CS 143: Introduction to Computer Vision

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

Is that a queen or a bishop?
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
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

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

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

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

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.

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

Vision-guided robots position nut runners on wheels
Mobile robots

NASA’s Mars 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

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