AI in Industry: Case Studies

Hue Davis, Global Lead Automotive Smart Manufacturing, NVIDIA
INDUSTRIAL AI APPLICATIONS

- Automated Weeding Reduces Chemical Use 90%
- Semiconductor Manufacturing
- Oilfield Inspection
- Rail Transportation
- Turbine Predictive Maintenance Saves $6M/plant/year
- Robust Remaining Useful Life Prediction
- Auto Manufacturing
- Bin Picking and Automated Logistics
- Electronics Manufacturing
- Display Inspection
AI ushers in Industry 4.0

**Artificial Intelligence**
Early artificial intelligence stirs excitement.

**Machine Learning**
Machine learning begins to flourish.

**Deep Learning**
Deep learning breakthroughs drive AI boom.
Deep Neural Networks

Hinton et al., 2006; Bengio et al., 2007; Bengio & LeCun, 2007; Lee et al., 2008, 2009

Visual Object Recognition Using Deep Convolutional Neural Networks

Rob Fergus (New York University / Facebook)

Industrial Manufacturing

**FACTORY INSPECTION**
- Quality Inspection
- Fault Detection & Classification
- Inventory Inspection

**PREDICTIVE MAINTENANCE**
- Condition Based Maintenance
- Remaining Useful Life
- Failure Prediction

**PROCESS CONTROL**
- Yield Improvement
- Optimization
Sample Industrial Applications

**FACTORY INSPECTION**

**FIELD INSPECTION**

**PREDICTIVE MAINTENANCE**
Factory Inspection

Videos courtesy of Musashi Seimitsu and FANUC
Field Inspection

INDUSTRIAL STRENGTH AI & IMAGING ANALYTICS
Ser Nam Lim, General Electric

FPI – Fluorescent Penetrant Inspection

End-to-end system for automated defect detection
- Fluorescent penetrant area detection
- Unsupervised method to identify fluorescent penetrant area
- Deep learning based defect detection and classification
- Crack localization and automatic report generation using 3D techniques
Predictive Maintenance

AI-based RLS Fault Detection

Select Target Card from Field Operation

14

Input Card

Heavy Gas Interference + Sticking Barrel in Middle

Detection Time: 0.73 secs

Random Auto Select Target Card

Auto Run
Rising customer expectations for impeccable quality is a great opportunity for high precision manufacturers to differentiate -- but it also raises the bar for increased accuracy for detecting the smallest micron-scale product defects. This is especially challenging for the fast paced consumer electronics markets, where this level of quality inspection needs to be scaled up as quickly as new production ramps.

Foxconn Interconnect Technology Group is deploying AI inspection with NVIDIA HGX-1, Tesla V100/P4, and Jetson TX2. Foxconn’s traditional escape rate for CPU socket defect detection is 4.3% with expert inspectors. Using GPU-power AI, that defect rate has been reduced to 0.015% - a 287x performance improvement at the industrial scale.
Injection molding process steps

An injection molding machine is a multi-axis robot and rich with sensors.

Source: Smart Injection Molding – Application of NVIDIA Accelerator on Deep Learning, Joseph Wang, CTO Foxconn Interconnect Technology, GTC Taiwan 2018
成型工藝中的變異
積碳、磨耗、材料變異，……

即使有leakage flow，還是會積碳

仔細觀察閉合面積碳狀況

新料 + 次料 → 混合料

最大射壓

(Before 更換螺管) ~100

(After) ~20

Source: Smart Injection Molding – Application of NVIDIA Accelerator on Deep Learning, Joseph Wang, CTO Foxconn Interconnect Technology, GTC Taiwan 2018
Lens AVI supervised learning procedure

\[ Y = f_1(x) \]
**AI accelerator**

- **Training** (訓練中心)
- **優化加速** (TensorRT)
- **Inferencing** (邊緣佈署)

- Tesla P4: 13.9ms/image
- Jetson TX2: 200 ms/image
- CPU (4.2GHz): 333.6ms/image

Image (512x512)

Source: Smart Injection Molding – Application of NVIDIA Accelerator on Deep Learning, Joseph Wang, CTO Foxconn Interconnect Technology, GTC Taiwan 2018
Due to the increasingly sophisticated design of its cars and the high quality standards at Audi, the company inspects all components directly after production in the press shop. In addition to visual inspection by employees, several small deep learning-based cameras trained on NVIDIA GPUs are installed directly in the presses that detects the finest cracks in sheet metal with the utmost precision in a matter of seconds.

Whether doors, engine hoods or fenders - current cameras need to be reconfigured for every new component produced in the press shop. In the future, it will be possible to apply the deep learning approach to other visual quality inspections, such as supporting paint shops or assembly shops.
SOLDER JOINT DEFECTS

- HIP occurs when two balls form (right) instead of single ball (left)
- Joint can function, but connection is contact only
- Heat, stress, and vibration can make connection intermittent or break it altogether

Example of HIP failure

Good Ball | HIP Failure

HIP failure, X-ray 45°

HIP failure, X-ray 0°

Img courtesy: http://www.indium.com/blog/hip-in-shanghai.php
PUMPING AI INTO THE OIL & GAS INDUSTRY

A 1% reduction in downtime for an offshore platform, improves revenue by $38M per year per platform at $70/barrel.

NVIDIA and Baker Hughes (BHGE) are using AI and GPU-accelerated computing to help companies distill oceans of data and reduce the cost of finding, extracting, processing and delivering oil. BHGE’s applied AI services and NVIDIA’s end-to-end AI supercomputing solutions – from the NVIDIA DGX-1 in data centers, to the NVIDIA DGX Station deskside or at remote locations, to NVIDIA Jetson at the edge— can unlock insights from data that was previously as hidden as the oil underground.
Industrial Content

Deep Learning at BMW: Robust AI in the Production Chain
Beyond Autonomous Driving: Unleashing Value via Machine Learning Applications in the Automotive Industry
Customizable Keypoint Detection with a Compact CNN for Visual Inspection in Manufacturing
Physics-based AI for Semiconductor Inspection using a GPU based Optical Neural Network (ONN)
Deep Learning for Industrial Inspection Analysis
Deep Learning with Sparse Uncertain Data: An Oil & Gas Perspective
Contextual Product Search with Vectorized Part Descriptions
Deep Learning for Railway Track Faults using GPUs
Defect Inspection from Scratch to Production
Deploying Machine Learning on the Oilfield: From the Labs to the Edge
Learn How IBM Visual Insights from Watson IoT Uses Deep Learning to Help Manufacturers “See” Defects Instantly
Crack Detection for Inspection with Deep Learning
GPUs in Industrial Image Processing Applications
Digital Twin for the Railway Network
Disrupting Logistics and Optimization with AI
Fraud Detection via Deep Learning
GPU Powered Optimization of Distributed Product Inventory
Identifying Defect Patterns in Hard Disk Drive Magnetic Media Manufacturing Processes
Mars Rovers to End to End Industrial Inspection Solutions: GPUs for Machine Intelligence
Multi-Resolution 3D Convolutional Neural Network for Object Recognition
Name Entity Detection Using Deep Learning
The Future of Swiss Railway Dispatching: Deep Learning and Simulation on DGX-1