

Computer Vision (CS 482)

Professor

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Course Web Page

<https://piazza.com/gmu/fall2013/cs482/home>

Handouts

- signup sheet
- intro slides
- image filtering slides

Today

- Intros
- Computer vision overview
- Course overview
- Image processing

Readings

- Book: [Richard Szeliski, Computer Vision: Algorithms and Applications](#)
 - (please check [course web site](#) for updated drafts)
 - Intro: Ch 1.0

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?



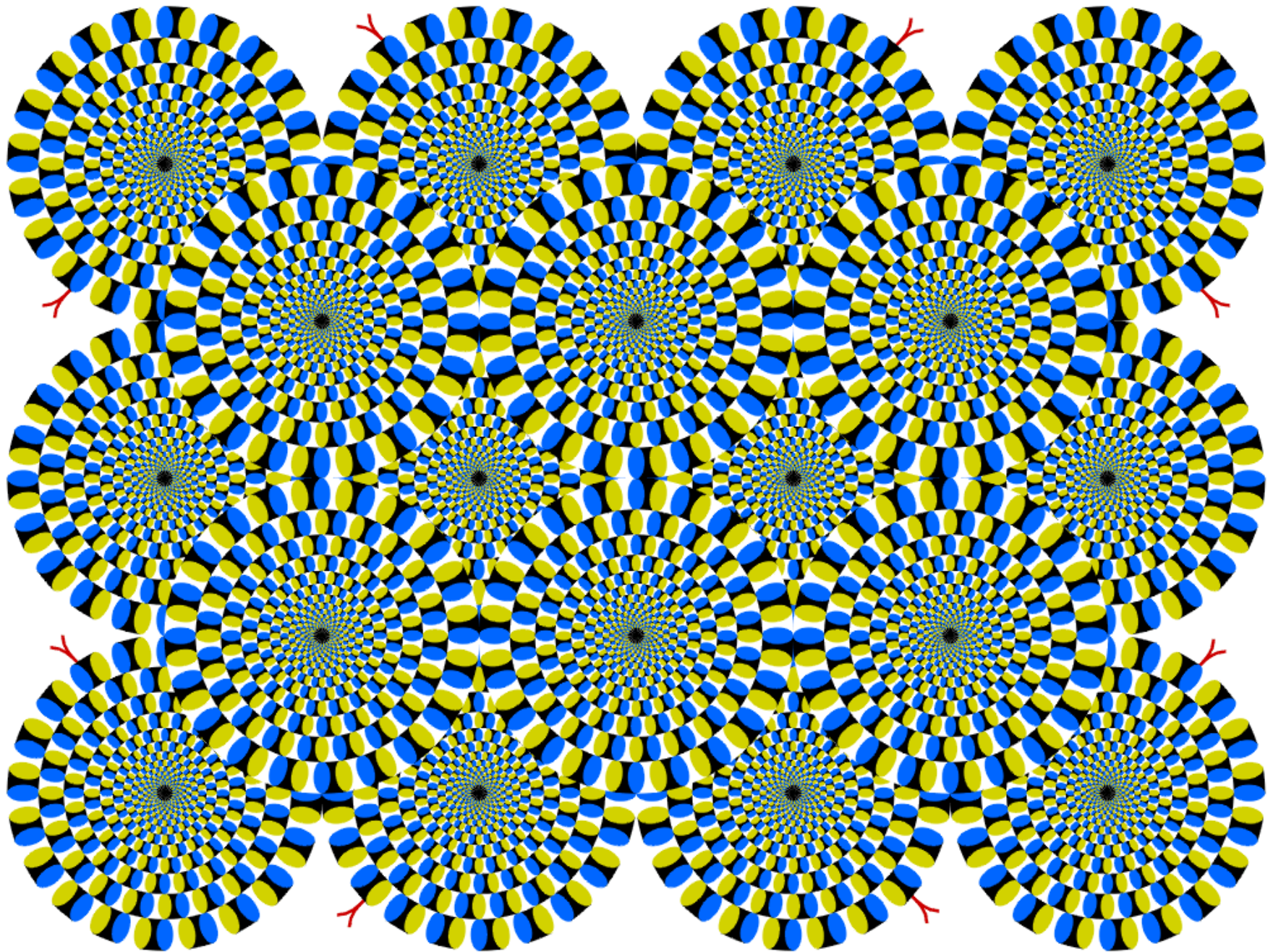
Yes and no (but mostly no!)

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

Human perception has its shortcomings...



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



Copyright [A.Kitaoka](#) 2003

Current state of the art

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

Earth viewers (3D modeling)

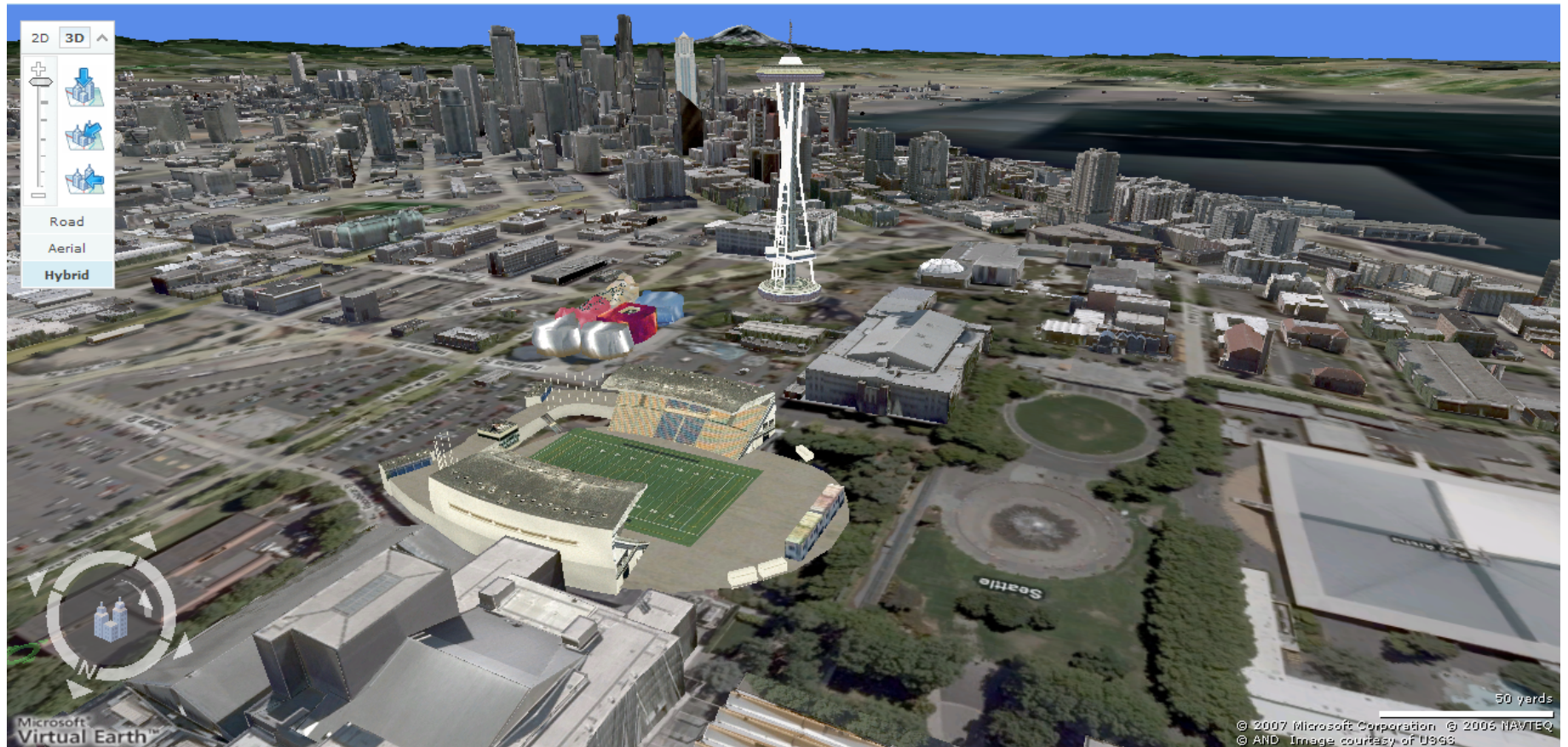


Image from Microsoft's [Virtual Earth](#)
(see also: [Google Earth](#))

Home

- Try it
- What is Photosynth?
- 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.

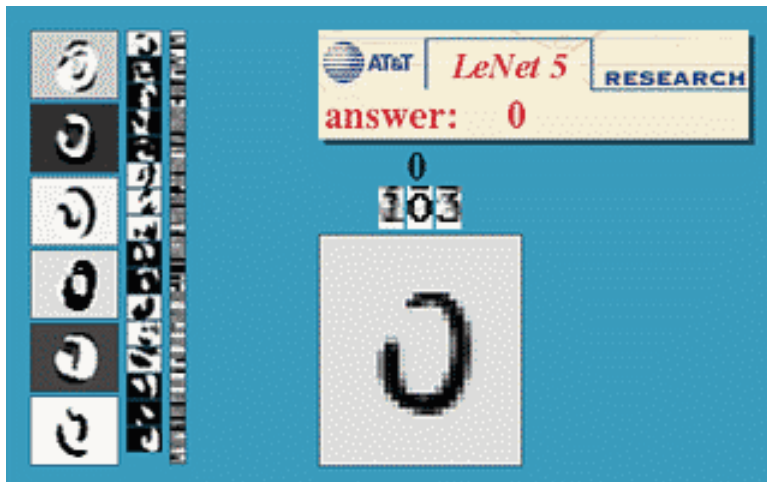
<http://photosynth.net>

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

Optical character recognition (OCR)

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



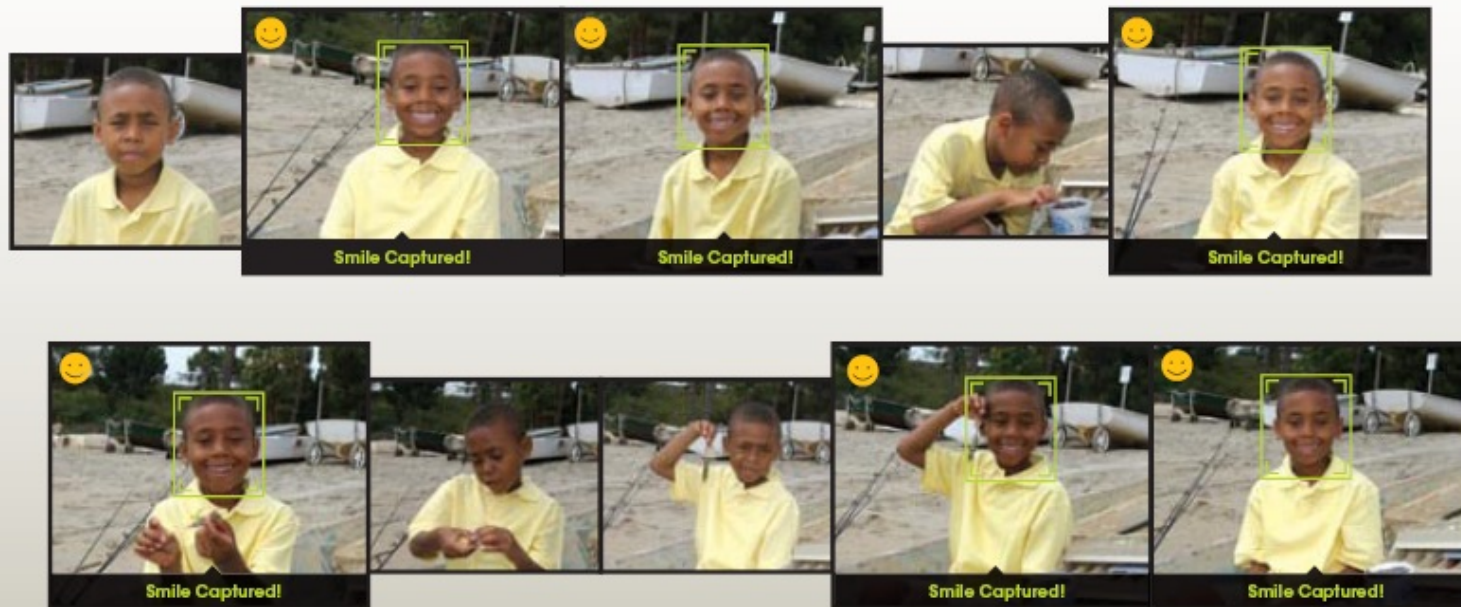
Many new digital cameras now detect faces

- Canon, Sony, Fuji, ...

Smile detection?

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](#)

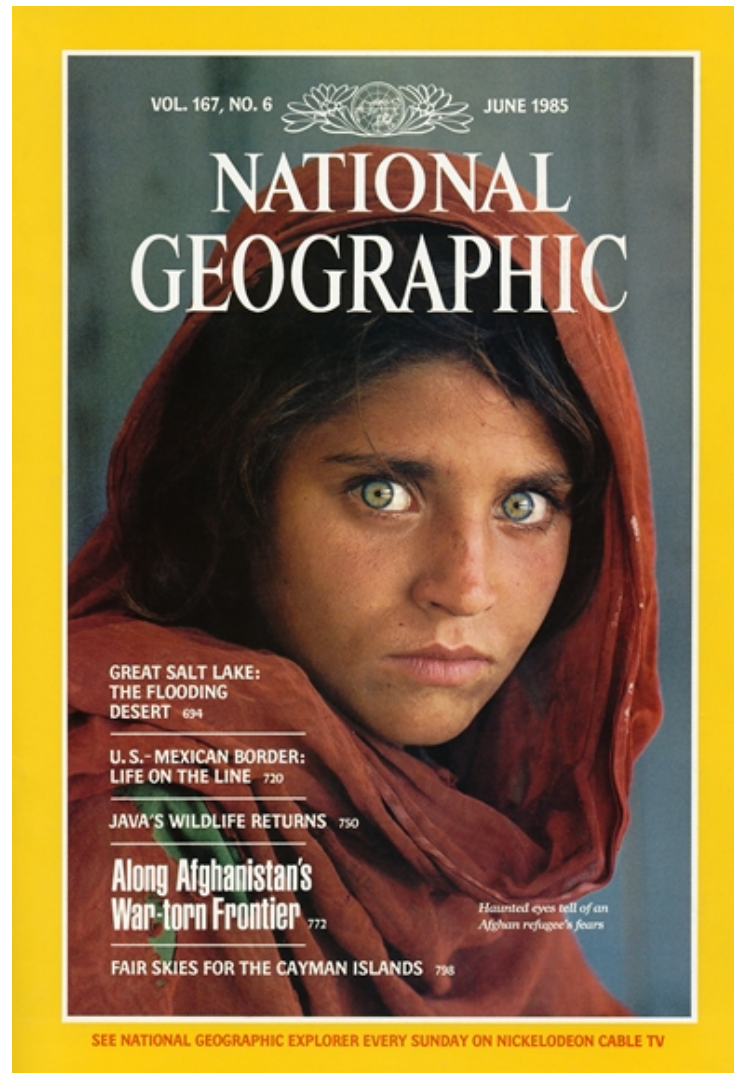
Object recognition (in supermarkets)



[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

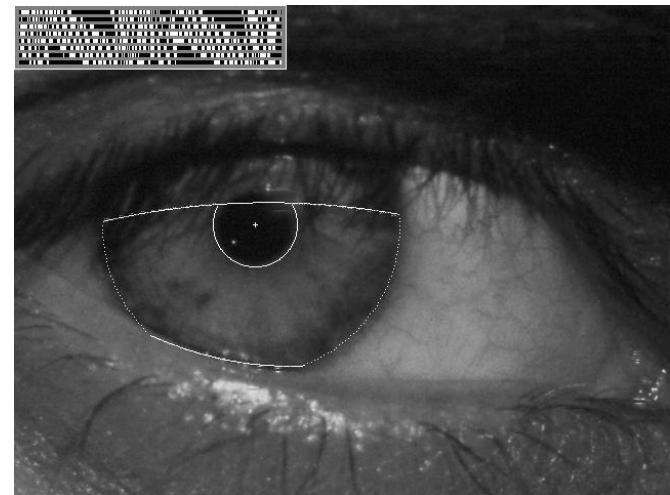
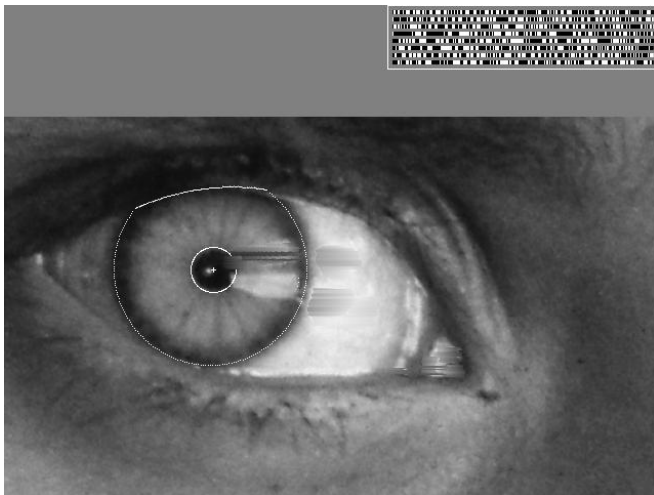


Who is she?

Vision-based biometrics



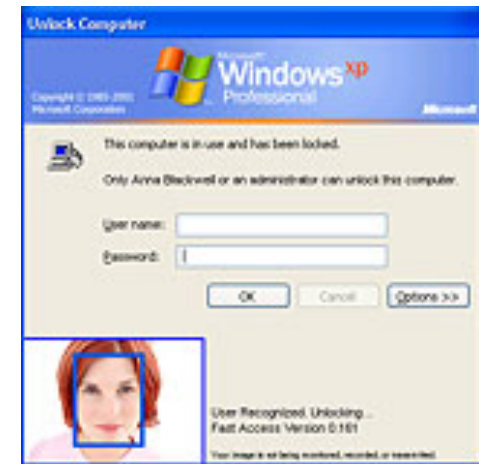
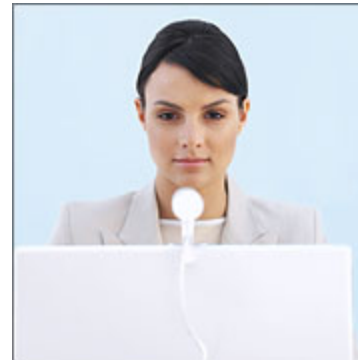
“How the Afghan Girl was Identified by Her Iris Patterns” Read the [story](#)



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 Caribbean, Industrial Light and Magic

Sports



Sportvision first down line
Nice [explanation](http://www.howstuffworks.com) on www.howstuffworks.com

Smart cars

Slide content courtesy of Amnon Shashua

The screenshot displays the Mobileye website with a top navigation bar containing 'manufacturer products' and 'consumer products'. The main banner features the slogan 'Our Vision. Your Safety.' above a car with three camera fields of view: 'rear looking camera', 'side looking camera', and 'forward looking camera'. Below the banner are three product sections: '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 dashboard display. A right sidebar includes 'News' with headlines about Volvo's collision warning system and 'Events' with mentions of Equip Auto and SEMA. Each section includes a 'read more' link.

manufacturer products consumer products

Our Vision. Your Safety.

rear looking camera

side looking camera

forward looking camera

EyeQ Vision on a Chip

Vision Applications
Road, Vehicle, Pedestrian Protection and more

AWS Advance Warning System

News

- > Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System
- > Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end
- > all news

Events

- > Mobileye at Equip Auto, Paris, France
- > Mobileye at SEMA, Las Vegas, NV
- > read more

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

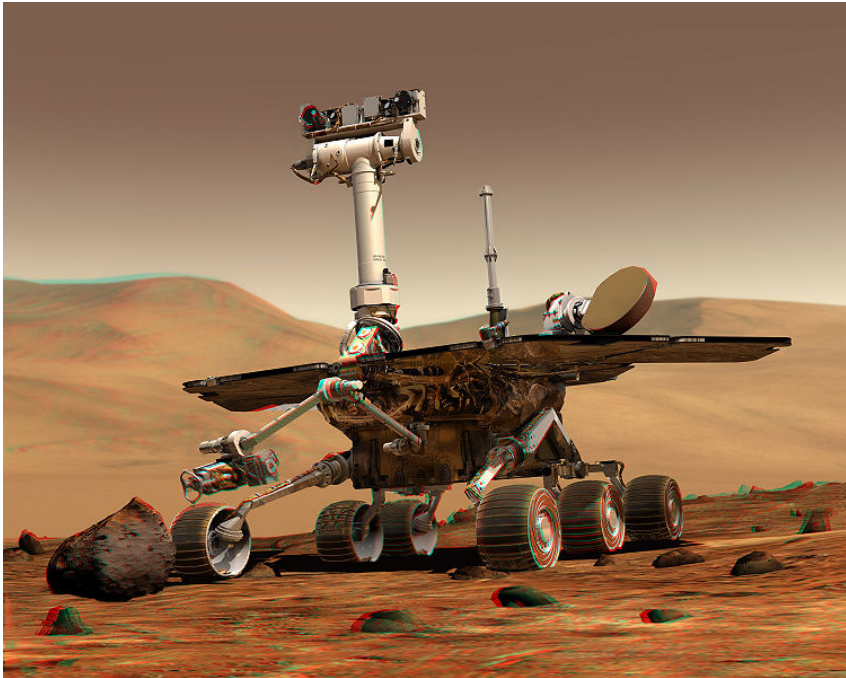


[NASA'S Mars Exploration Rover Spirit](#) captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

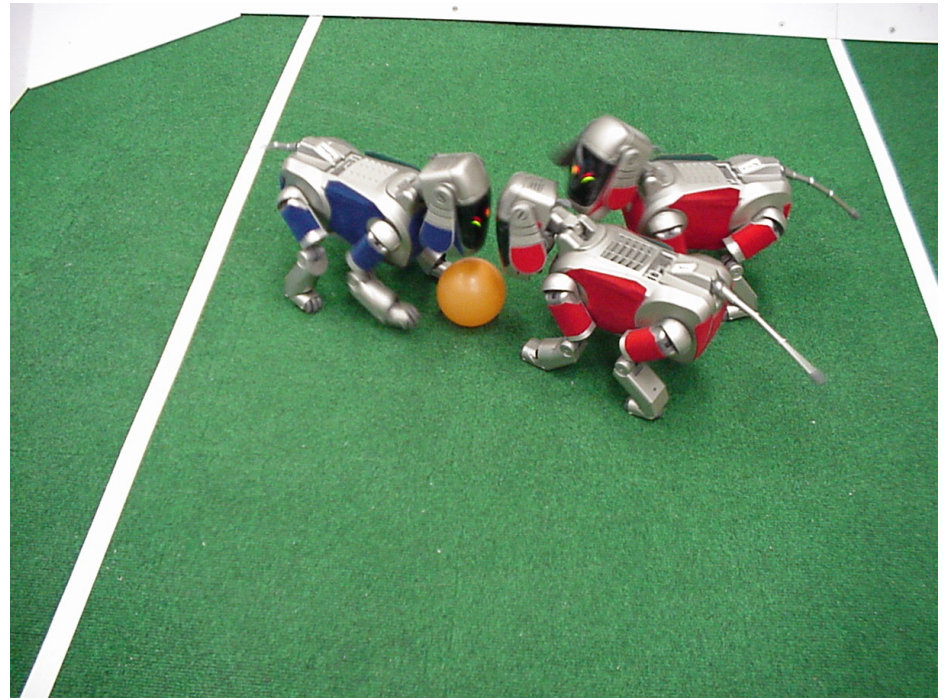
Vision systems (JPL) used for several tasks

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

Robotics

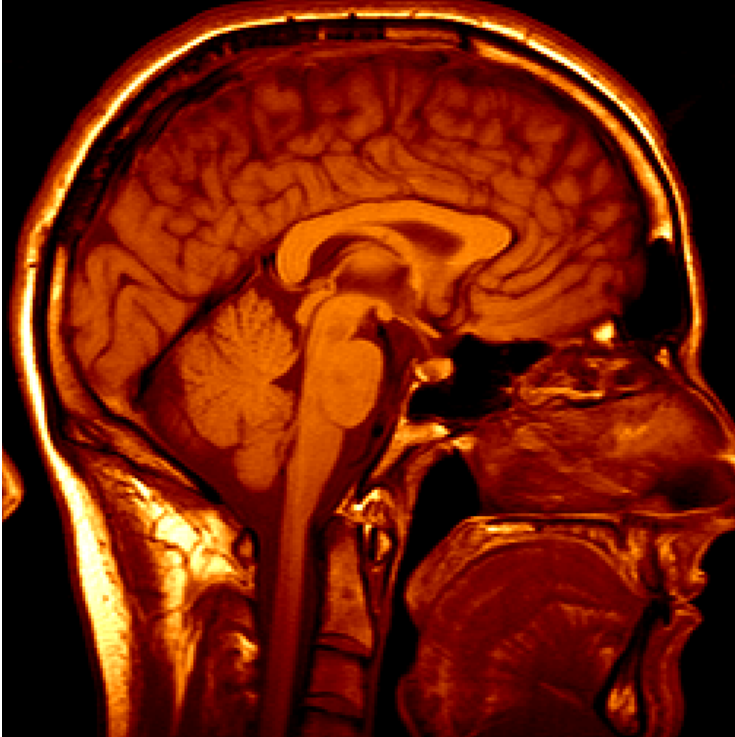


NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover



<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](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>

This course

<https://piazza.com/gmu/fall2013/cs482/home>

Grading

- Class attendance and participation 10%.
- Homeworks and projects 50% (about every 2 weeks).
- A midterm 20%.
- A final 20%.

General Comments

Prerequisites—*these are essential!*

- Data structures
- A good working knowledge of Python, Java, or C and C++ programming
 - We will use OpenCV and Matlab
- Linear algebra
- Vector calculus

Course does ***not*** assume prior imaging experience

- computer vision, image processing, graphics, etc.

You need to install OpenCV on your computer