

Computer Graphics

**Image Analysis
(Computer Vision)**

Computer Vision: Understanding the “content” of an image (usually by creating a “model” of the depicted scene)

Computer graphics: Creating an image from scratch
Using a computer model.

Every image tells a story



- Goal of computer vision: perceive the “story” behind the picture
- Compute properties of the world
 - 3D shape
 - Names of people or objects
 - What happened?

The goal of computer vision



0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

Can the computer match human perception?



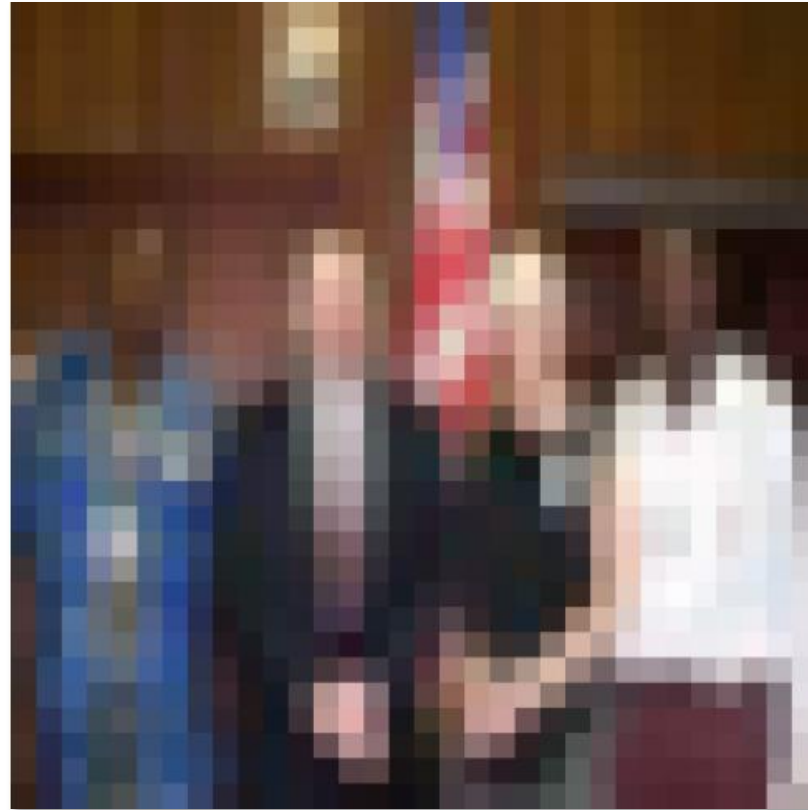
- Yes and no (mainly no)
 - computers can be better at “easy” things
 - humans are much better at “hard” things
- But huge progress has been made
 - Especially in the last 10 years
 - What is considered “hard” keeps changing

Human perception has its shortcomings



[Sinha and Poggio, *Nature*, 1996](#)

But humans can tell a lot about a scene from a little information...



Source: "80 million tiny images" by Torralba, et al.

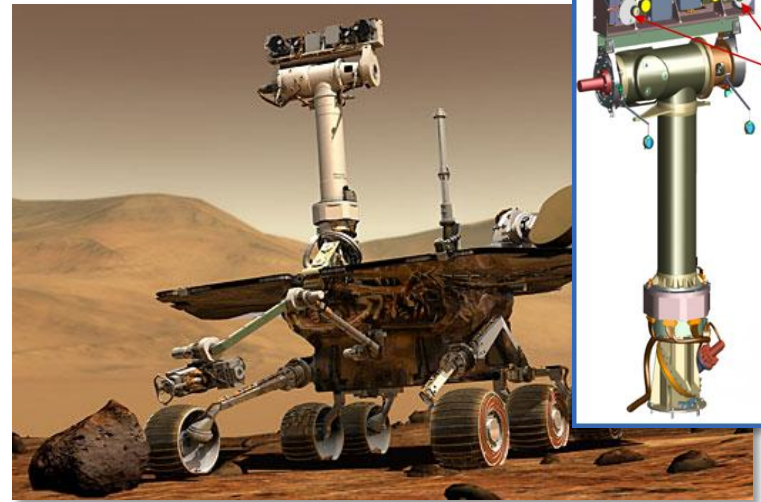
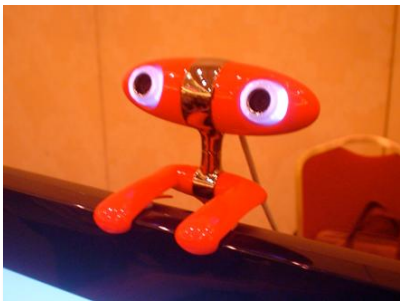


The goal of computer vision



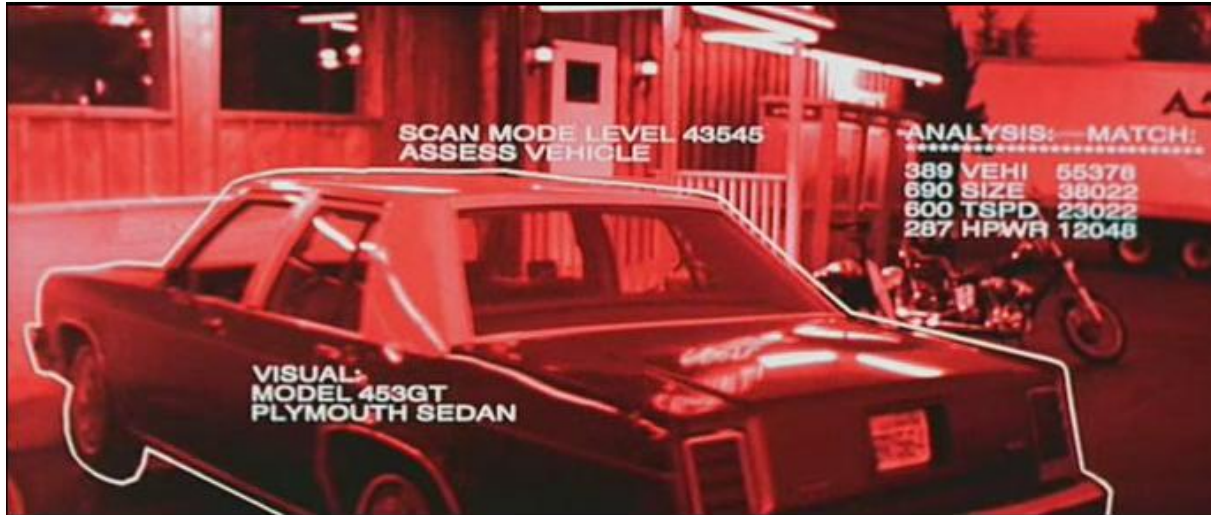
The goal of computer vision

- Computing the 3D shape of the world



The goal of computer vision

- Recognizing objects and people





sky

building

flag

face

banner

wall

street lamp

bus

bus

cars

slide credit: Fei-Fei, Fergus & Torralba



Why study computer vision?

- Millions of images being captured all the time



- Loads of useful applications
- The next slides show the current state of the art

Optical character recognition (OCR)

- If you have a scanner, it probably came with OCR software



Digit recognition, AT&T labs

<http://www.research.att.com/~yann/>

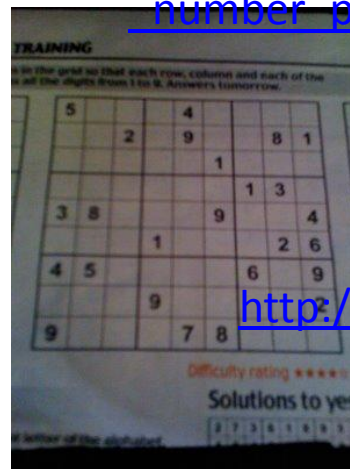


License plate readers

http://en.wikipedia.org/wiki/Automatic_number_plate_recognition



Automatic check processing



Sudoku grabber

<http://sudokugrab.blogspot.com/>

Source: S. Seitz

Face detection

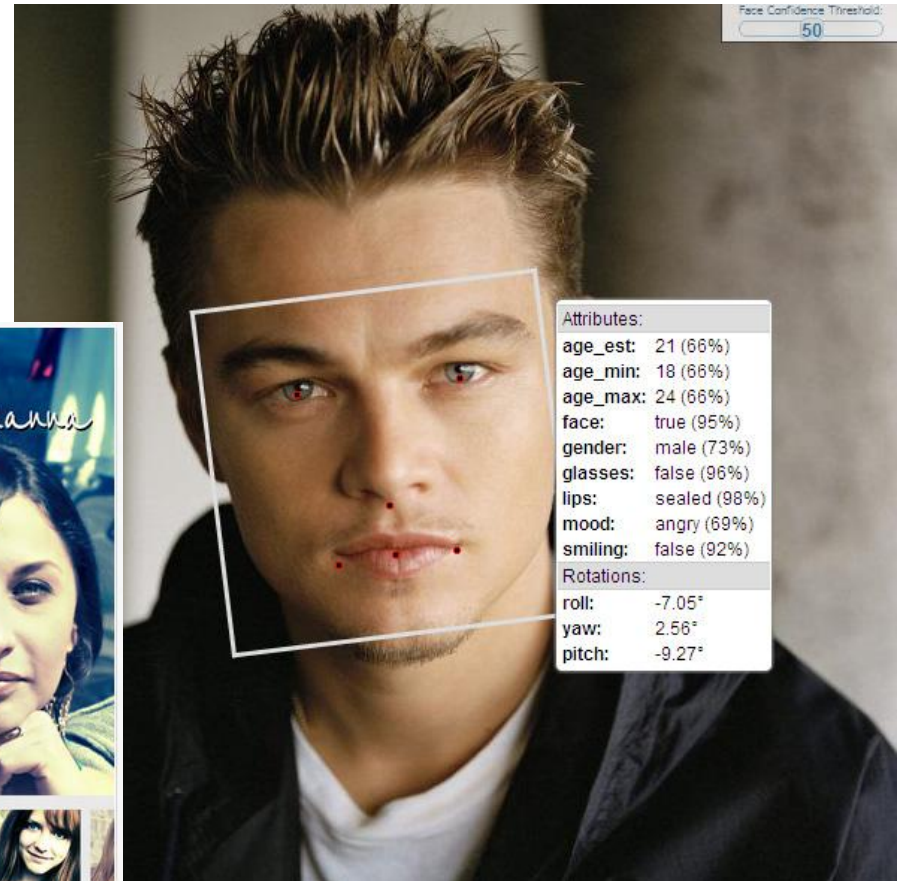


- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...

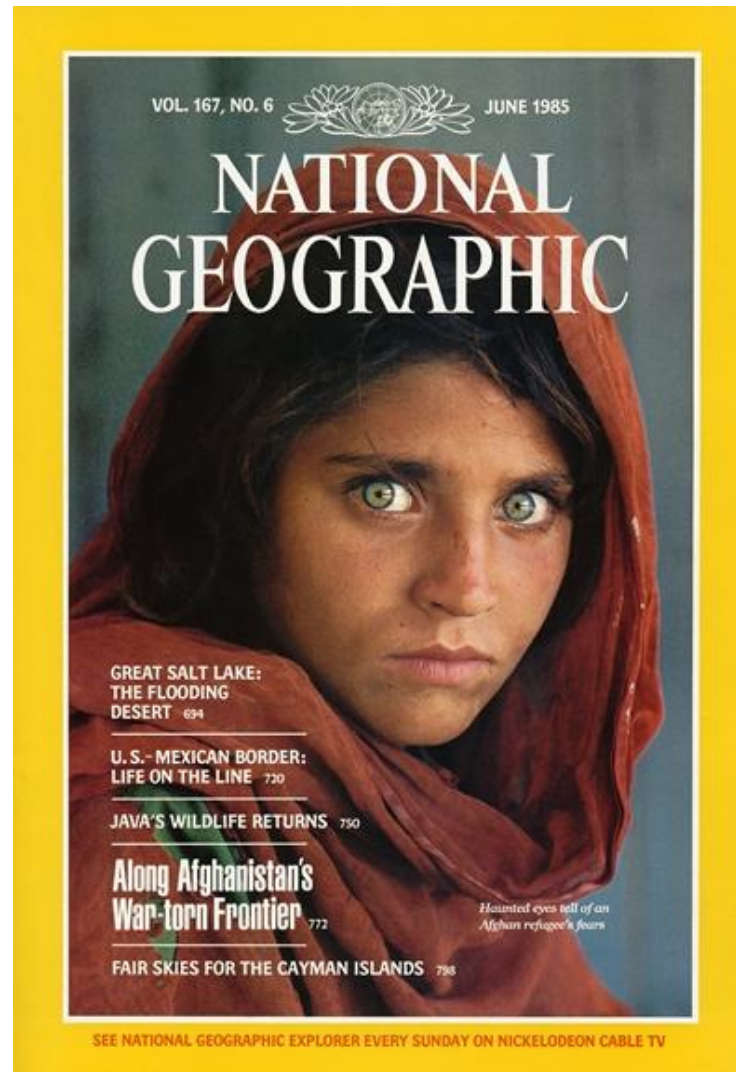
Face Recognition



<http://developers.face.com/tools/>



Face recognition



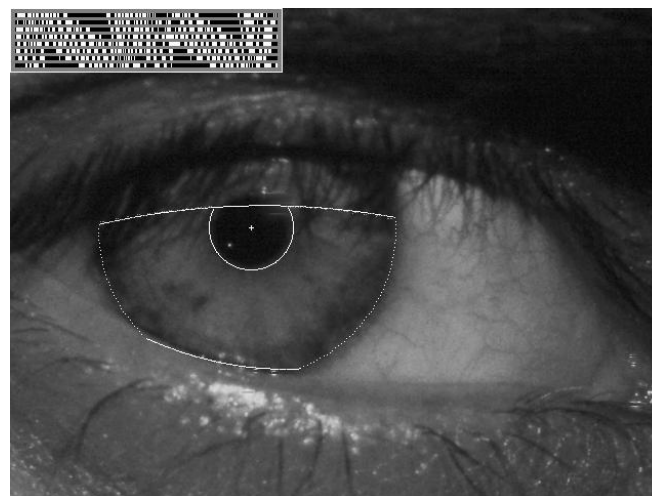
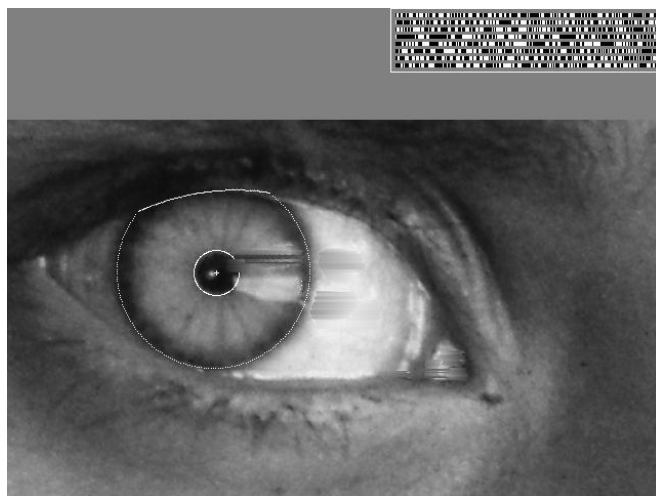
Who is she?

Source: S. Seitz

Vision-based biometrics



“How the Afghan Girl was Identified by Her Iris Patterns” Read the [story](#)



Source: S. Seitz

Login without a password...



Fingerprint scanners on many new laptops, other devices



Face recognition systems now beginning to appear more widely

<http://www.sensiblevision.com/>

Object recognition (in supermarkets)



[LaneHawk by EvolutionRobotics](#)

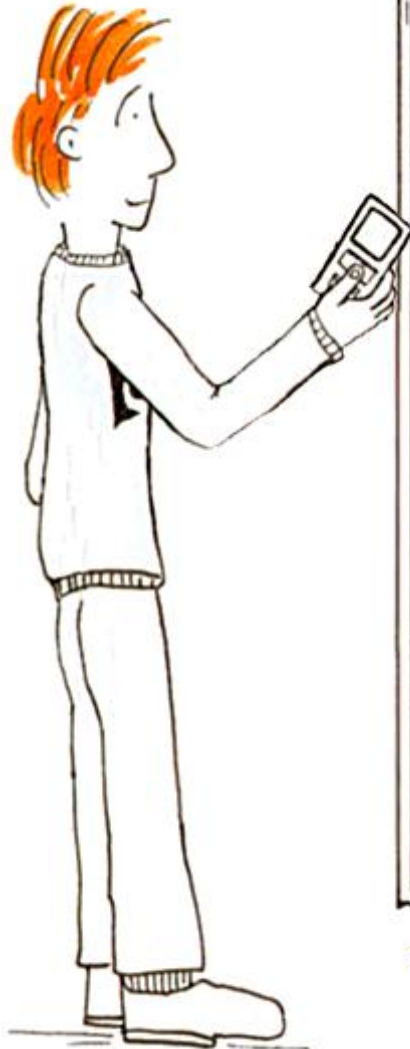
“A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it... “

Object recognition (in mobile phones)



iPhone Apps: kooaba (www.kooaba.com)

MOBILE IMAGE RECOGNITION?
TRY IT OUT NOW!!!



[Show another poster](#)

Movie data provided by:



1. **POINT**
YOUR MOBILE
PHONE CAMERA TO
THE MOVIE
POSTER.

2. **SNAP** A
PICTURE AND SEND
IT:

IN SWITZERLAND:
MMS TO 5555 (OR
079 394 57 00
FOR ORANGE
CUSTOMERS)

IN GERMANY:
MMS TO 84000

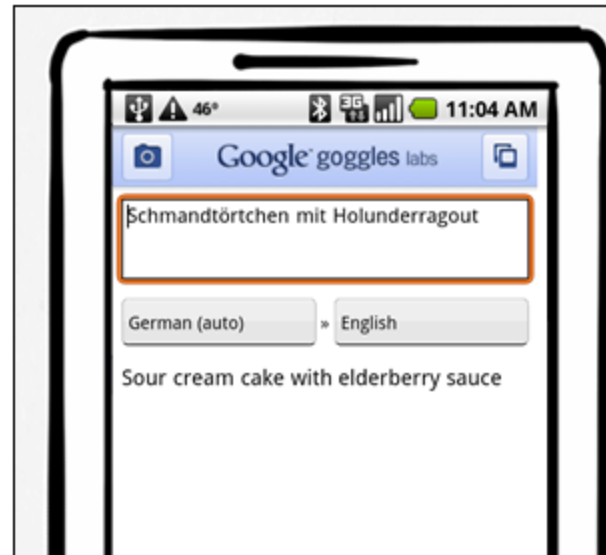
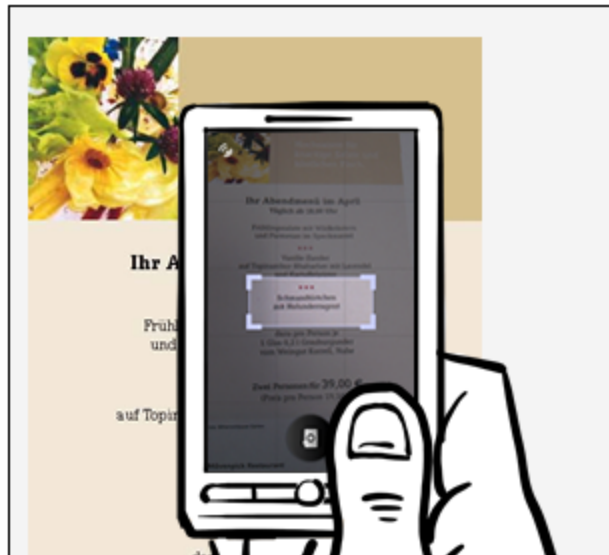
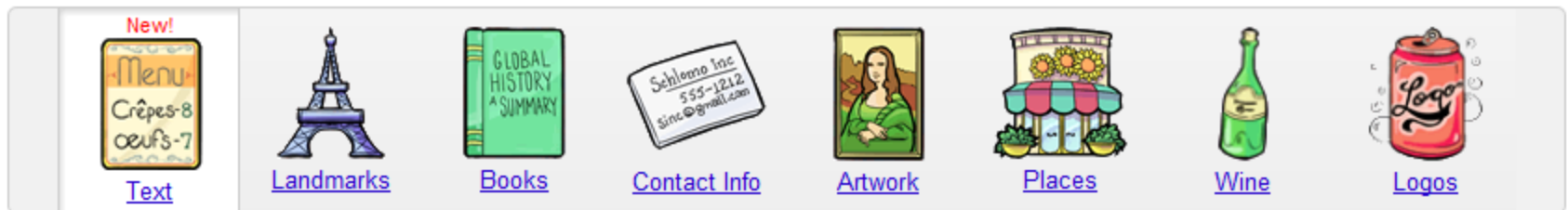
EVERYWHERE:
EMAIL TO
M@KOOABA.COM

3. **FIND** ALL
RELEVANT INFOR-
MATION ABOUT THE
MOVIE ON YOUR
MOBILE PHONE

Google Goggles

Google Goggles in action

Click the icons below to see the different kinds of objects and places you can search for using Google Goggles.



Google Search by Image

Leaf of the Bottlebrush Buckeye

Leafsnap: An Electronic Field Guide

Leafsnap is the first in a series of electronic field guides being developed by researchers from [Columbia University](#), the [University of Maryland](#), and the [Smithsonian Institution](#). This free mobile app uses visual recognition software to help identify tree species from photographs of their leaves.

Leafsnap contains beautiful high-resolution images of leaves, flowers, fruit, petiole, seeds, and bark. Leafsnap currently includes the trees of the Northeast and will soon grow to include the trees of the entire continental United States.

This website shows the tree species included in Leafsnap, the collections of its users, and the team of research volunteers working to produce it.

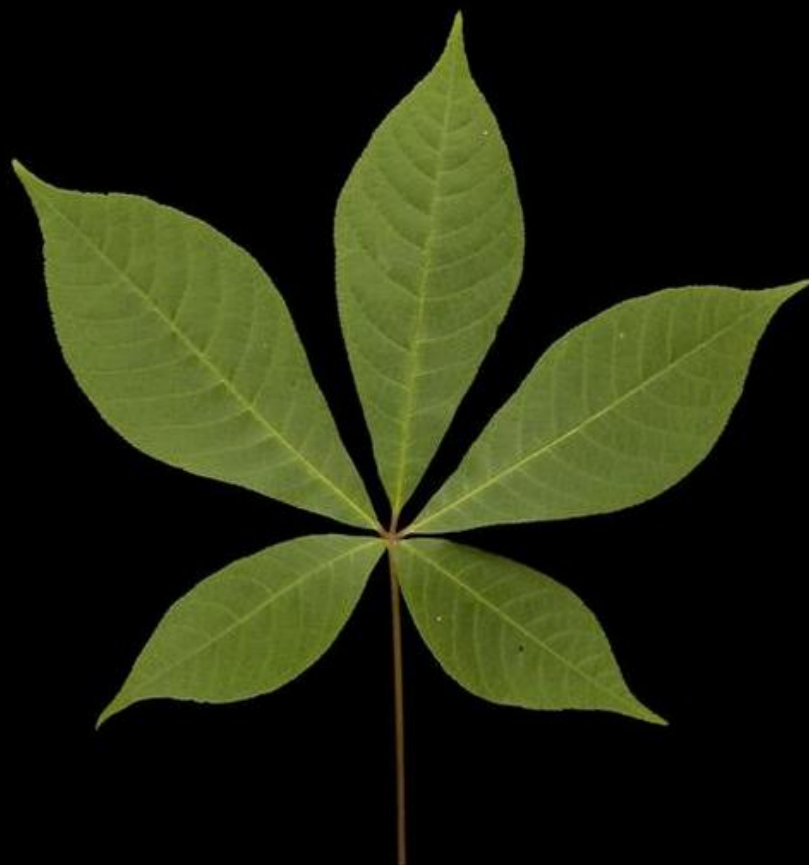
Free for iPhone:



and iPad:



guardian.co.uk



Vision-based interaction (and games)



Assistive technologies

Nintendo Wii has camera-based IR tracking built in. See [Lee's work at CMU](#) on clever tricks on using it to create a [multi-touch display](#)!

Kinect



Smart cars

The screenshot displays the Mobileye website interface. At the top, there are navigation tabs for 'manufacturer products' and 'consumer products'. The main banner features the slogan 'Our Vision. Your Safety.' and a top-down view of a car with three camera fields of view highlighted: 'rear looking camera', 'side looking camera', and 'forward looking camera'. Below the banner are three product highlights: 'EyeQ Vision on a Chip' with an image of the chip, 'Vision Applications' showing a pedestrian detection box, and 'AWS Advance Warning System' with a circular display showing a car icon and a distance of 0.8. On the right side, there are sections for 'News' and 'Events', each containing a list of recent articles and a 'read more' link.

- [Mobileye](#)

- Vision systems currently in high-end BMW, GM, Volvo models