# CS 143:
# Introduction to Computer Vision


Instructor: James Hays
TAs: Evan Wallace (HTA), Sam Birch,
Paul Sastrasinh, Libin “Geoffrey” Sun

Image by
kirkh.deviantart.com

# Today's Class

- Introductions
- What is Computer Vision?
- Computer Vision at Brown
- Specifics of this course
- Questions

# A bit about me

# Thesis: Large Scale Scene Matching for Graphics and Vision

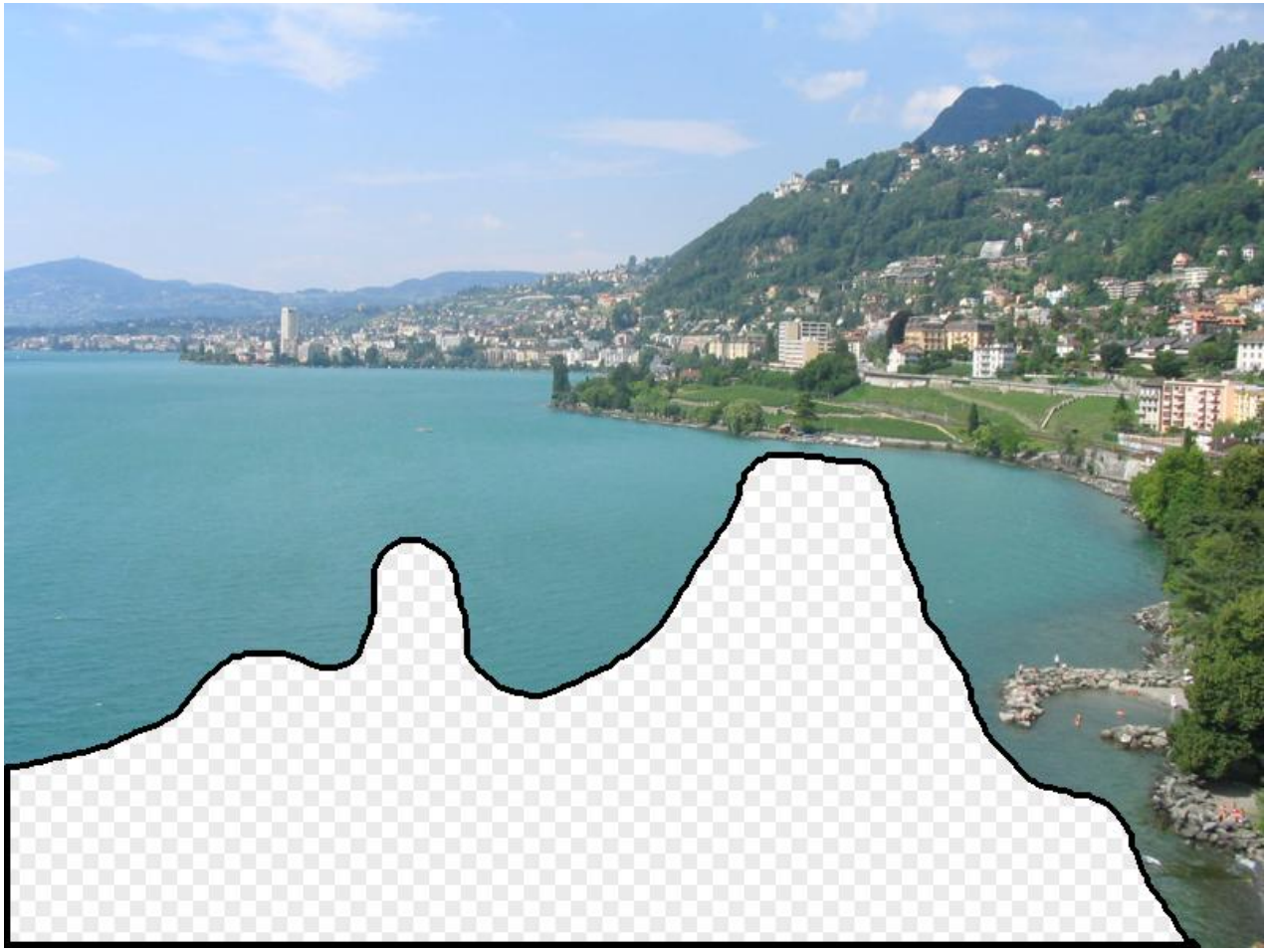
## Thesis

**hays_thesis.pdf**, 107MB

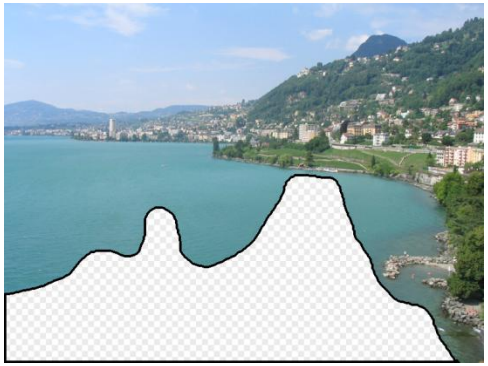
## Committee

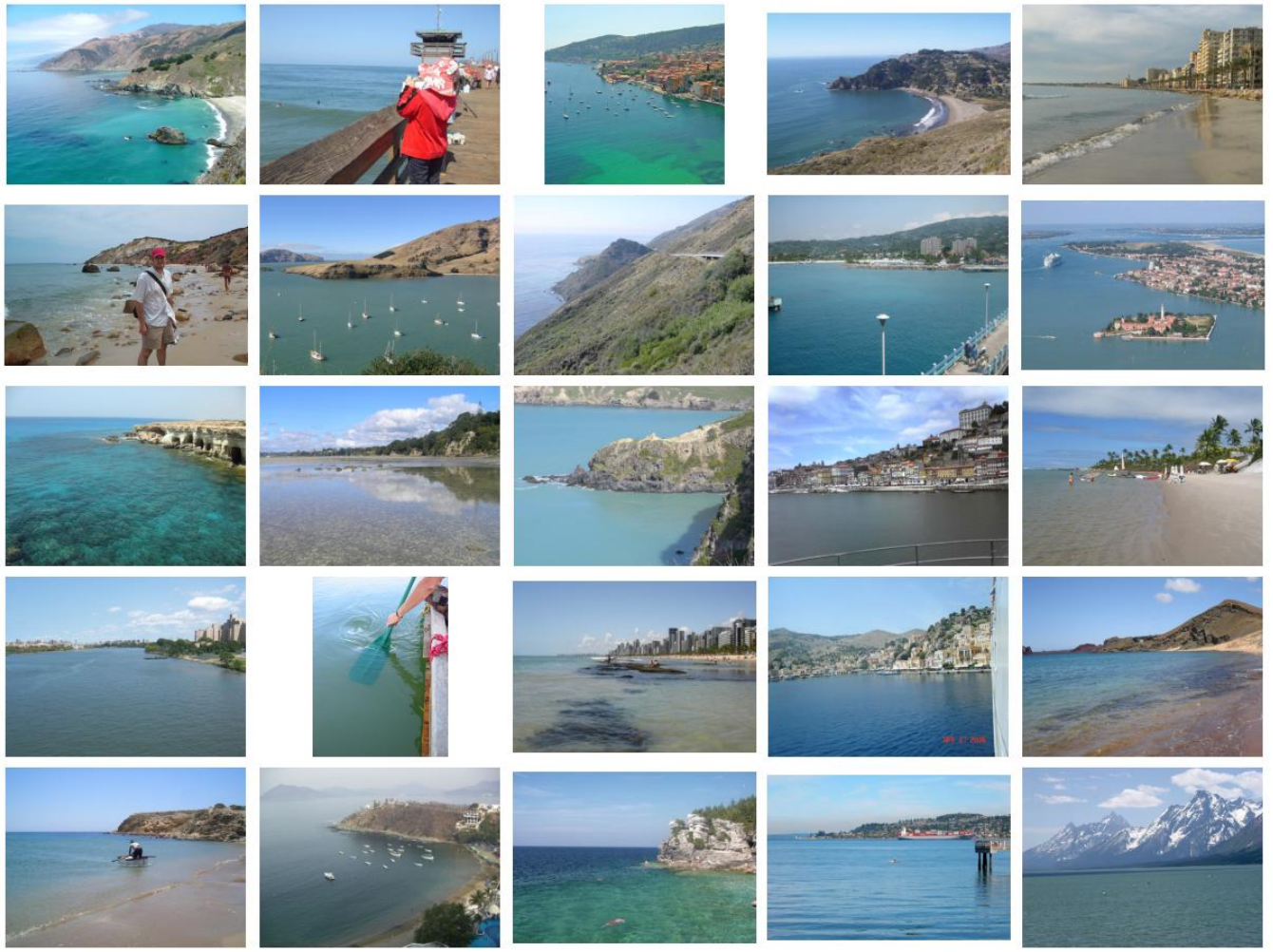
- **Alexei A. Efros** (chair)
- **Martial Hebert**
- **Jessica K. Hodgins**
- **Takeo Kanade**
- **Richard Szeliski**, Microsoft Research

# Scene Completion



[Hays and Efros. Scene Completion Using Millions of Photographs. SIGGRAPH 2007 and CACM October 2008.]





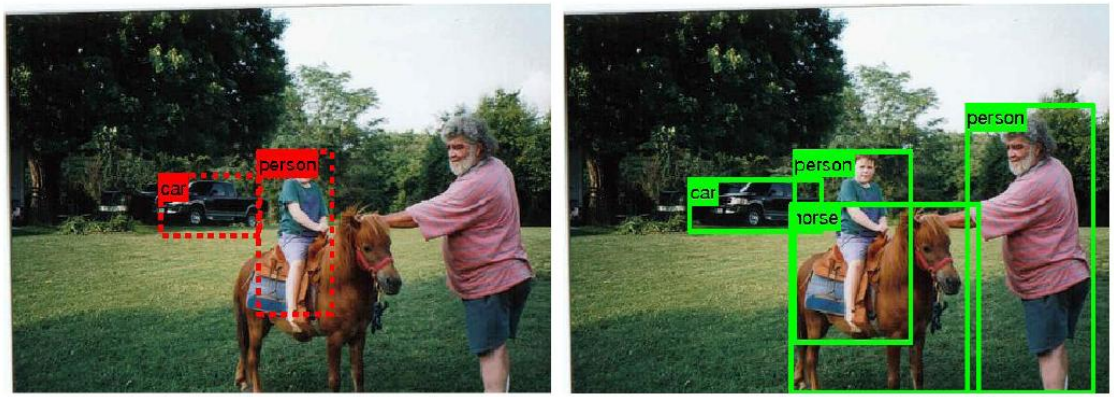
Nearest neighbor scenes from database of 2.3 million photos


Graph cut + Poisson blending

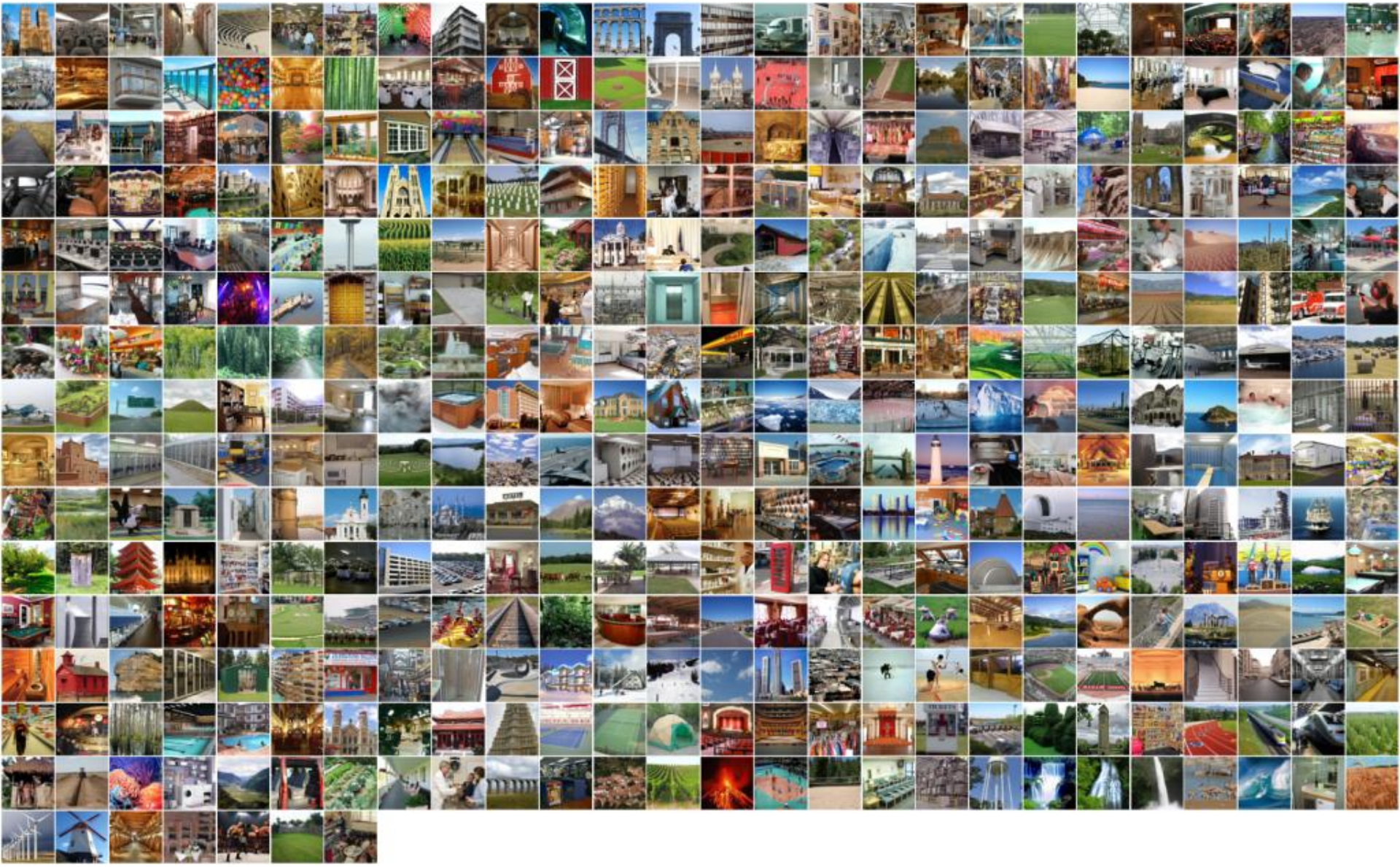
# My Research

IM2GPS: estimating geographic information from a single image

An Empirical Study of Context in Object Detection

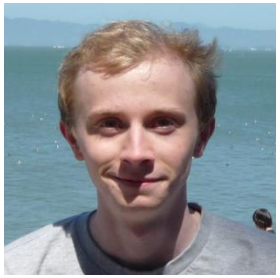


# Categories of the SUN database



# CS 143 TAs

Evan Wallace (HTA)



Sam Birch

Paul Sastrasinh

Libin “Geoffrey” Sun

# What is Computer Vision?

# 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?

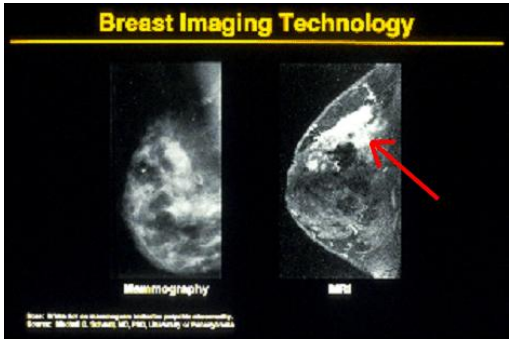
…

# 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

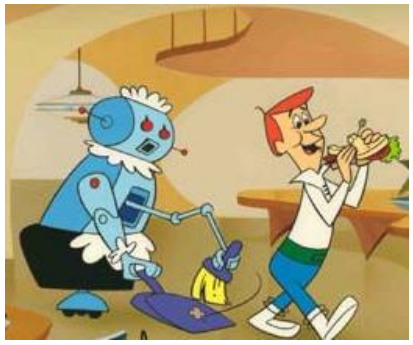
# Why computer vision matters

Safety



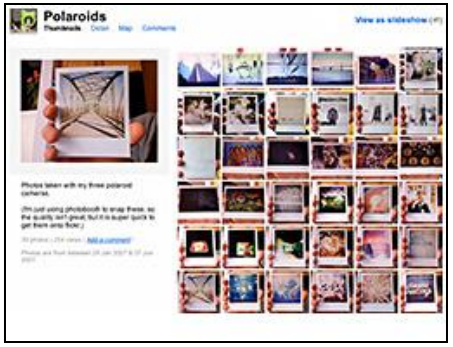

Health

Security



Comfort

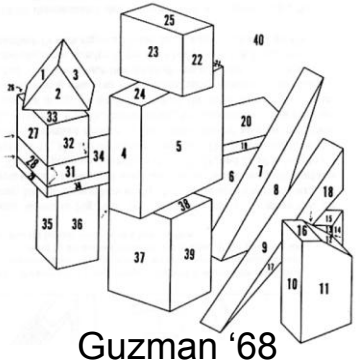
Fun



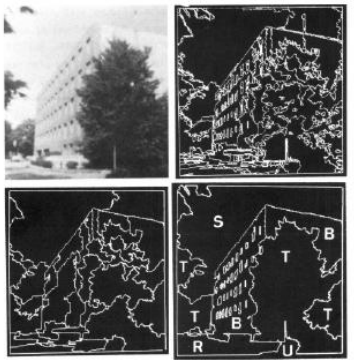

Access

# Ridiculously brief history of computer vision

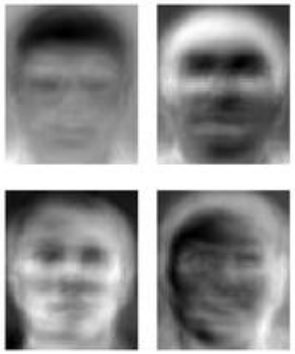
- 1966: Minsky assigns computer vision as an undergrad summer project
- 1960's: interpretation of synthetic worlds
- 1970's: some progress on interpreting selected images
- 1980's: ANNs come and go; shift toward geometry and increased mathematical rigor
- 1990's: face recognition; statistical analysis 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

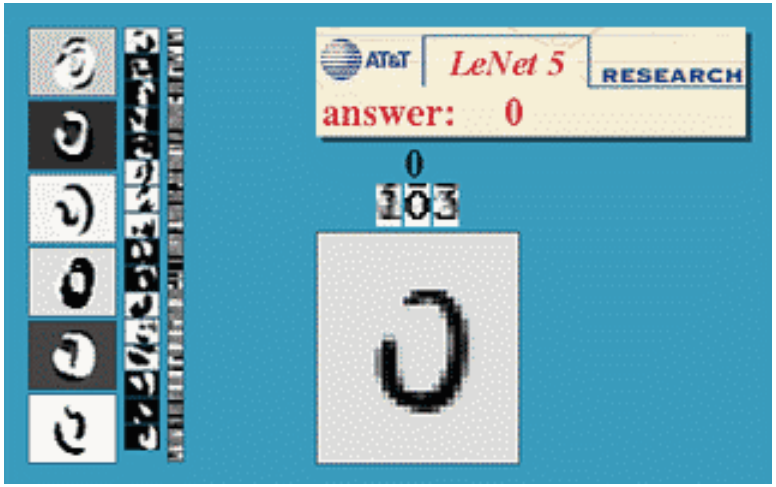
- Examples of state-of-the-art

Some of the following slides by Steve Seitz

# Optical character recognition (OCR)

## Technology to convert scanned docs to text

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



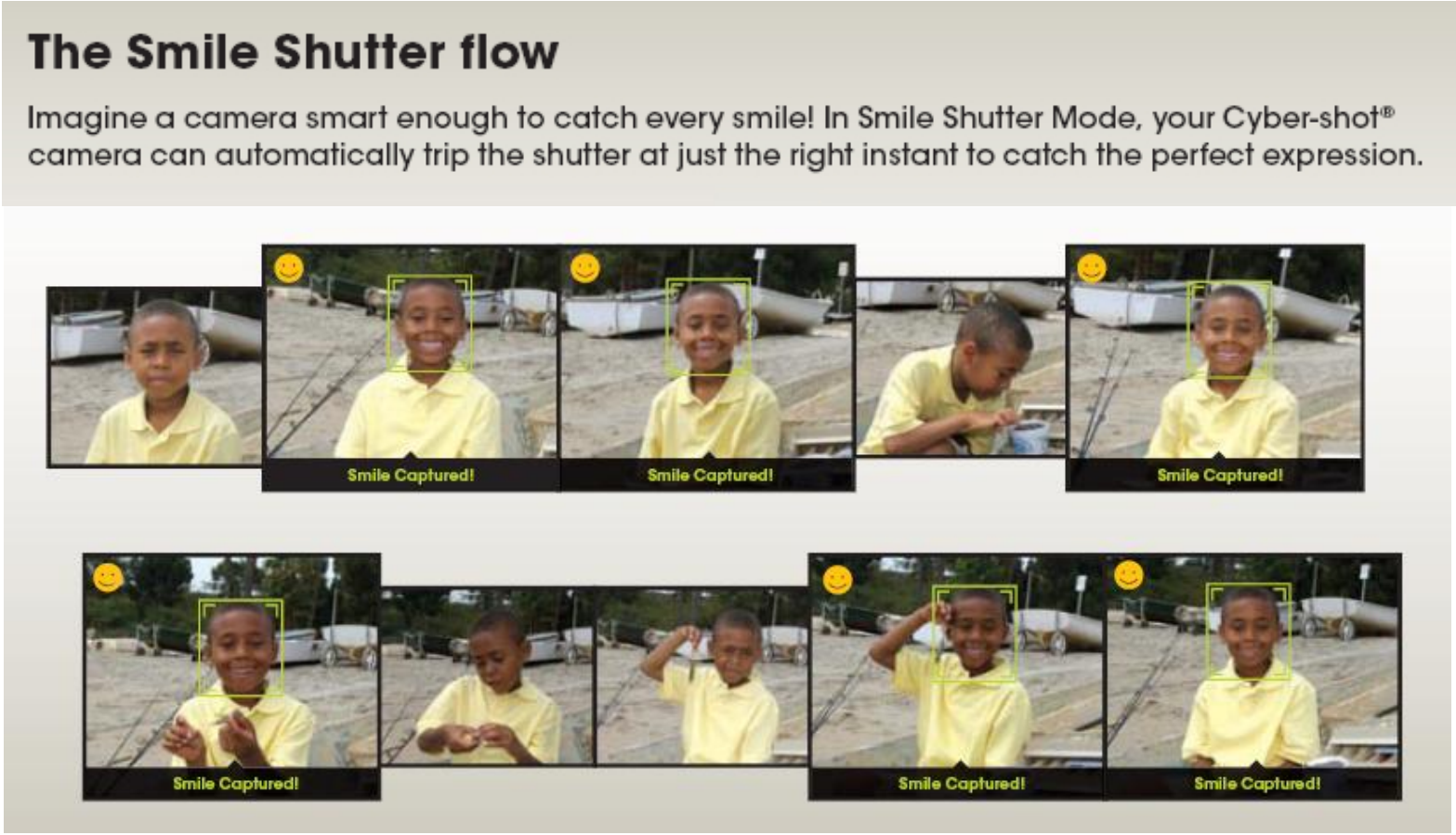

Digit recognition, AT&T labs
http://www.research.att.com/~yann/


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




[Sony Cyber-shot® T70 Digital Still Camera ]

# 3D from thousands of images

Building Rome in a Day: Agarwal et al. 2009

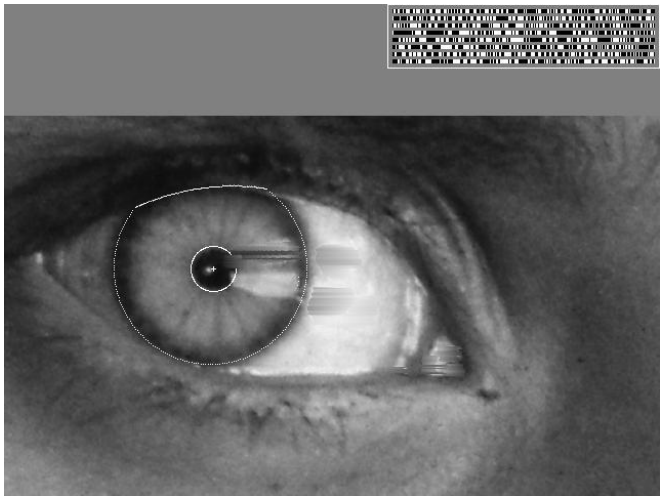
# Object recognition (in supermarkets)

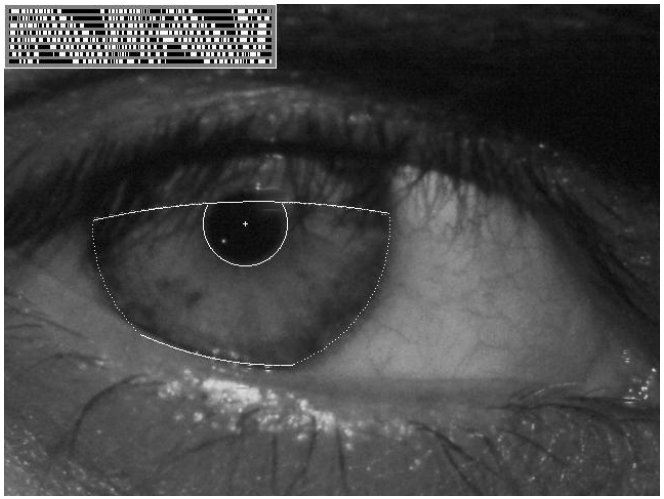

LaneHawk by EvolutionRobotics

“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 Carribean*, Industrial Light and Magic

# Sports


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

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

# Smart cars

Slide content courtesy of Amnon Shashua

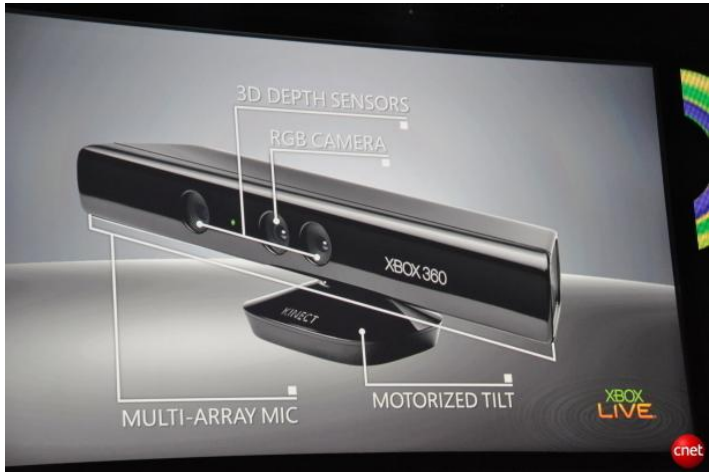

- Mobileye
  - Vision systems currently in high-end BMW, GM, Volvo models
  - By 2010: 70% of car manufacturers.

# Google cars

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

# Interactive Games: Kinect

- Object Recognition: http://www.youtube.com/watch?feature=iv&v=fQ59dXOo63o
- Mario: http://www.youtube.com/watch?v=8CTJL5lUjHg
- 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.

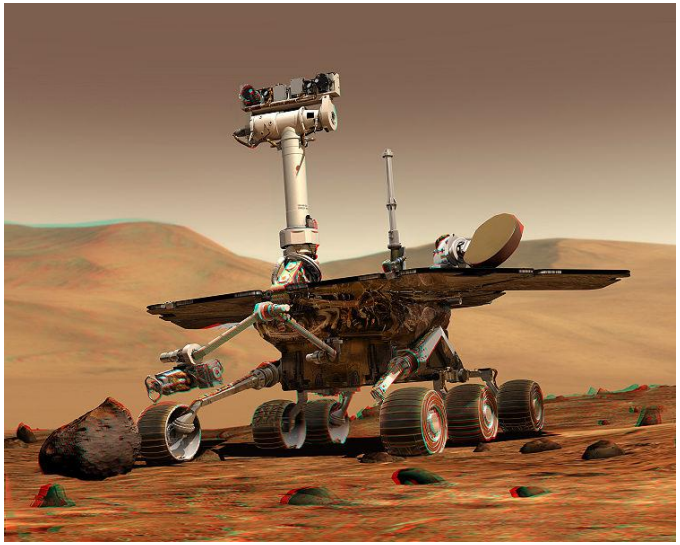
## Vision systems (JPL) used for several tasks

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

# Industrial robots

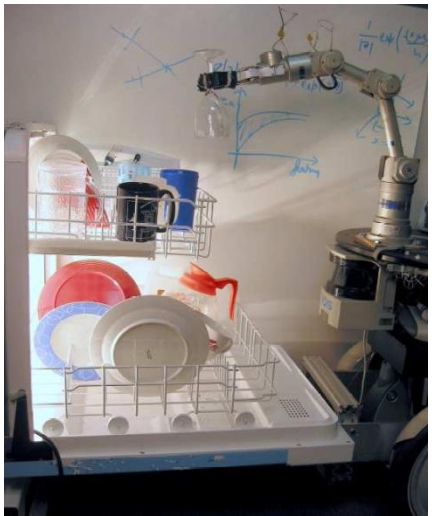

Vision-guided robots position nut runners on wheels

# Mobile robots



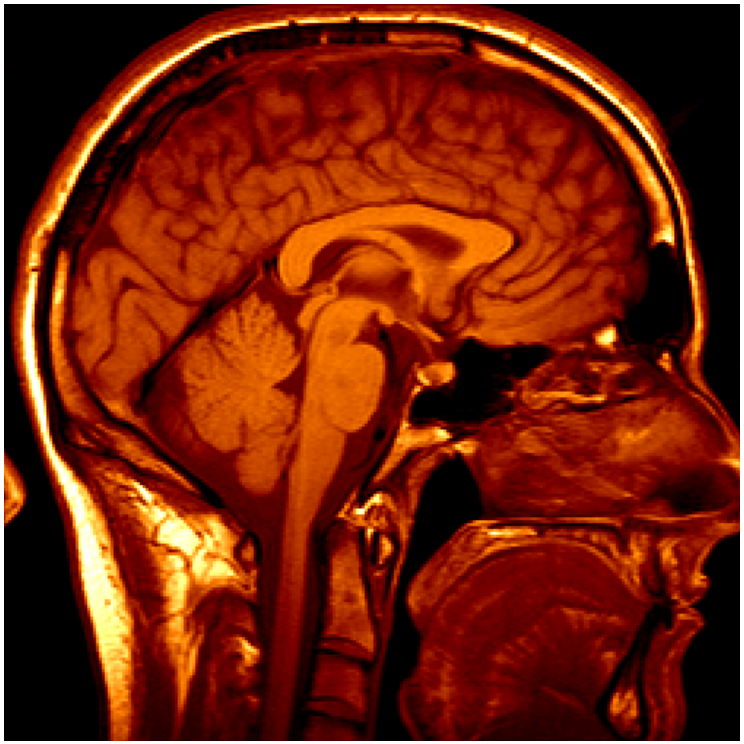
NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover

http://www.robocup.org/



Saxena et al. 2008
STAIR at Stanford

# Medical imaging



3D imaging
MRI, CT

Image guided surgery
Grimson et al., MIT

# Computer Vision at Brown

CS



Other departments








# Course Syllabus

- http://www.cs.brown.edu/courses/csci1430/

# Projects

- Hybrid images with Laplacian pyramids
- pB Lite: learning image boundaries
- Scene recognition with bag of words
- Face Detection
- Structure from Motion
- Your choice for final project