



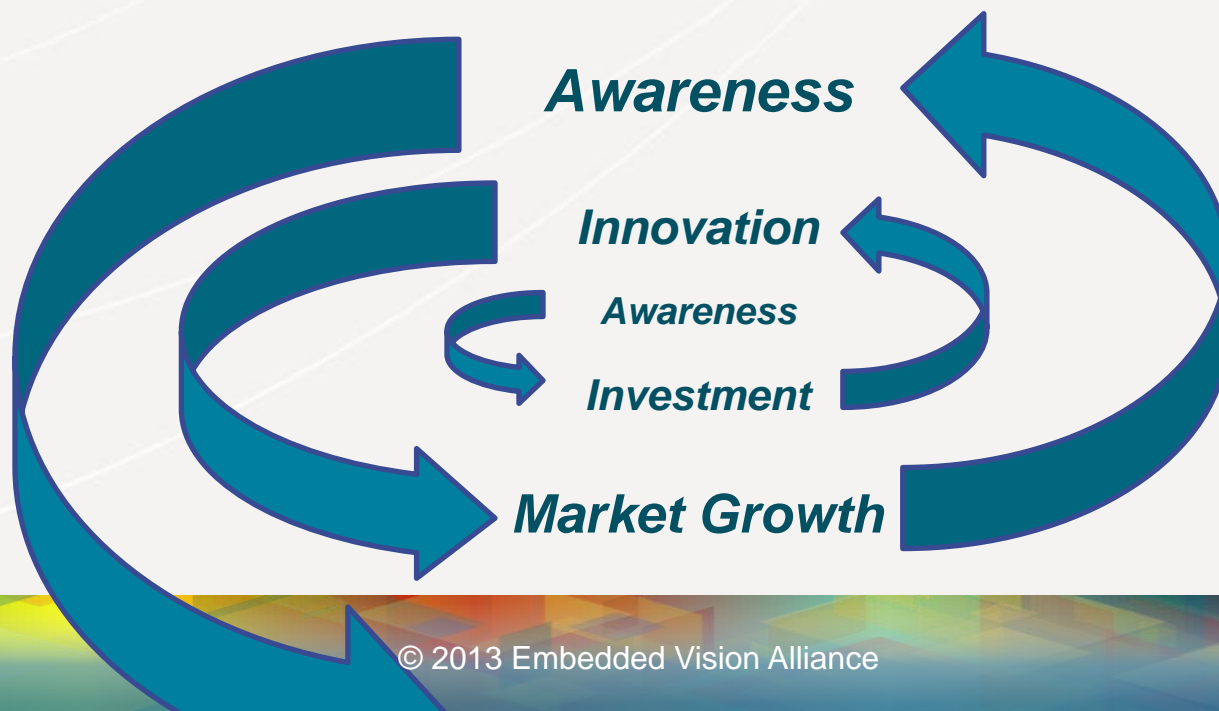
Development and Deployment of Embedded Vision in Industry: An Update

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

NIWeek—August 7, 2013

“Computer vision” is crossing the chasm from expensive niche technology to become “embedded vision,” a ubiquitous technology

- Successful deployments in diverse markets: healthcare, automotive, entertainment, education, industrial, retail, consumer, security, ...
- Using varied system architectures: embedded systems, smartphones and tablets, PCs, the cloud



- The big picture
- “Savior” apps
- Advances in enabling technology
- Smartphones and tablets lead the way
- Public awareness
- Industry awareness
- Regulation
- Supplier ecosystem challenges
- Impact on scientific and engineering applications

Beyond established niches in factory automation, military, and security, new vision markets are attaining commercial significance:

- **Automotive Safety:** forward collision avoidance, lane keeping, etc.
 - IMS Research predicts annual revenue growth of 6-9% for vision processors in under-the-hood automotive applications, reaching \$187 million worldwide by 2016
- **Gaming**
 - Over 24 million Microsoft Kinect units sold (> \$1 billion revenue)
 - The next-generation Xbox One console requires the new Kinect
- **Augmented Reality** (especially on mobile devices)
 - Several mobile AR apps have exceeded 1 million downloads
 - SmarTech Publishing forecasts that augmented-reality-related retail and promotional activities will generate \$300 million by 2017

Mercedes Benz 2013 A Class



<http://www.youtube.com/watch?v=WGgSyA8HXyY>

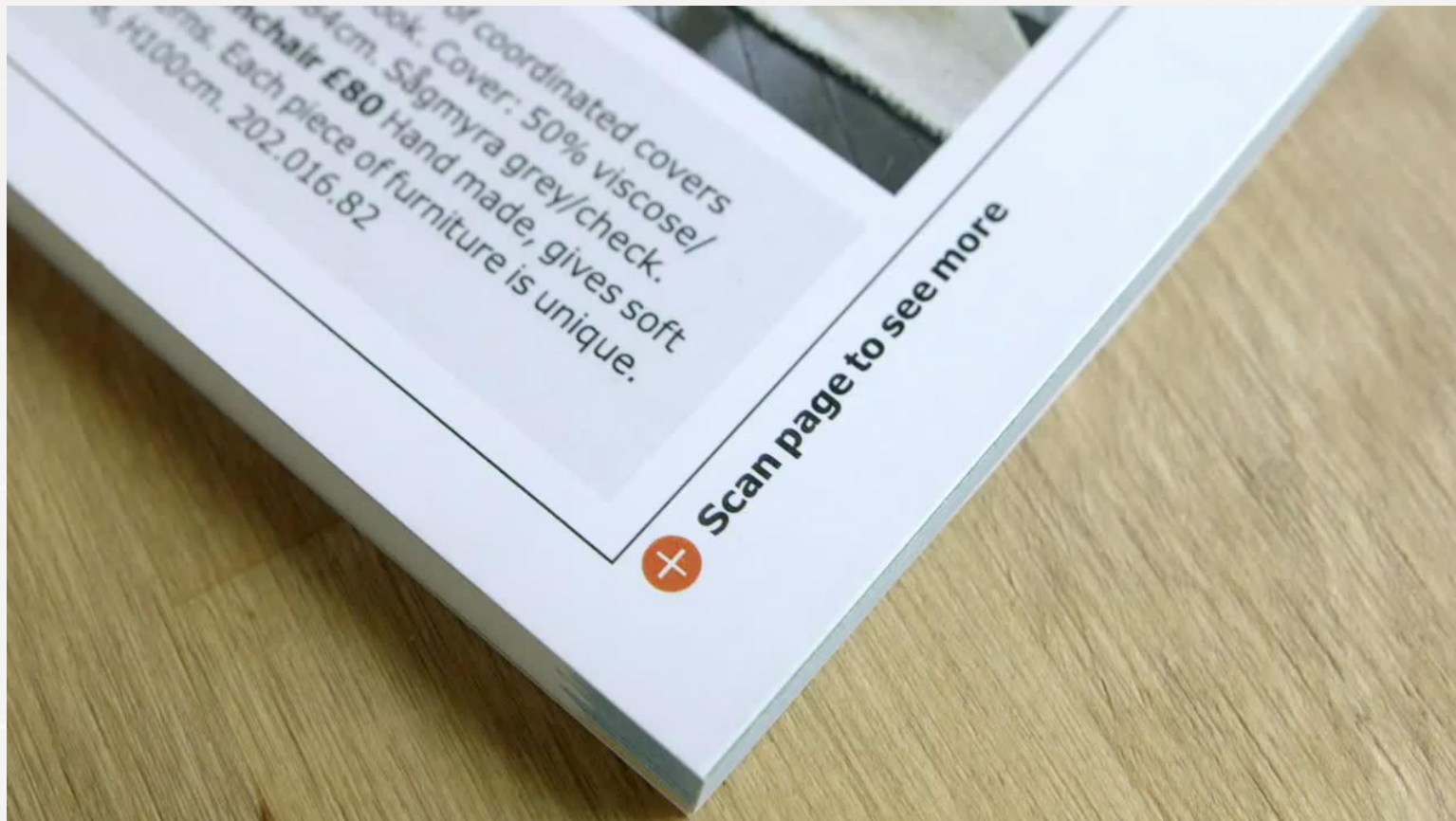
A Seminal Embedded Vision Product: Kinect

The Microsoft Kinect has brought vision to 20 million living rooms.



www.youtube.com/watch?v=DyLWGGKiNLRy

What would it look like if... ?



www.youtube.com/watch?v=dwt-mgxq_ao

Established Markets:

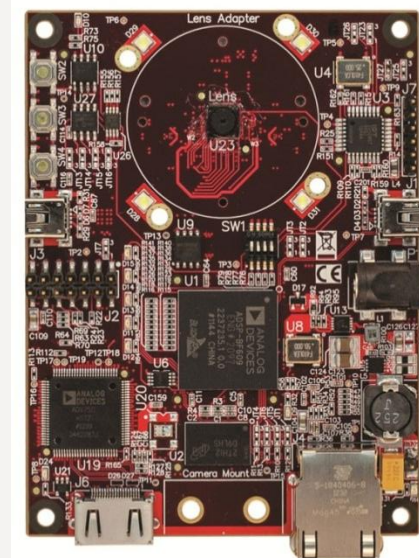
- **Manufacturing:** inspection, motion control (already a \$3 billion industry)
- **Military:** security, surveillance, target tracking

Emerging Markets:

- **Retail:** visual search, augmented reality kiosks, interactive digital signs
- **Health care:** surgical robots, home health monitoring
- **Consumer electronics:** natural user interfaces, personal robots
- **Transportation and other infrastructure:** safety, security, congestion

To enable ubiquitous embedded vision, enabling technologies must be robust, inexpensive, small, energy efficient—and easy to use

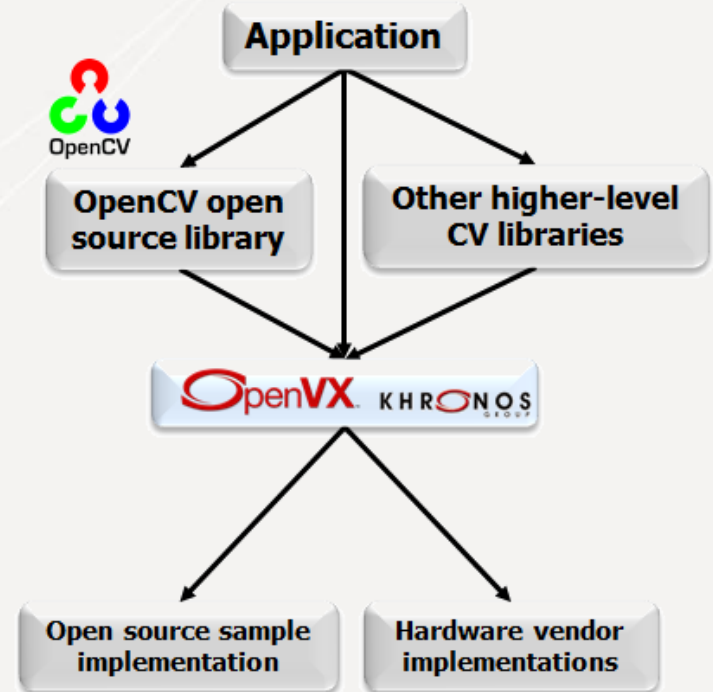
- Vision-specific **processors**: e.g., CogniVue, CEVA, Tensilica, TI, STMicro, Renesas, Toshiba, Imagination Technologies
- Vision-specific embedded **development kits**: e.g., Analog Devices/Avnet, Xilinx, Raspberry Pi
- Low-cost **3D sensors**: e.g., SoftKinetic, PrimeSense, PMD Tech, Leap Motion
- Vision-specific **software libraries, frameworks, tools, etc.**: e.g., OpenCV, Vuforia, FastCV, LabVIEW Vision, Perceptual Computing SDK
- Vision-oriented **standards**: e.g., Khronos OpenVX



OpenVX

- **Vision Hardware Acceleration Layer**
 - Enables hardware vendors to implement accelerated imaging and vision algorithms
 - For use by high-level libraries or apps
- **Focus on enabling real-time vision**
 - On mobile and embedded systems
- **Diversity of *efficient* implementations**
 - From programmable processors, through GPUS to dedicated hardware pipelines

Dedicated hardware can help make vision processing performant and low-power enough for pervasive 'always-on' use



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

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 (as they have borrowed PC technology in the past)



www.digitaltrends.com

Smartlones: Chinese consumers perplexed by similar smartphones

Staff Reporter | 2011-06-09 | 14:26 (GMT+8)



www.wantchinatimes.com



www.fingerfood.5thfinger.com

Thanks to the success of the Kinect, vision-based mobile apps, and automotive safety systems, consumers are increasingly aware of embedded vision technology...
... in both positive and negative ways

Mandatory Kinect on Xbox One raises privacy concerns

By Christopher Grant on Jun 07, 2013 at 11:25p @chrisgrant

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16 DAYS AGO

KINECT ON XBOX ONE WILL UPLOAD YOUR CONVERSATIONS

WRITTEN BY Michael McWhorter on June 06, 2013

Xbox One's Kinect camera and microphone conversations, Microsoft says in a new

The Video Tech That Helped Find The Boston Bombing Suspects

Software that spots colored cars and hats, and even specific the ages and genders, helps analysts comb through hours of surveillance footage.

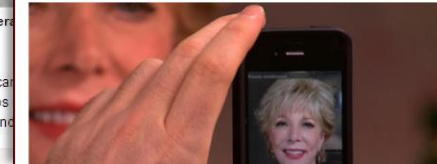
By Francie Diep Posted 04.19.2013 at 1:00 pm 6 Comments



One of the Boston bombing suspects, from a video the Federal Bureau of Investigation released yesterday

Three days after the Boston Marathon bombings, a security camera caught a man robbing a 7-11. Law enforcement recognized him from photos released yesterday. The identification led police to the manhunt now underway.

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Block Facial Recognition With New Glasses That Ease Privacy Concerns

The Huffington Post | By Betsy Isaacson
Posted: 06/21/2013 11:59 am EDT

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Privacy visor glasses jam facial recognition sy...



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As awareness of vision technology grows, so does interest in regulating it, particularly with respect to privacy and safety

With little current regulation and low barriers to entry, there's a risk that privacy abuses will spur a backlash

Industry is showing little leadership in this realm

Facebook facial recognition software violates privacy laws, says Germany
Social network must stop programme and delete data already collected on users – or face fines up to €300,000, says official

KickingTires
THE BLOG FOR OWN BUYERS
Federal Backup Camera Mandate Pushed Back Again



Variety
FILM TV DIGITAL VOICES VIDEO SCENE VSCORE MORE
HOME | DIGITAL | NEWS
House Bill Would Restrict Camera-Enabled 'Spy' Set-Tops
JUNE 14, 2013 | 10:00AM PT
Legislation would force video services to display message about data collection and provide option for camera-free box
MUST-WATCH VIDEOS DIRECT FROM
VARIETY
STUDIO
EMMY EDITION

Pidd in Berlin
ardian, Wednesday 3 August 2011 10:08 EDT
up to comments (34)
book is threatened with legal action in Germany, which critics say violates privacy and data protection laws.
ol runs all photos uploaded to the social network and identifies the user's friends on each photo when it was rolled out in June to more than 100 million users. Users can opt out of the automatic tagging, but Facebook will keep (indefinitely) all photos added to the site.
Hamburg's data protection official has written to Facebook asking it to stop running the facial recognition programme on its users.

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Car Seat Safety Comment Rules One Comment
Rule changes at Euro NCAP in 2013 make it harder for cars to get five stars
Tristan Honeywill
On January 30, 2013
<http://twitter.com/carsafetyrules>
Rule changes at Euro NCAP in 2013 will make it harder for cars to get five stars. The safety organisation is changing the way that it assesses child safety and is asking car makers to fit more driver assistance systems.

Euro NCAP's Secretary General Michiel van Ratingen is satisfied with the progress made on safety so far: "I'm happy we were able to test all the cars on our wish-list last year," he says. "Manufacturers are still interested in getting the rating, and even if it is harder to get a five-star rating, many were successful."
With a lot of cars still getting five stars, it's not obvious how much has changed in safety in recent years. Basically, to keep getting top marks from Euro NCAP, the organisation has been asking car companies to steadily increase the scores they get in all areas of the assessment. It has meant improving everything, not just the easy stuff.

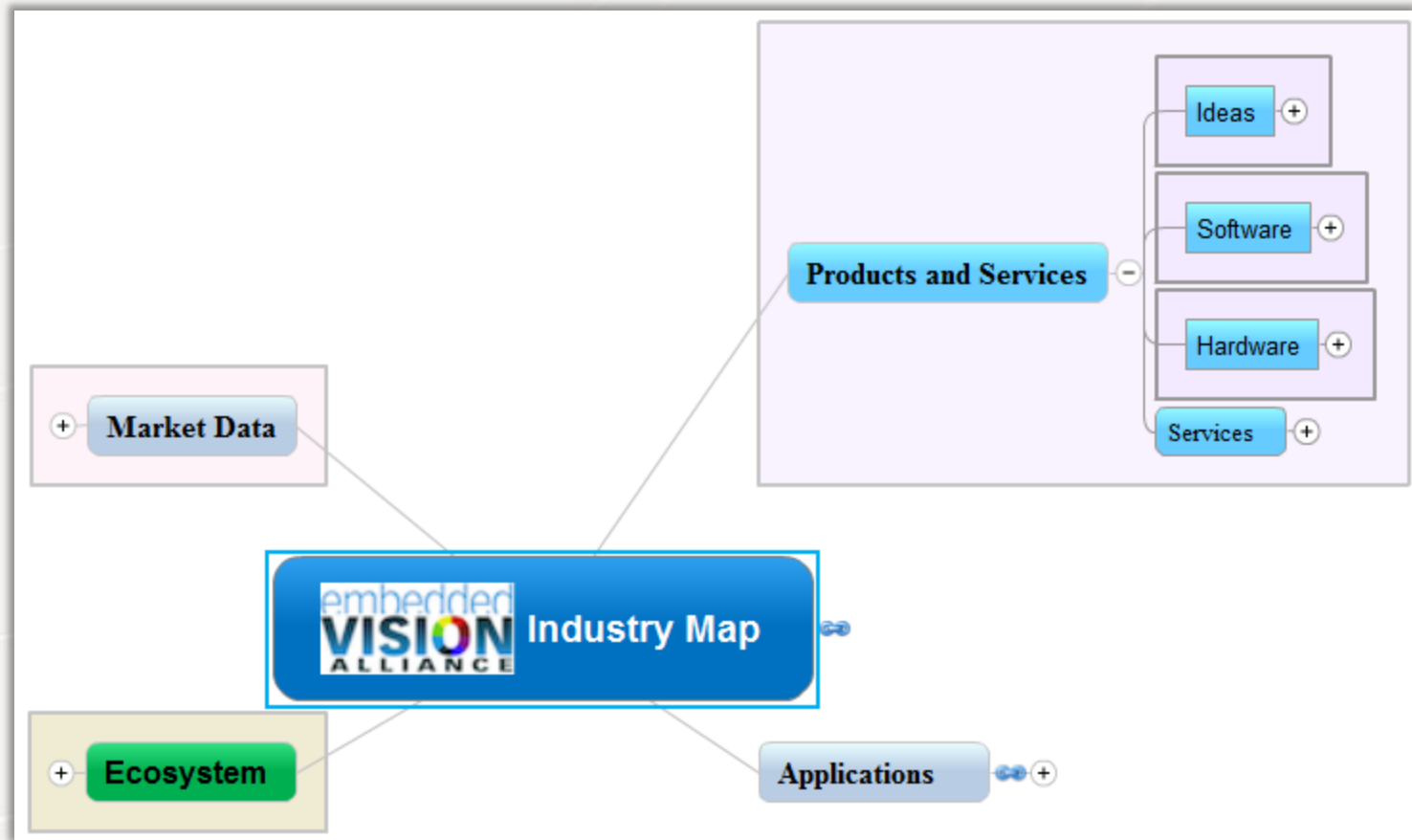


Since its 2008 passage as part of federal auto-safety legislation requiring all new cars to have backup cameras has been in effect until 2015. Bloomberg news reported, Federal

Awareness of the expanded applicability of embedded vision is growing rapidly in industry, outside of traditional niche applications

- Semiconductor suppliers are investing heavily to raise awareness
 - E.g., Intel's "Perceptual Computing" initiative
- Low-cost resources such as the Kinect, embedded development kits, and SDKs make it easier to get started
- The Embedded Vision Alliance has engaged with over 10,000 product creators through its web site, webinars, conferences, etc.
 - Offering resources such as the Quick-Start OpenCV Kit

The supplier ecosystem is growing, but is fragmented and confusing



How Do Broader Embedded Vision Trends Affect Scientific and Engineering Applications?

- Huge investment surge in enabling technology → accelerated innovation
 - Scientific and engineering applications are adopting technology from other markets, creating disruption
- Increased awareness of vision technology → new opportunities
 - For vision suppliers
 - For vision engineers → increased competition for talent
- Smaller, less expensive, lower-power vision systems → new markets
 - Including more vision deployed in the field (not only in the factory)



Tackling the Developer Awareness and Skills Gap

Embedded Vision Summits are embedded-vision-focused technical educational events for engineers in industry

- High-quality, practically-oriented technical talks
- Inspiring keynote presentations
- Exciting demos of the latest apps and technologies
- Extensive networking opportunities



600 professionals have attended Summits so far, and have given the events an average rating of 8.5/10

Next Summit: Boston, October 2-3, 2013

Summits are being planned for China, Japan, Germany, Israel, and Silicon Valley

For more information, go to
www.EmbeddedVisionSummit.com



Free Resources from the Embedded Vision Alliance



- The Embedded Vision Alliance web site, at www.Embedded-Vision.com covers embedded vision applications and technology, including interviews and demonstrations
- The Embedded Vision Academy, a free service of the Alliance, offers free in-depth tutorial articles, video “chalk talks,” code examples and discussion forums: www.EmbeddedVisionAcademy.com
- The Embedded Vision Insights newsletter provides updates on new materials available on the Alliance website. Sign up at www.Embedded-Vision.com/user/register
- 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 has arrived
- Automotive safety, gaming and consumer augmented reality are key growth applications
- Smartphones and tablets are key
- Consumer awareness is growing, sparking interest but also concerns
 - Privacy concerns and regulation are real risks
- Industry awareness of the expanded applicability of embedded vision is growing rapidly
- Low-cost resources make it easier to get started
- Supplier ecosystem is growing, but fragmented and confusing
- Most vision technology innovation is now aimed at non-traditional markets
 - Creating opportunity and disruption for traditional applications

Thank You!

Visit us at www.Embedded-Vision.com

