

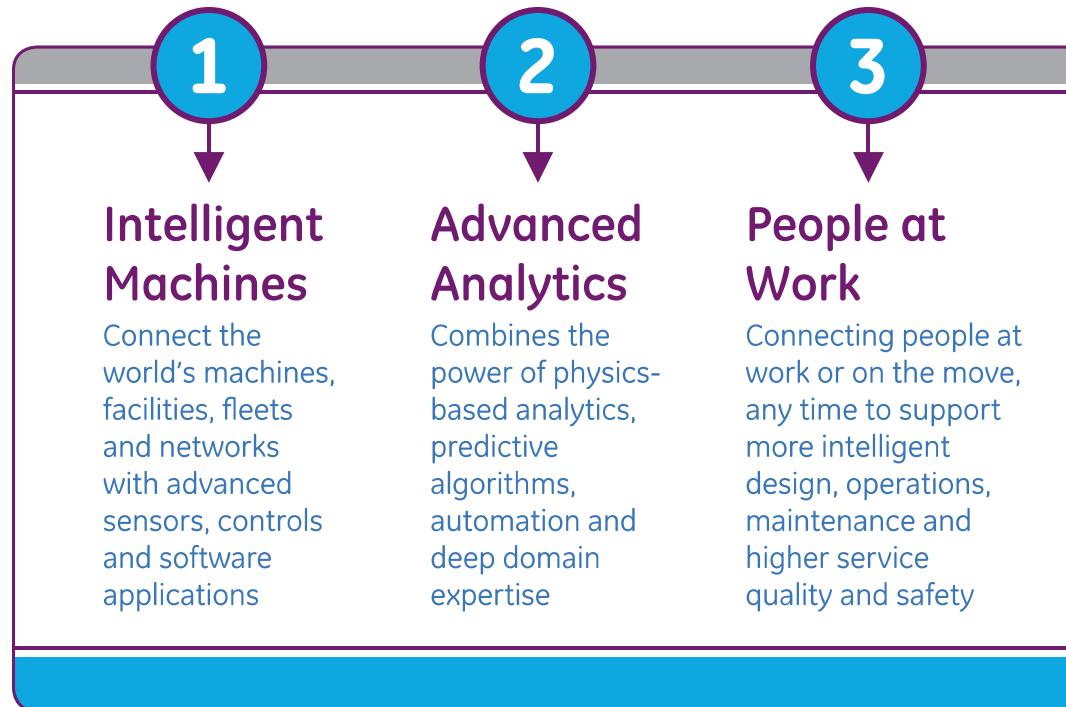


**Vision Everywhere:
How New Technology is Expanding
the Capabilities and Applications of
“Machines that See”**

Vincent Ratford
Executive Director
Embedded Vision Alliance

#TheVisionShow

The Industrial Internet



Source: GE

Embedded Vision is a key enabler

Partnerships Are Key

If the Industrial Internet were a baseball game, we would just now be picking teams

Foxconn Is Quietly Working With Google on Robotics"

The Wall Street Journal

GE partners with AT&T, Cisco, Intel for 'Industrial Internet'"

Reuters

Germany Eyes New Internet Industrial Revolution"

phys.org

Cisco Sees SDN, Internet of Things in Its 2014 Crystal Ball"

Computerworld India

How Building a Smarter Planet Could Send IBM Soaring"

Motley Fool

Source: Sight Machine

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Empowering Product Creators to Harness Embedded Vision

The Embedded Vision Alliance (www.Embedded-Vision.com) is a partnership of 35 leading embedded vision technology and services suppliers



Mission: Inspire and empower product creators (including mobile app developers) to incorporate visual intelligence into their products

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

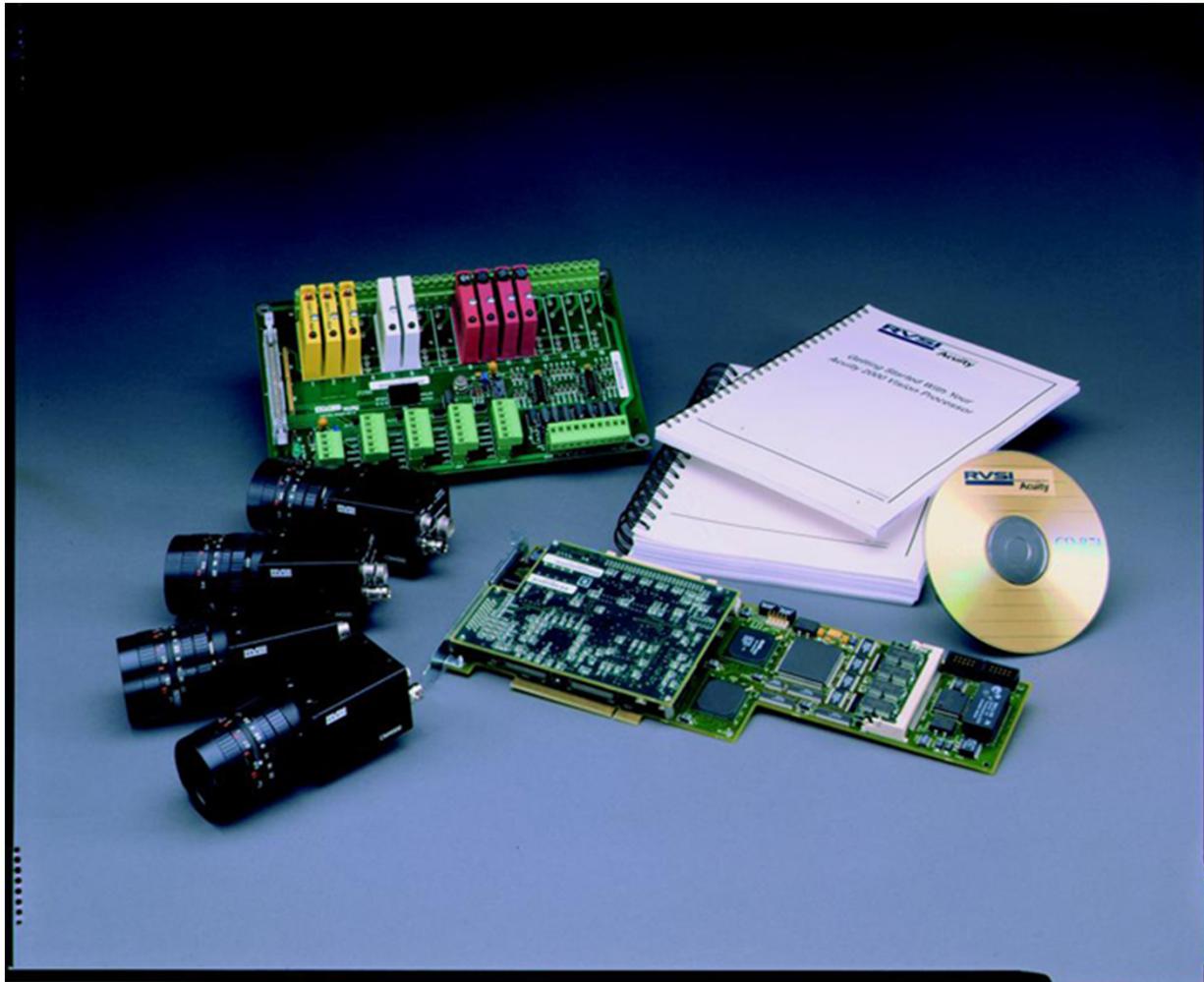
- The Alliance website offers in-depth tutorial articles, video “chalk talks,” code examples, tools and discussion forums
- The *Embedded Vision Insights* newsletter delivers news, Alliance updates and new resources
- Embedded Vision Summit conferences provide classroom and hands-on learning, exciting demos and keynotes, and unique networking opportunities



Embedded Vision Alliance



Computer Vision -> Machine Vision



Source: MICROSCAN

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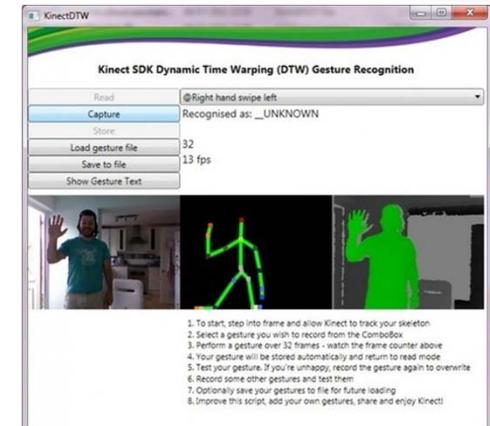
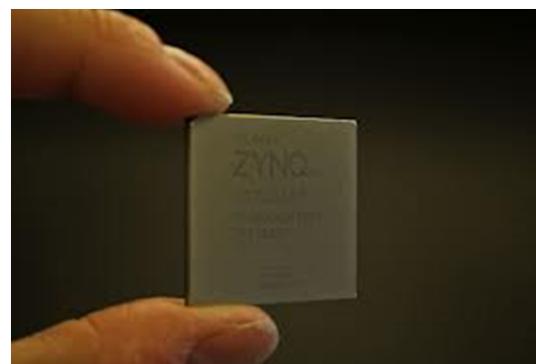
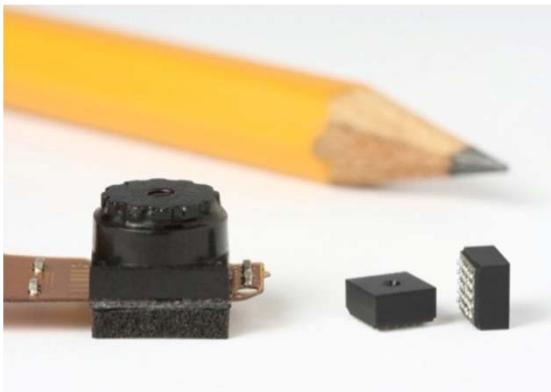
Machine Vision -> Embedded Vision



Source: National Instruments

Why is Embedded Vision Proliferating Now?

- Hardware: Heterogeneous multi-core processors, sensors
- Software: tools, algorithms, libraries, APIs
- Smaller, cheaper, lower power
- Easier to use
- Standards



What Does Embedded Vision Enable?

Embedded vision upgrades what machines know about the physical world, and how they interact with it

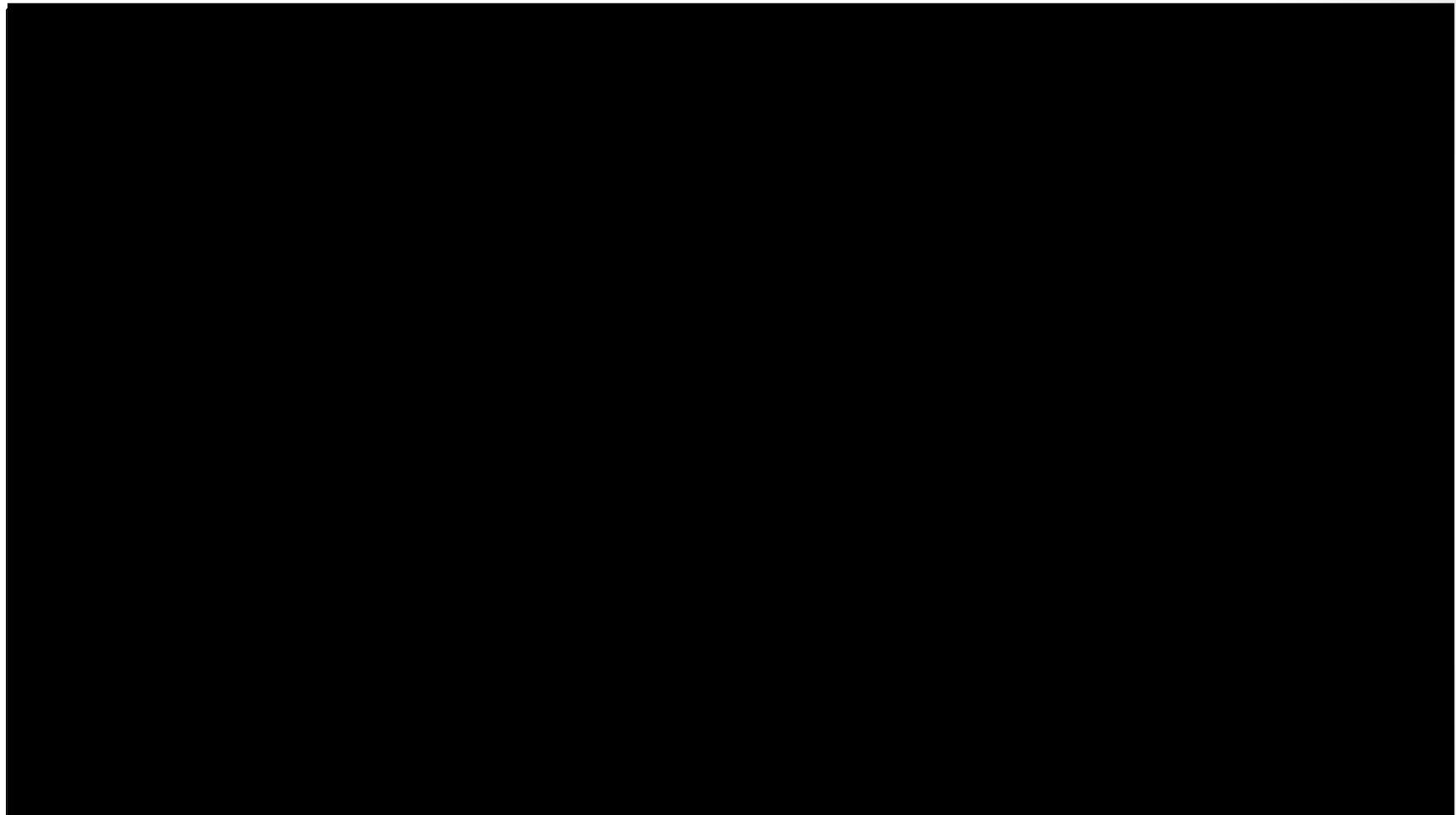
This enables dramatic improvements in existing products—and creation of new types of products



Embedded vision can:

- **Boost efficiency:** Improving throughput and quality
- **Enhance safety:** Detecting danger and preventing accidents
- **Simplify usability:** Making the “user interface” disappear
- **Fuel innovation:** Enabling us to do things that were impossible

Augmenting Human Capabilities: OrCam Visual Interpreter for the Sight Impaired



www.youtube.com/watch?v=ykDDxWbt5Nw

Supplementing Human Vision: Mercedes Benz Automotive Safety



<http://www.youtube.com/watch?v=WGqSyA8HXyY>

Augmented Reality Grows Up

www.youtube.com/watch?v=n-3K2FVwkVA

Augmented Reality Finds a Market: IKEA Catalog



www.youtube.com/watch?v=DhbHnec4se0

Exceeding Human Capabilities: Reading Heart Rate

PHILIPS

www.youtube.com/watch?v=2M7AFoqJyDI

Embedded Vision Markets

Established (or rapidly growing) embedded vision markets:

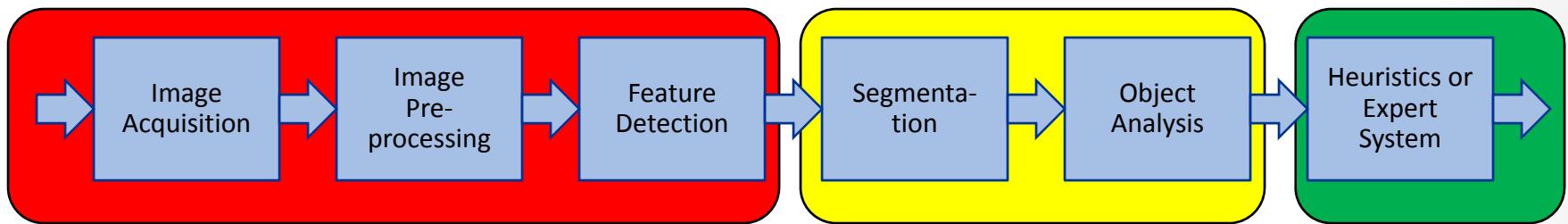
- Factory automation
- Agriculture
- Video game consoles
- Military
- Automotive safety
- Augmented reality for retail
(in store, at home, mobile)
- Public safety and security

Emerging embedded vision markets:

- Building automation
- Toys and games
- User interfaces (mobile devices, cars, consumer electronics)
- Robots for many uses and settings
- Education
- Clinical and home health care
- Field service (e.g., equipment repair)
- Aids for the visually impaired

How Does Embedded Vision Work?

A typical embedded vision pipeline:



Typical total compute load: ~10-100 billion operations/second

Loads can vary dramatically with pixel rate and algorithm complexity

Example: Lane Marking Detection

Original image



Edges detected



Lines detected



Lane markings detected

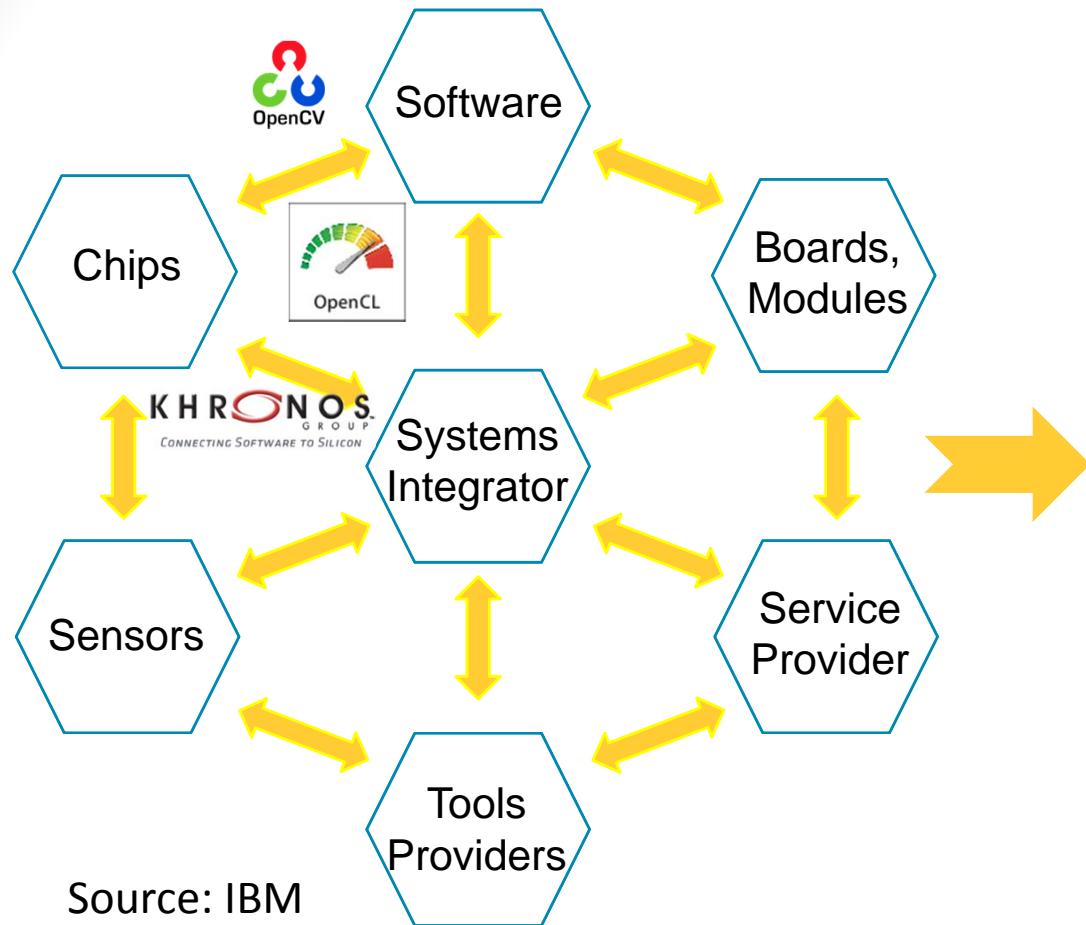


What Makes Embedded Vision Hard?

- Infinitely varying inputs in many applications: uncontrolled lighting, orientation, motion, occlusion
- Complex, multi-layered algorithms
- Lack of analytical models means exhaustive experimentation is required
- Numerous algorithms and algorithm parameters to choose from
- Most vision applications involve high data rates and complex algorithms → high computation requirements
- For vision to be widely deployed, it must be implemented in many designs that are constrained in cost, size, and power consumption
- Most product creators lack experience with embedded vision



An Ecosystem Model for the Industrial Internet



Source: Vision Robotics

How do I incorporate Embedded Vision ?

Embedded Vision Summits—

The only industry events focused on enabling engineers to create “machines that see”

Attendees say:

“Awesome!” “Outstanding. Wish there was more!”

“Good balance of technical content and application-driven examples.”



2014 Embedded Vision Summit West—May 29th

- Santa Clara Convention Center, co-located with Augmented World Expo
- Two tracks, organized around themes of **Recognition** and **Autonomy**
 - Keynotes by Yann LeCun, Facebook & Nathaniel Fairfield, Google
- Technology demos in the Technology Showcase
- Interaction with experts





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