

# Computer Vision

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# What is computer vision?

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[Terminator 2](#)



[Enemy of the State](#)

# Every picture tells a story

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Goal of computer vision is to write computer programs that can interpret images

# Can computers match (or beat) human vision?

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Yes and no (but mostly no!)

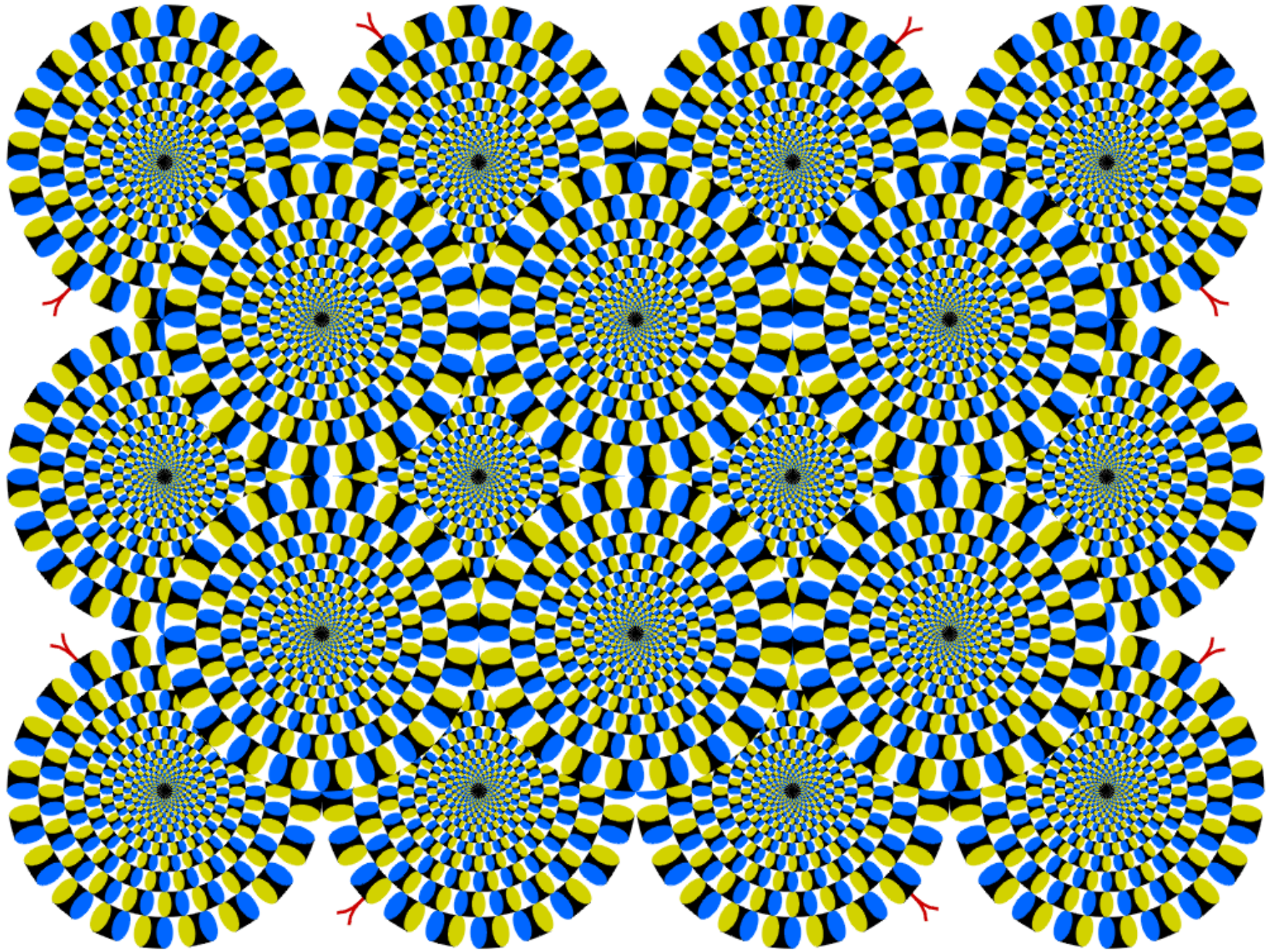
- humans are much better at “hard” things
- computers can be better at “easy” things

# Human perception has its shortcomings...

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



Copyright [A.Kitaoka](#) 2003

# Current state of the art

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The next slides show some examples of what current vision systems can do



# Earth viewers (3D modeling)

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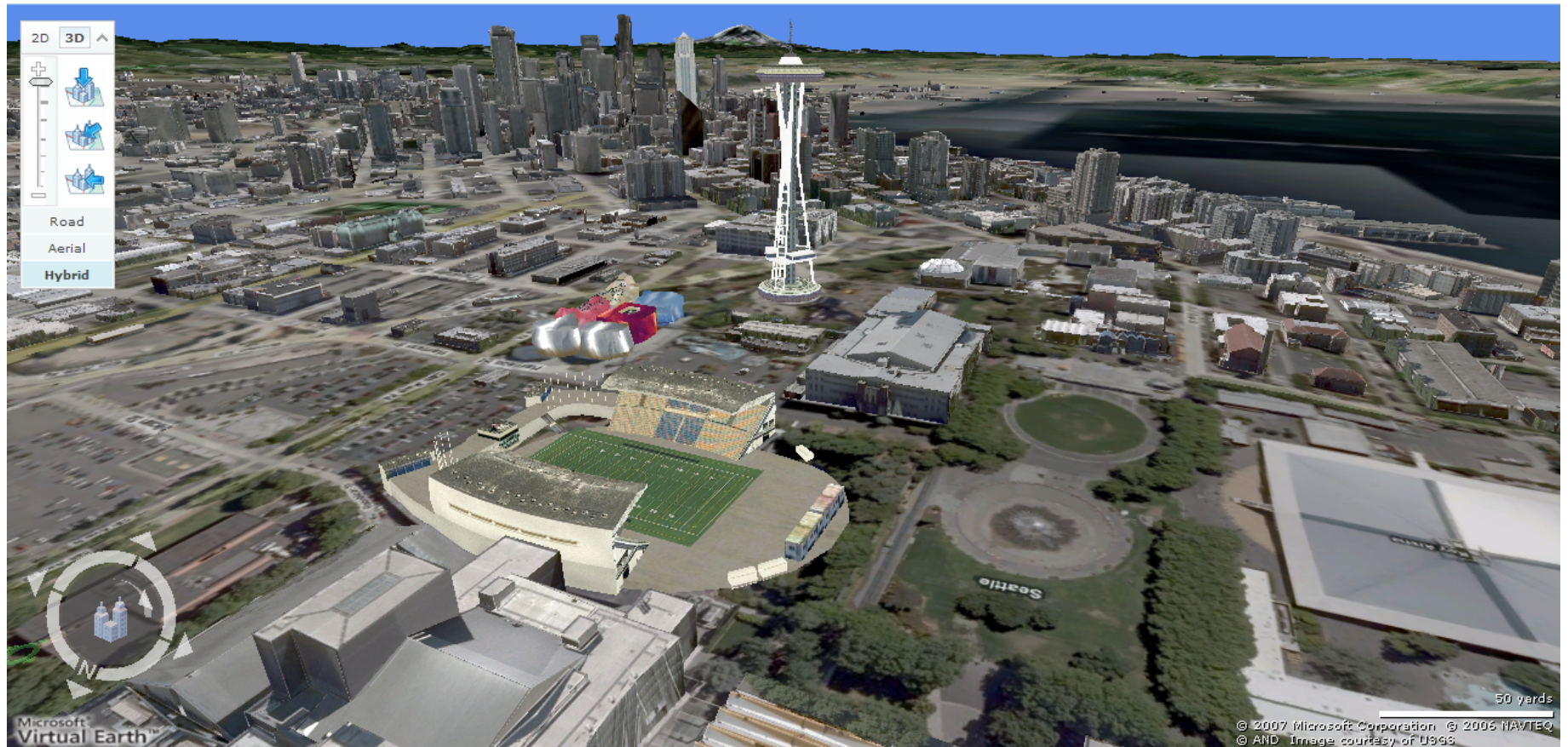


Image from Microsoft's [Virtual Earth](#)  
(see also: [Google Earth](#))

Home

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- Collections
- Team blog
- Videos
- System requirements
- About us
- FAQ

*"What if your photo collection was an entry point into the world, like a wormhole that you could jump through and explore..."*

Try it



Try the Tech Preview

The **Photosynth Technology Preview** is a taste of the newest - and, we hope, most exciting - way to **view photos** on a computer. Our software takes a large collection of photos of a place or an object, analyzes them for similarities, and then displays the photos in a reconstructed **three-dimensional space**, showing you how each one relates to the next.

<http://photosynth.net>

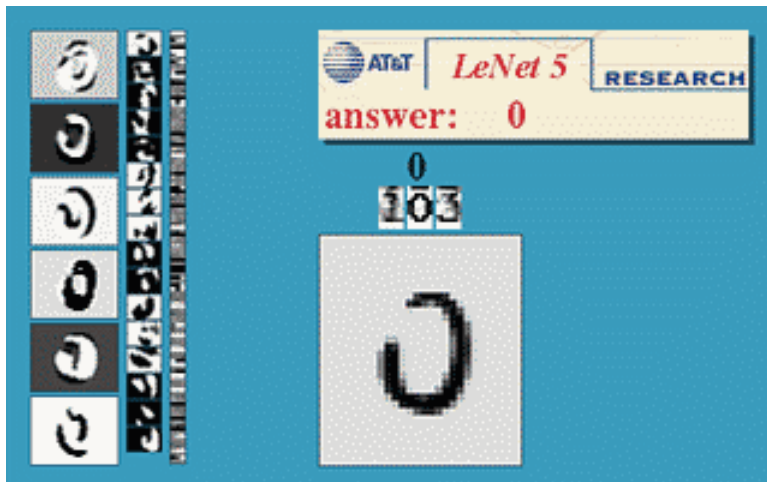
Based on [Photo Tourism technology](#) developed by Noah Snavely, Steve Seitz, and Rick Szeliski

# Optical character recognition (OCR)

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Technology to convert scanned docs to text

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



Digit recognition, AT&T labs

<http://yann.lecun.com/ex/research/index.html>



License plate readers

[http://en.wikipedia.org/wiki/Automatic\\_number\\_plate\\_recognition](http://en.wikipedia.org/wiki/Automatic_number_plate_recognition)

# Face detection

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Many new digital cameras now detect faces

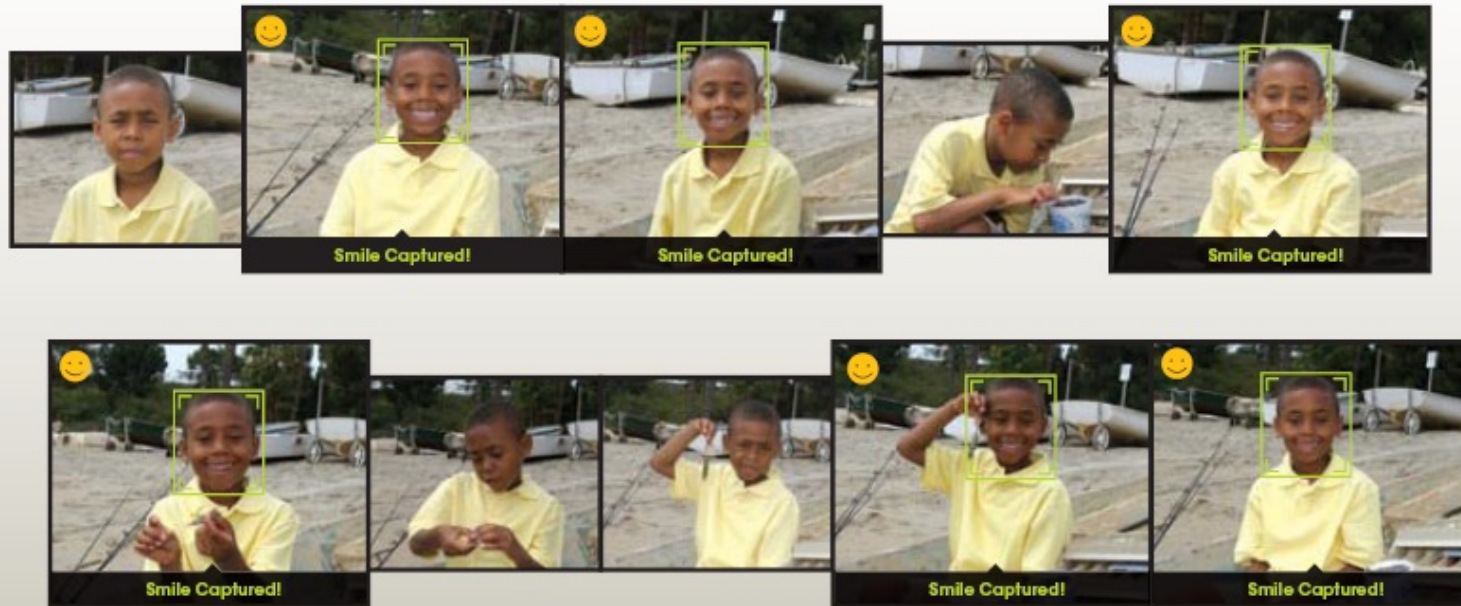
- Canon, Sony, Fuji, ...

# Smile detection?

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## The Smile Shutter flow

Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot® camera can automatically trip the shutter at just the right instant to catch the perfect expression.



[Sony Cyber-shot® T70 Digital Still Camera](#)

# Object recognition (in supermarkets)

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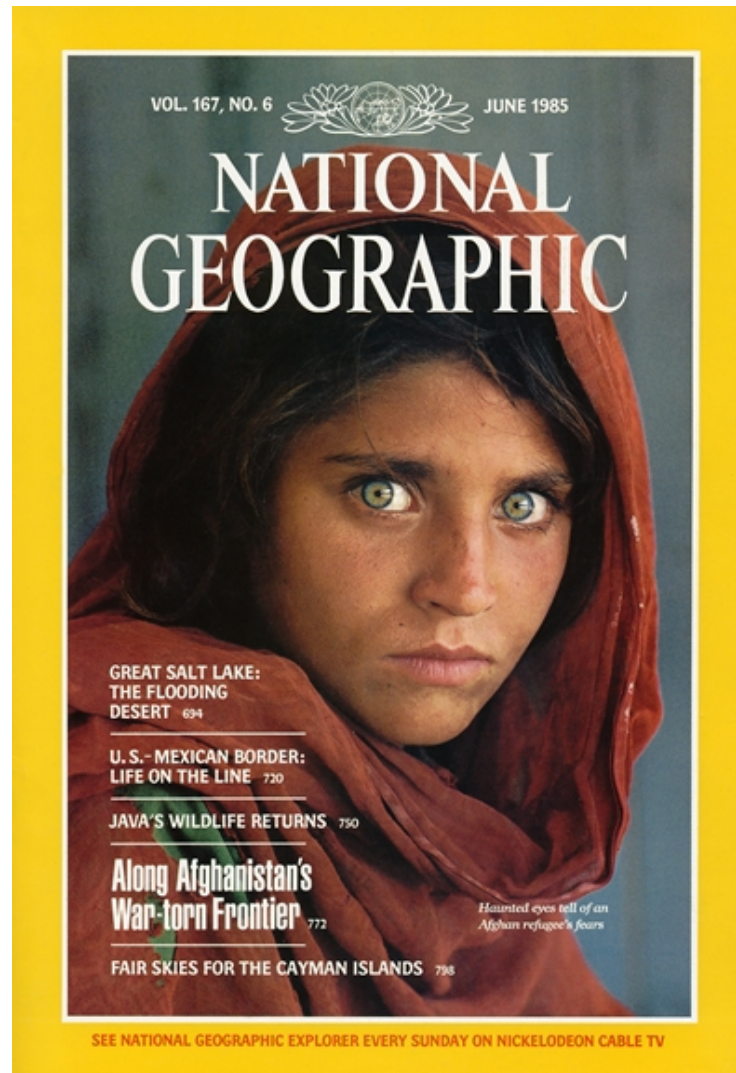


## [LaneHawk by EvolutionRobotics](#)

“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...”

# Face recognition

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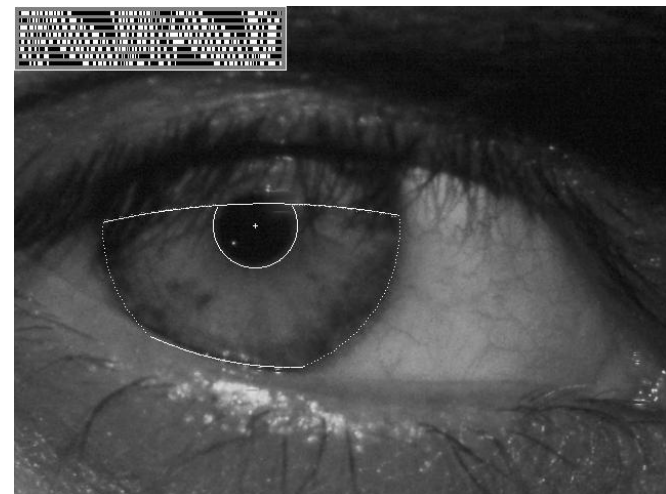
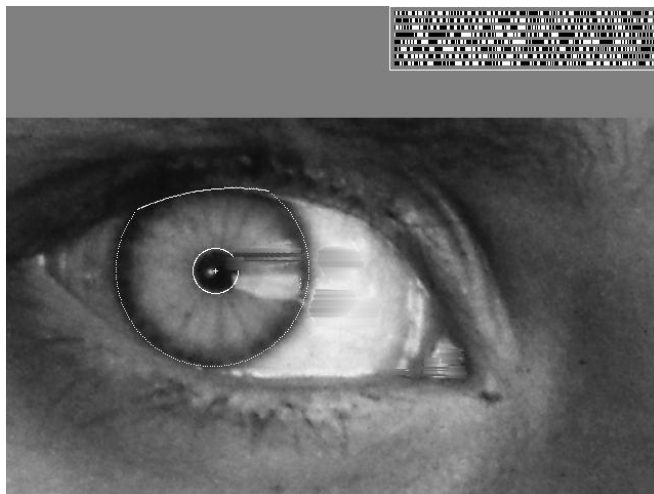
Who is she?

# Vision-based biometrics

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



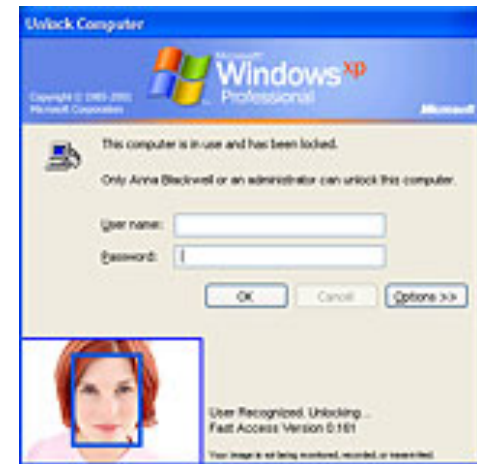
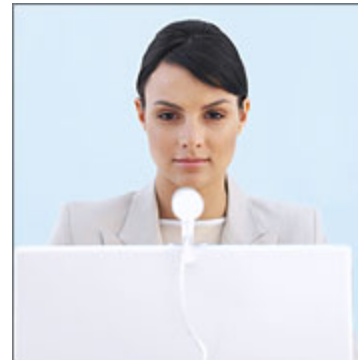


# Login without a password...

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Fingerprint scanners on many new laptops, other devices



Face recognition systems now beginning to appear more widely  
<http://www.sensiblevision.com/>

# Object recognition (in mobile phones)



This is becoming real:

- **Lincoln** Microsoft Research

# Special effects: shape capture

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*The Matrix* movies, ESC Entertainment, XYZRGB, NRC

# Special effects: motion capture

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*Pirates of the Caribbean*, Industrial Light and Magic

# Sports

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*Sportvision* first down line

Nice [explanation](http://www.howstuffworks.com) on [www.howstuffworks.com](http://www.howstuffworks.com)

# Smart cars

Slide content courtesy of Amnon Shashua

The screenshot displays the Mobileye website interface. At the top, there are navigation tabs for "manufacturer products" and "consumer products". The main header reads "Our Vision. Your Safety." Below this is a top-down view of a car with three camera fields of view highlighted: "rear looking camera", "side looking camera", and "forward looking camera".

On the right side, there is a "News" section with two articles: "Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System" and "Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end". Below the news is an "Events" section listing "Mobileye at Equip Auto, Paris, France" and "Mobileye at SEMA, Las Vegas, NV".

The bottom section features three product highlights:

- EyeQ Vision on a Chip**: Accompanied by an image of the EyeQ chip and a "read more" link.
- Vision Applications**: Accompanied by an image of a pedestrian and the text "Road, Vehicle, Pedestrian Protection and more", with a "read more" link.
- AWS Advance Warning System**: Accompanied by an image of a circular display showing a car icon and a "0.8" reading, with a "read more" link.

## Mobileye

- Vision systems currently in high-end BMW, GM, Volvo models
- By 2010: 70% of car manufacturers.
- [Video demos](#)

# Vision-based interaction (and games)

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Nintendo Wii has camera-based IR tracking built in. See [Lee's work at CMU](#).



[Digimask](#): put your face on a 3D avatar.



[“Game turns moviegoers into Human Joysticks”](#), CNET  
Camera tracking a crowd, based on [this work](#).

# Vision in space

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[NASA'S Mars Exploration Rover Spirit](#) captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

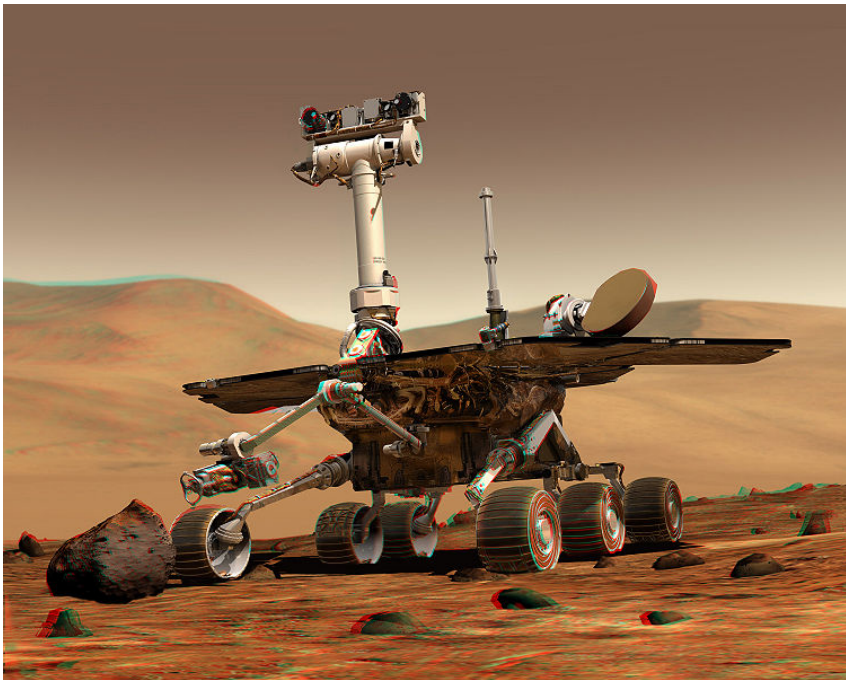
## Vision systems (JPL) used for several tasks

- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read “[Computer Vision on Mars](#)” by Matthies et al.

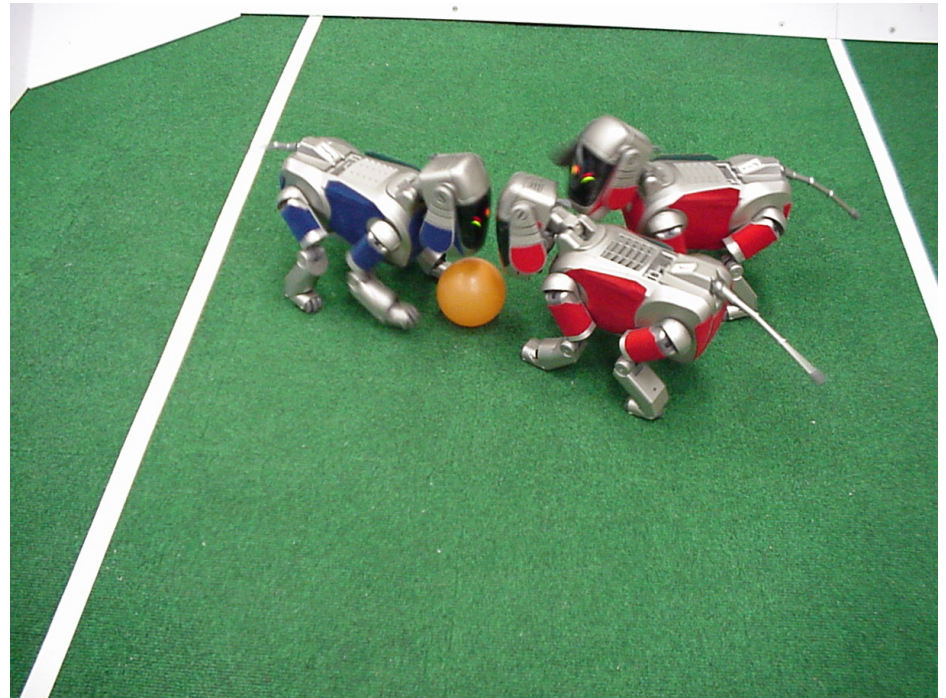


# Robotics

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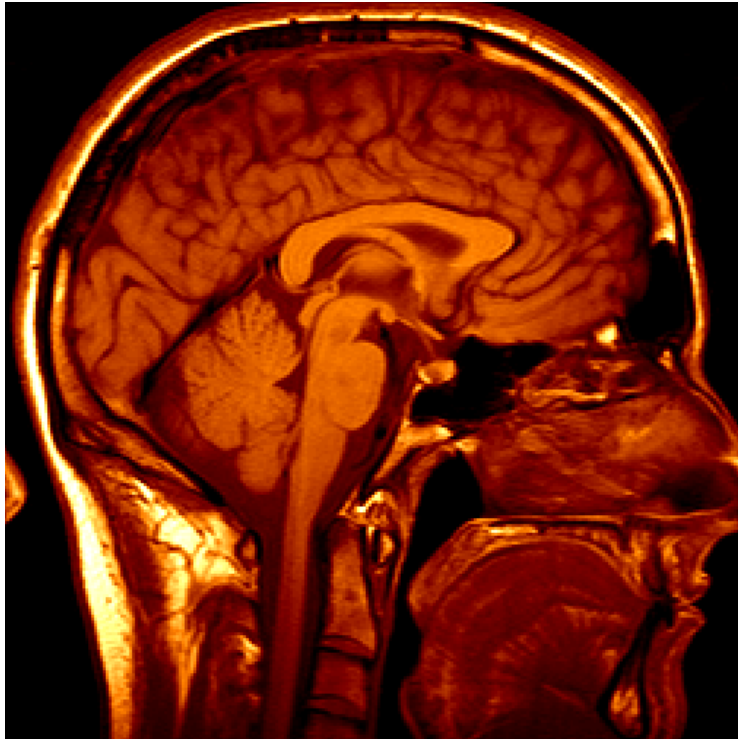
NASA's Mars Spirit Rover  
[http://en.wikipedia.org/wiki/Spirit\\_rover](http://en.wikipedia.org/wiki/Spirit_rover)



<http://www.robocup.org/>

# Medical imaging

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3D imaging  
MRI, CT



Image guided surgery  
[Grimson et al., MIT](#)

# Current state of the art

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You just saw examples of current systems.

- Many of these are less than 5 years old

This is a very active research area, and rapidly changing

- Many new apps in the next 5 years

To learn more about vision applications and companies

- [David Lowe](http://www.cs.ubc.ca/spider/lowe/vision.html) maintains an excellent overview of vision companies
  - <http://www.cs.ubc.ca/spider/lowe/vision.html>