

A detailed, steampunk-style mechanical scene. The central focus is a large, glowing blue lens or camera element, surrounded by intricate brass and copper gears, pipes, and mechanical components. The scene is lit with warm, golden light, creating a sense of depth and complexity. The overall aesthetic is reminiscent of a vintage camera's internal mechanism or a complex industrial machine.

CS 143: Introduction to Computer Vision

Instructor: James Hays

Computer Vision and Nearby Fields

- Computer Graphics: Models to Images
- Comp. Photography: Images to Images
- Computer Vision: Images to Models

Computer Vision

Make computers understand images and video.



What kind of scene?

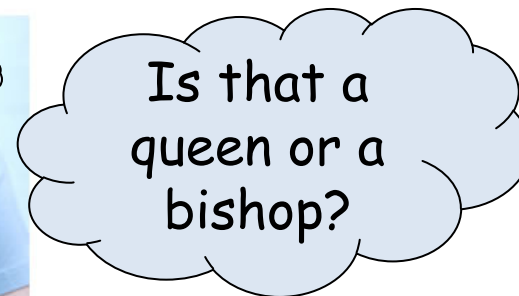
Where are the cars?

How far is the building?

...

Vision is really hard

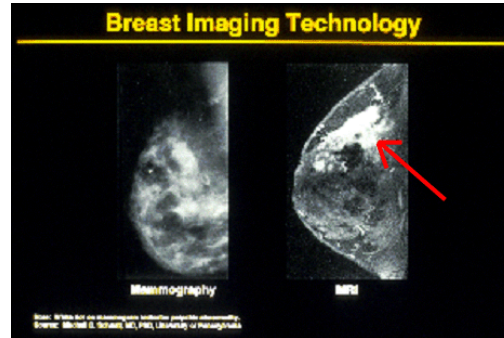
- Vision is an amazing feat of natural intelligence
 - Visual cortex occupies about 50% of Macaque brain
 - More human brain devoted to vision than anything else



Why computer vision matters



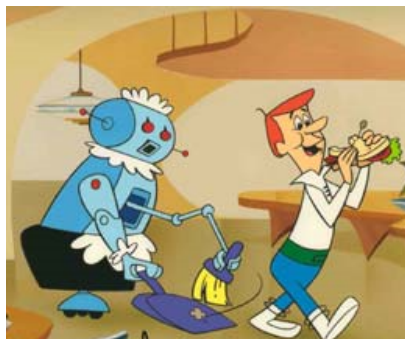
Safety



Health



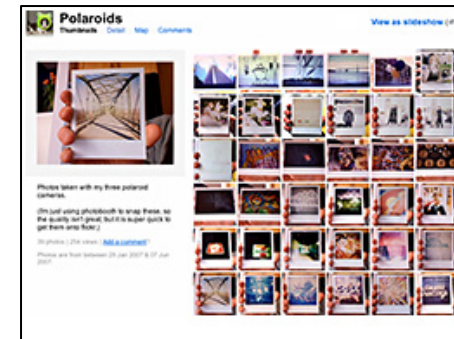
Security



Comfort



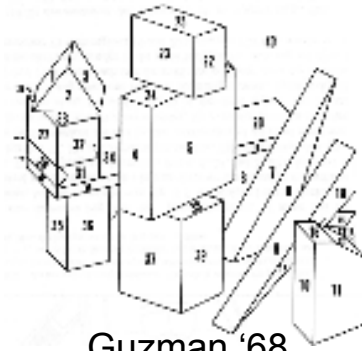
Fun



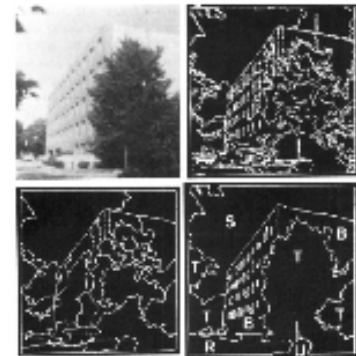
Access

Ridiculously brief history of computer vision

- 1966: Minsky assigns computer vision as an undergrad summer project
- 1960's: interpretation of synthetic worlds
- 1970's: some progress on interpreting selected images
- 1980's: ANNs come and go; shift toward geometry and increased mathematical rigor
- 1990's: face recognition; statistical analysis in vogue
- 2000's: broader recognition; large annotated datasets available; video processing starts



Guzman '68



Ohta Kanade '78



Turk and Pentland '91

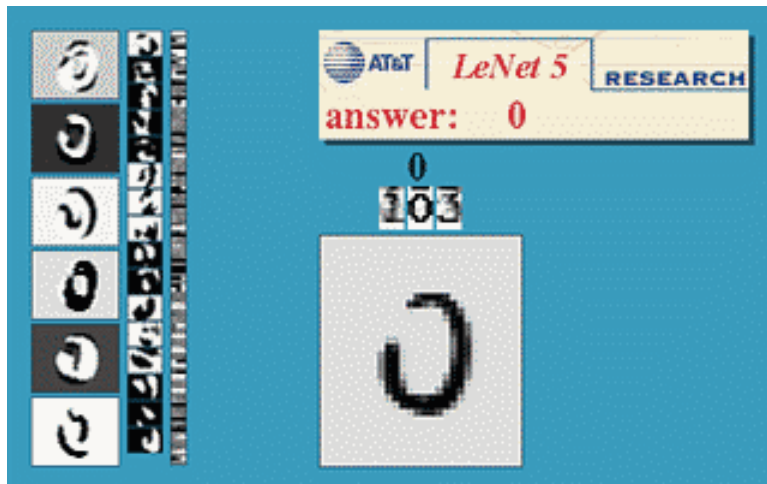
How vision is used now

- Examples of state-of-the-art

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



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

Face detection

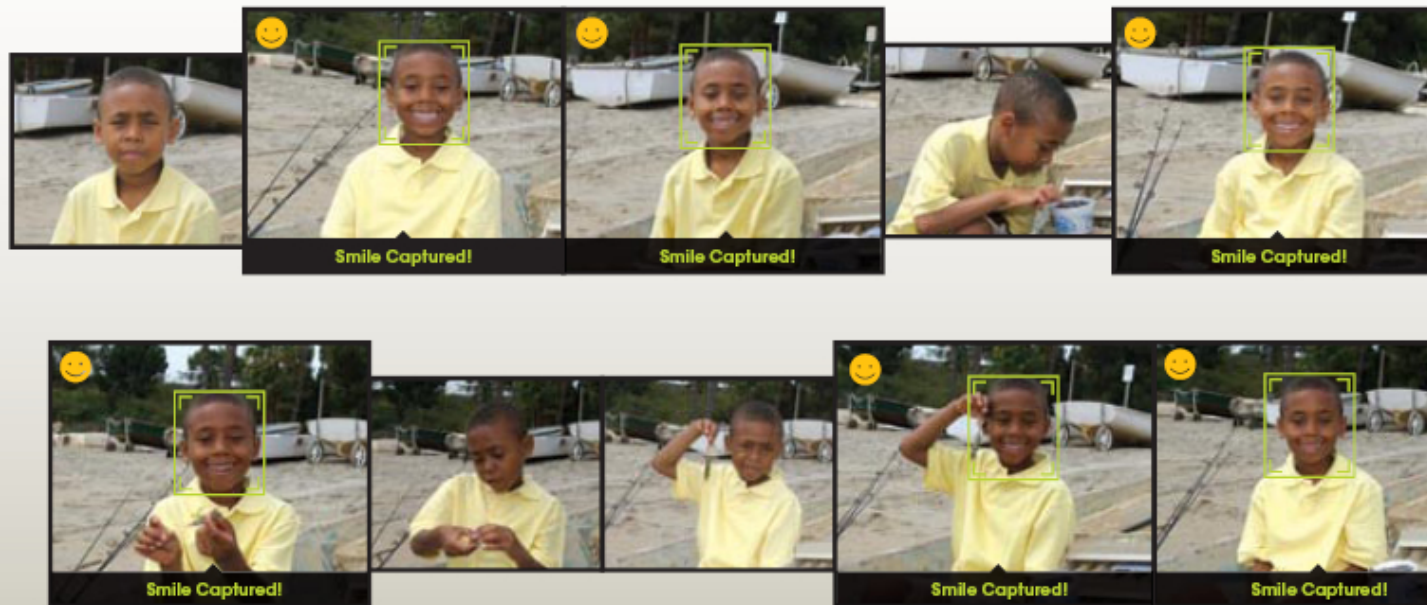


- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...

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](#)

3D from thousands of images



Object recognition (in supermarkets)



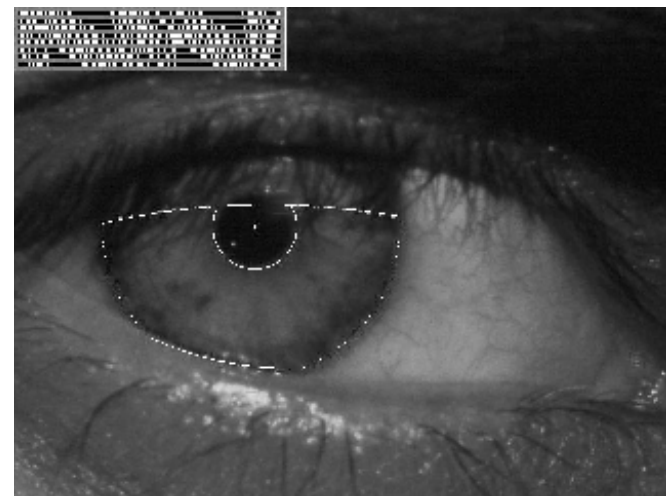
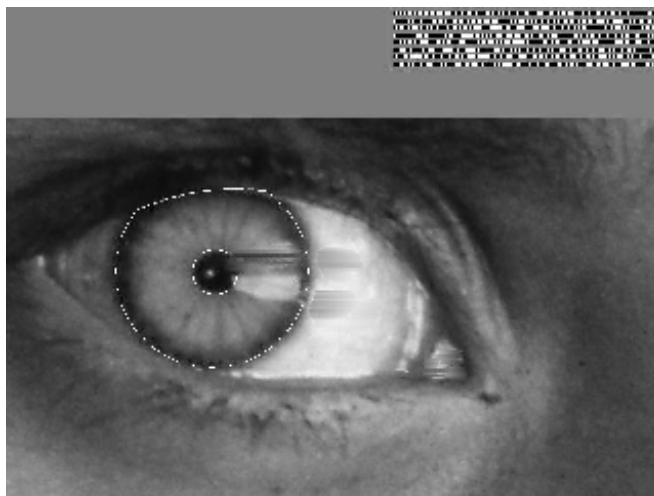
[LaneHawk by EvolutionRobotics](#)

“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... “

Vision-based biometrics



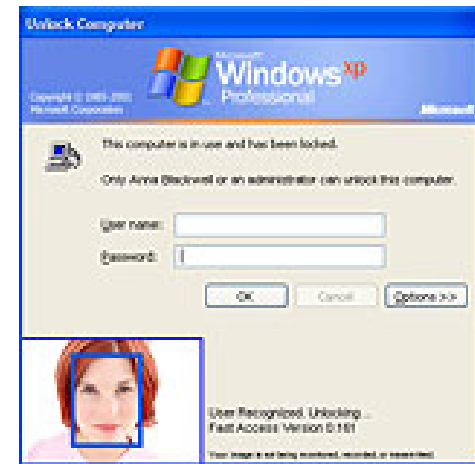
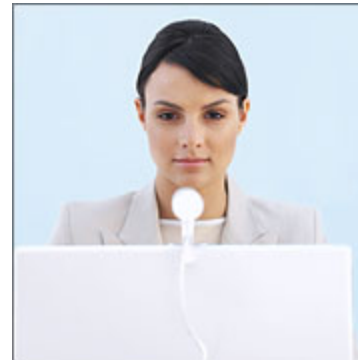
“How the Afghan Girl was Identified by Her Iris Patterns” Read the [story](#)
[wikipedia](#)



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)



[Point & Find, Nokia](#)

[Google Goggles](#)

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

<http://www.sportvision.com/video.html>

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, a top-down view of a car is shown with three camera fields of view: 'rear looking camera', 'side looking camera', and 'forward looking camera'. The bottom section features 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 with a list of recent updates and a 'read more' link.

- [Mobileye](#)

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

Google cars



<http://www.nytimes.com/2010/10/10/science/10google.html?ref=artificialintelligence>

Vision-based interaction (and games)



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](#)!



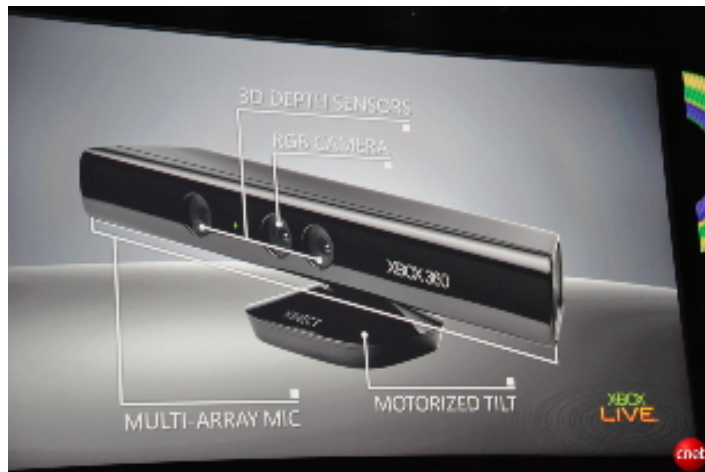
[Digimask](#): put your face on a 3D avatar.



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

Interactive Games: Kinect

- Object Recognition: <http://www.youtube.com/watch?feature=iv&v=fQ59dXOo63>
[o](#)
- Mario: <http://www.youtube.com/watch?v=8CTJL5IUjHg>
- 3D: <http://www.youtube.com/watch?v=7QrnwoO1-8A>
- Robot: <http://www.youtube.com/watch?v=w8BmgtMKFbY>



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

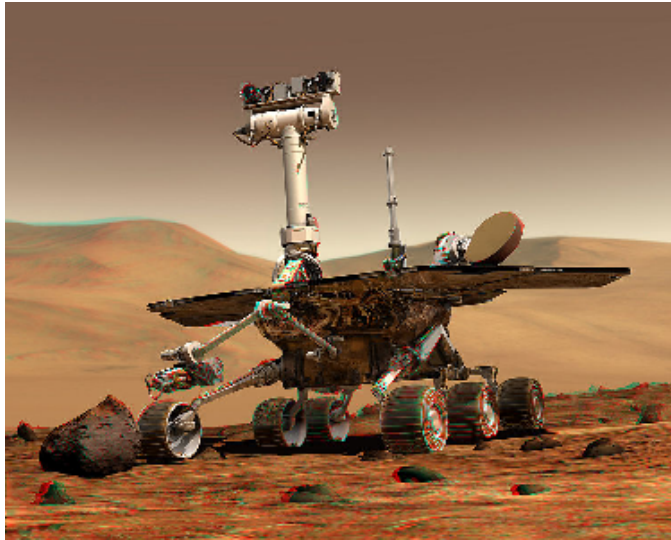
- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read “[Computer Vision on Mars](#)” by Matthies et al.

Industrial robots

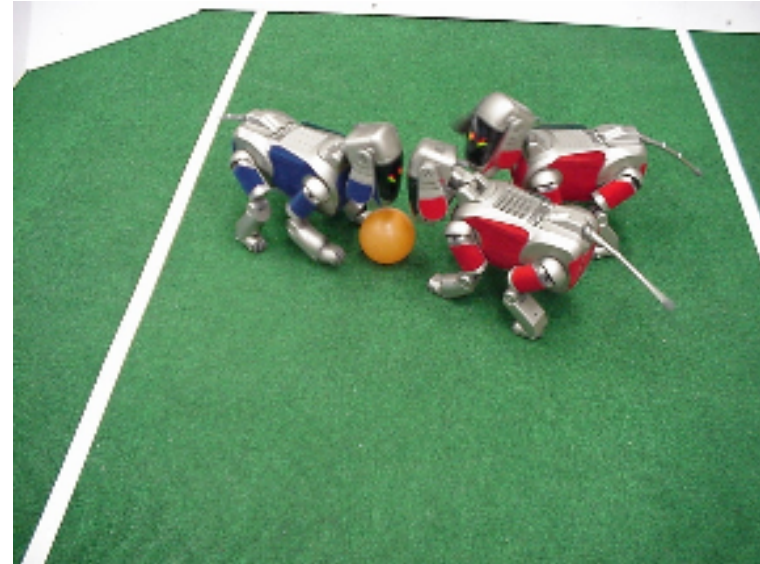


Vision-guided robots position nut runners on wheels

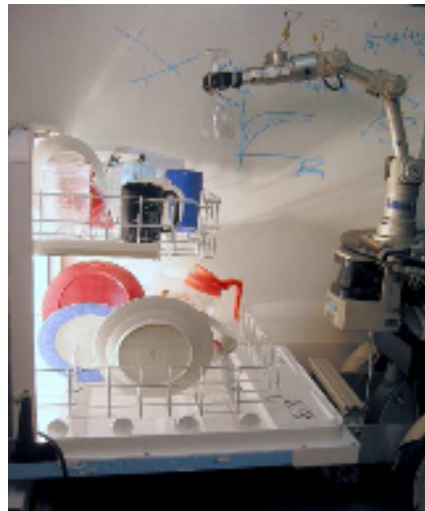
Mobile robots



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

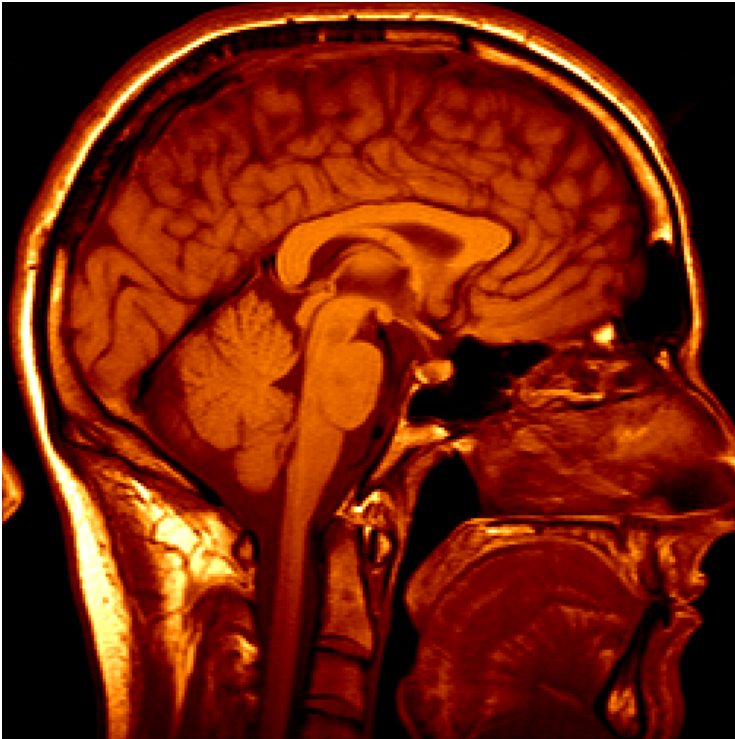


<http://www.robocup.org/>



Saxena et al. 2008
[STAIR](#) at Stanford

Medical imaging



3D imaging
MRI, CT



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