

CS 1114: Introduction to Computing Using MATLAB and Robotics



Prof. Noah Snavely

CS1114

<http://cs1114.cs.cornell.edu>



Cornell University
Computer Science

Robots: 2029



Cornell University

Robots: 2012



Sony AIBO



iRobot Create



Wowwee Rovio



Robots: cute but dumb

- What do they know about the world around them?
 - Without your help, very little
 - Can't even notice a bright red lightstick
- Your mission: make them smarter
- Lots of interesting math and computer science, some computer programming
 - Lots of experience with programming, even with robots, won't give you a leg up in 1114



Overview



- What is CS 1114?
 - An honors-level intro to CS using camera-controlled robots (Sony Aibo, Wowwee Rovio)
 - An alternative to CS1112 or CS1132, to fulfill your Matlab computing requirement
 - Formerly known as CS100R

Goals of CS1114

- Give you an intuition about computational problem solving
- Teach you useful (and interesting) computer science
- Give you fluency in the Matlab programming environment
- Have fun with robots

Requirements

- Exposure to programming (in any language)
- Some interest in math
 - Computer science is about much more than programming, and so is this course



Staff

- Noah Snively – Instructor (me)
- **Consultants:**
 - Rocky Li (frl8)
 - Gautam Kamath (gck43)
 - Andrew Rzesnik (ajr234)
 - Ian Purnell (iap9)
 - Jason Boada (jwb292)
 - Markus Burkardt (mb833)
 - Madeline Burton (mrb248)
 - Margaret Scheiner (ms948)
 - Stephanie Lee (snl27)



Many options for intro computing courses

- CS1110, CS1113 – Java
- CS1112, CS1114 – Matlab



CS111X AND CS113X

Beginning Fall 2007: every engineering student takes CS111X (4 credits) and CS113X (1 credit)

CS1112 or CS1114 (this course). Then CS1130.
Matlab, then Java

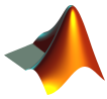
or

CS1110 or CS1113. Then CS1132.
Java, then Matlab.

CS2110 prerequisite: CS1110 or CS1130.

Java or Matlab?

- Both CS1110 and CS111[24] teach fundamental problem solving skills and computer science techniques



- The destination is the same...
- ... but the vehicle is different



Questions?



CS1114 Logistics

- Lectures: Tue Thu 11:15–12:05, UPS 211
- Sections:
 - Wed 1:25 - 2:15, Upson 317
 - Wed 2:30 - 3:20, Upson 317
 - Wed 3:35 - 4:25, Upson 317
 - Please go to same section for the entire course
- Sections will be led by Rocky, Gautam, and others



CS1114 Logistics

- CS1114 lab: Upson 317
- You will soon have access to the lab and passwords for the computers
- Office hours will generally be held in the lab (see staff page for hours)



Course webpage

The screenshot shows the Cornell University Department of Computer Science website for the CS1114 course. The header includes the university logo, name, and a search bar. Navigation tabs include Course info, Staff info, Lectures, Assignments, Helpful links, and Sponsors. The main content area is titled "CS1114: Introduction to Computing using Matlab and Robotics Spring 2012". It features an "Announcements" section with a link to a Cornell Chronicle article, a "Logistics" section detailing the course schedule (Tuesdays and Thursdays at 11:15-12:05 in Upson 211, and Wednesdays at 1:25-2:15, 2:30-3:20, and 3:35-4:25), and a note about the Academic Integrity Code. Three featured articles are displayed: "A CS1000 with robots?" (teaching programming with Sony Aibo and Wowwee RoVio), "And with computer vision?" (teaching basic computer vision techniques), and "Matlab" (used as the programming language for image data manipulation).

<http://cs1114.cs.cornell.edu/>

Piazza

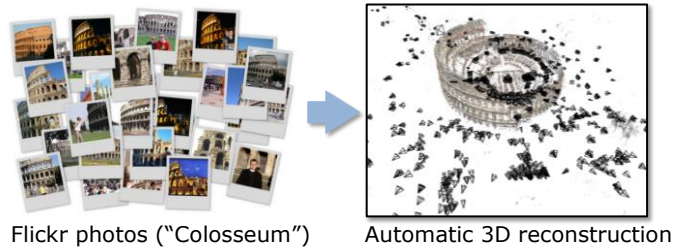
The screenshot shows the Piazza discussion board for the CS 1114 course. The browser address bar shows "piazza.com/class/spring2012/cs1114". The interface includes a search bar, a "Settings" button, and a "Search or add a post..." field. Below the search bar are "Popular Tags" such as #logistics, #gottagetdownonfriday, #importantprogramminglesson, and #section1. The main content area is divided into sections: "YESTERDAY" with a post titled "When are office hours?" (6:13PM) and "LAST WEEK" with posts titled "When and where is class?" (Fri) and "Version control tutorial" (Fri). A sidebar on the right contains "Tips & Best-Practice Integration with FERPA, Privacy" and "Try It Out" sections.

About me

- Noah Snavely
- <http://www.cs.cornell.edu/~snave/>
- Research
 - Computer vision
 - Computer graphics

Research focus

- 3D reconstruction from unorganized image collections



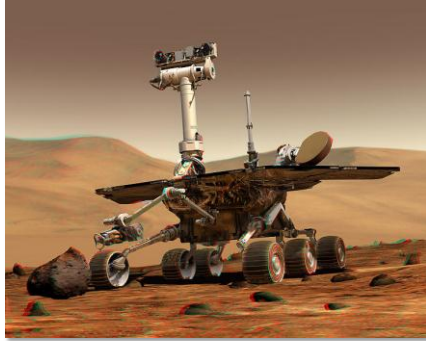
- Microsoft *Photosynth*



What can we do with computer science and computer vision?



Robotics



NASA's Mars Spirit Rover

http://en.wikipedia.org/wiki/Spirit_rover

Sports



Sportvision first down line

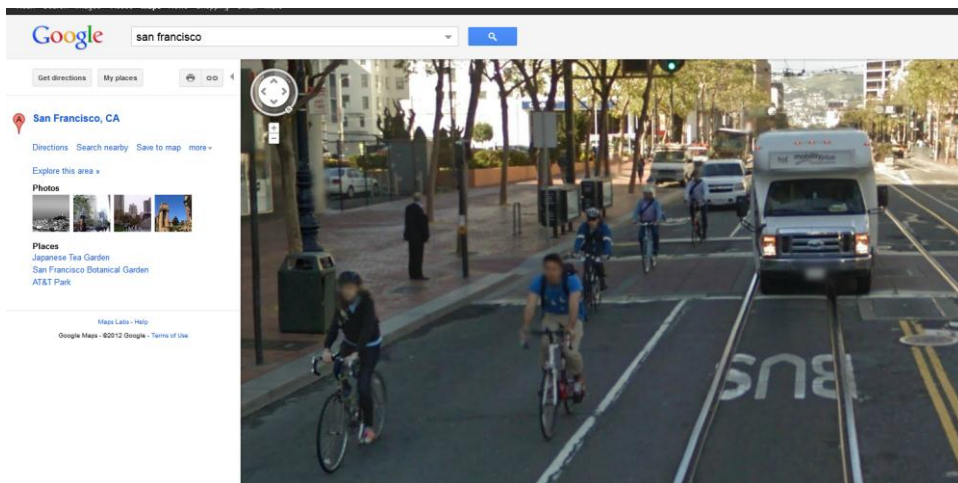
Nice [explanation](http://www.howstuffworks.com) on www.howstuffworks.com

Face detection



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

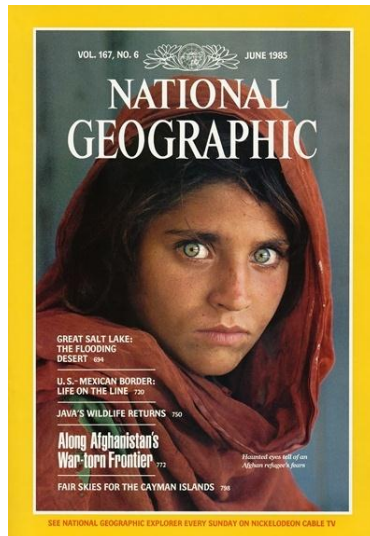
Source: S. Seitz



- What's wrong with this picture?



Face recognition



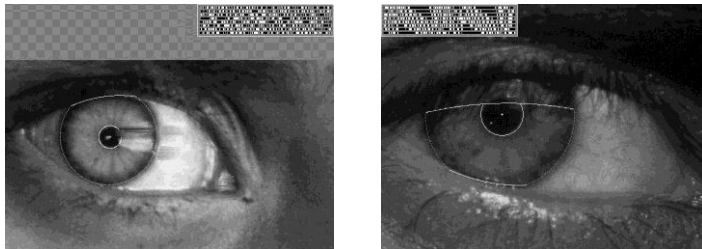
Who is she?

Source: S. Seitz

Vision-based biometrics

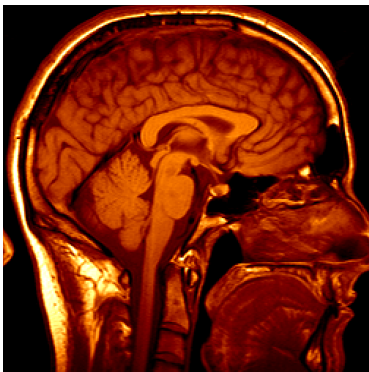


"How the Afghan Girl was Identified by Her Iris Patterns" Read the [story](#)



Source: S. Seitz

Medical imaging



3D imaging
MRI, CT



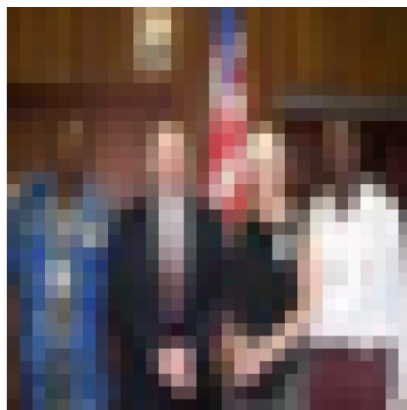
Image guided surgery
[Grimson et al., MIT](#)

Source: S. Seitz

User interfaces



Human vision



Source: "80 million tiny images" by Torralba, et al.

Question: How many people are in this image?

Interpreting images



Q: Can a computer (or robot) understand this image?
A: Yes and no (mostly no)



Major CS1114 Projects

- From a camera, figure out the position of a bright red lightstick
 - Use this to guide a robot around



What we see

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

What the robot sees



Assignments

- Approximately one mini-quiz every two weeks
 - In class, usually at start of Thursday lecture
 - Corollary: be on time, or write fast...
- 5-6 robot programming assignments with multiple parts
 - You will demo each part to the lab TA's
- 3 exams, probably in-class
- Free-form final project (required)



Major CS1114 Projects

- Robot security guard
 - Detect and track moving objects
- Object recognition – find the right DVD in your collection
- Do Something Cool (final project)



Grading

- Programming assignments (10-20%)
- In-class quizzes (15-25%)
- Exams (50-60%)

Questions?

Getting started with Matlab



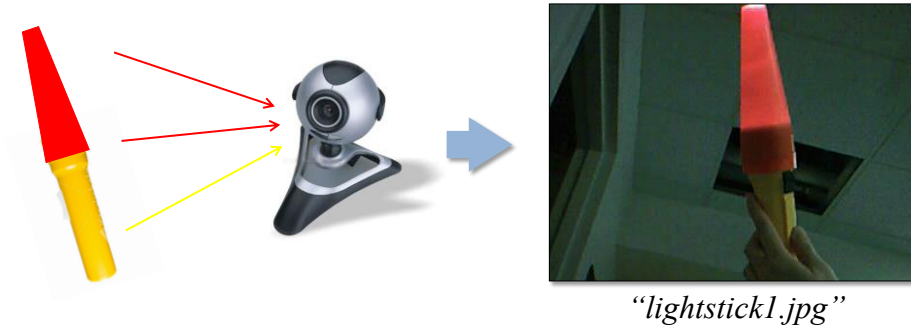
Interpreting images



Q: Can a computer (or robot) find the lightstick?
A: With your help, yes!*

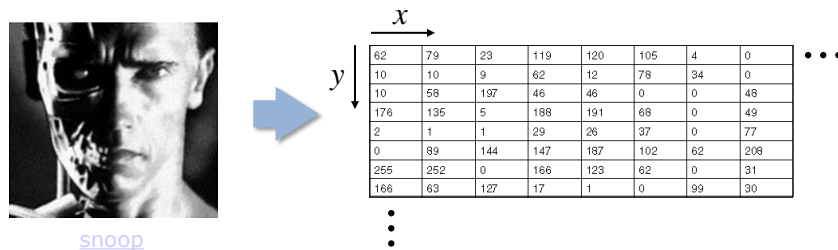


What is an image?



What is an image?

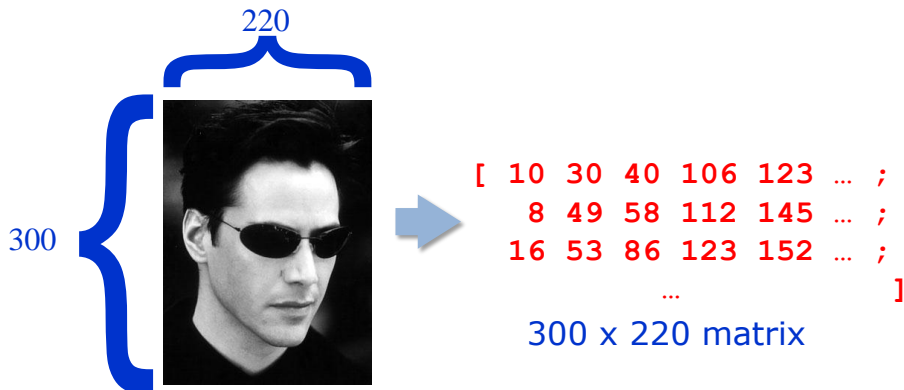
- A grid of numbers (*intensity values*)



- Intensity values range between 0 (black) and 255 (white)

What is an image?

- A grid of numbers (*intensity values*)
- In Matlab, a *matrix*



Matrices in Matlab

- 1D matrix is often called a vector
 - Similar to arrays in other languages

```
A = [ 10 30 40 106 123 ]      B = [ 10 ;  
      Row vector              30 ;  
      (or 1 x 5 matrix)       40 ;  
                               106 ;  
                               123 ]  
                               Column  
                               vector  
                               (or 5 x 1  
                               matrix)
```

```
A(1) == 10  
A(4) == 106
```



Matrices in Matlab

```
C = [ 10 30 40 106 123 ;  
      8 49 58 112 145 ;  
      16 53 86 123 152 ]
```

3 x 5 matrix

```
C(1,1) == 10
```

```
C(2,4) == 112
```

can also *assign* to a matrix entries

```
C(1,1) = C(1,1) + 1
```



For next time

- Visit the course website
<http://cs1114.cs.cornell.edu>
- Read the Matlab tutorial
- Attend section in the lab tomorrow

