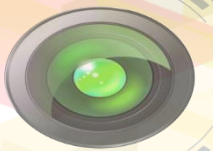
When Every Device Can See



Cadence Embedded Neural Network Summit — February 1, 2017

Jeff Bier
Founder, Embedded Vision Alliance
General Chairman, Embedded Vision Summit
President, BDTI

www.Embedded-Vision.com
bier@embedded-vision.com

The Evolution of Vision Technology

***Computer vision*:** research and fundamental technology for extracting meaning from images

***Machine vision*:** factory applications

***Embedded vision*:** thousands of applications

- Consumer, automotive, medical, defense, retail, gaming, security, education, transportation, …
- Embedded systems, mobile devices, PCs and the cloud

Overcoming Critical Challenges

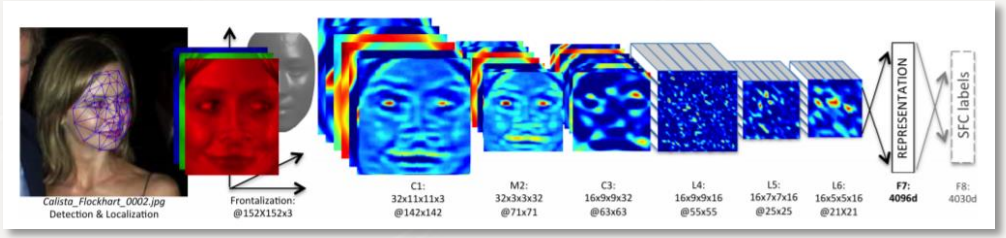
- For embedded vision to achieve its potential, we need:
  - More capable and reliable **algorithms**
  - High-performance, energy-efficient, inexpensive **processors**
  - More-capable, more integrated and less expensive image **sensors**
  - Improved **software** development productivity
  - More skilled **engineers**

Vision Algorithms are Hard

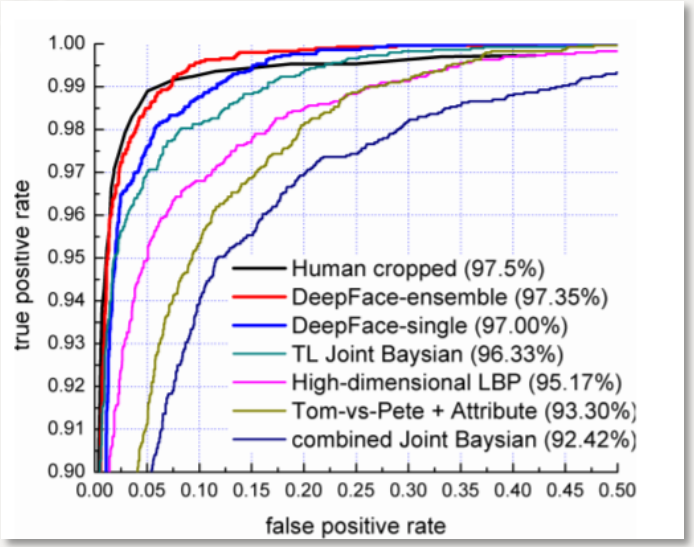
dot.gov

xkcd.com

Approaching Human Abilities

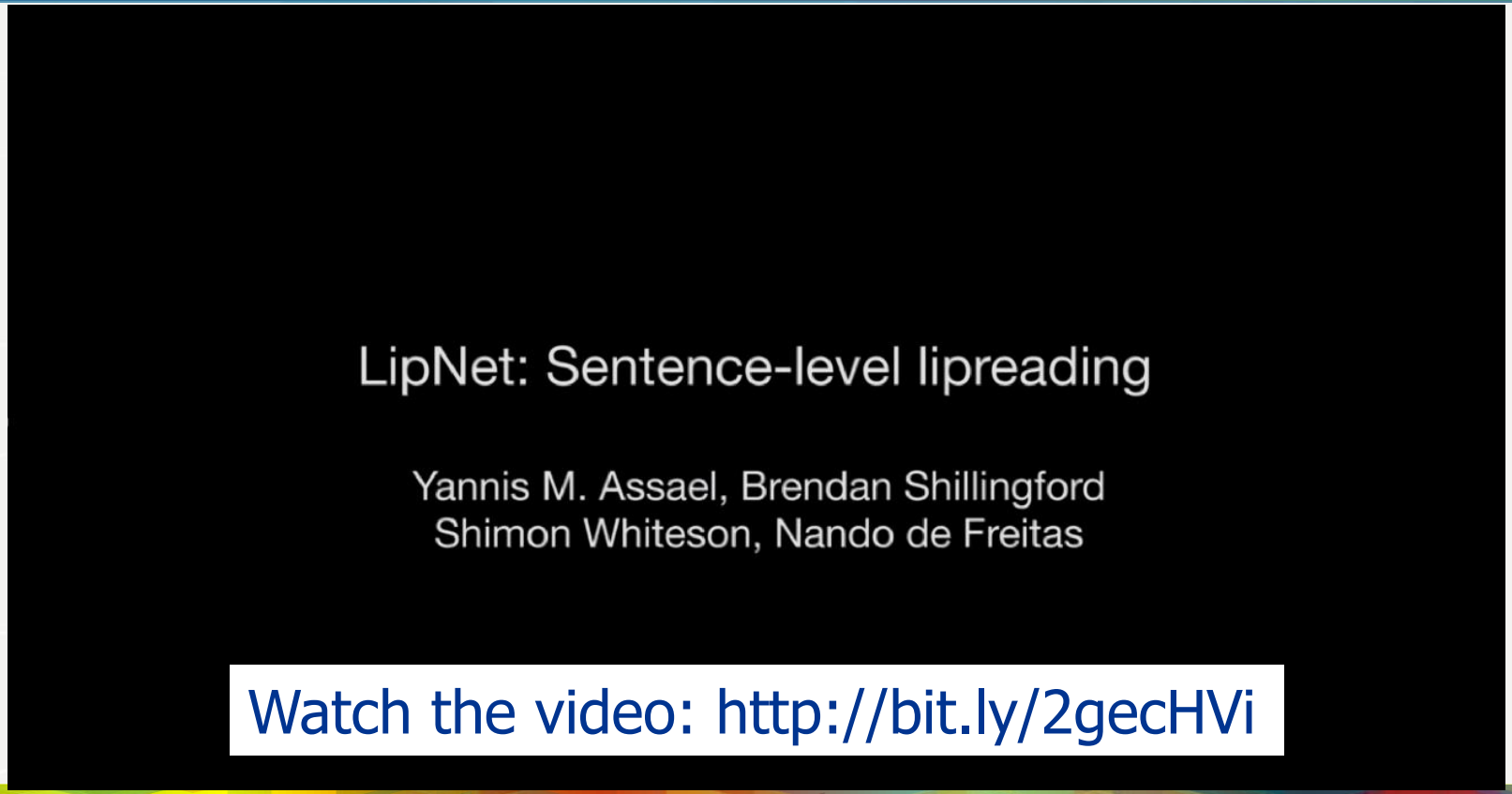


Esteva et al., *Nature* 2017



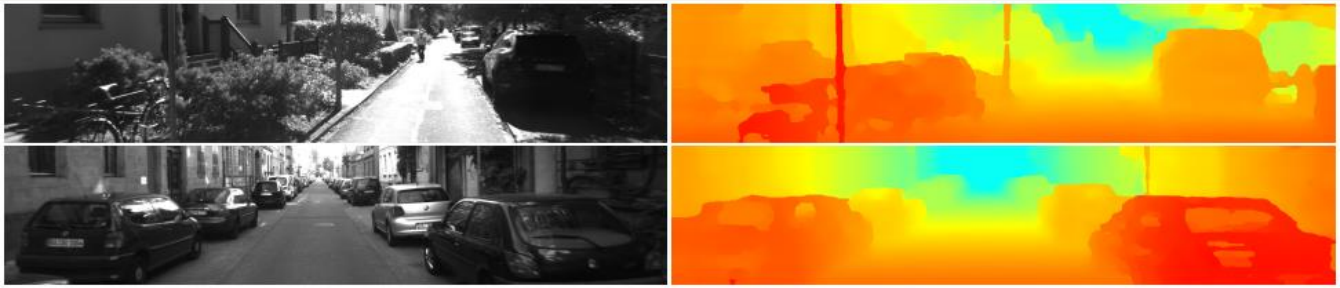
Taigman et al., CVPR 2014

Expanding Applicability of Deep Learning



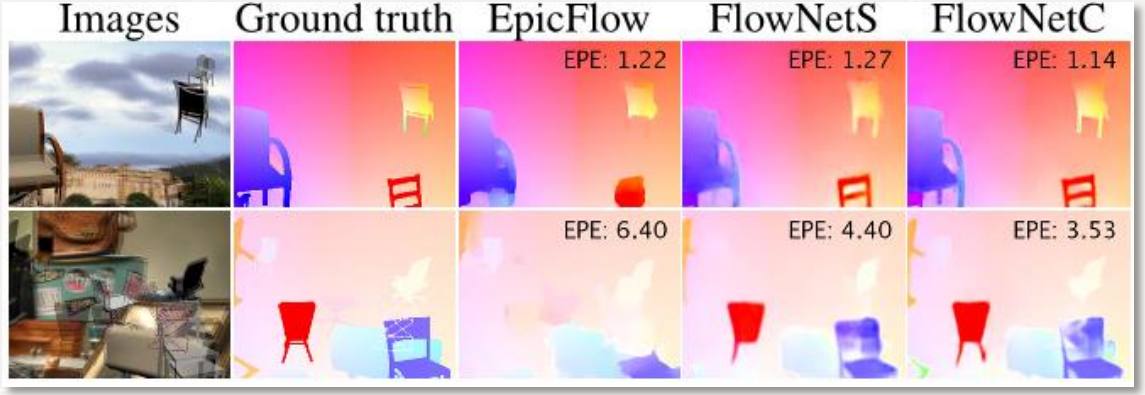
Watch the video: http://bit.ly/2gecHVi

Expanding Applicability of Deep Learning



Stereo Matching

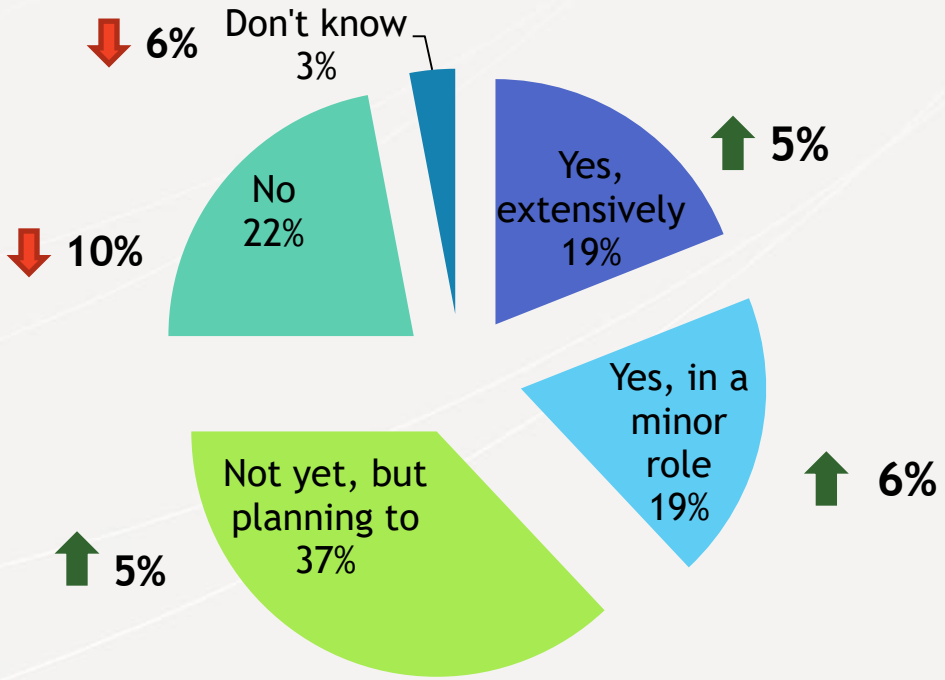
Zbontar and LeCun, CVPR 2015



Optical Flow

Dosovitskiy et al., ICCV 2015

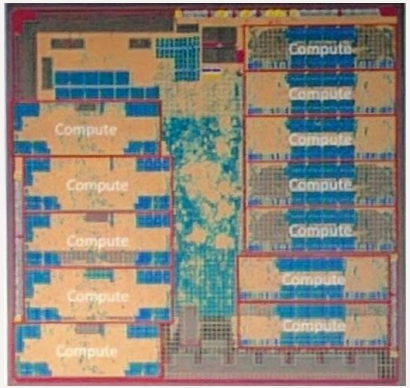
Use of Neural Networks for Vision Functions



Embedded Vision Alliance Developer Survey, July 2016

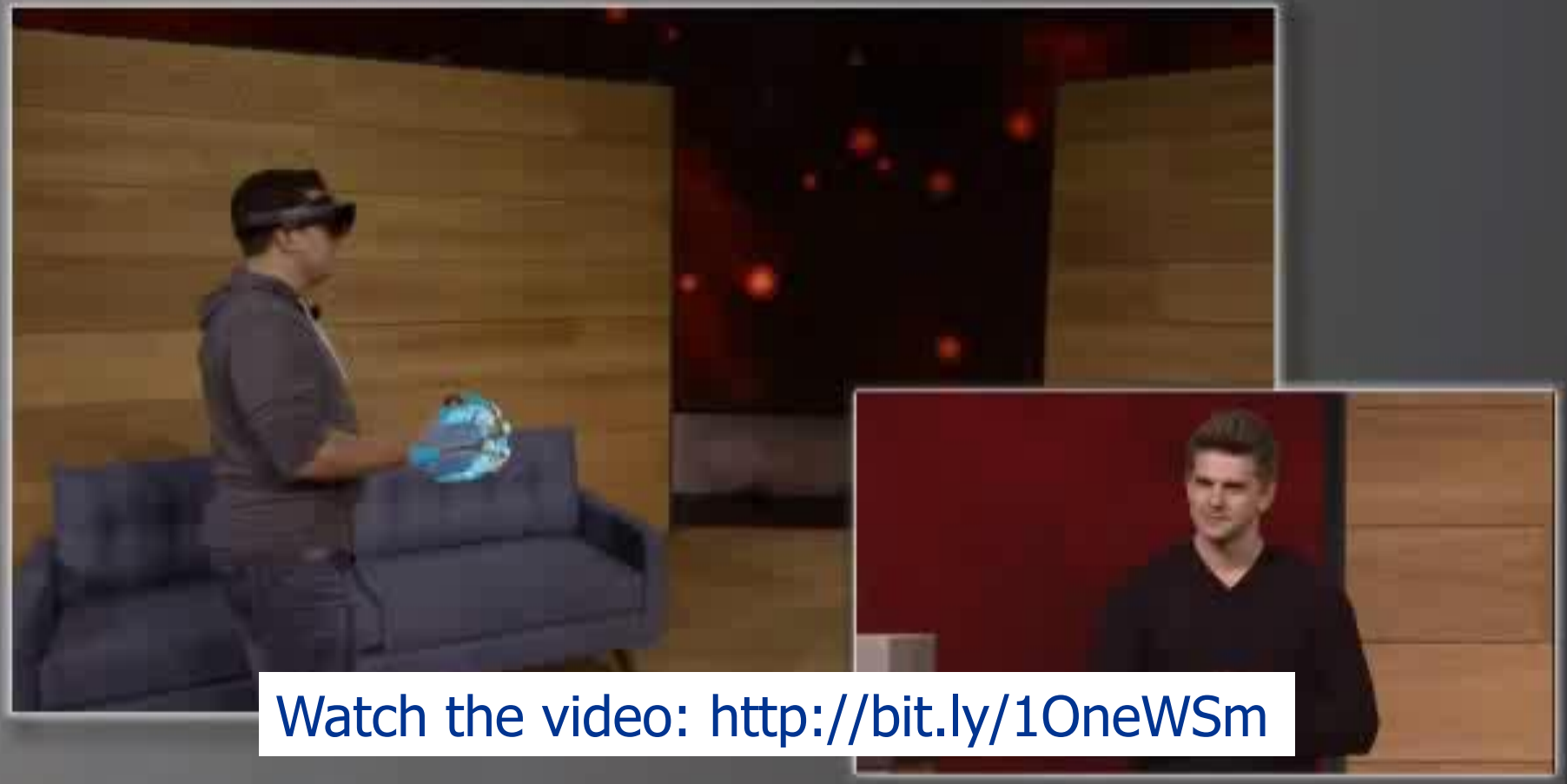
Showing results for end-product developers only

Maximizing Visual Perception per Watt: HoloLens

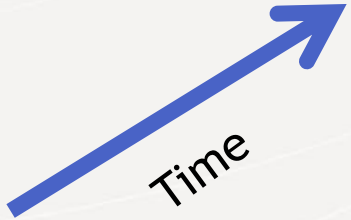


Microsoft

KitGuru


Watch the video: http://bit.ly/1OneWSm

Trend: Processors for Deep Learning



Dedicated Co-processor

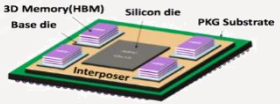
Architecture Focus

Architecture Enhancements

Software Packages/ Libraries, Frameworks

None

Google Tensor Processing Unit



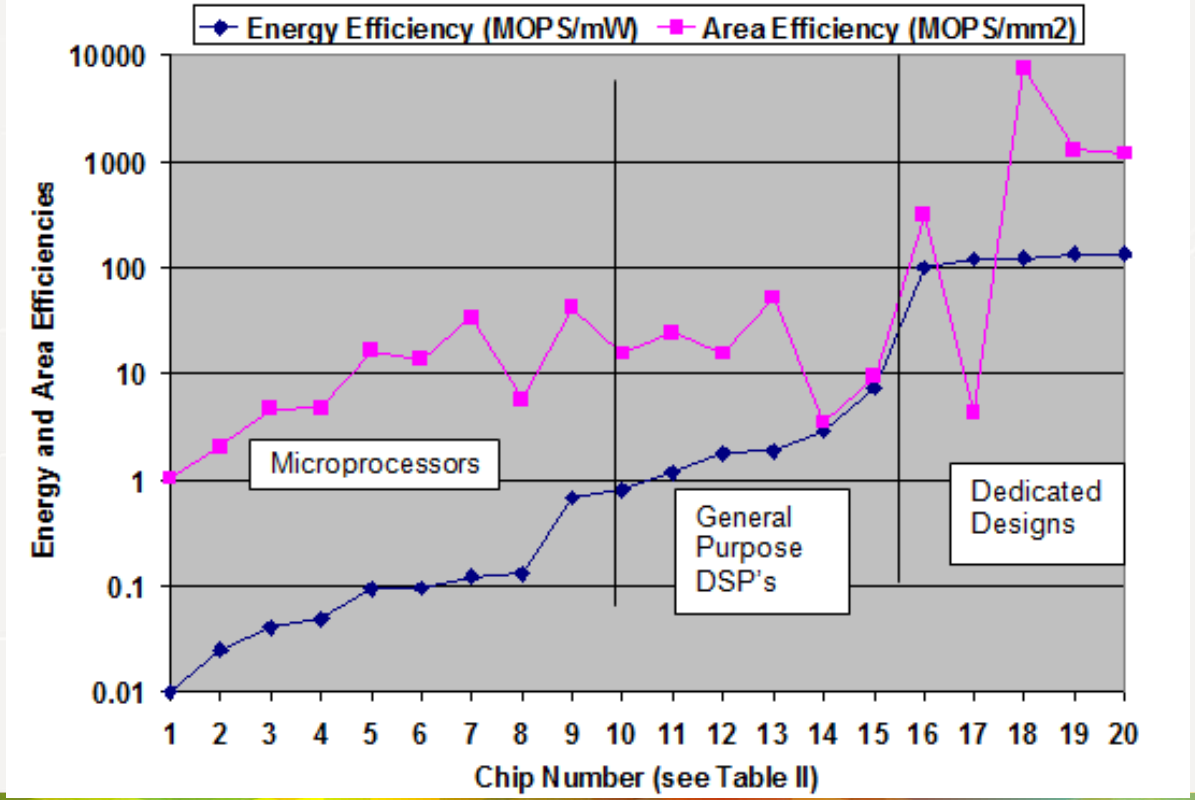
Nervana (now Intel)

Movidius (now Intel) Myriad 2

NVIDIA Tegra X1

Degree of Specialization

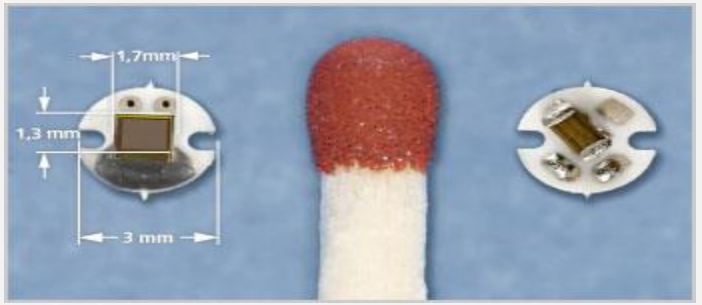
Architecture Specialization Drives Efficiency



Zhang and Brodersen, 2002

Sensor Innovation Accelerates

Edn-europe.com



ims—chips.de

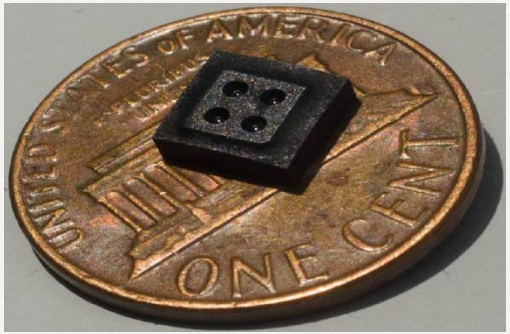
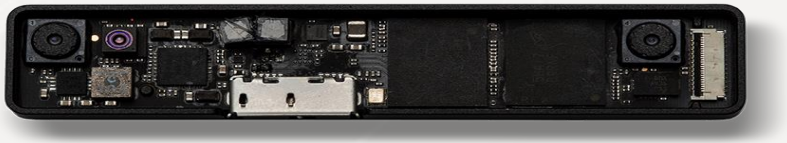


Image Sensors World

Chronocam

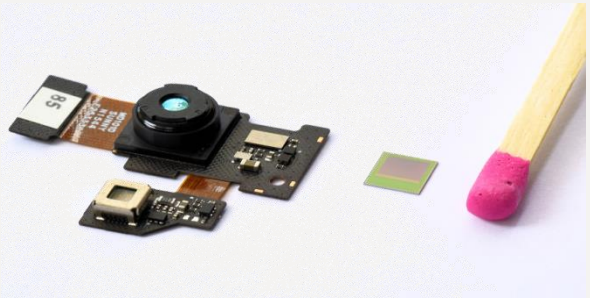
Proliferation of 3D Sensors

Photographylife.com



Inuitive-tech.com

Scandy.co



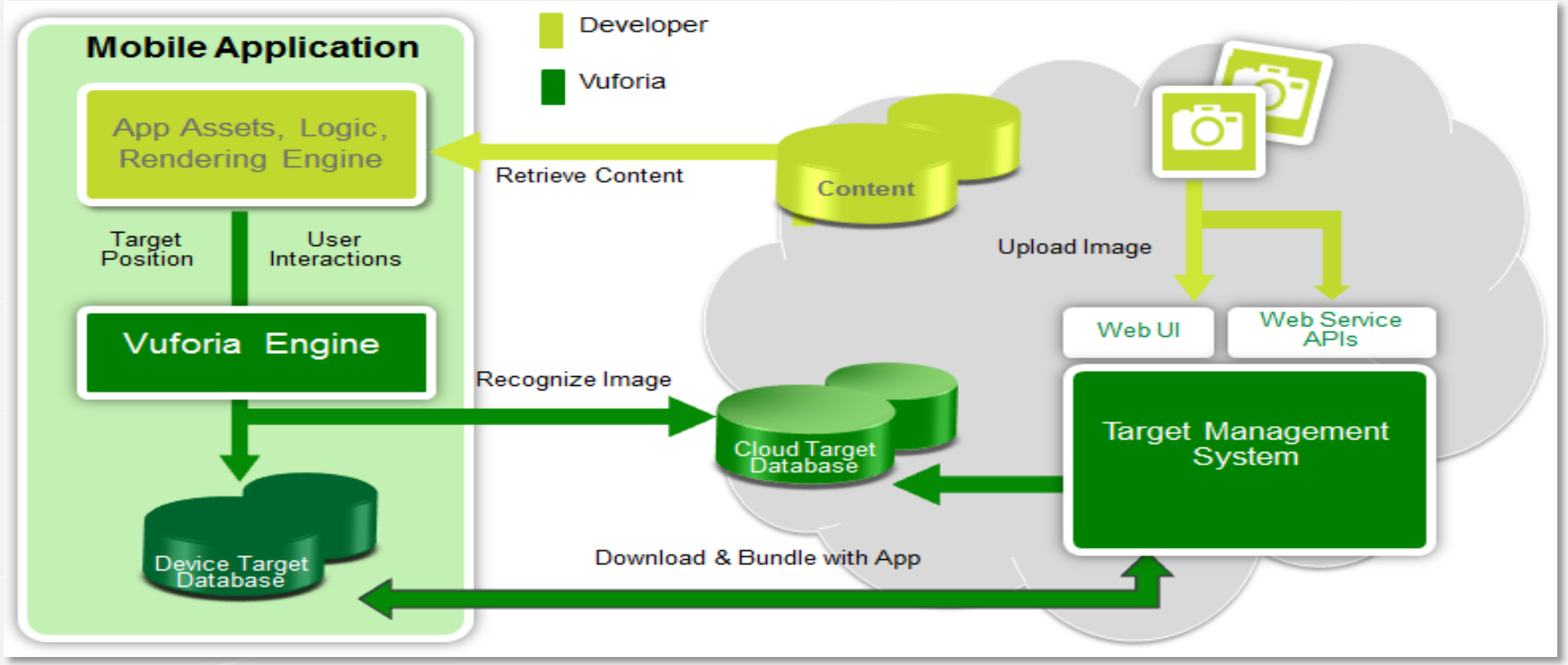
Infineon.com

Understanding our 3D World: DJI Phantom 4

Watch the video: http://bit.ly/1QqfVmh

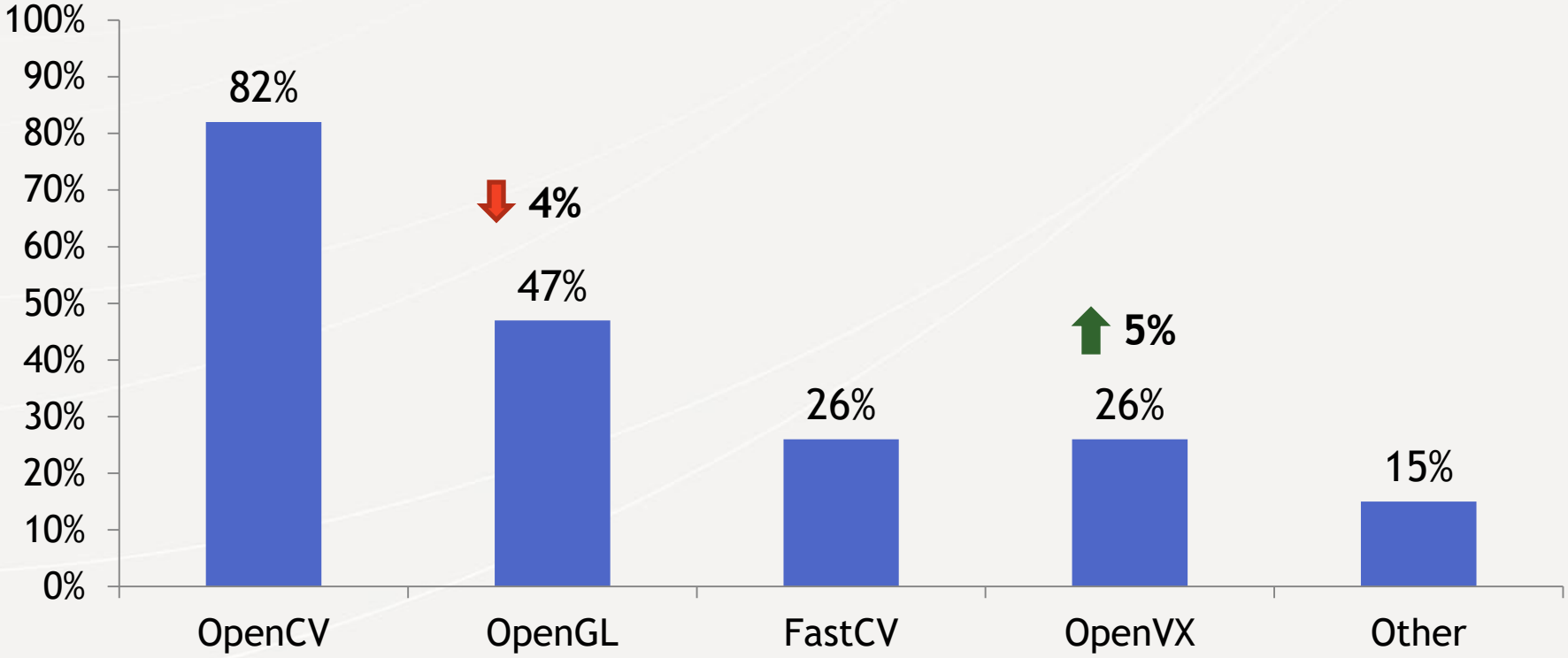
Digital Trends

Solution: Domain-specific Frameworks



Gravity Jack

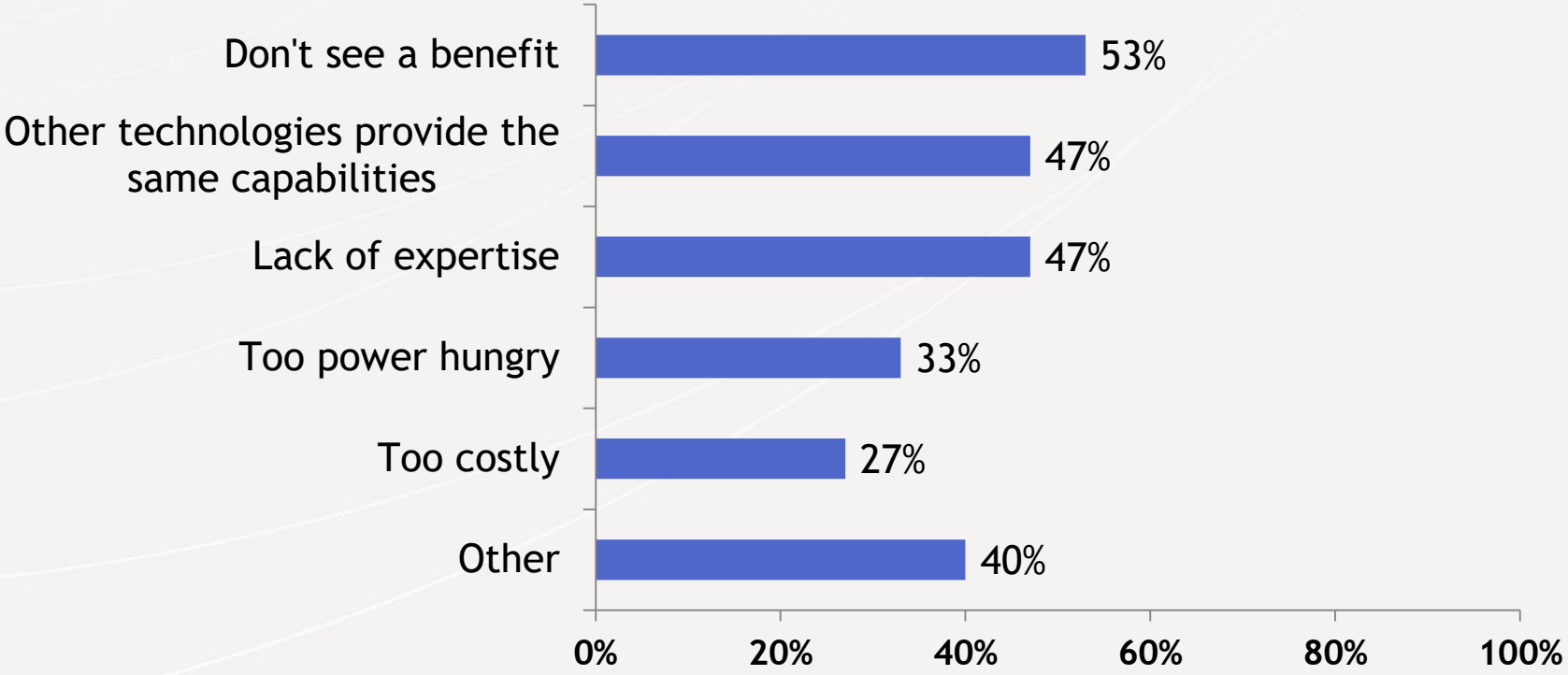
Libraries and APIs Used for Vision Tasks



Embedded Vision Alliance Developer Survey, July 2016

Showing results for end-product developers only

Reasons For Not Using Computer Vision



Embedded Vision Alliance Developer Survey, July 2016

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Empowering Product Creators to Harness Embedded Vision

The Embedded Vision Alliance (www.Embedded-Vision.com) is a partnership of 60+ leading embedded vision technology and services suppliers

Mission: Inspire and empower product creators to incorporate visual intelligence into their products

The Alliance provides low-cost, high-quality technical educational resources for engineers

- Alliance website offers tutorial articles, video "chalk talks," forums
- Embedded Vision Insights newsletter delivers news and updates

Register for updates at www.Embedded-Vision.com

Join us at the Embedded Vision Summit—May 1-3, 2017—Santa Clara, California

The only industry event focused on enabling developers to create "machines that see"

- *"Awesome! I was very inspired!"*
- *"Fantastic. Learned a lot and met great people."*
- *"Wonderful speakers and informative exhibits!"*

Embedded Vision Summit 2017 highlights:

- **Inspiring keynotes** by leading innovators
- Practical **technical, business and product talks**
- Exciting **demos** of the latest technologies

- *Visit www.EmbeddedVisionSummit.com for details*
- Register by February 8 using discount code **enns17**

Conclusions

- Embedded vision enables systems and apps to extract **meaning from visual inputs**
- **Embedded vision can be deployed widely,** thanks to improved processors, sensors, algorithms, tools, and engineering skills
- Deep **neural networks are transforming how we extract meaning from pixels**
- **Embedded vision enables a wide range of devices** to be:
  - More responsive
  - More personal and secure
  - Safer, more autonomous
  - Easier to use
- **Leverage the Embedded Vision Alliance** to accelerate your success in embedded vision
  - www.Embedded-Vision.com

Embedded Vision Alliance Member Companies

Questions?

Email me for:

- Links to more videos of cool embedded-vision-based products
- Discount code and any questions about the Embedded Vision Summit, May 1-3 in Santa Clara

Jeff Bier
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Chairman, Embedded Vision Summit
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