What Can You Do With Embedded Vision?

Jeff Bier, Founder, Embedded Vision Alliance / President, BDTI

Embedded Vision Summit, October 2, 2013

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

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

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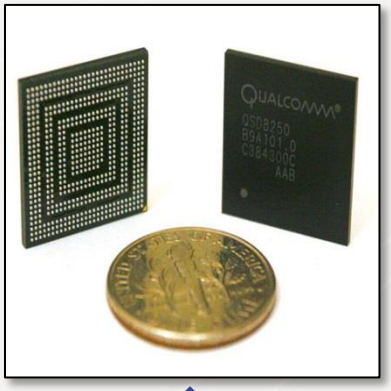
Embedded Vision:
The Software-Defined Sensor



?

```
// convert cpu Mat to gpu array
void mat_to_array(cv::Mat& input, array& output) {
    input.convertTo(input, CV_32FC3); // floating point
    const unsigned size = input.rows * input.cols;
    const unsigned w = input.cols;
    const unsigned h = input.rows;
    float r[size];
    float g[size];
    float b[size];
    int tmp = 0;
    for (unsigned i = 0; i < h; i++) {
        for (unsigned j = 0; j < w; j++) {
            Vec3f ip = input.at<Vec3f>(i, j);
            tmp = j * h + i; // convert to column major
            r[tmp] = ip[2];
            g[tmp] = ip[1];
            b[tmp] = ip[0];
        }
    }
    output = join(2,
                  array(h, w, r),
                  array(h, w, g),
                  array(h, w, b))/255.f; // merge, set range [0-1]
}
```

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Example Embedded Vision Application Areas

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)

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Augmenting Human Capabilities: OrCam Visual Interpreter for the Sight Impaired

www.youtube.com/watch?v=ykDDxWbt5Nw

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Supplementing Human Vision: Mercedes Benz Automotive Safety

www.youtube.com/watch?v=5XXypu3dVPM

Relieving Humans of Tedious Tasks: Mercedes Self-Driving Car Prototype

www.youtube.com/watch?v=CKqJccK_EkM

Exceeding Human Capabilities: Reading Heart Rate

PHILIPS

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

Augmented Reality Finds a Market: IKEA Catalog

www.youtube.com/watch?v=DhbHnec4se0

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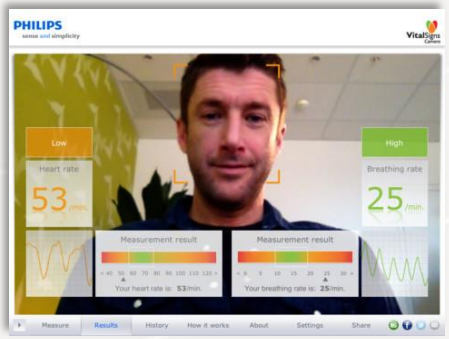
Smartphones and Tablets Lead the Way

In smartphones and tablets, vision enables natural user interfaces, computational photography, augmented reality and other novel functions

Mobile processor suppliers are investing to enable vision

- E.g., Qualcomm Vuforia and FastCV, NVIDIA TDP and OpenCV
- Enabling offload of vision processing to GPU, DSP, etc.



itunes.apple.com

nocamels.com

edudemic.com

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Who Cares About Mobile Computer Vision?

- Advertisers, retailers and publishers, because it enables enhanced customer engagement
- Consumers and app developers, because it provides ease of use, impressive new capabilities, and fun
- OEMs, processor vendors, and network operators, because they must differentiate increasingly commoditized products
- Embedded systems developers, who are increasingly borrowing mobile technology

www.digitaltrends.com

www.wantchinatimes.com

www.fingerfood.5thfinger.com

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Next: Create Something!

What's your next embedded vision product?

- A smarter _____?
- A safer _____?
- A more efficient _____?
- An easier to use _____?
- A more responsive _____?
- A more entertaining _____?
- The first _____?

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Helping Product Creators 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 free, high-quality technical educational resources for engineers

- The Embedded Vision Academy 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

Companies interested in becoming sponsoring members of the Alliance should contact info@Embedded-Vision.com

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

Smartphones and tablets are an important part of this trend

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

The Embedded Vision Alliance provides a wide range of resources to help product creators incorporate visual intelligence into their products

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Thank You

Visit us at www.Embedded-Vision.com

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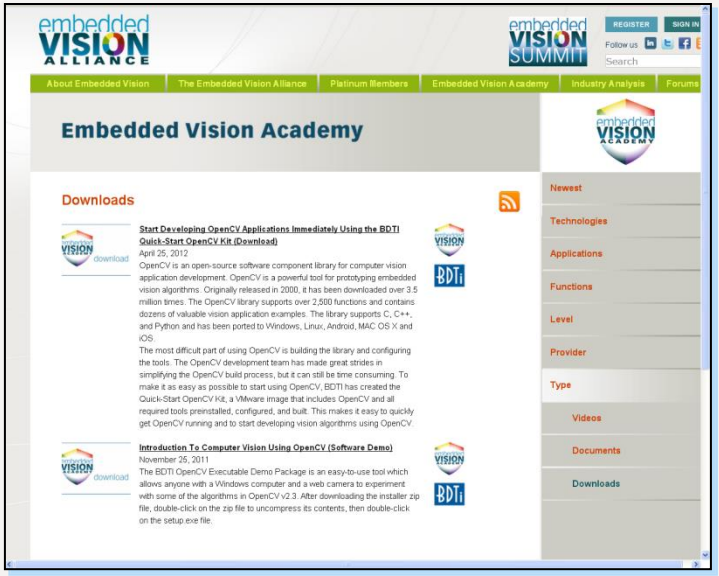
Resources

- Eye-Catching Vision Video Clips: http://www.embedded-vision.com/eye-catching-embedded-vision-clips
- Embedded Vision Alliance News Stream: http://www.embedded-vision.com/news
- BDTI OpenCV Executable Demo Package—No programming required: www.embeddedvisionacademy.com/opencvdemo
- BDTI Quick-Start OpenCV Kit: www.embeddedvisionacademy.com/opencvkit



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