# Computer Vision

Zoran Duric

zduric@cs.gmu.edu

http://cs.gmu.edu/~zduric

# What is computer vision?

# What is computer vision?

*Terminator 2*

*Enemy of the State*

# Every picture tells a story


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

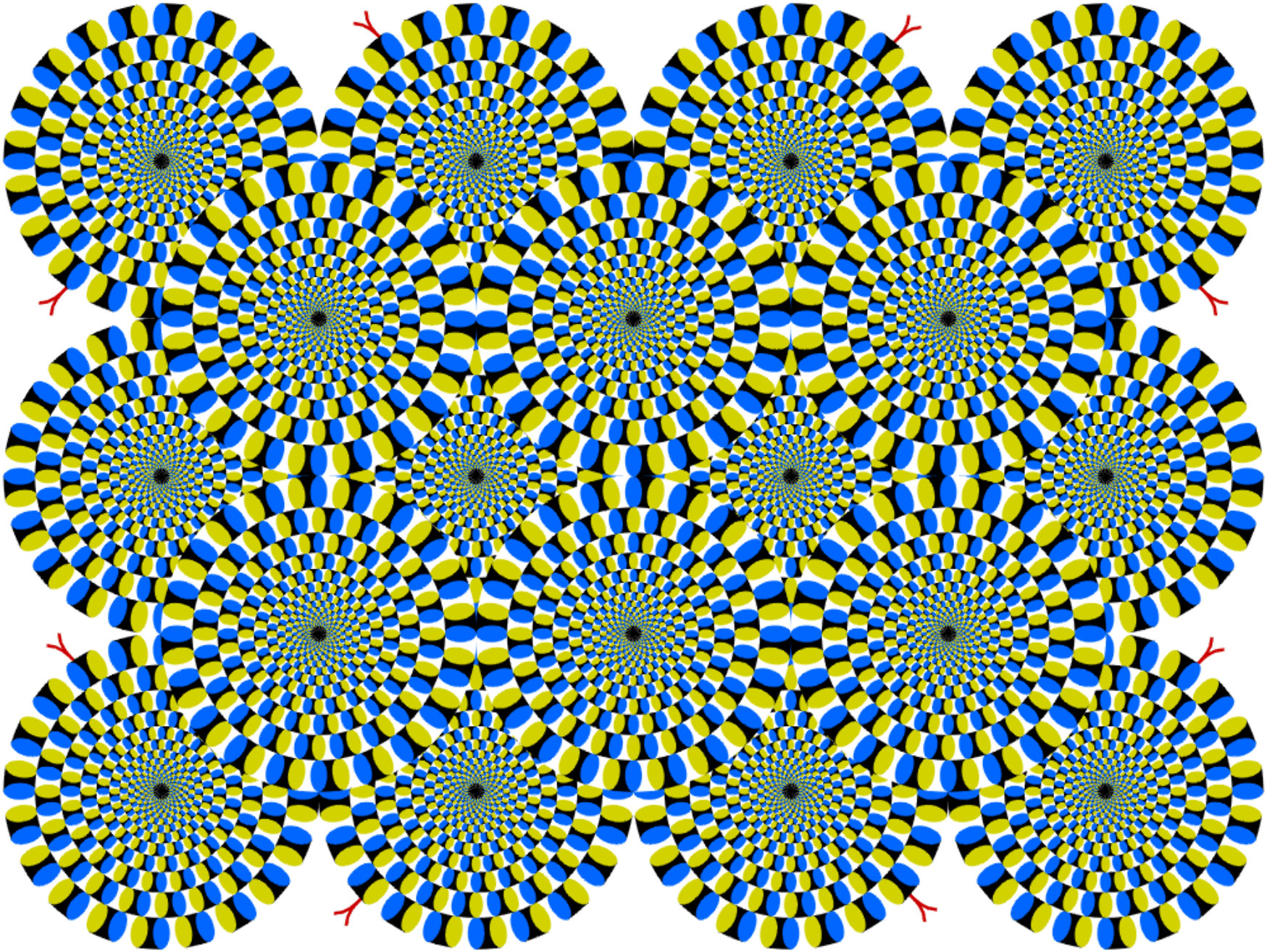
# Can computers match (or beat) human vision?


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…

Sinha and Poggio, *Nature*, 1996



# Current state of the art

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

# Earth viewers (3D modeling)

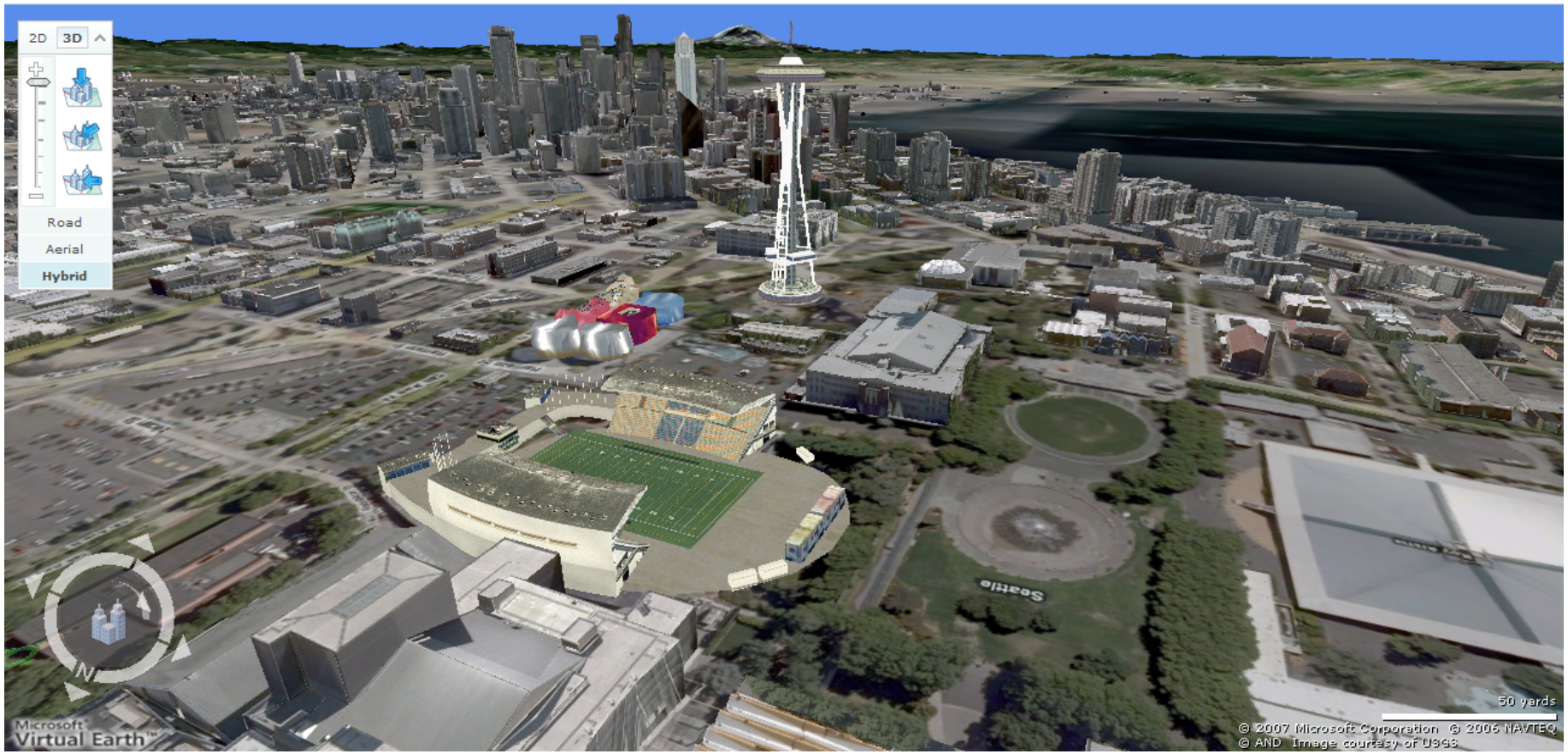
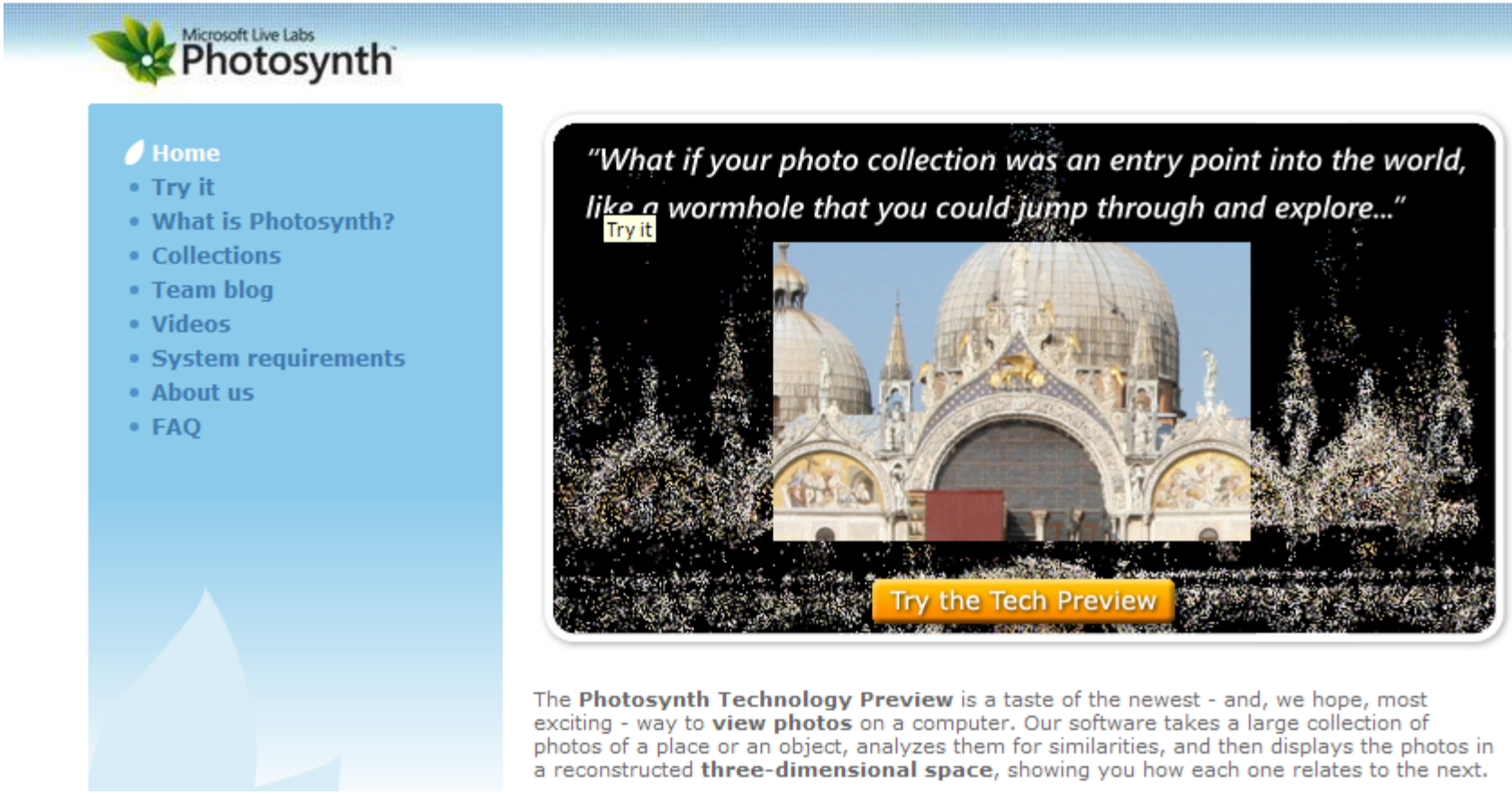



Image from Microsoft's Virtual Earth
(see also: Google Earth)



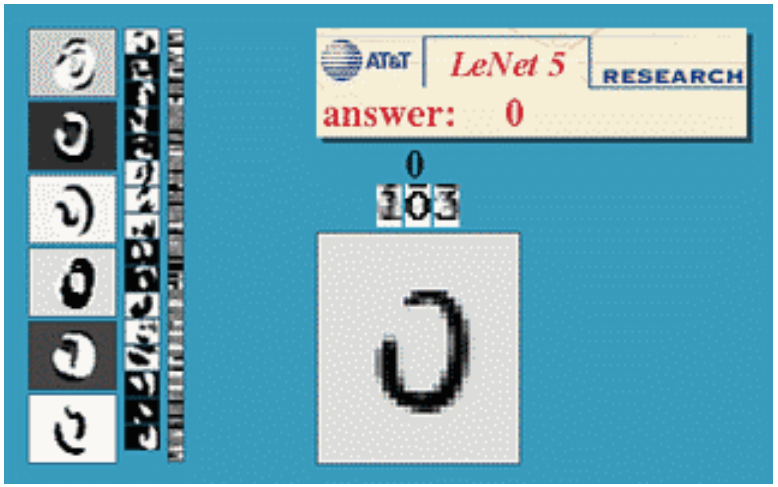

http://photosynth.net

Based on Photo Tourism technology developed by Noah Snavely, Steve Seitz, and Rick Szeliski

# Optical character recognition (OCR)

## 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

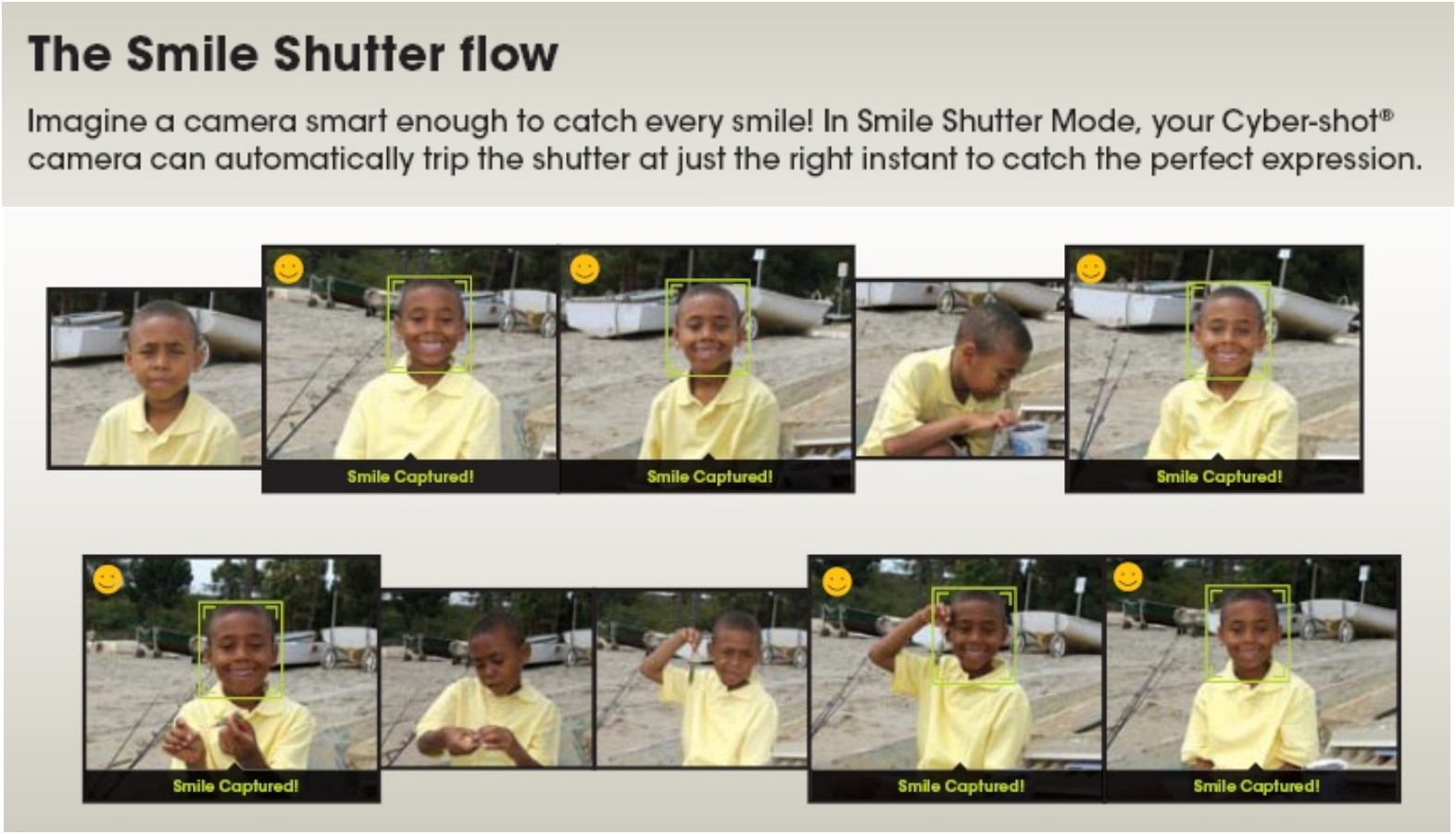

License plate readers
http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

# Face detection


Many new digital cameras now detect faces

- Canon, Sony, Fuji, …

# Smile detection?



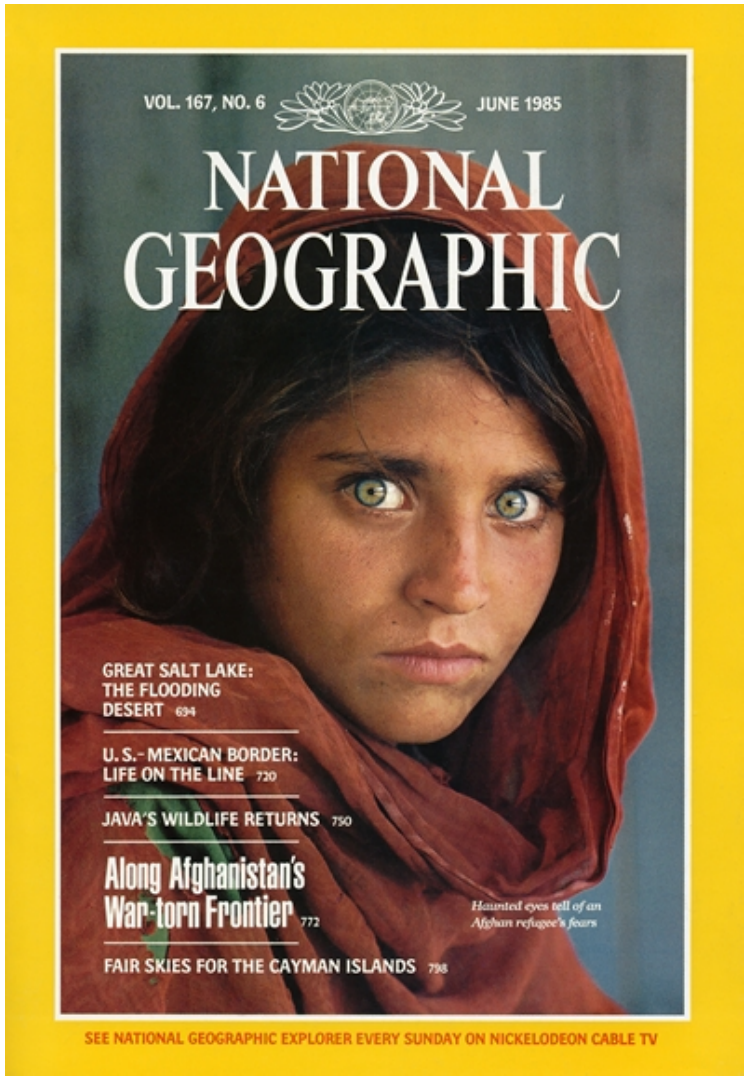

[Sony Cyber-shot® T70 Digital Still Camera]

# 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… “

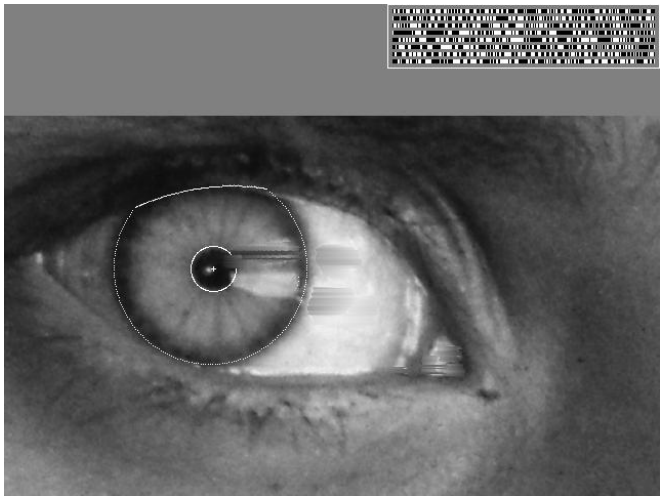
# Face recognition

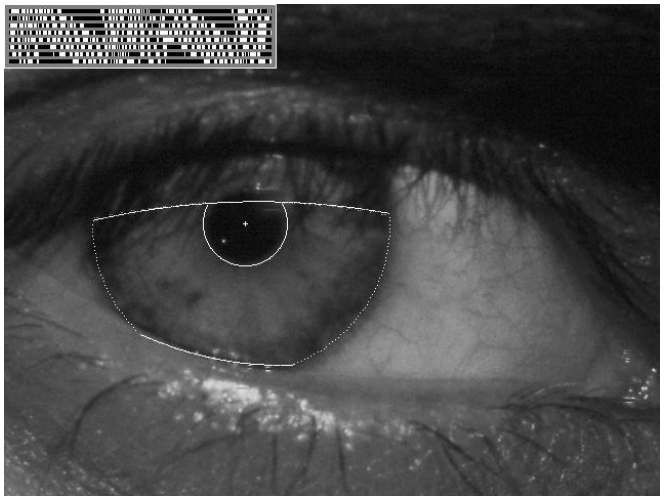



Who is she?

# Vision-based biometrics

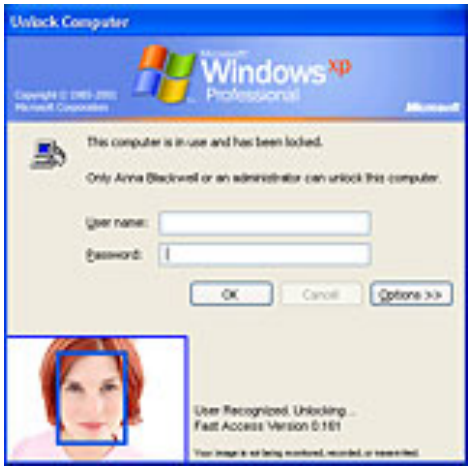
"*How the Afghan Girl was Identified by Her Iris Patterns*" Read the story





# 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 mobile phones)


This is becoming real:

- Lincoln Microsoft Research

# Special effects:  shape capture

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

# Special effects:  motion capture

*Pirates of the Carribean*, Industrial Light and Magic

# Sports


*Sportvision* first down line
Nice explanation on www.howstuffworks.com

# Smart cars

Slide content courtesy of Amnon Shashua


## Mobileye

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

# Vision-based interaction (and games)


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.

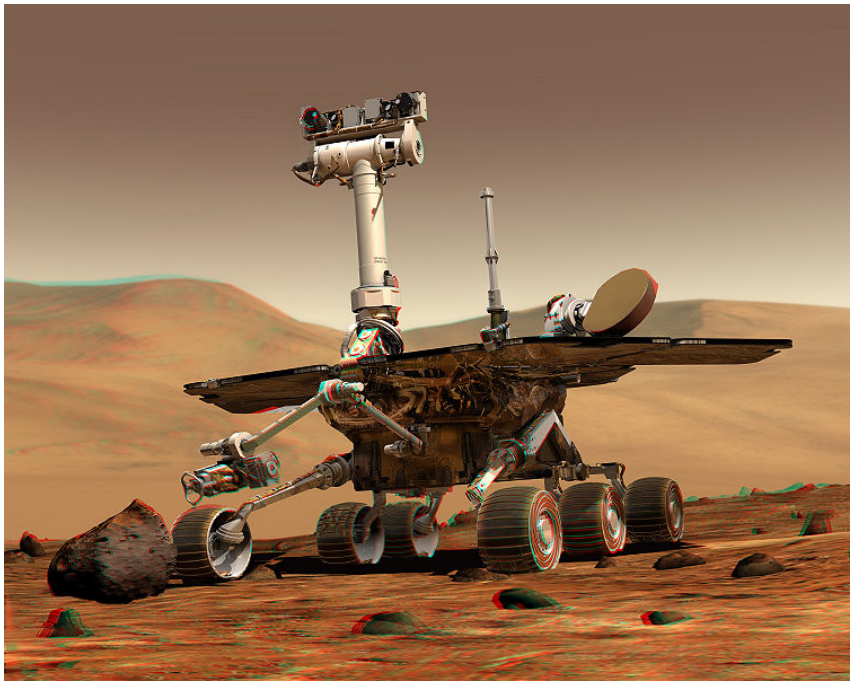
# Vision in space

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

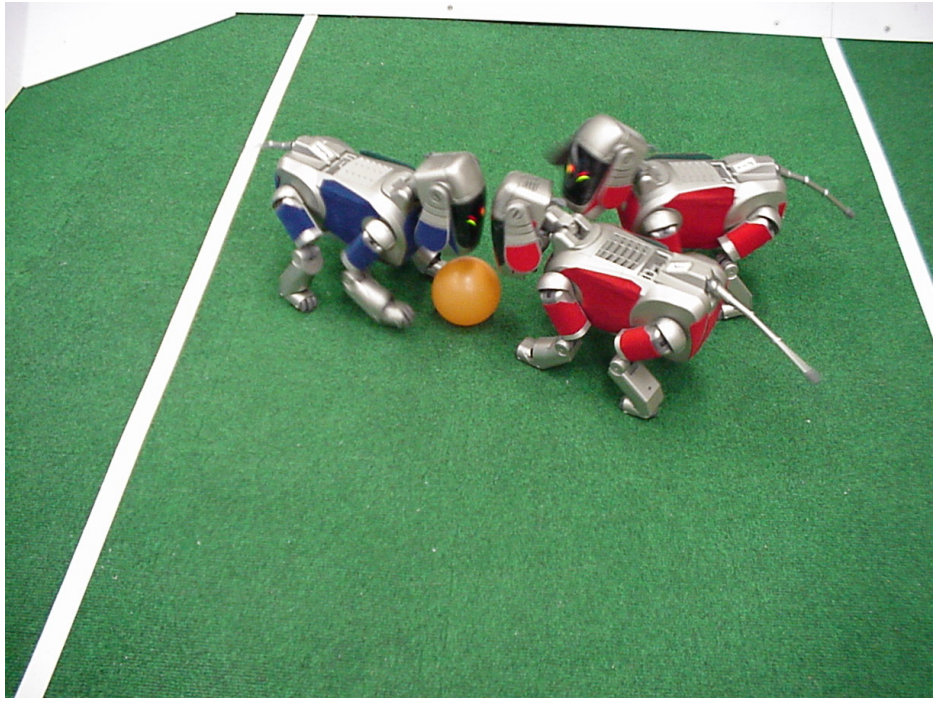
## Vision systems (JPL) used for several tasks

- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read "Computer Vision on Mars" by Matthies et al.

# Robotics

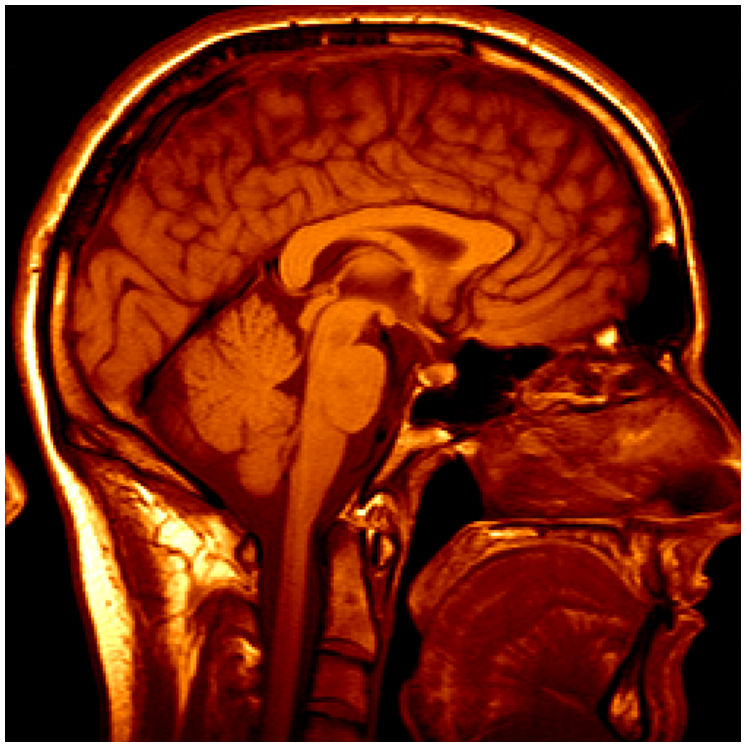


NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover



http://www.robocup.org/

# Medical imaging



3D imaging
MRI, CT

Image guided surgery
Grimson et al., MIT

# Current state of the art

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 maintains an excellent overview of vision companies
  - http://www.cs.ubc.ca/spider/lowe/vision.html