ADS – RADX Transform-CV Example

RADX NVIDIA-based PXIe-GPUs Enable AI-based Machine & Deep Learning Computer Vision Applications

Introduction

With its superior modularity, consistent performance and outstanding life-cycle support, PXIe-based software-defined instruments are widely employed in manufacturing, Q/A and repair related test & measurement (T&M) applications. These applications often require component and subsystem visual or sensor-based inspection, detection, and analysis for a wide variety of purposes, including:

- Anomaly and Defect Detection
- Package and Label Detection
- Safety and Security Monitoring
- Assembly Defect Detection

Historically, such applications are common in Semiconductor, Machining & Welding, Additive Manufacturing Automotive, Optics, Medical and other types of precision manufacturing applications may be implemented via traditional Computer Vision (CV) techniques that perform rule-based comparisons and convolutions with reference images to determine compliance or detect defects. However, traditional CV methodologies are inflexible and often require significant precision in fixturing to ensure valid data acquisition and comparisons. For a good comparison of Traditional Computer (Machine) Vision versus Deep Learning seen in Figure 1, please visit https://www.mariner-usa.com/blog/deep-learning-vs-traditional-machine-vision.

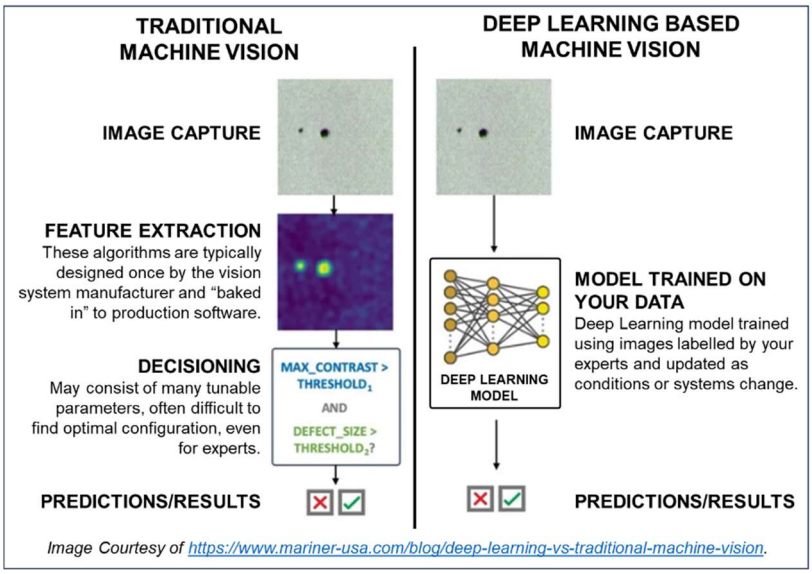


Figure 1: *Deep Learning can often simplify Machine (Computer) Vision application development as well as deliver superior performance when compared to Traditional Machine Version approaches.*

Unlike rule-based CV approaches, AI-based approaches use compute-intensive neural-network (or similar) approaches that "train" the system to recognize objects in images or videos based on perceived similarities to objects in the training database. With AI, the confidence of the algorithm is largely dependent on the AI model and the degree of training employed. Prior to the advent of NVIDIA GPUs and their ability to perform literally trillions of operations per second, AI applications were uncommon, since the computational complexity for both training and inference exceeded the capacity of most systems, especially embedded or factory floor systems. With the advent of powerful GPUs, combined with their ease-of-programming and low cost, the ability to use AI-based Deep Learning for Computer Vision applications has become quite common in many markets.

Until recently, however, PXIe-GPUs were not available, so GPU-based AI processing for PXIe-based systems required a separate PC and means to communicate the PXIe acquired data to the PC for processing via sneakernet, LAN, PCIe interface or other methods, all of which result in increased data latency, system complexity, added SWaP and IT and other hassles. With the introduction of RADX NVIDIA-based PXIe-GPUs (Figure 2) in 2022, system integrators and developers can now readily add cost-effective AI-based CV Applications to their PXIe systems.



Figure 2: *RADX Catalyst and Trifecta PXIe-GPUs feature NVIDIA GPUs.*

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Transform-CV DL-Based CV Example

To illustrate the relative ease of implementing a PXIe-based, Deep Learning-based Computer Vision application, Acquired Data Solutions (ADS) and RADX have developed Transform-CV, a simple Python-based example that shows the power of GPU-accelerated Deep Learning in a PXIe environment (see Figure 3). Transform-CV emulates an assembly-line Q/A application for a hardware company that desires to ensure the contents of an assembly of screws, nuts and washers match the Bill-of-Materials (BOM).

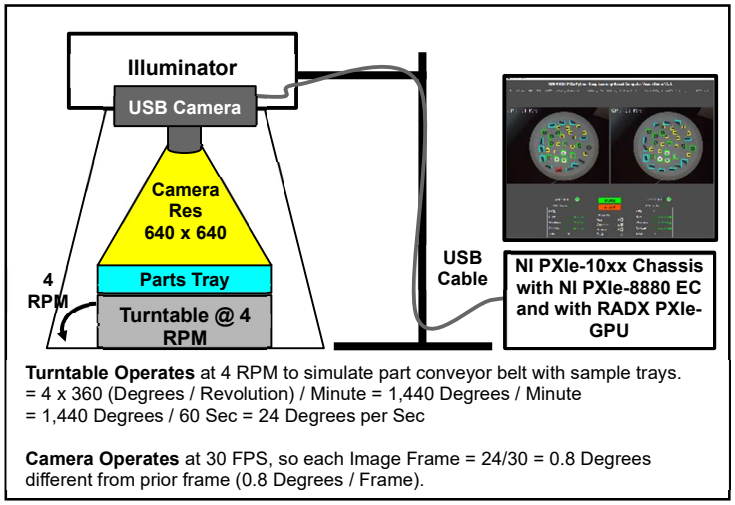


***Figure 3**: PXIe-based Deep Learning Computer Vision Demo Setup emulates a typical Manufacturing Q/A Application for Defect / Anomaly Detection.*

As shown in Figure 3, the Transform-CV Demo System emulates a typical manufacturing Q/A system and includes the following items:

- NI PXIe-Chassis with NI PXIe-8880 Embedded Controller (CPU with 2.3 GHz, 8C/16T Intel Xeon E5-2618L v3)
- RADX Catalyst or Trifecta PXIe-GPU
- HD 1920x1080, 30 FPS USB Video Camera
- Illuminator for Consistent Contrast Images
- Turntable to Simulate a Conveyor Belt
- Parts Tray with User Selectable Number of Screws, Washers, and Nuts
- ADS Python-based CV App based on a YOLO-5m or YOLO 5l Model, Open CV V4.6.0 & PyTorch V1.13.14, and PyQt5 V5.15.9 (GUI)

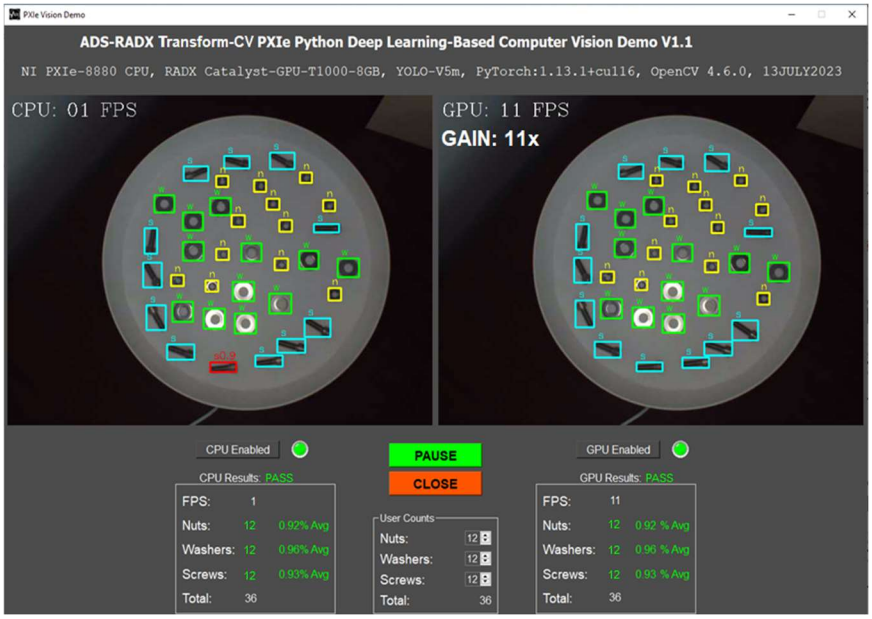


***Figure 4:** ADS-RADX Transform-CV Python / Deep Learning-Based Computer Vision Application with RADX PXIe-GPU Acceleration.*

Prior to deployment, ADS personnel acquired and labelled about five hundred (~500) images (total) of the three different parts, which were then used to train the Transform-CV YOLO-5m model via PyTorch V1.13.1 and OpenCV 4.6.0 to achieve a Confidence Level > 92%.

Because it's Python-based, Transform-CV readily runs on both the Embedded Controller CPU and the PXIe-GPU. As indicated in Figure 4, when deployed, users select the target number of parts per the BOM and then start operation. With a BOM of twelve (12) x three (3) different parts (36 x screws, nuts, and washers), the results indicate **GPU/CPU Performance and Value Gains of 11x and 41.3x**, as shown below:

COMPUTE ENGINE	Q323 MSRP	FPS	PARTS / SEC	PERF GAIN (GPU / CPU)	VALUE (PARTS/SEC/$k)	VALUE GAIN (GPU/CPU)
NI PXIe-8880 CPU	**$15K**	**1**	**36**	**1x**	**2.4**	**1x**
RADX PXIe-GPU-T1000	**$4K**	**11**	**396**	**11x**	**99**	**41.3x**

Conclusion and Call to Action

Transform-CV illustrates the relative ease with which RADX PXIe-GPU accelerated AI-based applications may now be added to PXIe systems. Also, Transform-CV provides a framework that can be employed for a wide range of AI-based Computer Vision applications useful in many PXIe-based manufacturing, Q/A, and other market segments. ***For more info on how Transform-CV and RADX PXIe GPUs can improve your application, please contact ADS at info@acquiredata.com or RADX at info@radxtech.com.***

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