Advantech AI Deep Learning

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DEEP LEARNING IS SWEEPING ACROSS INDUSTRIES

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ADVANTECH
Deep Feature Learning

**APPROACH**

**TRADITIONAL**
- **CURATE DATA**
- **FEATURE ENGINEERING**
- **FEATURE EXTRACTION**
- **DETECTION**
- **CLASSIFICATION**
- **SEGMENTATION**

*Disadvantages*
- Laborious & manual - not scalable
- 1-2% available data used

**DEEP LEARNING**
- **CURATE DATA**
- **DEEP FEATURE LEARNING**
- **DETECTION**
- **CLASSIFICATION**
- **SEGMENTATION**

*Advantages*
- Higher accuracy, lower false positives
- Full picture from all the data
- Leverage domain experts for higher value activity
Out Performance of Deep Learning

ImageNet Large Scale Visual Recognition Challenge (ILSVRC)
Identifying the right data, contextualizing that data so it’s mapped to desired objectives, and **linking the entire process back into existing workflows** is where the real heavy lifting comes in, creating obstacles for all but the most progressive companies.
Vertical AI
AOI (Automatic Optical Inspection) in Machine Vision

Motion Control

Lighting

Defect Inspection

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ADVANTECH
Machine Vision in Factory Automation

1. Processing Inspection

2. Assembly
   Guiding for Alignment
   Inspection & TTC (Track, Trace and Control)

3. Inspection & Testing
   Inspection, Gauge & TTC

4. Packaging
   Inspection & TTC

5. Logistics
   Inspection & TTC

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Expert Inspection (Manual Visual inspection)

- Some defects have no OBVIOUS features, Criteria of OK/NG (e.g. appearance) rely on operators and the training of operators is time consuming.
- The results are not consistent between operators, and even for the same operator when he or she inspect the boards all day.

Inspect by operators as many times as the no. of boards.
Intelligent AOI machines with Camera/Computing CAN DO “routine” “Visual “inspection” jobs automatically through “Deep Learning Training” and output “consistent results”, with performance similar to (or better than) well-trained operators.

- Lower Total cost of ownership? (Machine costs? Training Cost of operators? )
- Quality of Boards improved? Customer Satisfaction improved?......
Deep Learning AOI

1. Data Sets with Labels
   - Bridge, empty, Solder Ball, Appearance

2. CNN Training with Data Sets

3. Model running in the inference for visual inspection
   - Accuracy and Training time
   - Inspection speed
   - Image capture Speed & quality
POC Results
1st phase Project Summary

- **Data Sets:**
  - 2.9K images (1280 x 800 pixels), 1 Board might contain up to 72 images
  - Performance issues: Area Scan takes 2 mins (**Line Scan takes less than 10 seconds**)

- **Server configuration & Pre-Processing & CNN**
  - Core I CPU + 2 * NVIDIA General GPU (**planning to change to P4**)
  - Patch data (data Scientist): 253K images (200 x 200 pixels)
  - Transfer Learning, 52 layers, pre-trained with 14 millions images, 8M parameters
  - Performance: Training process takes about 4 hrs

- **Inference Configuration & speed**
  - Core I CPU + 1 * NVIDIA General GPU, no DLA (**Planning to change to P4**)
  - Single 1280 x 800 image takes 3 seconds
**Image Data Sets captures with cameras**

**Area Scan vs. Line Scan**

**Area Scan**
- Resolution: **1280 * 800**
- **W: 64mm * L: 40 mm**
- >120 seconds
- Off-line, cost-effective, multiple images

**Line Scan**
- Resolution: **7.3K**
- **W: 350 mm, L: unlimited**
- <10 seconds
- Good for in-line application, high speed requirement
AREA SCAN

- Data Sets collection with Area Scan Camera & XY stage
- Good for small boards (e.g. ETX, COM Express,...)
- 20 images (example)
Data Sets collection with Line Scan Camera on Conveyor.

- Good for most boards (e.g. ITX, ...)
- ONLY 1 whole image
Key Index: FNR & FPR

NG
OK

Ground Truth

理想狀況

NG

正確拒絕

模型判斷為
NG

模型判斷為
OK

漏網之魚

命中

模型判斷
NG

模型判斷
OK

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Enhancement Process
Results after label modification
Challenges & On-going Tasks

■ Challenge
  • Lower FNR (False Negative Rate, 漏網之魚) & lower FPR (False Positive Rate, 誤殺)
  • Training takes a long time (especially with new defect Data Sets!)
  • Inference time is too long, comparing to the existing AOI systems and manual Inspection.

■ Future tasks
  • SRP (Solution Ready Package)
  • Incremental Learning, Pseudo Label & Knowledge Distillation,....
  • Leverage new development of DLA (Deep Learning Accelerator), Model Truncate & Compression, close cooperation with Data Scientists and computing experts
Suggestions

Deep learning has the potential to be integrated into other aspects of Factory Automation. To Screen the various automation tasks, the criteria are:

• **Nature of tasks**: The task is complex and *ambiguous*. It often means that human experience has so far remained an integral part of the task.

• **Speed**: It is an off-line, or semi real-time task, so that the required response speed is not much shorter than 1 second.

• **Accuracy**: Accuracy requirement can be high, but it is possible to have a *supplementary process* to enhance accuracy, if the direct outcome from deep learning did not meet the bar.

• **Training and transferability**: The training of a “deep learning“ system takes reasonable resources (e.g. time) and can accommodate changes in operation.

Bernstein Research
Advantech as your AI Partner

Technology Solution

- Training Server
- Inference Server/IPC/Node
- Embedded Server for AI
- Connectivity Technology
- Network/Storage

Technology Partners

- NVIDIA
- HALCON
- Memorence
- Linker Networks
- RENESAS
- YUAN