案例分析與未來建議

案例分析－即時影像處理

- 待測物為 0402 的被動元件，振動送料機送料速度為 70 個/秒，廠商要求 FOV 要看到前後料的狀態，方便後續驗證。
  - 0402 → 1mm * 0.5mm
  - 看到前後料， FOV = 3mm * 1.5mm
  - 70 個/秒 → 14ms/ 個
  - 取像速度 >> 14ms/3 (4.6 ms)

案例分析－即時影像處理

Sensor 選用 (PYTHON 300)：

SPECIFICATIONS

Key Specifications

Table 1. GENERAL SPECIFICATIONS

Parameter	Specification
Pixel type	In–pixel CDS. Global shutter pixel architecture
Shutter type	Pipelined and triggered global shutter
Frame rate Zero ROT/ Normal ROT mode	P1–SN/SE/FN: PYTHON 300: 815/545 fps PYTHON 500: 545/385 fps PYTHON 1300: 210/165 fps P2–SN/SE: 50/43 fps P3–SN/SE/FN: NA/90 fps
Master clock	P1, P3–SN/SE/FN: 72 MHz when PLL is used, 360 MHz (10–bit) / 288 MHz (8–bit) when PLL is not used P2–SN/SE: 72 MHz
Windowing	8 Randomly programmable windows. Normal, sub–sampled and binned readout modes
ADC resolution	10–bit, 8–bit (Note 1)
LVDS outputs	P1–SN/SE/FN: 4/2/1 data + sync + clock P3–SN/SE/FN: 2/1 data + sync + clock
CMOS outputs	P2–SN/SE: 10–bit parallel output, frame_valid, line_valid, clock
Data rate	P1–SN/SE/FN: 4 x 720 Mbps (10–bit) / 4 x 576 Mbps (8–bit) P2–SN/SE: 72 Mhz P3–SN/SE/FN: 2 x 720 Mbps (10–bit)
Power dissipation (10–bit mode)	P1–SN/SE/FN: 620 mW (4 data channels) P1, P3–SN/SE/FN: 420 mW (2 data ch.) P1, P3–SN/SE/FN: 270 mW (1 data ch.) P2–SN/SE: 420 mW
Package type	48–pin LCC

Table 2. ELECTRO–OPTICAL SPECIFICATIONS

Parameter	Specification
Active pixels	$\boxed{\text{PYTHON 300: 640 (H) x 480 (V)}}$ PYTHON 500: 800 (H) x 600 (V) PYTHON 1300: 1280 (H) x 1024 (V)
Pixel size	$\boxed{4.8\ \mu m \times 4.8\ \mu m}$
Conversion gain	0.096 LSB10/e⁻ 140 μV/e⁻
Dark temporal noise	< 9 e⁻ (Normal ROT, 1x gain) < 7 e⁻ (Normal ROT, 2x gain)
Responsivity at 550 nm	7.7 V/lux.s
Parasitic Light Sensitivity (PLS)	<1/8000
Full Well Charge	10000 e⁻
Quantum Efficiency at 550 nm	56%
Pixel FPN	< 1.0 LSB10
PRNU	< 2% or 10 LSB10 on half scale response of 525LSB10
MTF	68% @ 535 nm – X–dir & Y–dir
PSNL at 20°C	120 LSB10/s, 1200 e⁻/s
Dark signal at 20°C	5 e⁻/s, 0.5 LSB10/s
Dynamic Range	> 60 dB in global shutter mode
Signal to Noise Ratio (SNR max)	40 dB

FOV = 3mm * 1.5mm

Sensor size W = 640*4.8um = 3.07mm

Sensor size H = 480*4.8um = 2.3 mm

1X Lens = 3.07mm * 2.3mm

0.5X Lens = 6.14mm * 4.6mm

案例分析 – 即時影像處理

速度匹配 (PYTHON 300) ：

SPECIFICATIONS

Key Specifications

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Frame rate Zero ROT/ Normal ROT mode	P1–SN/SE/FN: PYTHON 300: 815/545 fps PYTHON 500: 545/385 fps PYTHON 1300: 210/165 fps P2–SN/SE: 50/43 fps P3–SN/SE/FN: NA/90 fps
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Pixel size	4.8 μm x 4.8 μm
Conversion gain	0.096 LSB10/e⁻ 140 μV/e⁻
Dark temporal noise	< 9 e⁻ (Normal ROT, 1x gain) < 7 e⁻ (Normal ROT, 2x gain)
Responsivity at 550 nm	7.7 V/lux.s
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Pixel FPN	< 1.0 LSB10
PRNU	< 2% or 10 LSB10 on half scale response of 525LSB10
MTF	68% @ 535 nm – X–dir & Y–dir
PSNL at 20°C	120 LSB10/s, 1200 e⁻/s
Dark signal at 20°C	5 e⁻/s, 0.5 LSB10/s
Dynamic Range	> 60 dB in global shutter mode
Signal to Noise Ratio (SNR max)	40 dB

Physical speed: 14ms/PCS

Object size W = 1mm/4.8um = 208 pixel
Object size H = 0.5mm/4.8um = 104 pixel

Image speed: 208/14 = 14.9pixel/ms

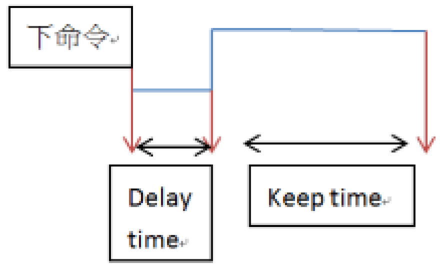
Exposure time: 0.5pixel/14.9 = 0.03ms

Capturing speed: 815fps ➔ 1.2ms
Capturing speed: 545fps ➔ 1.8ms

Moving pixel/capturing: 1.2*14.9 = 18pixel
Moving pixel/capturing: 1.8*14.9 = 27pixel

案例分析 – 即時影像處理

- 圖示所需進行的處理：



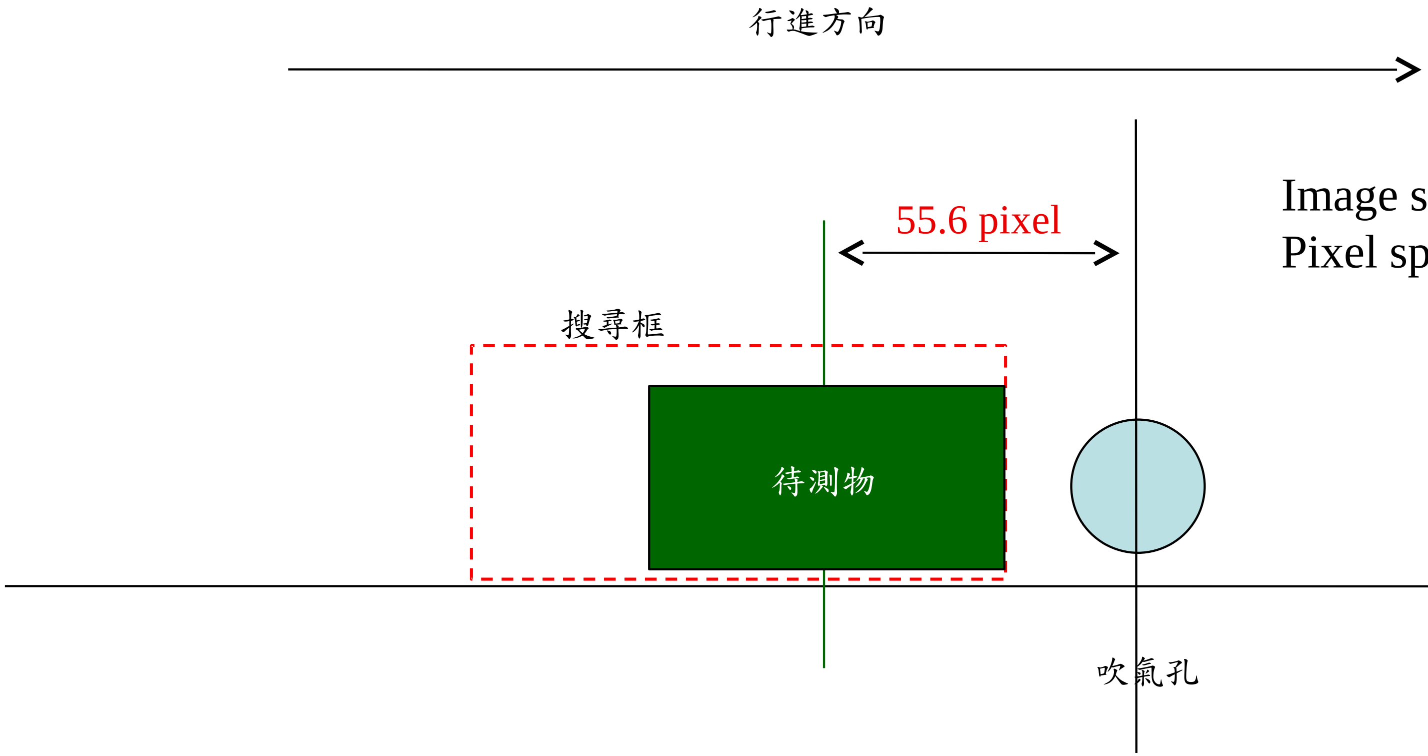


Image speed: 208/14 = 14.9pixel/ms
Pixel speed: 14/208 = 0.07ms/pixel

Consume time = Exposure time + Capturing time + Processing time + uncertain system delay time
Consume time = 0.03 ms + 1.2ms + 1ms + 1.5ms = 3.73ms ➔ 3.73*14.9 = 55.6 pixel

https://www.youtube.com/watch?v=ExgSRelC7RY

案例分析－即時影像處理

□注意事項：

- 連續取像時間與處理時間是否匹配。
- 延遲時間是否能準確控制，關鍵因素包含計算時間、位置資訊及非即時作業系統的變動性。
- 軌道上移動速度是否一致？(盡可能縮短判斷位置到吹氣位置的距離，降低變速所帶來的影響)。
- 送料速度是否能準確估測？
- 電磁閥的反應時間是否需要考慮進來？
- 吹氣跟洩氣的反應速度。

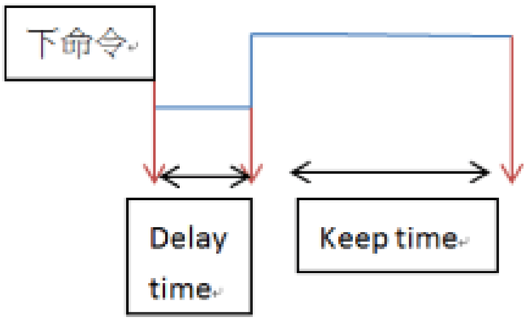


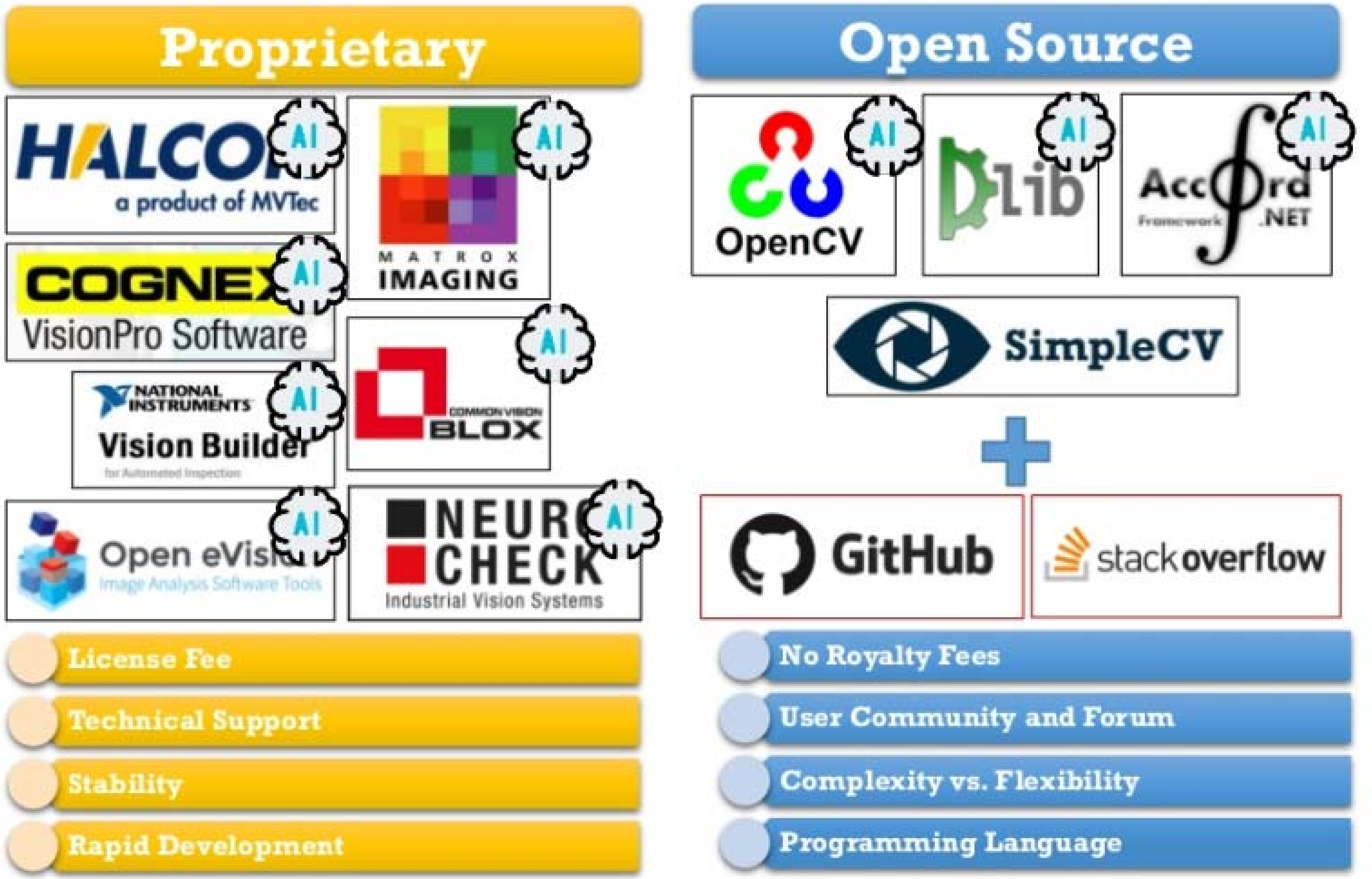
Image speed: 208/14 = 14.9pixel/ms

現在進行式

Industries	Applications	Machine Vision Algorithms	Strength of AI
• Electric components and equipment • Manufacturing • Semiconductors • Machinery parts • Material production • Packaging • Printing • Agriculture and food • Health care and life science • Logistics • Monitoring and surveillance • etc.	• Gauging and measurement • 3D measurement • Bar code and data code reading • OCR • Object detection • Object recognition • Print inspection • Surface inspection • Defect detection • Completeness check • Robotic guidance • etc.	• Basic processing • 1D & 2D measurement • Color analysis • Segmentation • Matching • Shape finding • Pattern recognition • Feature extraction and analysis • OCR • Registration • Calibration • Blob analysis • Morphology • etc.	• **Complex background** • **Size and shape variation** • **Distortion** • **Classification** • **Object detection** • **Feature extraction** • **etc.**

現在進行式

Machine Vision + Deep Learning https://www.youtube.com/watch?v=7tBTE1EFYUI

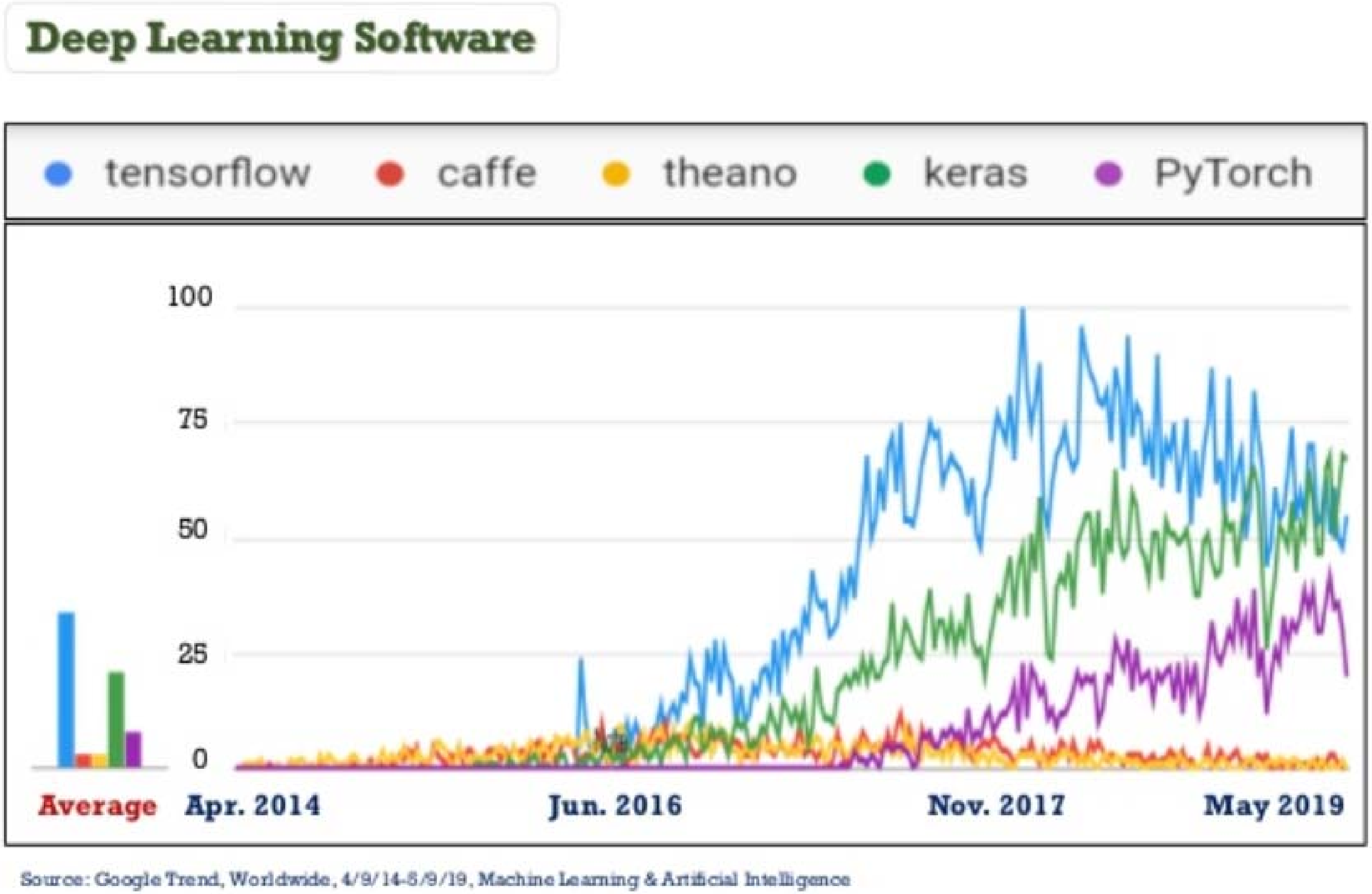


現在進行式

Deep Learning Software

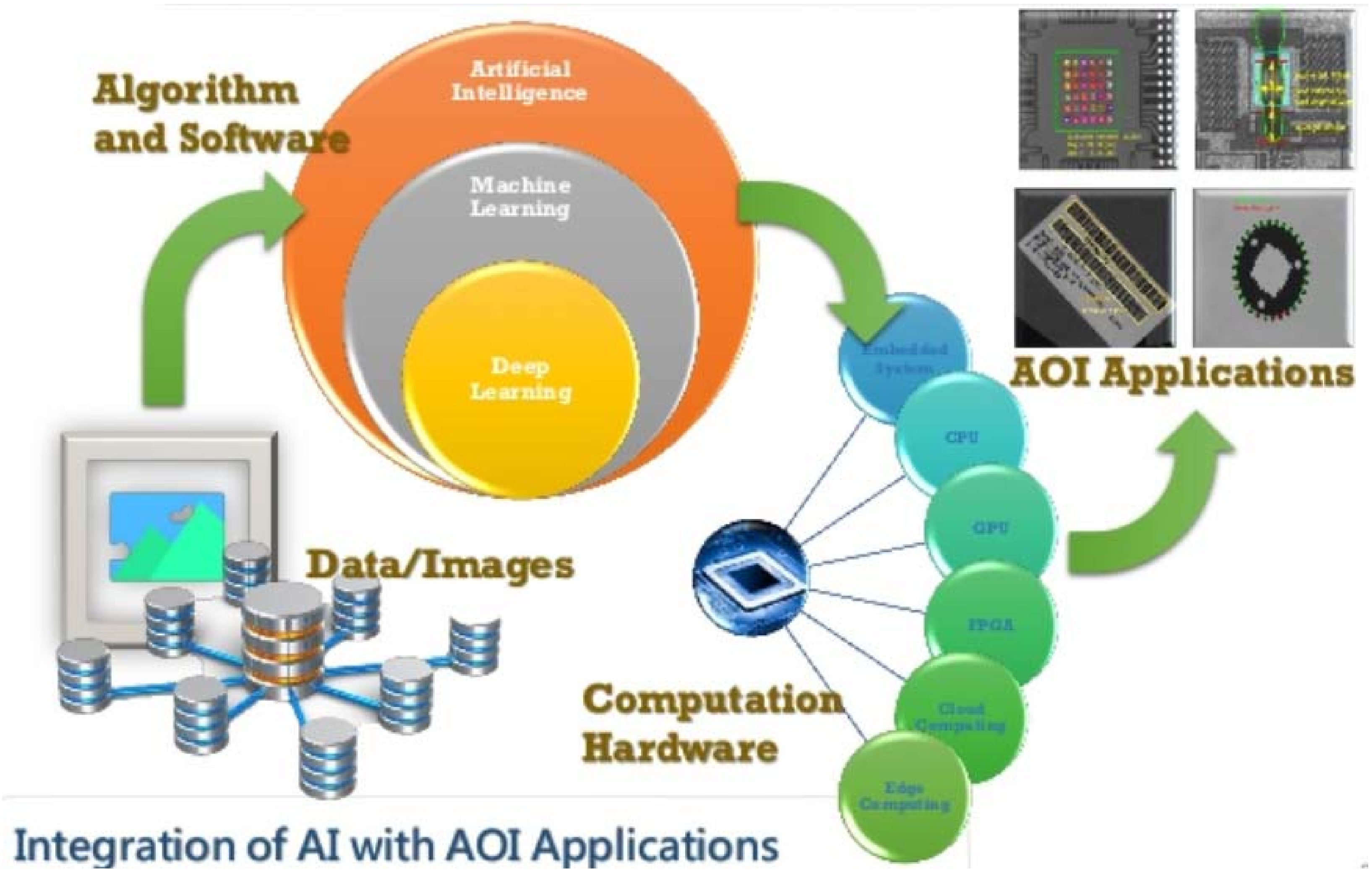
Software	Initial Release	Open Source	Language	CUDA Support	Actively Developed
Dlib	2002	Yes	C++	Yes	Yes
Theano	2007	Yes	Python	Yes	No
Caffe	2013	No	Python, C++	Yes	No
TensorFlow	2015	Yes	C++, Python	Yes	Yes
Chainer	2015	Yes	Python	Yes	Yes
Keras	2015	Yes	Python, R	Yes	Yes
Apache MXNet	2015	Yes	C++, Python, Matlab, R, etc.	Yes	Yes
Microsoft Cognitive Toolkit (CNTK)	2016	Yes	Python, C++, C#/.NET	Yes	Yes
PyTorch	2016	Yes	Python	Yes	Yes
Matlab		Yes	Matlab	Yes	Yes
Wolfram Mathematica		Yes	Wolfram Language	Yes	Yes

現在進行式



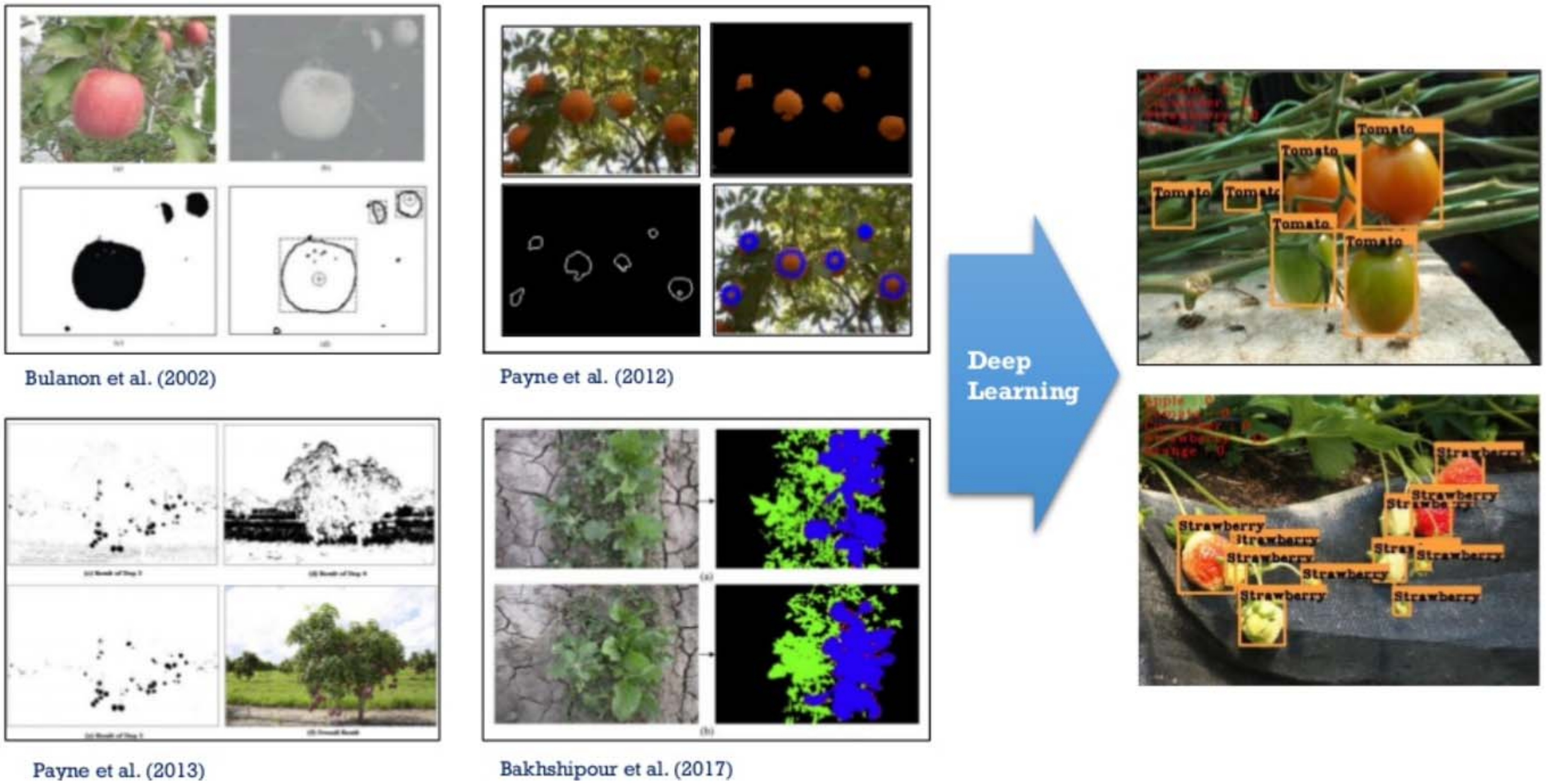
Deep Learning Software
tensorflow
caffe
theano
keras
PyTorch
100
75
50
25
0
Average
Apr. 2014
Jun. 2016
Nov. 2017
May 2019
Source: Google Trend, Worldwide, 4/9/14-8/9/19, Machine Learning & Artificial Intelligence

現在進行式


Algorithm and Software
Artificial Intelligence
Machine Learning
Deep Learning
Data/Images
Computation Hardware
CPU
GPU
FPGA
Cloud Computing
Edge Computing
AOI Applications
Integration of AI with AOI Applications

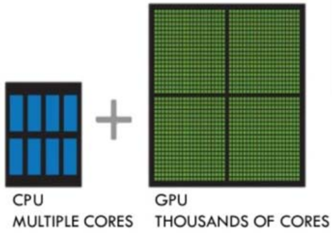
應用案例

The problem of fruit or weed detection

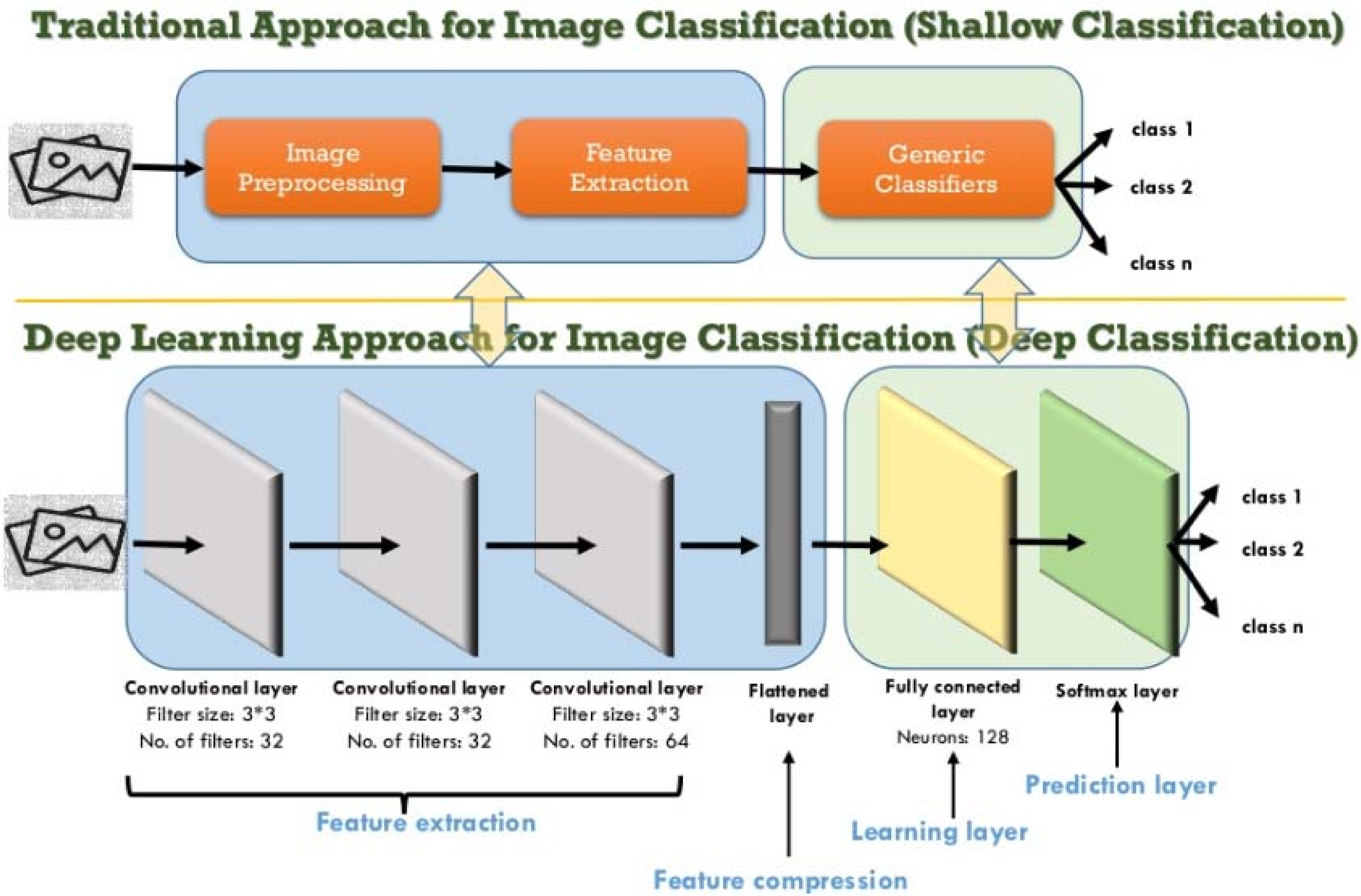


應用案例

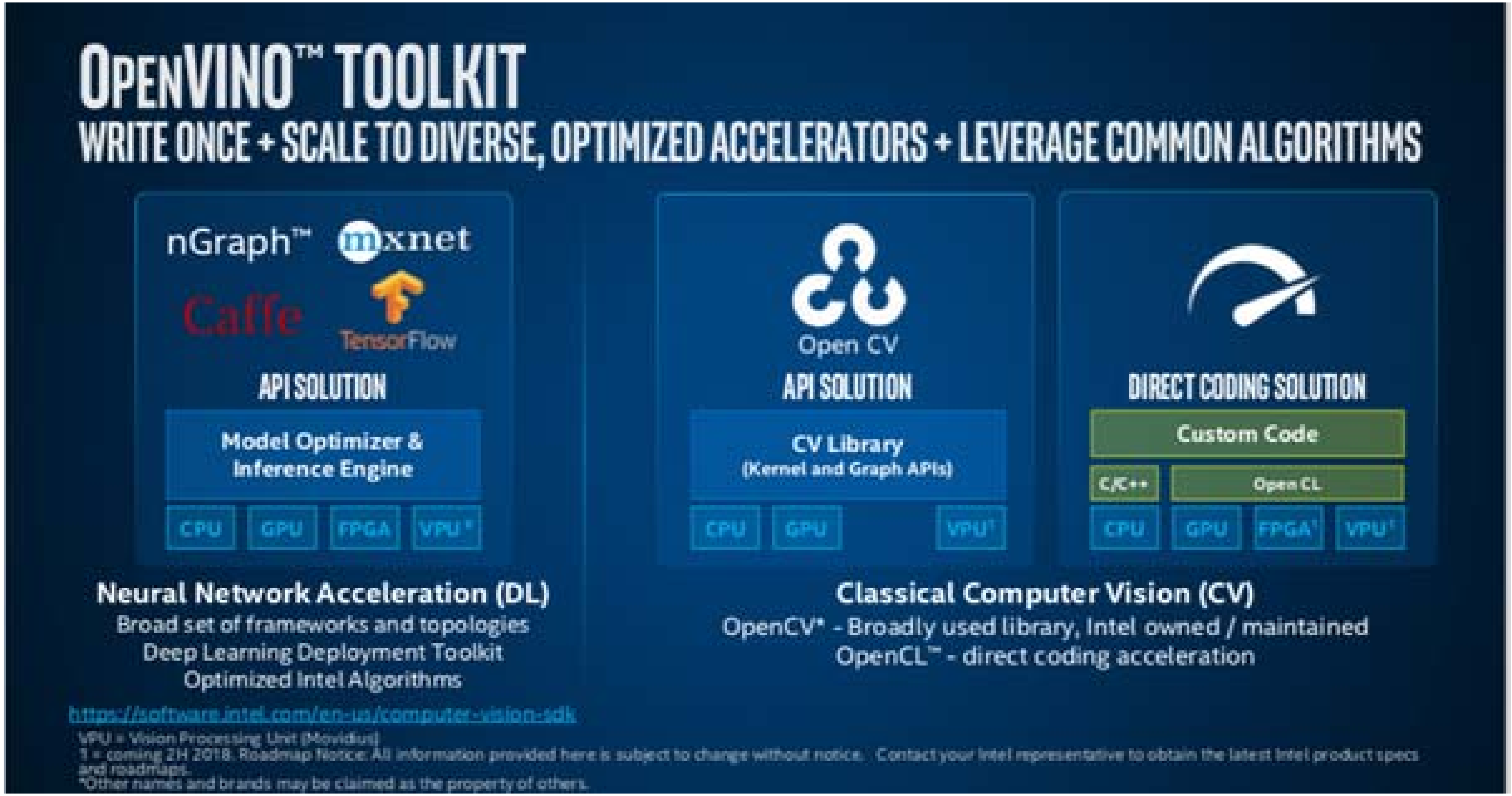
https://www.youtube.com/watch?v=M3SGScaShhw


CPU
MULTIPLE CORES
GPU
THOUSANDS OF CORES

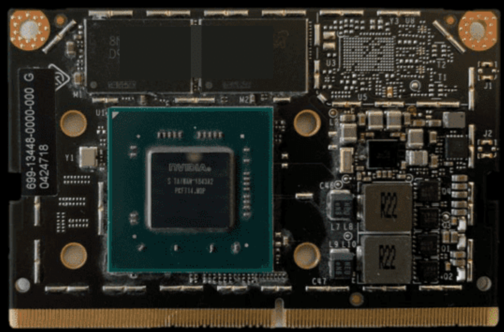
應用案例


Traditional Approach for Image Classification (Shallow Classification)
Image Preprocessing
Feature Extraction
Generic Classifiers
class 1
class 2
class n
Deep Learning Approach for Image Classification (Deep Classification)
class 1
class 2
class n
Convolutional layer
Filter size: 3*3
No. of filters: 32
Convolutional layer
Filter size: 3*3
No. of filters: 32
Convolutional layer
Filter size: 3*3
No. of filters: 64
Flattened layer
Fully connected layer
Neurons: 128
Softmax layer
Feature extraction
Feature compression
Learning layer
Prediction layer

技術前沿


OPENVINO™ TOOLKIT
WRITE ONCE + SCALE TO DIVERSE, OPTIMIZED ACCELERATORS + LEVERAGE COMMON ALGORITHMS
nGraph™
mxnet
Caffe
TensorFlow
API SOLUTION
Model Optimizer &
Inference Engine
CPU
GPU
FPGA
VPU*
Open CV
API SOLUTION
CV Library
(Kernel and Graph APIs)
CPU
GPU
VPU¹
DIRECT CODING SOLUTION
Custom Code
C/C++
OpenCL
CPU
GPU
FPGA¹
VPU¹
Neural Network Acceleration (DL)
Broad set of frameworks and topologies
Deep Learning Deployment Toolkit
Optimized Intel Algorithms
Classical Computer Vision (CV)
OpenCV* - Broadly used library, Intel owned / maintained
OpenCL™ - direct coding acceleration
https://software.intel.com/en-us/computer-vision-sdk
VPU = Vision Processing Unit (Movidius)
1 = coming 2H 2018. Roadmap Notice: All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest Intel product specs and roadmaps.
*Other names and brands may be claimed as the property of others.

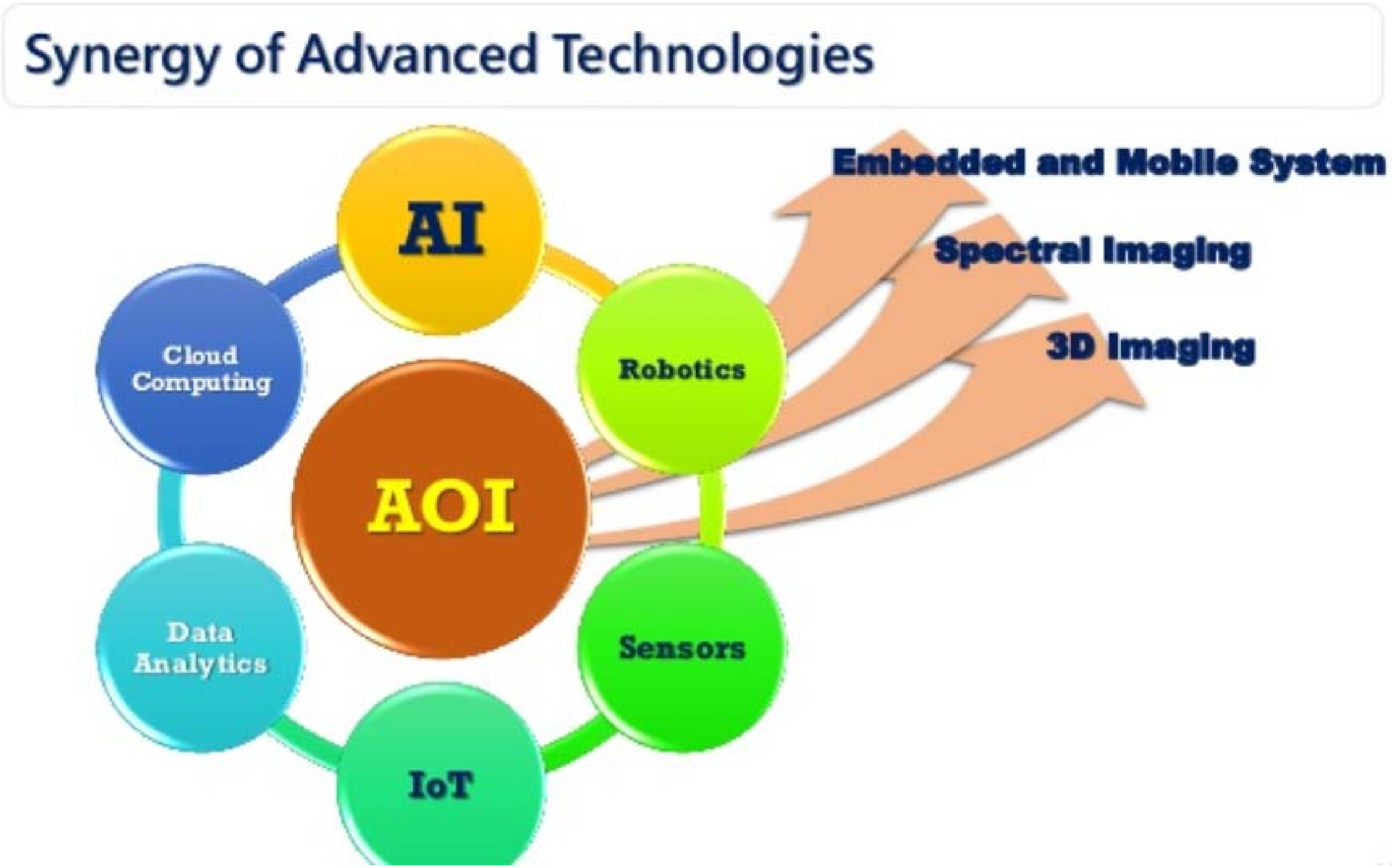
JETSON NANO SPECIFICATIONS



GPU	128 Core Maxwell 472 GFLOPs (FP16)
CPU	4 core ARM A57 @ 1.43 GHz
Memory	4 GB 64 bit LPDDR4 25.6 GB/s
Storage	16 GB eMMC
Video Encode	4K @ 30 | 4x 1080p @ 30 | 8x 720p @ 30 (H.264/H.265)
Video Decode	4K @ 60 | 2x 4K @ 30 | 8x 1080p @ 30 | 16x 720p @ 30 | (H.264/H.265)
Camera	12 (3x4 or 4x2) MIPI CSI-2 DPHY 1.1 lanes (1.5 Gbps)
Display	HDMI 2.0 or DP1.2 | eDP 1.4 | DSI (1 x2) 2 simultaneous
UPHY	1 x1/2/4 PCIE 1 USB 3.0
SDIO/SPI/SysIOs/GPIOs/I2C	1x SDIO / 2x SPI / 5x SysIO / 13x GPIOs / 6x I2C

9 NVIDIA.

未來建議

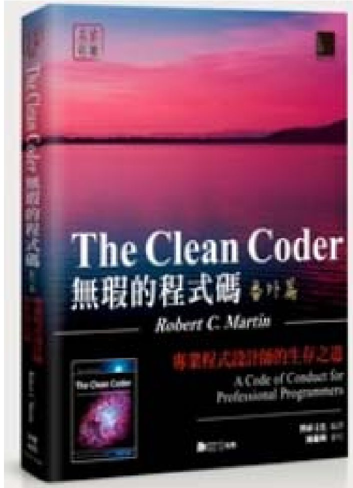

Synergy of Advanced Technologies
AI
Cloud Computing
Robotics
AOI
Data Analytics
Sensors
IoT
Embedded and Mobile System
Spectral Imaging
3D Imaging

未來建議

未來建議

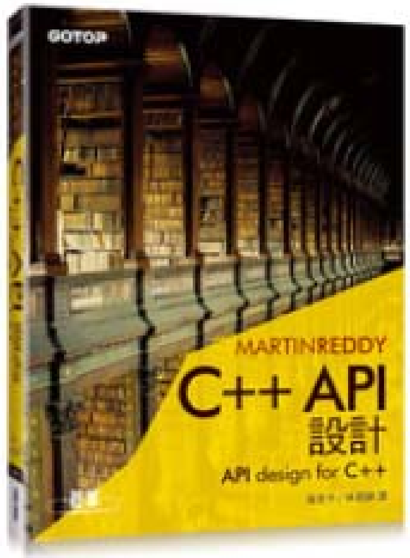
□程式進修：

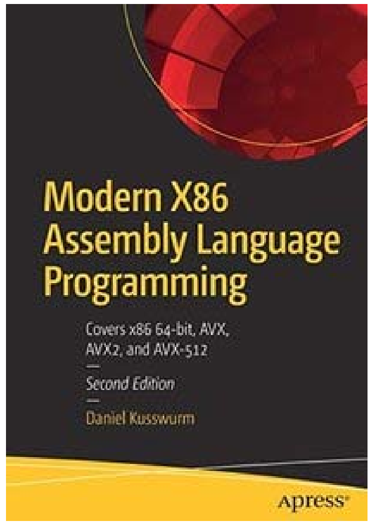

Clean Code
無瑕的程式碼
Robert C. Martin
敏捷軟體開發技巧守則
A Handbook of
Agile Software Craftsmanship


The Clean Coder
無瑕的程式碼
Robert C. Martin
A Code of Conduct for
Professional Programmers


Clean Architecture
無瑕的程式碼
Robert C. Martin
A Craftsman's Guide to
Software Structure and Design

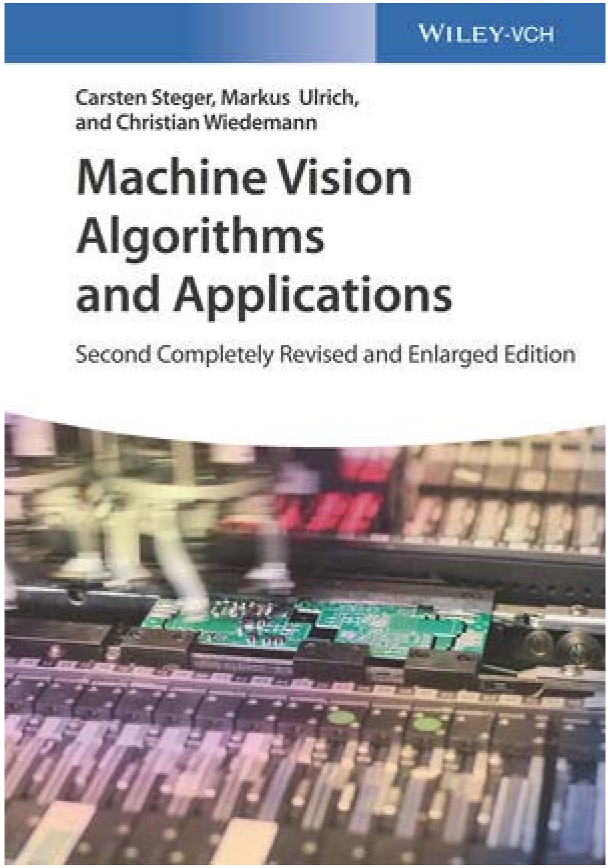

編寫程式的邏輯
如何用
物件導向
實作複雜的業務需求

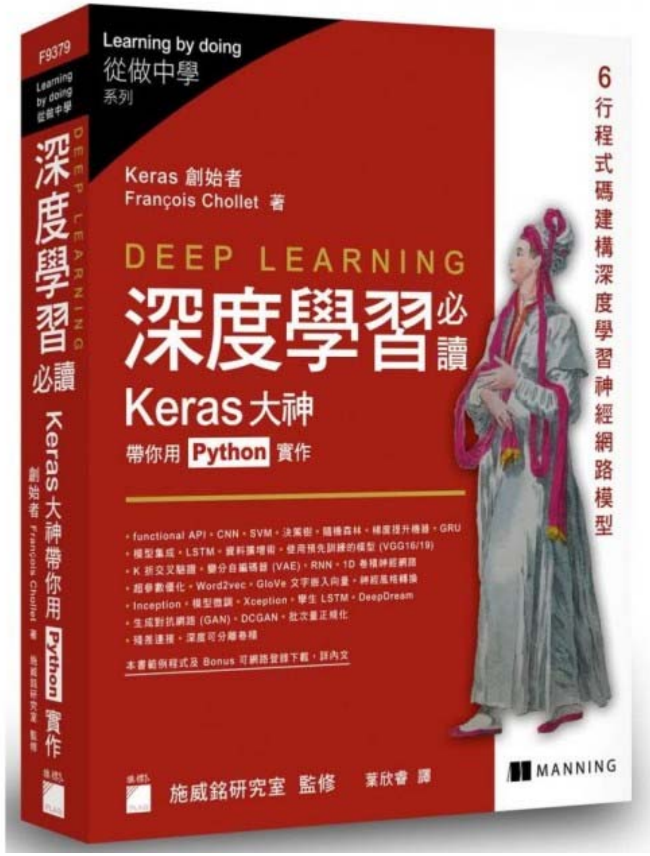

GOTOP
MARTIN REDDY
C++ API
設計
API design for C++


Modern X86
Assembly Language
Programming
Covers x86 64-bit, AVX,
AVX2, and AVX-512
Second Edition
Daniel Kusswurm
Apress

未來建議

□機器視覺與 AI ：





DIY 專案開發

- 人臉定位 (Dlib, HoG-SVM) + 人臉辨識 (ResNet) + 肢體動作(運動)辨識 (Skeleton + Machine learning)

  https://www.youtube.com/watch?v=CBPsMGQB5p0

- 雜草辨識 (Deeping learning) + 自走車導航 (Motion control + SLAM) + 自動噴灑除草劑 (I/O control)