



Implementing Embedded Vision: Designing Systems That See and Understand Their Environments

Day 1: What Can You Do with Embedded Vision?

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Objectives of This Presentation

- Introduce embedded vision
- Explore representative functionality and applications
- Introduce the week-long Design News Continuing Education Center course, “Implementing Embedded Vision: Designing Systems That See and Understand Their Environments”

What is Computer Vision?

“Computer vision is the science and technology of **machines that see**, where ‘see’ means that the machine is able to **extract information from an image** that is necessary to solve some task.”

– Adapted from en.wikipedia.org/wiki/Computer_vision

Computer vision is distinct from other types of video and image processing: it involves **extracting meaning** from visual inputs.

“Half of the human brain is devoted directly or indirectly to vision.”

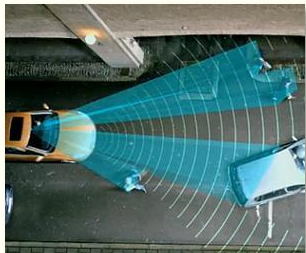
– Paraphrased from Prof. Mriganka Sur, MIT

Welcome to the Era of *Embedded Vision*

“Embedded vision” refers to the incorporation of computer vision into a wide range of products and applications

- Industrial, automotive, medical, defense, retail, gaming, consumer electronics, security, education, ...

Computer/embedded vision are not new; widespread deployment is

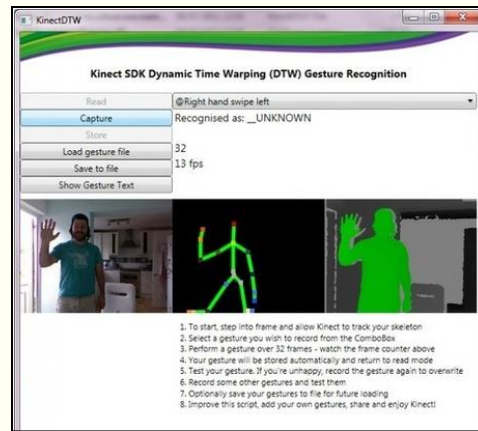
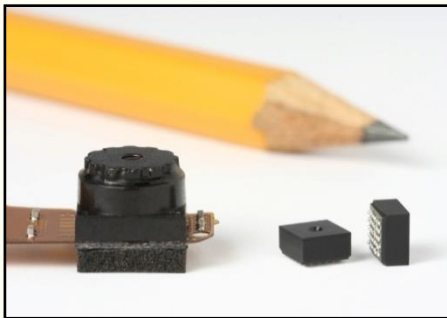


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Embedded Vision is Brought to You By...

The proliferation of embedded vision is enabled by:

- Hardware: processors, sensors, etc.
- Software: Tools, algorithms, libraries, APIs



Embedded Vision Delivers Compelling Benefits in Many Applications

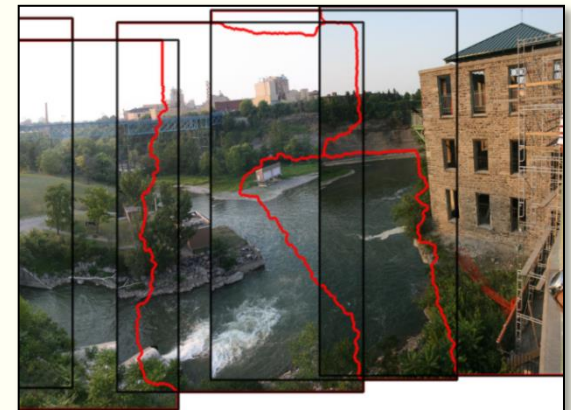
Embedded vision upgrades what machines know about the physical world, and how they interact with it...

... enabling dramatic improvements in existing products—and creation of new types of products

In virtually every industry, 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

Example Applications



What is a “Gesture”?



Implementing Embedded Vision is Challenging

- It's a whole-system problem
- There is limited experience in building practical solutions
- Embedded systems are often highly constrained in cost, size, and power consumption
- It's very computationally demanding
 - E.g., a 720p optical flow algorithm, optimized for a modern VLIW DSP architecture, consumed about 200 MHz/frame/second → 5 fps @ 1 GHz
 - Many vision functions will require highly parallel or specialized hardware
 - Algorithms are diverse and dynamic, so fixed-function compute engines are less attractive

Conclusions

To date, embedded computer vision has largely been limited to low-profile applications like surveillance and industrial inspection

Thanks to the emergence of high-performance, low-cost, energy efficient programmable processors, this is changing

Embedded vision upgrades what machines know about the physical world, and how they interact with it, enabling dramatic improvements in existing products—and creation of new types of products

But implementing embedded vision applications is challenging, and most engineers who could benefit from embedded vision don't have expertise in it

Next Up

Throughout this week, we'll explore embedded vision implementation from a number of different perspectives.

Each day we'll have a different hand-picked, world-class presenter.

- March 19: ***Interfacing to and Processing Data from Image Sensors*** (José Alvarez, Xilinx)
- March 20: ***Improving Image Understanding by Improving Image Quality*** (Michael Tusch, Apical)
- March 21: ***When to Use FPGAs to Accelerate Embedded Vision Applications*** (Daniel Wilding, National Instruments)
- March 22: ***Developing Low-Cost, Low-Power, Small Vision Systems*** (Simon Morris, CogniVue)



RESOURCES



The Embedded Vision Alliance

Free Resources on Embedded Computer Vision

The Embedded Vision Alliance web site, at www.Embedded-Vision.com, provides free, high-quality technical educational resources for engineers

Register on the Alliance web site for free access to:

- The Embedded Vision Academy—in-depth tutorial articles, video “chalk talks,” code examples, and discussion forums.
- Embedded Vision Insights—bimonthly newsletter with industry news and updates on new resources available on the Alliance website.

Embedded vision technology and services companies interested in becoming sponsoring members of the Alliance may contact info@Embedded-Vision.com



Embedded Vision Insights
The Latest Developments on Designing Machines that See

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Embedded Vision Summit

A Free Educational Event for Engineers—San Jose, April 25th

Learn how to use the hottest new technology in the industry to create “machines that see”

- Technical presentations on sensors, processors, tools, and design techniques
- Keynote by Prof. Pieter Abbeel, UC Berkeley, a leader in developing machine intelligence
- Cool demonstrations and opportunities to meet with leading vision technology suppliers



Co-located with UBM Electronics' DESIGN West

- DESIGN West also includes the Embedded Systems Conference, Black Hat Summit, and exhibits

The Summit is free, but space is limited. To register to attend, go to www.embedded-vision.com/embedded-vision-summit

Additional Resources

See our related Design News CEC course archive from September 2012:

http://www.designnews.com/lecture.asp?doc_id=248898



BDTI's web site, www.BDTI.com, provides a variety of free information on processors used in vision applications.



BDTI's free "InsideDSP" email newsletter covers tools, chips, and other technologies for embedded vision and other DSP applications. Sign up at www.BDTI.com.

