CSE 455: Computer Vision

Instructors

Neel Joshi
neel@cs

Ira Kemelmacher
kemelmi@cs

Ian Simon
iansimon@cs

TAs

Rahul Garg
 rahul@cs

Jiun-Hung Chen
 jhchen@cs

Web Page

- http://www.cs.washington.edu/455

Time: MWF 1:30-2:20pm
Place: EEB 037

Today

- Course administration
- Computer vision overview
- Projects overview

Course Info

- We expect you to have:
    - Programming experience
    - Experience with basic Linear algebra
    - Experience with Vector calculus
    - Creativity and enthusiasm
- All programming projects will use MATLAB
- Course does **not** assume prior
    - Matlab experience
    - Imaging experience -- computer vision, image processing, graphics, etc.

- Textbook: CSE 455 Course Reader, available at UW Bookstore in the CSE textbook area

Topics

- Images
- Filtering
- Content-aware image resizing
- Edge and corner detection
- Resampling
- Segmentation, Recognition
- Cameras, geometry, features
- panoramas
- Structure from Motion
- Light, color, reflection
- Stereo, motion

- January 8 – MATLAB tutorial

Grading

Programming Projects (70%)

1. Seam-carving (in two parts), part 1 – solo, part 2 – in pairs.
2. Face recognition (eigenfaces) – solo.
3. Panoramas - in pairs.
4. Photometric stereo – solo.

Midterm (15%)

Final (15%)

Late projects will be penalized by 33% for each day it is late, and no extra credit will be awarded.

Questions?
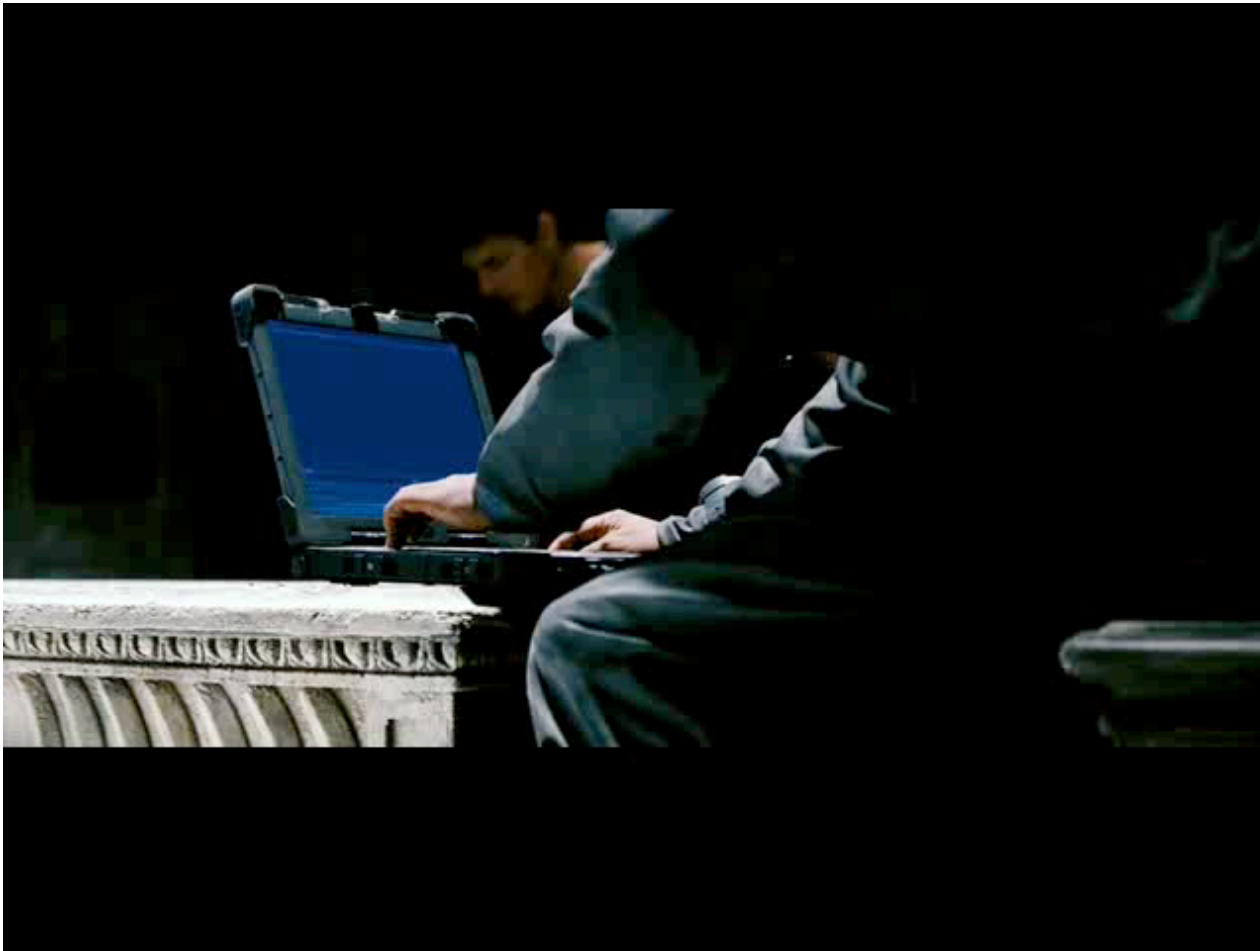
What is computer vision?

What is computer vision?

Compute properties of the three-dimensional world from digital images

Computer vision according to Hollywood

Computer vision according to Hollywood

Computer vision according to Hollywood

Every picture tells a story

La Gare Montparnasse, 1895

Can a computer infer what happened from the image?

The goal of computer vision

La Gare Montparnasse, 1895

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

Can computers match (or beat) human vision?

La Gare Montparnasse, 1895

Yes and no (but mostly no!)

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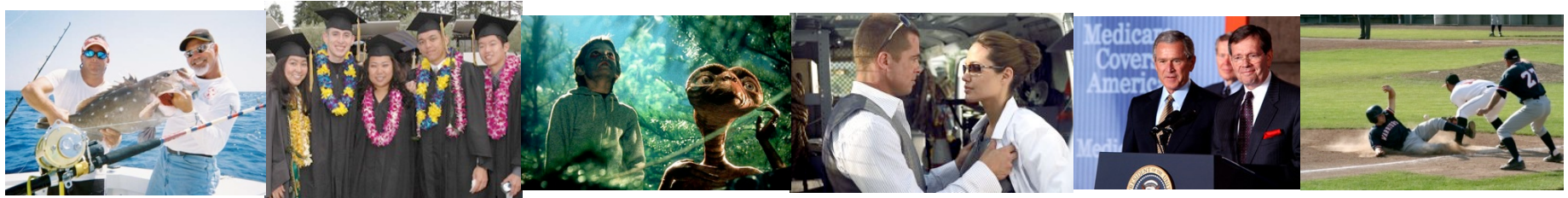- computers can be better at "easy" things

Human perception has its shortcomings…

Sinha and Poggio, *Nature*, 1996
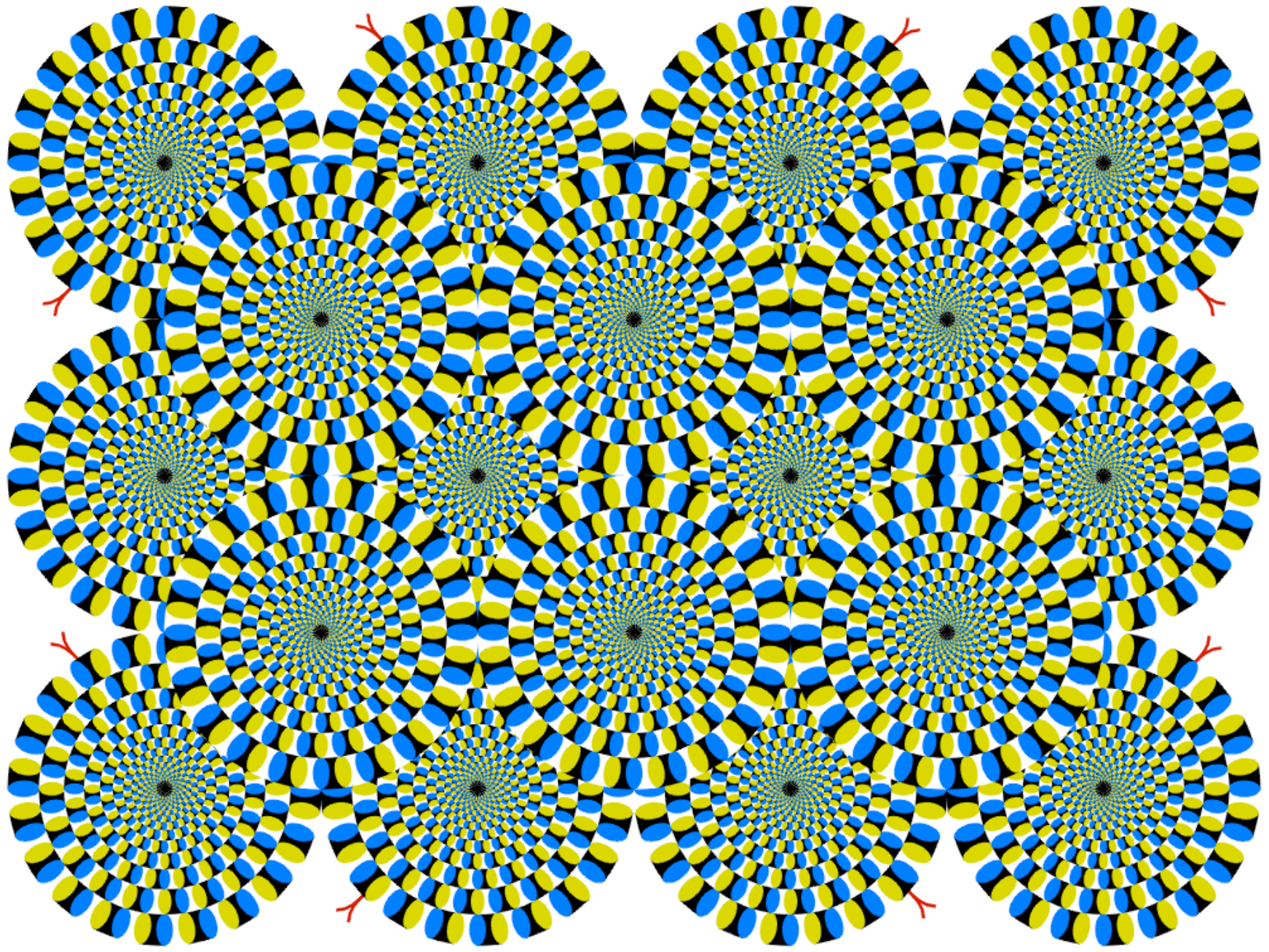
Copyright

Why study computer vision?

- Millions of images being captured all the time
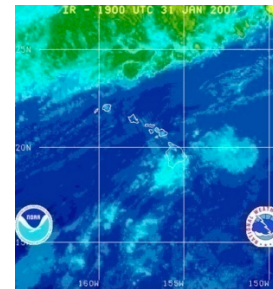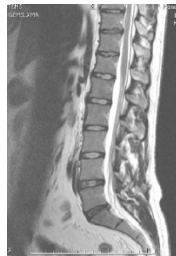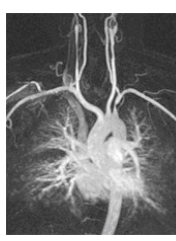
- Lots of useful applications
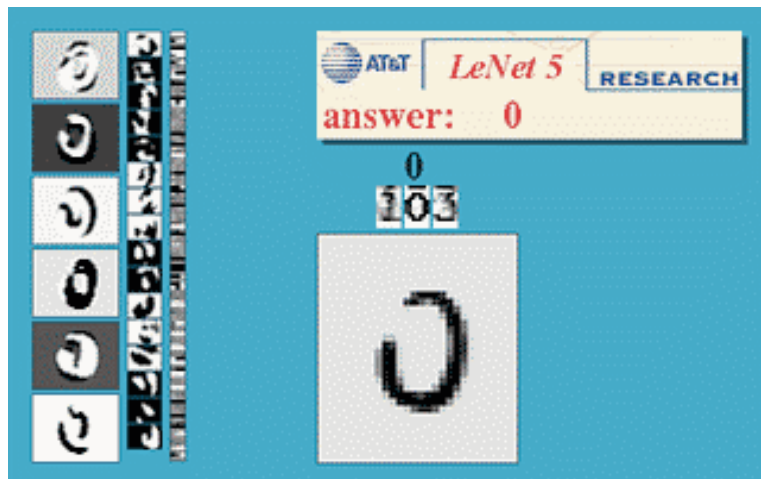- The next slides show the current state of the art

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
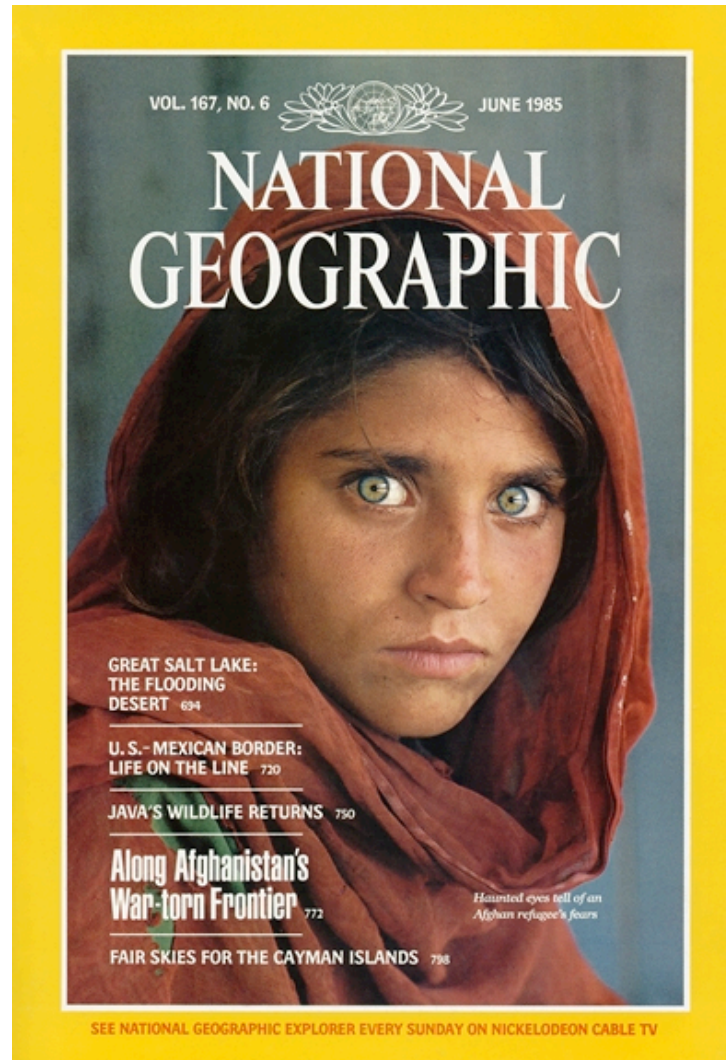
- Canon, Sony, Fuji, …

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.
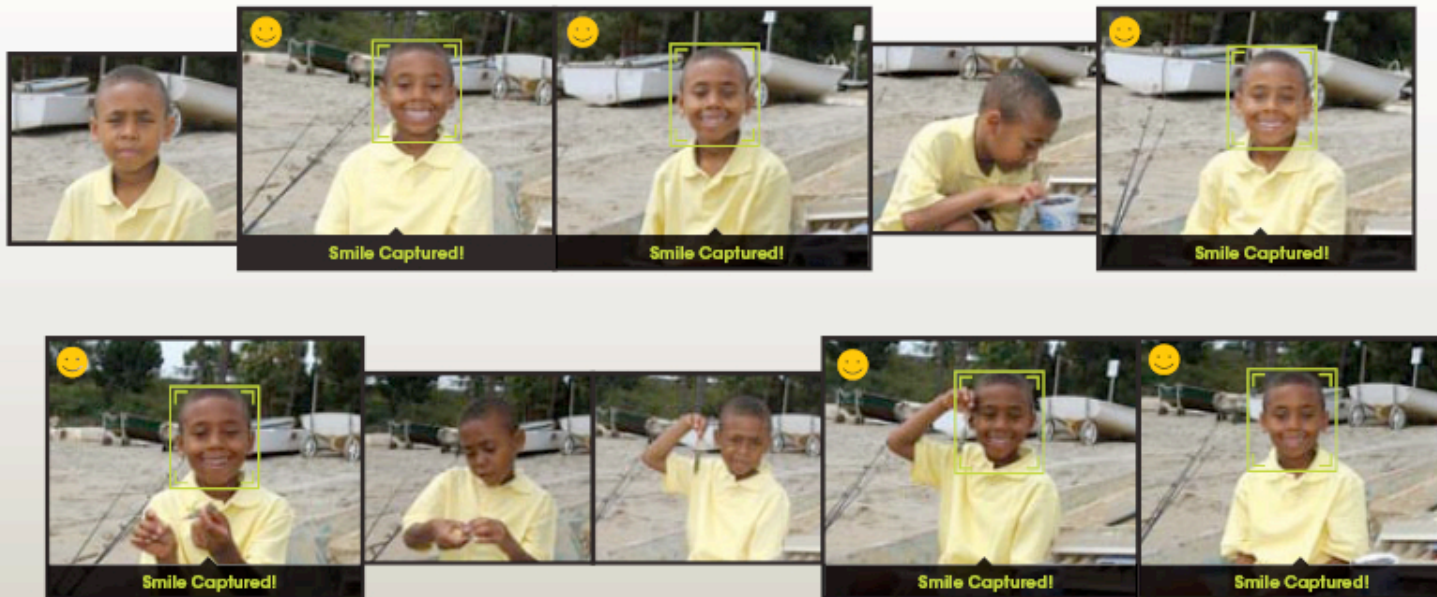
[Sony Cyber-shot® T70 Digital Still Camera](#)

Face recognition

Sharbat Gula at age 12 in an Afgan refugee camp in 1984

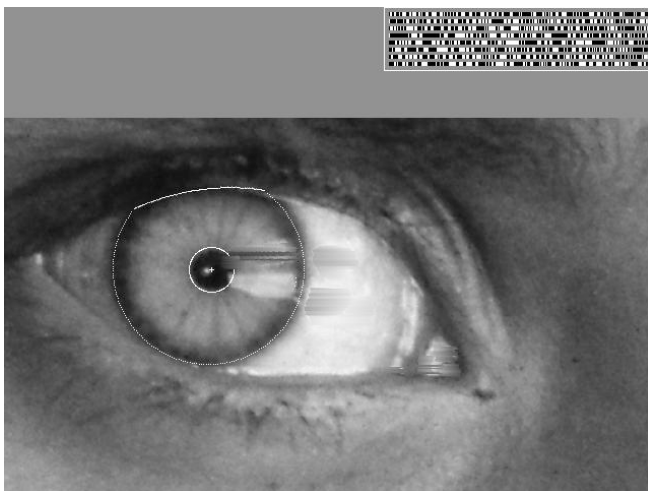Traced in 2002 but is she the same person?
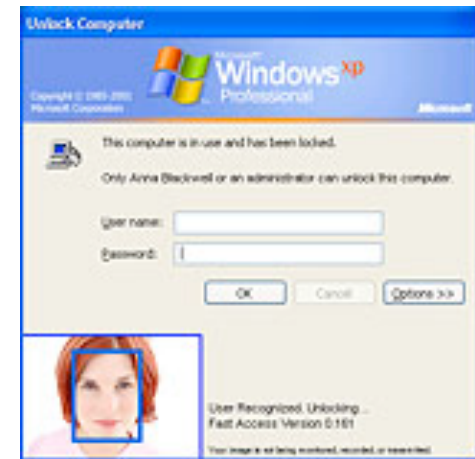
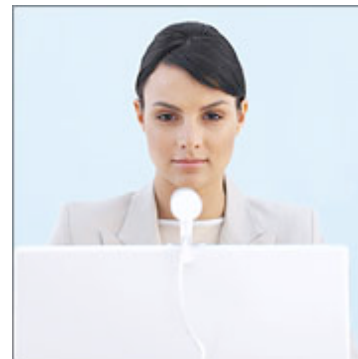Who is she?

Vision-based biometrics

1984

2002

"*How the Afghan Girl was Identified by Her Iris Patterns*" Read the story
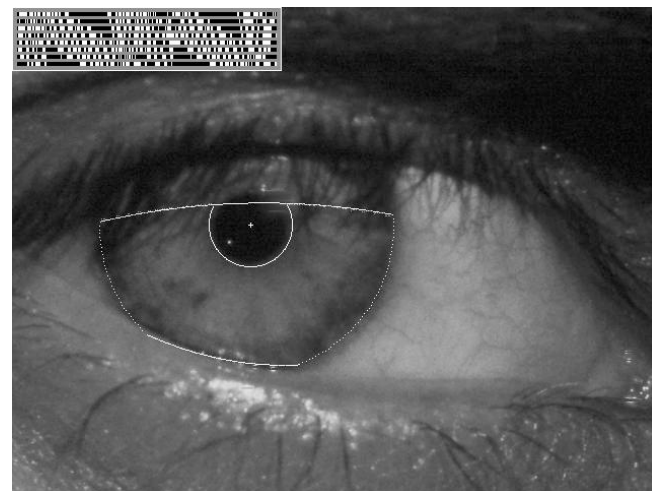
Login without a password…

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
- [Point & Find](), [Nokia]()

Earth viewers (3D modeling)
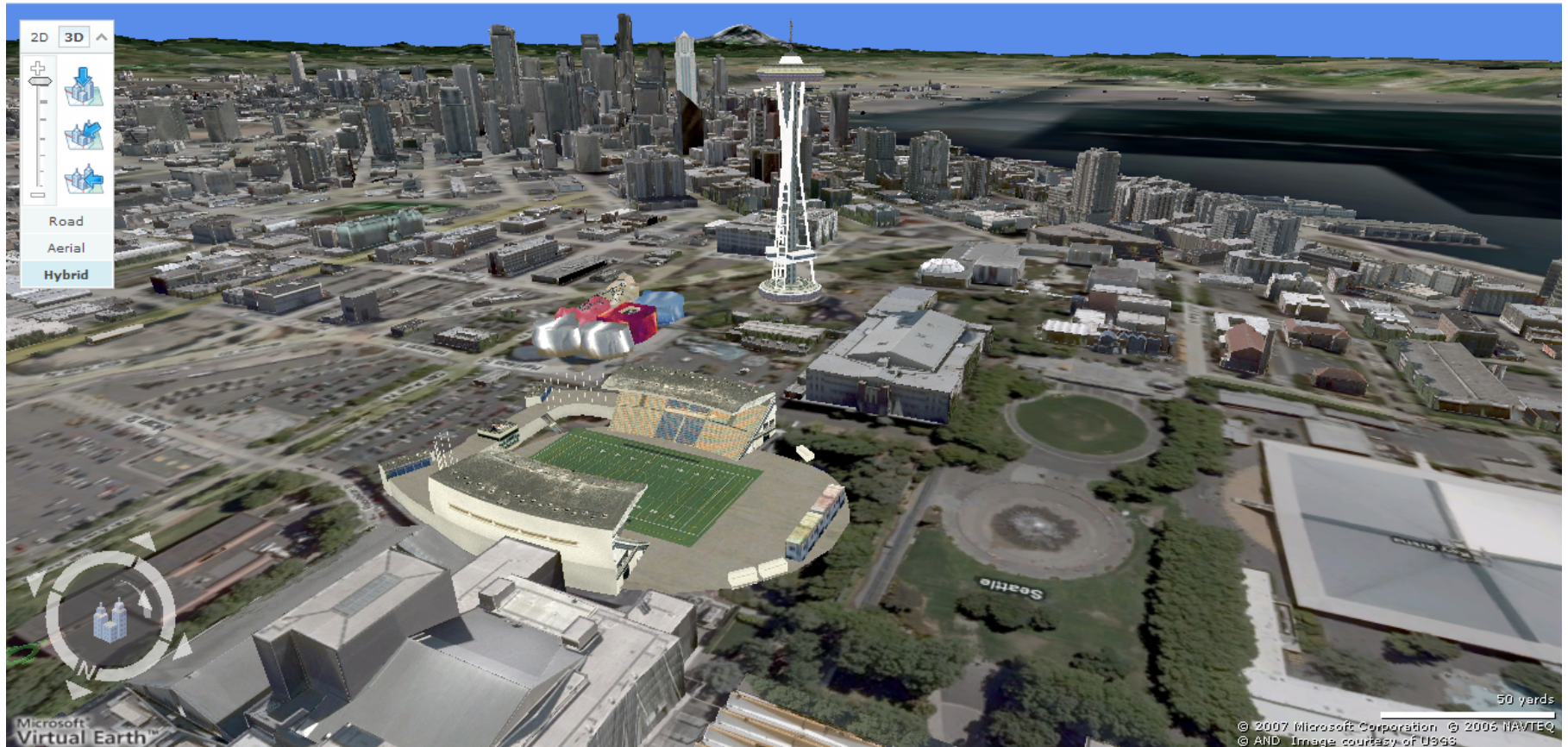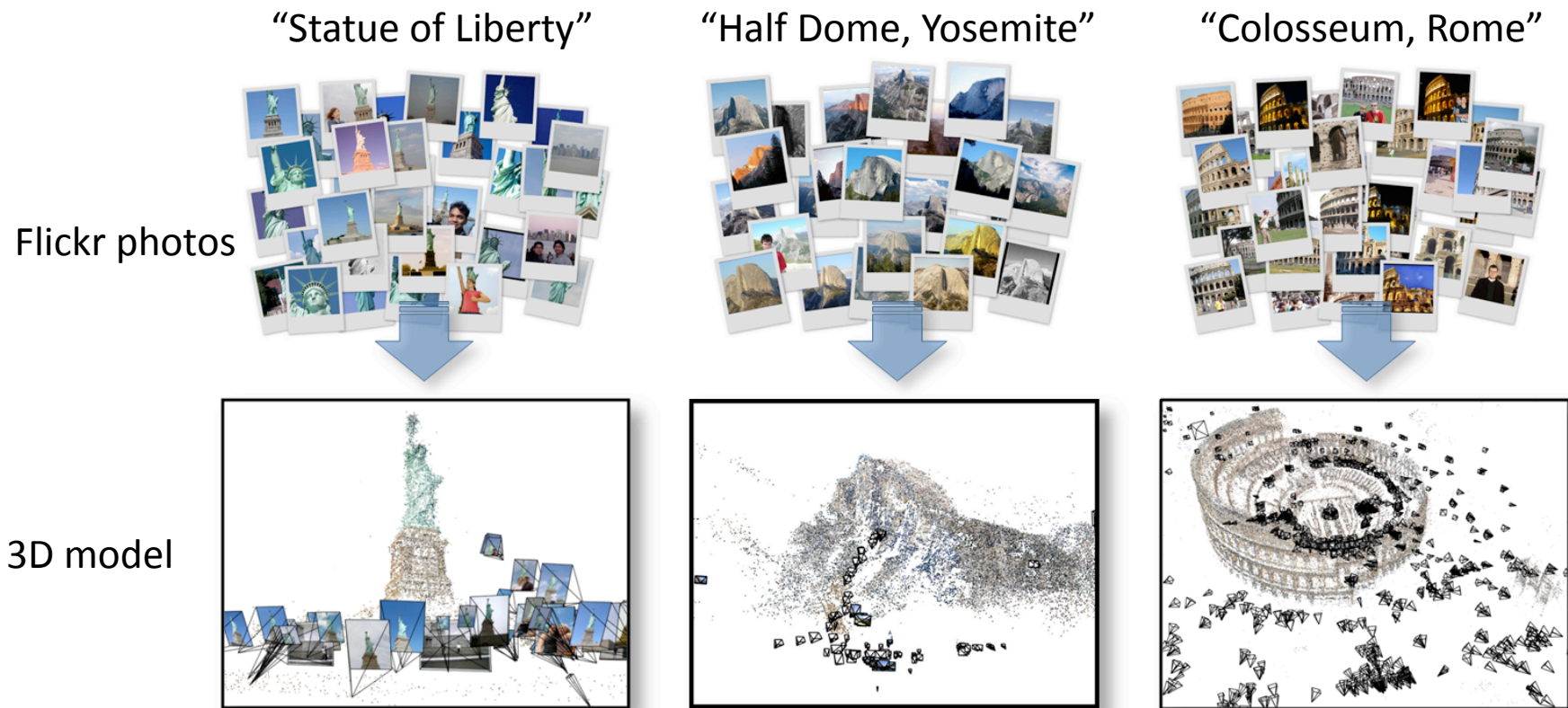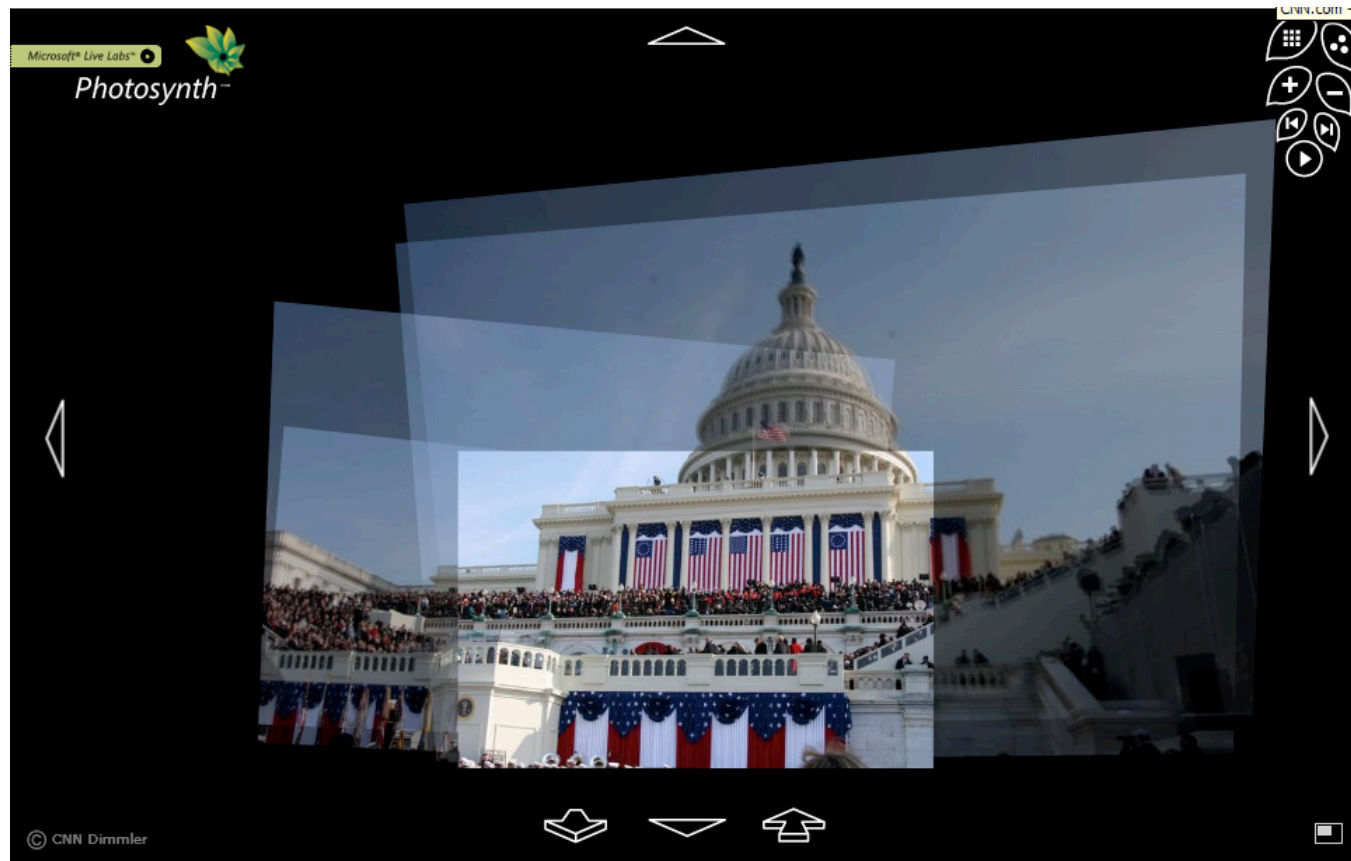

Image from Microsoft's Virtual Earth
(see also: Google Earth)

Phototourism

- Automatic 3D reconstruction from Internet photo collections

"Statue of Liberty" "Half Dome, Yosemite" "Colosseum, Rome"

Flickr photos

3D model

Photosynth

http://photosynth.net/
Based on Photo Tourism technology developed here in CSE!
by Noah Snavely, Steve Seitz, and Rick Szeliski

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… "

Special effects: shape capture

The Matrix movies, ESC Entertainment, XYZRGB, NRC

Special effects: motion capture

Pirates of the Carribean, Industrial Light and Magic
Click here for interactive demo

Sports

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

Smart cars

Mobileye

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

Vision-based interaction (and games)

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

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]()!

["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.
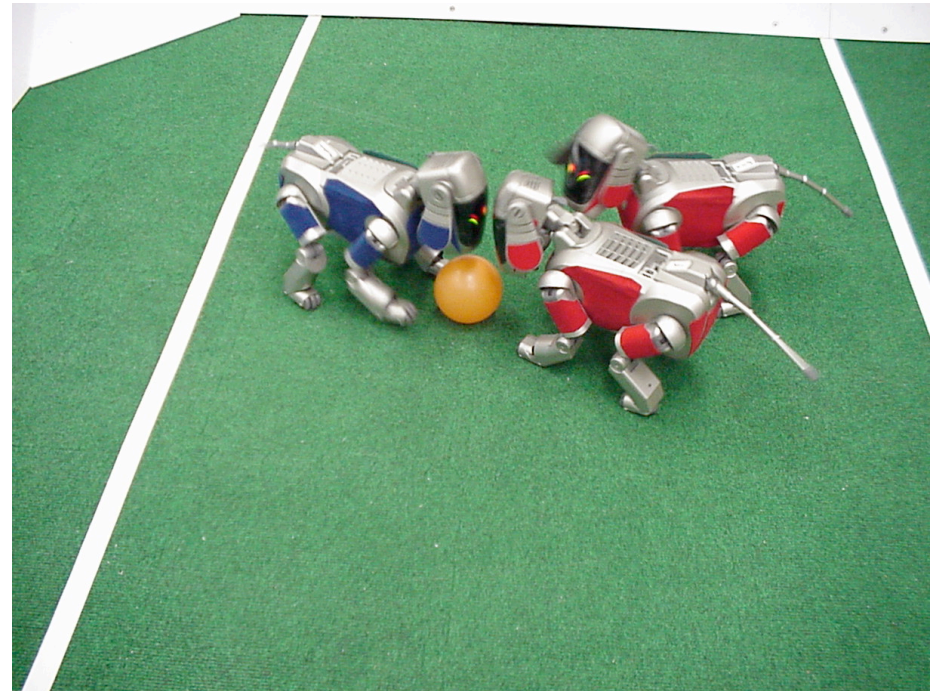
Vision systems (JPL) used for several tasks

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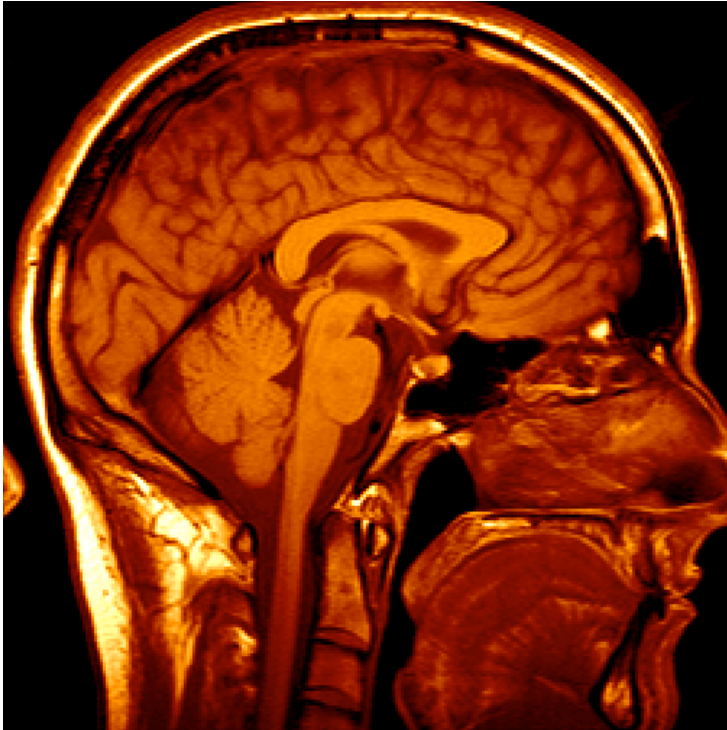- For more, read "Computer Vision on Mars" by Matthies et al.

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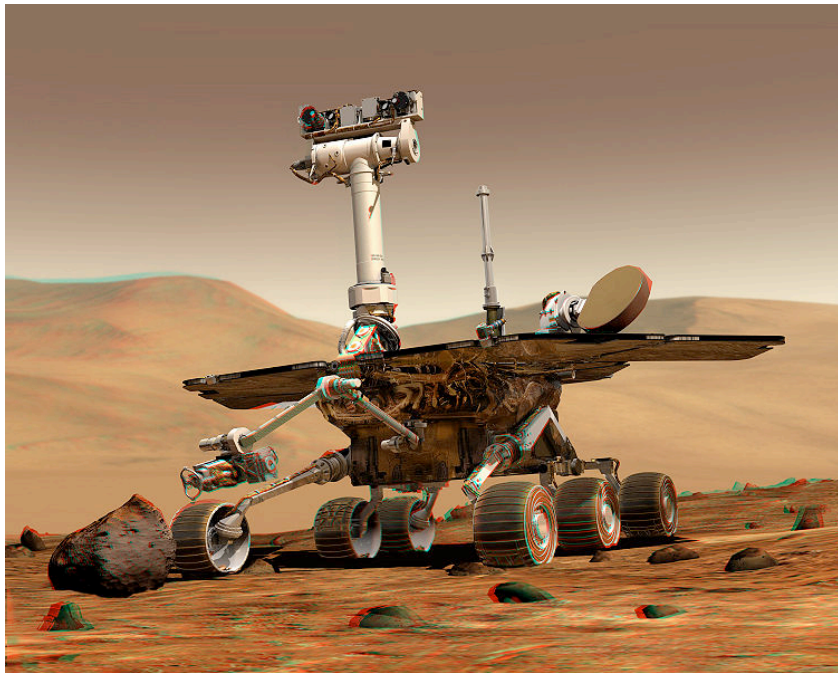
NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover

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

Goals

- To familiarize you with the basic techniques and jargon in the field

- To enable you to solve real-world computer vision problems

- To let you experience (and appreciate!) the difficulties of real-world computer vision

- To excite you!

Project 1: Seam Carving

Part 1: Getting to know MATLAB. Implement convolution with different filters
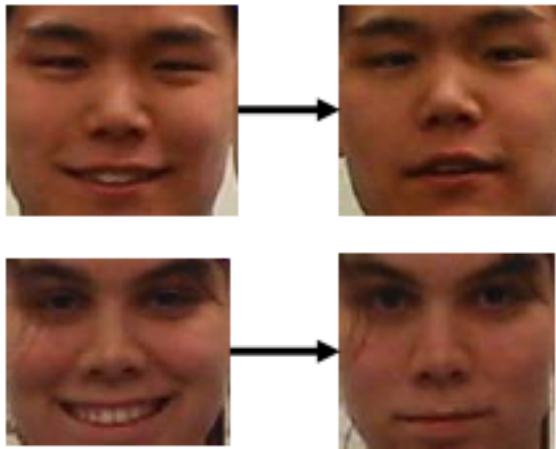
Part 2: Seam Carving (Content-aware image resizing)

Project 2: Face Recognition & detection

Eigenfaces:

Face recognition:

Face detection:
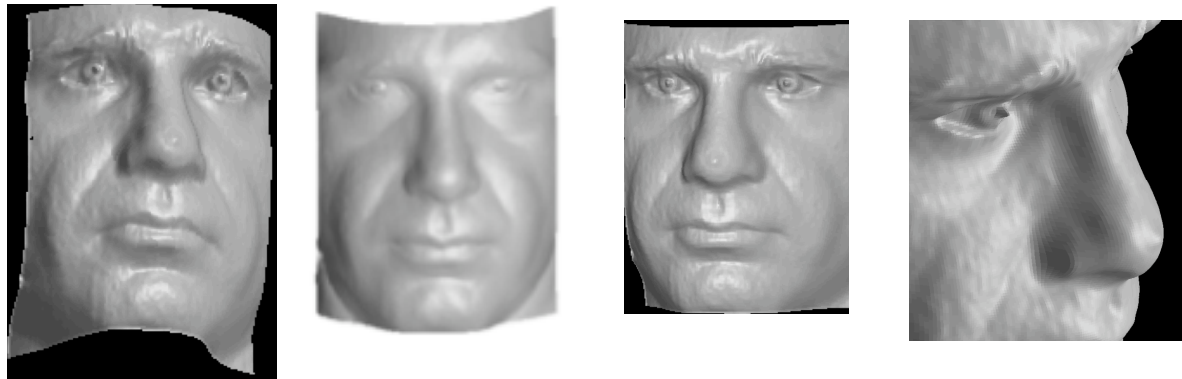
Project 3: Panorama stitching

By Oscar Danielsson

Project 4: Photometric Stereo

Questions?

CSE 455: Computer Vision

Reading for this week:

- Forsyth & Ponce, chapter 8

(Chapter 1 in reader, available at UW Bookstore in the CSE textbook area)

Next time:

- Ian Simon will lecture on Images and Filtering