- Unprecedented acceleration in **investment**, **innovation** and **deployment** of vision technology and solutions across a broad range of markets
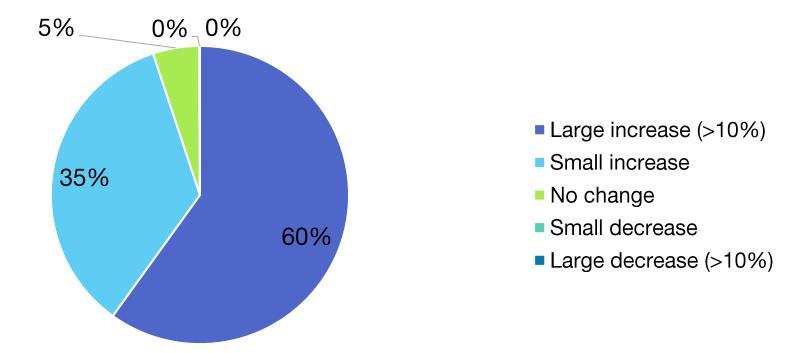

Source: Rudy Burger, Woodside Capital

Computer Vision Total Revenue

Source: Tractica

Source: Embedded Vision Alliance, *Computer Vision Developer Survey, 11/2017*
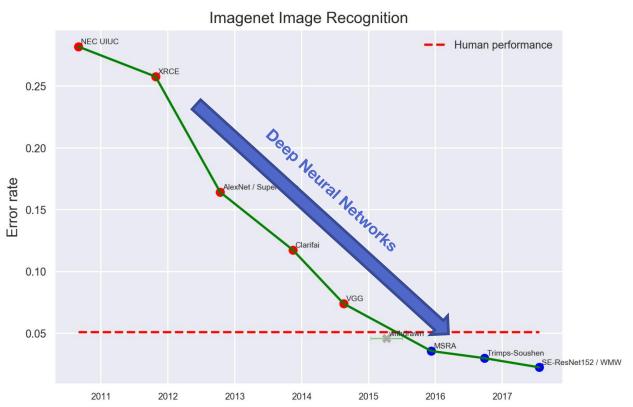
- Computer vision increasingly **works well enough** for real-world applications

- Computer vision can be deployed at **low cost and power consumption**

- Computer vision is increasingly **usable by non-specialists**

embedded
VISION
SUMMIT
2018

Imagenet Image Recognition

- - - Human performance

NEC UIUC

XRCE

AlexNet / Super

Clarifai

VGG

Deep Neural Networks

withdrawn

MSRA

Trimps-Soushen

SE-ResNet152 / WMW

Error rate

0.25
0.20
0.15
0.10
0.05

2011 2012 2013 2014 2015 2016 2017
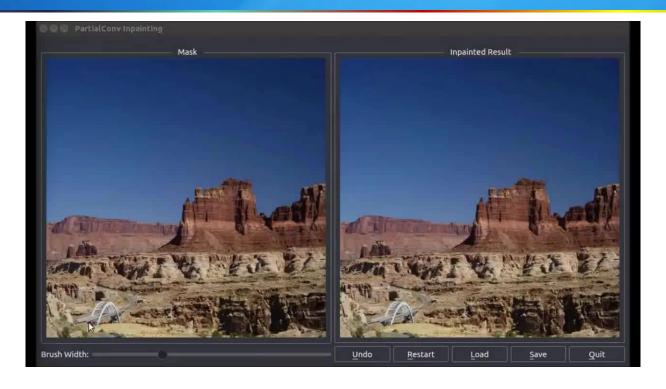
Source:
www.eff.org/ai/metrics

Source: Guilin Lin et al., NVIDIA
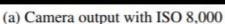
https://youtu.be/gg0F5JjKmhA

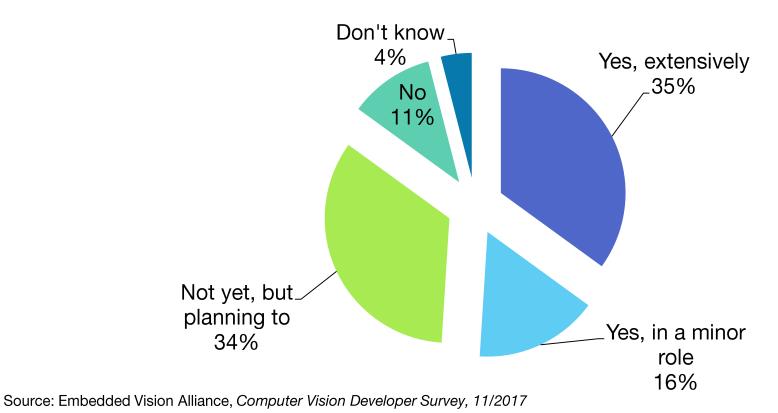(a) Camera output with ISO 8,000   (b) Camera output with ISO 409,600   (c) Our result from the raw data of (a)

Source: Learning to See in the Dark, Chen Chen, Qifeng Chen, Jia Xu and Vladlen Koltun, CVPR 2018

Use of Neural Networks to Perform Computer Vision Functions

Don't know
4%

No
11%

Yes, extensively
35%

Not yet, but planning to
34%

Yes, in a minor role
16%

Source: Embedded Vision Alliance, *Computer Vision Developer Survey, 11/2017*

Source: Microsoft

Source: Intel

Source: Occipital
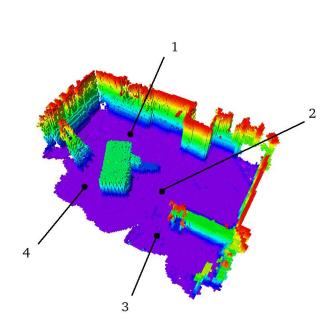
Source: pcc.disam.etsii.upm.es

Source: appleinsider.com

- 3D camera modules usually include infrared illumination
- Eight years after the debut of the Kinect, 3D camera modules are now ready for deployment in cost- and power-sensitive applications.

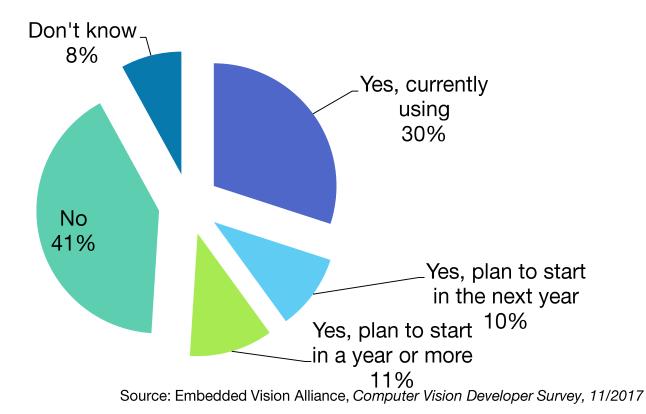Source: Guillaume Girardin, Yole Developpement

Don't know
8%

Yes, currently
using
30%

No
41%

Yes, plan to start
in the next year
10%

Yes, plan to start
in a year or more
11%

Source: Embedded Vision Alliance, *Computer Vision Developer Survey, 11/2017*

Current Use of 3D Perception in Products — By Industry

Source: Embedded Vision Alliance, *Computer Vision Developer Survey, 11/2017*

1. Algorithms

2. Processors

3. Frameworks, tools, middleware

2x-37x ➔ ~18x

15x-300x ➔ ~157x

3x-14x ➔ ~8x

= ~26,000x

- Roughly 50 companies developing processors for deep learning training or inference (most for inference), including…

AIMOTIVE   Ambarella™   AMD

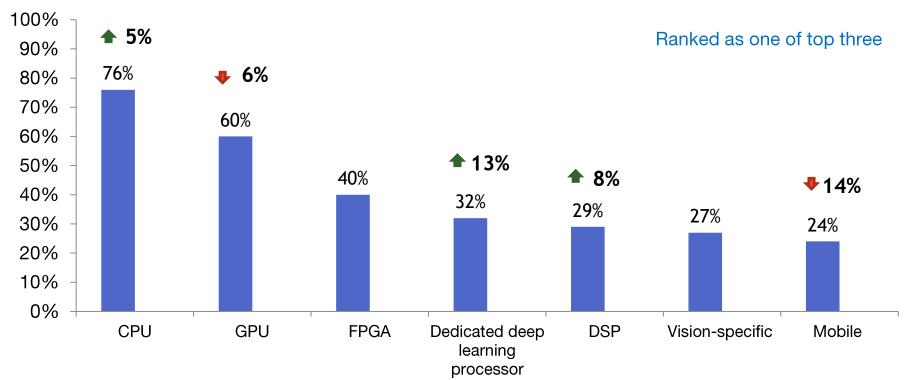arm   cadence®   CEVA

FotoNation®   地平线 Horizon Robotics   Imagination

intel   LATTICE SEMICONDUCTOR   NVIDIA

MYTHIC   NOVUMIND Making Things Think   synopsys®

QUALCOMM®   videantis   VeriSilicon

WAVE COMPUTING   XILINX

AI Chip – To Enable Embedded Intelligence

embedded VISION SUMMIT 2018

AI Chips	Power (W)	Performance (TOPS)	Perf/Watt (TOPS/W)
NovuTensor V2	5	20	4
Movidius Myriad2	1	0.2	0.2
CEVA XM6*	2	1	0.5
QCOM S835	2.5	0.19	0.08
HUAWEI Kirin970	2	1.9	0.95
Cadence C5*	2	2	1
Nvidia TX2	10	1	0.1
Nvidia Xavier (2018)	30	30	1
Google TPU1	40	23	0.58
Google TPU2	250	180	0.72
Nvidia P100 GPU	250	10.6	0.04
Nvidia V100 GPU	250	120	0.48

* IP vendor

400% better perf/watt

Low Power Low Performance

High Power High Performance

NOVUMIND   Copyright © 2018 NovuMind Inc.   17

Source: Ren Wu, NovuMind

Type of Processor Used for Vision Tasks

Ranked as one of top three

CPU: 76% ▲ 5%
GPU: 60% ▼ 6%
FPGA: 40%
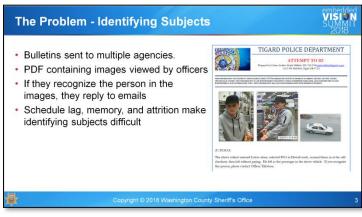Dedicated deep learning processor: 32% ▲ 13%
DSP: 29% ▲ 8%
Vision-specific: 27%
Mobile: 24% ▼ 14%

Source: Embedded Vision Alliance, *Computer Vision Developer Survey, 11/2017*

- It's rapidly getting easier to:
  - Develop effective computer-vision based systems and applications
  - Deploy those solutions at scale

- Why?
  - Deep learning shifts focus from algorithm development to training
  - Huge, accelerating investment in tools
  - Cloud computing

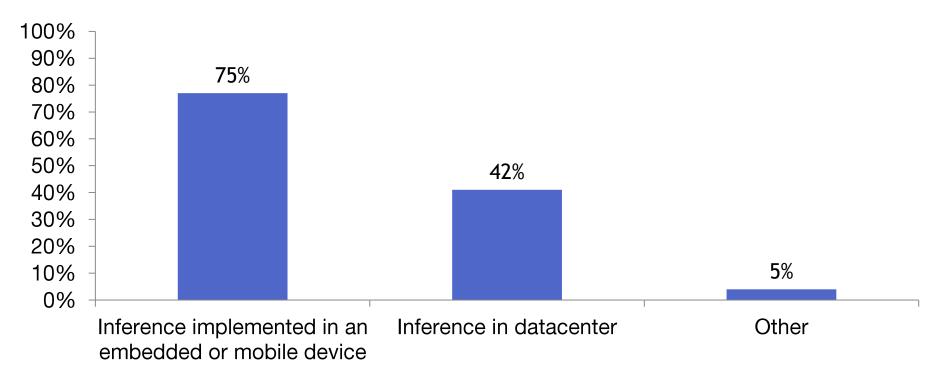

Source: Chris Adzima, WCSO

The Cloud Shuffles the Deck

	Edge	Cloud
Time-to-market		✔ ✔ ✔
Upgradability		✔ ✔
Accuracy		✔ ✔ ✔
Coordination among distributed devices		✔ ✔ ✔
Device cost		✔ ✔
Recurring costs	✔ ✔ ✔	
Internet connectivity, bandwidth required	✔ ✔ ✔	
Response time	✔ ✔ ✔	
Privacy/security	✔	

✔ = Advantage

How is Your Neural Network Deployed?

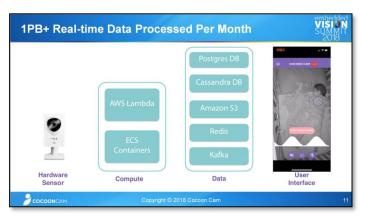Source: Embedded Vision Alliance, *Computer Vision Developer Survey, 11/2017*

- Five years ago, a start-up developing a large-scale, centralized vision-based solution would have had to build most of the infrastructure
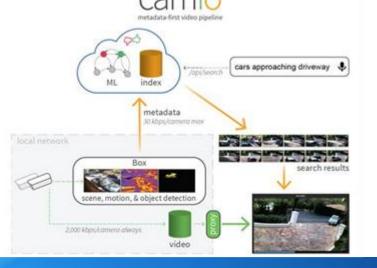- Today, all of the software and hardware infrastructure is available off the shelf
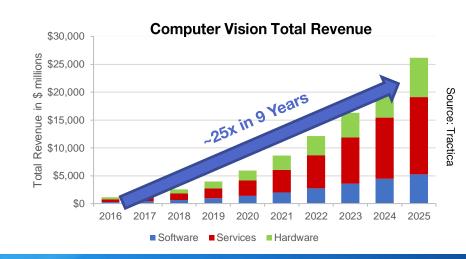

Source: Pavan Kumar, CocoonCam

Source: Camio

- Unprecedented acceleration in **investment**, **innovation** and **deployment** of vision technology and solutions, fueled by vision technology that:
  - Works
  - Is inexpensive, low-power, and small
  - Usable by non-specialists

Source: Rudy Burger, Woodside Capital

Source: Tractica

Source: The Ad Buzz

Source: States Chronicle

Source: Nissan

https://www.youtube.com/watch?v=laVRq3wXSwE

Thank you!

Jeff Bier — Founder, Embedded Vision Alliance | President, BDTI

May 2018