeling to model training to inference output – allowing users to quickly build object detection and classification capabilities based on visual inference without the need to program deep learning model algorithms on their own.

By integrating the Intel® OpenVINO™ toolkit, which enables deep learning computer vision inference across multiple Intel platforms, the Axiomtek AI Suite supports both Model Optimizer and Inference Engine for deploying deep neural network models built in mainstream frameworks, such as TensorFlow, MXNet, and Caffe. Software engineers can teach their own models to identify specific images by performing the tasks of image labeling and model training, or use the trained models to run inference projects directly on video feeds. The AI Suite adopts a web apps design, with intuitive graphic user interfaces to simplify model training workflow and control, allowing developers to rapidly train an AI model to perform vision inference without going through the pain of coding. The AI Suite also features a dashboard homepage, where users can check system hardware status at a glance and manage their trained models immediately after login, making information viewing fast and comfortable.

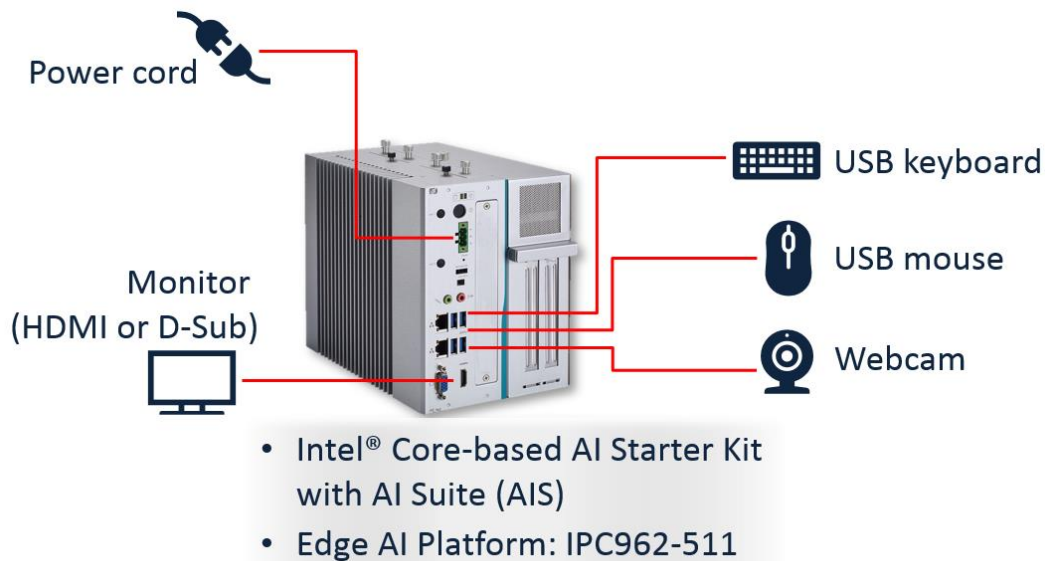


(The AIS dashboard homepage gives a quick look at the system hardware and model training projects.)

### Axiomtek AI Suite Highlights

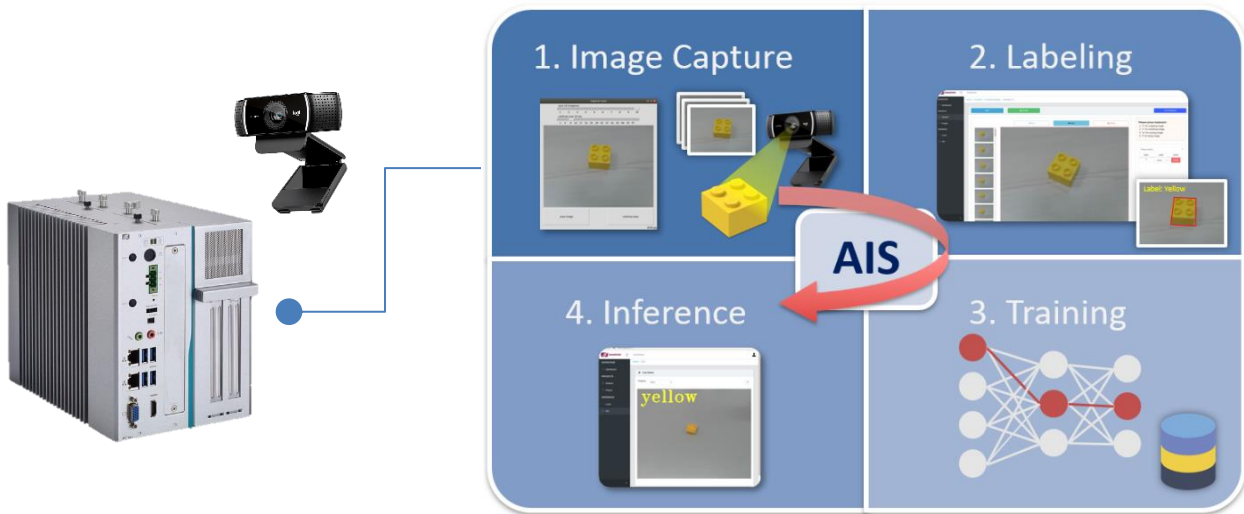
- Deploy AI without coding: web apps design with intuitive user interfaces and dashboard elements for users to quickly set up training and inference projects.
- Intel® Edge Insights for Industrial: supports Model Optimizer & Inference Engine via Intel® OpenVINO™ toolkit to enhance the performance of deep learning inference.
- End-to-end deep learning: delivers all-in-one implementation of deep learning applications – from training to inference processing – by supporting pre-defined deep neural network models (algorithms) for classification and object detection, as well as the major deep learning frameworks of TensorFlow, MXNet, and Caffe for training and deploying inference models.

### Environment & Peripheral Setup for Using the AI Starter Kit



## Training & Running Inference Models Using AIS

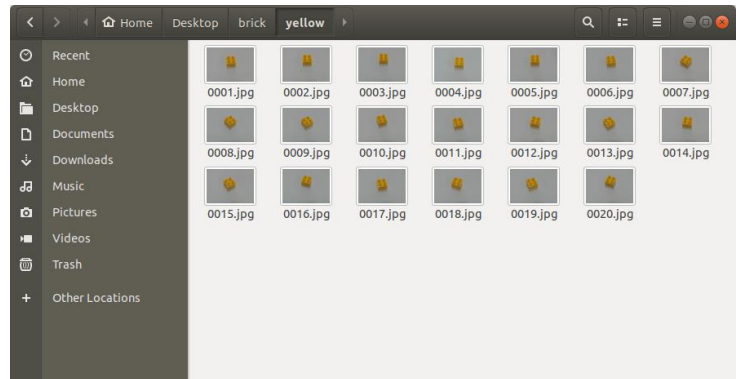
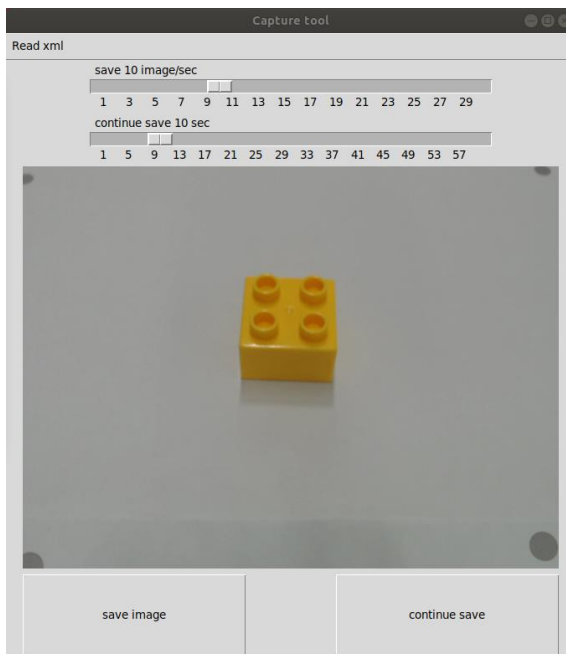
Here is a brief overview of how to use the Axiomtek AI Suite (AIS) to train a deep learning model to perform classification and object detection inference on video content.



(The workflow for training a deep learning model to run real-time inference on video feeds)

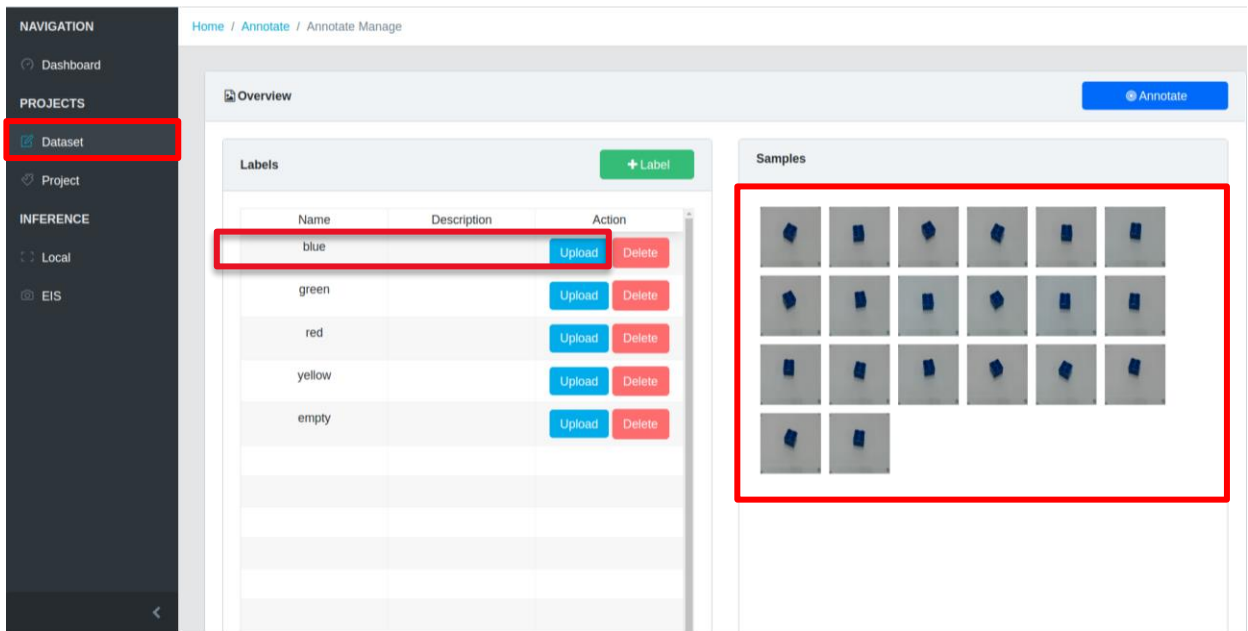
### 1. Image Capture

Capture a required number of object photos in different angles to be used for creating a training dataset.

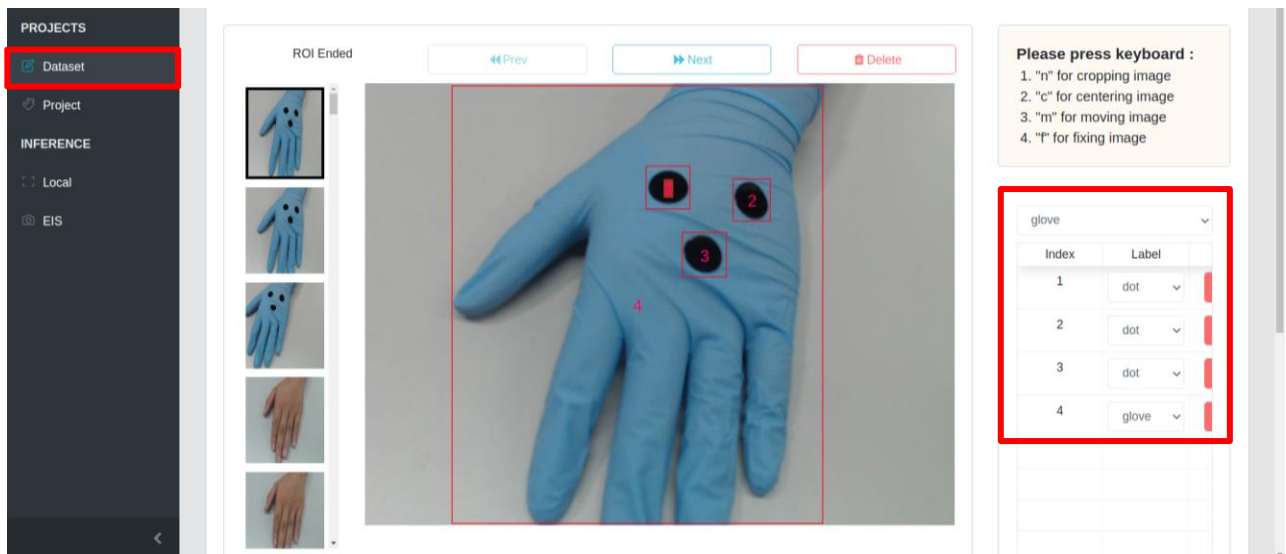


## 2. Image Labeling

Create a training dataset by adding labels and annotating all images (the process of attaching labels to the images to teach a model what the image is or what to look for in the image). Image labeling can be done by uploading the images to a specific label folder (assigning one label to the entire image), or by manually framing target areas to label multiple objects within the image (creating multiple labels within the image).



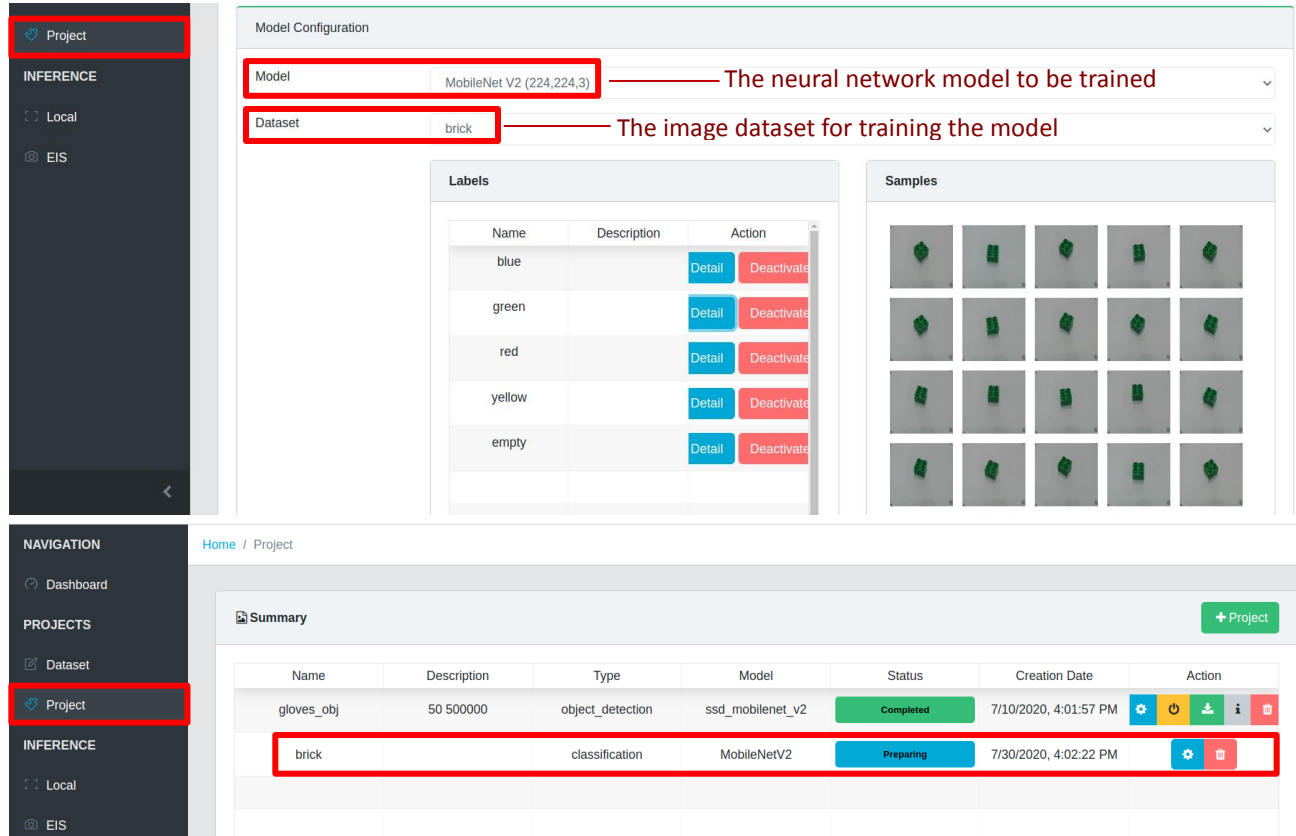
(Brick labeling snapshot: Labeling the blue brick as “blue” by uploading all its images to the “blue” label)



(Glove Labeling snapshot: Framing the glove and dots within the image and giving each item a label)

### 3. Training a Model

You can train a model as an image classifier to distinguish objects in similar shapes, or as an object detector to detect target objects such as defects. Create a training project by selecting a project type (classification or object detection), the neural network model to be trained (e.g. MobileNet V2), and the image dataset to feed the model. Set sample augmentation and epoch parameters (training steps) to start training.



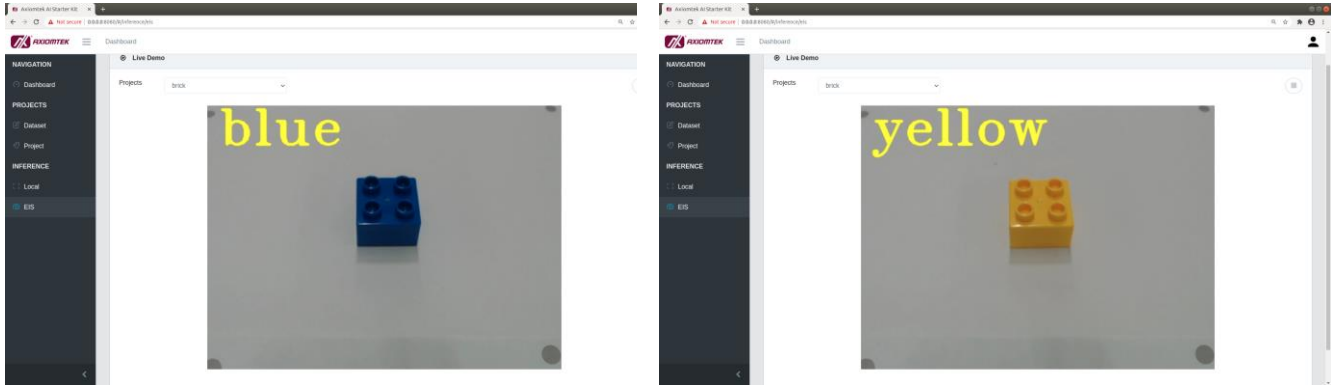
The screenshot displays the 'Model Configuration' and 'Summary' sections of the AI training interface. In the 'Model Configuration' section, the 'Model' dropdown is set to 'MobileNet V2 (224,224,3)' and the 'Dataset' dropdown is set to 'brick'. Below this, a 'Labels' table lists categories: blue, green, red, yellow, and empty, each with 'Detail' and 'Deactivate' buttons. To the right, a 'Samples' grid shows 20 images of green bricks. The 'Summary' section below shows a table of projects, with the 'brick' project highlighted in red, indicating it is currently 'Preparing'.

Name	Description	Type	Model	Status	Creation Date	Action
gloves_obj	50 500000	object_detection	ssd_mobilenet_v2	Completed	7/10/2020, 4:01:57 PM	[Settings] [Stop] [Download] [Info] [Delete]
brick		classification	MobileNetV2	Preparing	7/30/2020, 4:02:22 PM	[Settings] [Delete]

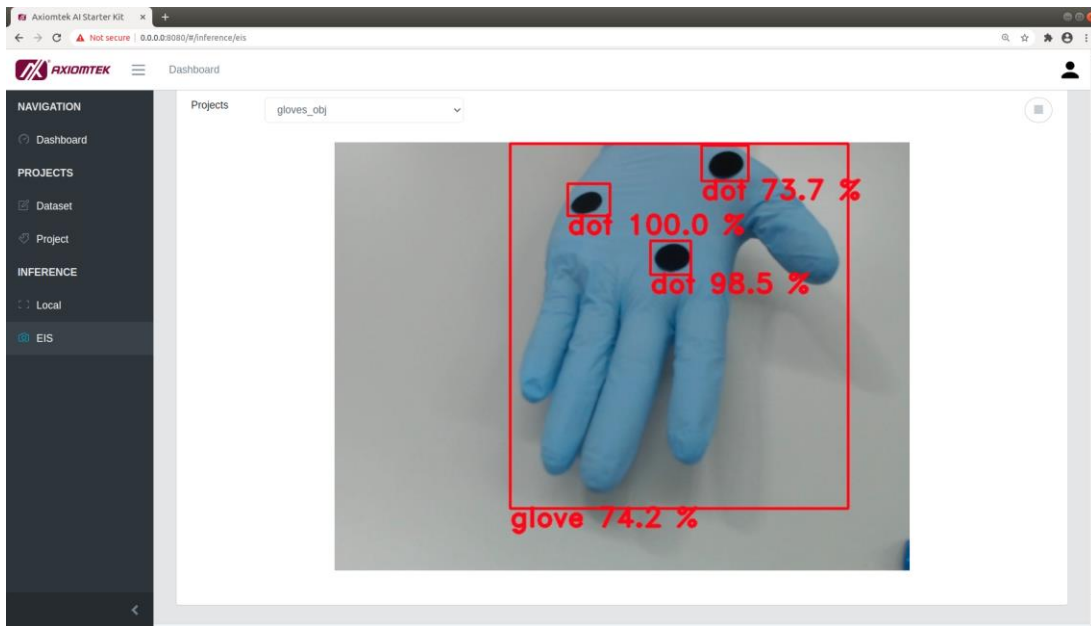
(Training project snapshot: model configuration and training processing for deploying a brick classifier model)

### 4. Running Inference

Load a trained model to execute object detection or classification inference on live videos streaming from the connected webcam, so that the computer is able to recognize objects in a video scene. For example, an image classifier model can be implemented to identify bricks in different colors and shapes, or to determine whether a human hand is wearing a glove or whether the glove has defects on it. The video inference output will draw rectangular bounding boxes around target objects in a video scene for easy tracking, with descriptive labels showing what the objects are.



(Brick classification inference: An image classifier model identifying bricks in different colors)



(Glove detection inference: An object detector model tracking a glove and dot stickers that simulate defects, with tags showing the object names and certainty percentages.)

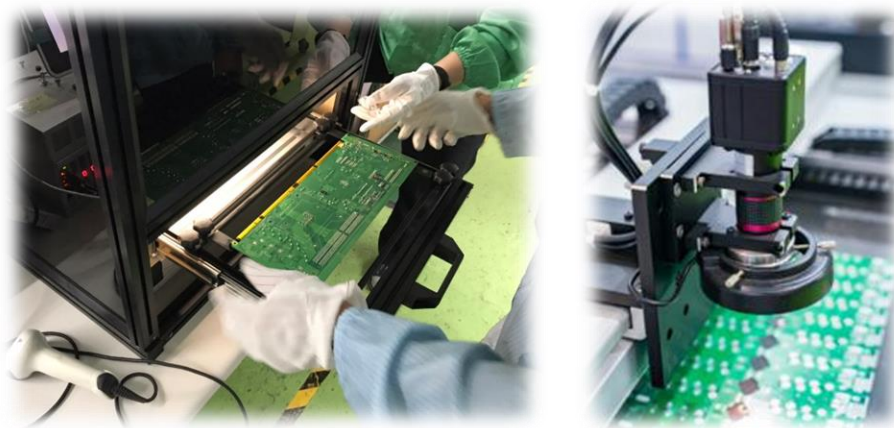


## Case Study: How the AI Starter Kit Helps Increase AOI Accuracy

The Axiomtek AI Starter Kit enables automated optical inspection (AOI) with greater speed and precision by extending the power of intelligent vision to the factory floor. With the Axiomtek AI Starter Kit, electronic hardware manufacturers can leverage deep learning software to develop automated defect detection systems with video analytics capabilities to catch defective solder joints on printed circuit boards (PCBs), not only decreasing cost and downtime but also maximizing quality check efficiency and performance not achievable with traditional machinery or human inspection.

Built on an Intel® Core™-based hardware platform, and also featuring Intel® Edge Insights for Industrial, an Intel® deep learning software package designed to accelerate video analytics workloads for industrial vision applications, the Axiomtek AI Starter Kit enables the deployment of customized deep learning models to carry out defect detection for optimized AOI accuracy:

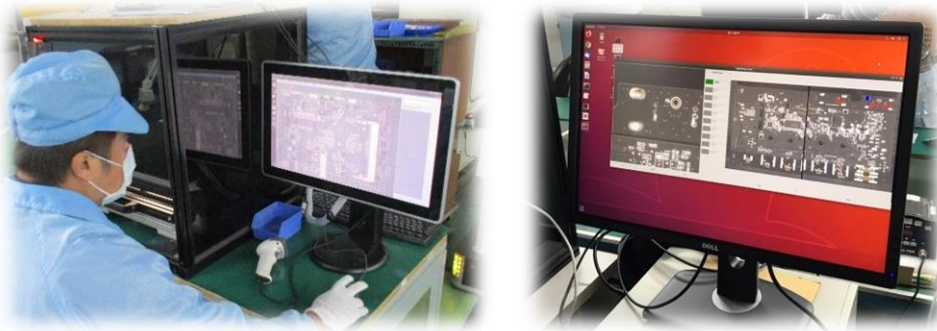
1. The Axiomtek AI Starter Kit allows the system to connect to industrial cameras for capturing large volumes of images to be used as training datasets.
2. The captured images are used to teach a deep learning model to identify each defect type.
3. Once trained, the defect detection model is deployed on the production line to perform inference on the camera input of the PCB products, to help inspectors detect and differentiate solder joint flaws and irregularities. This will allow for image analytics being executed right on the factory floor to reduce latency and power consumption, rather than having to send image data to remote compute centers for processing.



4. Based on inference results, all defective solder joints are marked on the video output to make them easily spottable. This accelerates inspection processes by directing the inspector to only check for the target anomalies.



5. Meanwhile, in order to achieve the highest precision possible, the software engineer will retrain the defect detection model by labeling new defect images for the model to learn, so that the optimized model can be used to carry out the next round of inspection. This loop of inference-training-inference continues, until the model is able to deliver the desired inference performance. As a result, the accuracy of the model to detect defects increases as more training images are ingested.



In conclusion, the AI Starter Kit developed by Axiomtek delivers an AI-driven solution capable of processing images to detect and classify solder defects right at the factory edge, not only helping PCB manufacturers convert visual data into process improvements to deliver business results, but also achieving reduced latency and data transfer cost, as well as substantial power savings.

## High-Performance Edge AI Embedded Platforms

### IPC962-511-FL

The AI Starter Kit uses Axiomtek's IPC962-511-FL as its edge AI compute platform, a 2-slot fanless industrial system powered by the 7th/6th gen Intel® Core™ i7/i5/i3 & Celeron® processor. It comes with two PCIe and PCI expansion slots, where developers can insert integrated GPUs or VPU accelerators to boost vision compute performance, or add vision I/O cards for connection to triggers and optical sensors. The system also provides multiple camera and display interfaces for video capture and streaming, as well as sufficient storage to accommodate massive image datasets.

#### IPC962-511-FL Feature Highlights



- LGA1151 socket 7th/6th gen Intel® Core™ i7/i5/i3 & Celeron® processor
- Intel® H110 chipset
- Dual PCIe expansion slots for GPU/VPU AI accelerator & vision I/O card support
- Compact, rich front I/O design
- Supports camera & display interfaces, including 4 USB 3.0, 2 GbE & dual views
- Supports 2 swappable 2.5" HDD
- Supports WLAN module & antenna (optional)
- Supports internal 125W power for accelerators
- Wide operating temperature: -10°C to +60°C

\*For detailed specifications, visit [www.axiomtek.com](http://www.axiomtek.com) and go to: [Products > Systems & Platforms > Industrial PC > Industrial System > IPC962-511-FL](#).

Aside from the IPC962-511-FL that comes with Axiomtek's the AI Starter Kit, the following IPC series products available from Axiomtek are highly recommended for use with the AI Starter Kit:

## IPC962-525

The IPC962-525 is Axiomtek's latest expandable 2-slot industrial system. It is powered by the LGA1151 Socket 9th/8th generation Intel® Core™ processor (code name: Coffee Lake and Coffee Lake Refresh), and comes equipped with the Intel® H310 chipset or Intel® Q370 chipset. This highly modularized and scalable industrial computer provides flexible expansion options, with one extension I/O module slot to accommodate optional I/O modules, and two high-speed PCIe/PCI expansion slots for adding GPU cards to enable AI vision applications. The system adopts a front-facing I/O connector design for easy access and deployment, while the optional air duct design for the GPU's heat dissipation can significantly reduce operating temperature to ensure superb GPU performance and clock frequency.

The IPC962-525 comes with a wide range of I/O interfaces including GbE LAN, USB and HDMI, plus two 2.5" swappable HDDs/SSDs and one M.2 Key M 2280 socket are available for extensive storage needs. In terms of wireless connectivity, the system features a full-size PCI Express Mini Card slot for integrating Wi-Fi, Bluetooth, and 4G/LTE modules, as well as one optional M.2 Key B slot supporting 5G connection.

With its extensive range of capabilities, the IPC962-525 can fully serve the purposes of industrial automation and manufacturing equipment applications, encompassing machine vision, motion control, deep learning, automated optical inspection (AOI), and much more.

### IPC962-525 Feature Highlights



- LGA1151 Socket 9th/8th generation Intel® Core™ processor, up to 65W
- One PCIe x16 and one PCIe x4 (AX96205)
- Front-access I/O with four USB 3.1 Gen2
- M.2 Key B slot for 5G wireless connection (optional)
- Two 2.5" swappable HDDs/SSDs supporting RAID 0,1 (Intel® Q370)
- Supports power-on delay function
- Supports TPM 2.0 and Intel® AMT 12 (Intel® Q370)

\*For detailed specifications, visit [www.axiomtek.com](http://www.axiomtek.com) and go to: [Products > Systems & Platforms > Industrial PC > Industrial System > IPC962-525](#).

## IPC974-519-FL

The IPC974-519-FL provides edge computing capabilities for a wide variety of industrial AIoT applications, such as real-time control, data analysis, deep learning and automated optical inspection, making great strides towards achieving an all-in-one automation solution. The industrial PC is powered by the high-performance Intel® Xeon® E3 v5, 7th/6th generation Intel® Core™ (codename: Kaby Lake/Skylake) or Celeron® processors with the Intel® C236 chipset. It features a wide operating temperature range of -10°C to +70°C with 0.5 m/s airflow, as well as a wide range of 19V to 30V DC power input for harsh operating environments. The IPC974-519-FL has a flexible I/O window slot to hold an optional I/O module, offering ease of customization to suit various application requirements. It also provides four high speed and full-size PCIe /PCI slots for users to add vision, motion, data acquisition and I/O cards, including support for add-on GPUs with up to 300W TDP. This AIoT industrial automation computer has an optional built-in power board which provides 300W power to add-on graphics cards. In addition, to satisfy wide temperature variations, it offers an easy-to-install fan module to help dissipate heat generated within the system when running high power consumption PCI/PCIe cards.

### IPC974-519-FL Feature Highlights



- LGA1151 socket Intel® Xeon® E3 v5, 7th/6th gen Intel® Core™ i7/i5/i3 & Celeron® processor, up to 80W (codename: Kaby Lake/Skylake)
- Intel® C236 chipset
- Provides four expansion slots for full-size add-on cards
- Supports add-on GPU (up to 300W TDP)
- Supports system power-on delay function
- -10°C to +70°C wide operating temperature range
- Supports ECM BIOS setting
- Supports Intel® RAID 0,1,5
- Supports TPM 2.0 and Intel® AMT 11.0

\*For detailed specifications, visit [www.axiomtek.com](http://www.axiomtek.com) and go to: [Products > Systems & Platforms > Industrial PC > Industrial System > IPC974-519-FL](#).

## About Axiomtek Co., Ltd.

Axiomtek has experienced extraordinary growth in the past 30 years because of our people, our years of learning which resulted in our tremendous industry experience, and our desire to deliver well-rounded, easy-to-integrate solutions to our customers. These factors have influenced us to invest in a growing team of engineers including software, hardware, firmware and application engineers. For the next few decades, our success will be determined by our ability to lead with unique technologies for AIoT and serve our key markets with innovatively-designed solution packages of hardware and software – coupled with unmatched engineering and value-added services that will help lessen the challenges faced by our systems integrator, OEM and ODM customers and prospects alike. We will continue to enlist more technology partners and increase collaborations with our growing ecosystem who are leaders in their fields. With such alliances, we will create synergy and better deliver solutions, value and the expertise our customers need.

Axiomtek is a Member of the Intel IoT® Solutions Alliance. A global ecosystem of more than 800 industry leaders, the Alliance offers its Members unique access to Intel technology, expertise, and go-to-market support—accelerating deployment of best-in-class solutions.