Introduction to Computer Vision

CS370   Lecture 1

Erik Learned-Miller

uren Manvelyan

Today

- Quick course overview
- What is computer vision?
- Relationships to other fields.
- Goals of computer vision.
- Assignment 1:
  The Prokudin-Gorsky photos.
- MATLAB.

Course Overview

- Computer vision as a decision making process under uncertainty.
  - Emphasis on decision making using probability and statistics.
  - General strategies apply to any area of artificial intelligence.
- 7 problem sets – 1 every two weeks
  - Some programming
  - Some math
- tests: 1 midterm, 1 final.
- Final grade: 60% assignments, 20% midterm, 20% final.
  - Possible quizzes or "fudge factor" for participation.
- Not everything will be available on line.
  - You need to come to class!

Web Page

- Google me "Learned-Miller"
- Go to Teaching Link
- Top link is CS370.

CS370: Introduction to Computer Vision

http://www.cs.umass.edu/~elm/Teaching/370_S11/

370   me   Visual illusions   Spectrum   Recycle   Awards   furnace2   asteroids   Furnace   arikan   polar   polar cds   FDDB Turk A...   Result 190   Compute Algebraic Code   NIH Pub Access   GraphVis

CS370: Introduction to Computer ...

CS370: Introduction to Computer Vision

• Spring 2011; Monday and Wednesday, 10:35-11:50 • LGRC 310A (See map)

Instructor	Erik Learned-Miller elm at cs.umass.edu (413) 545-2993
Teaching Assistant	Manjunath Narayana narayana at cs.umass.edu (413) 545-0528
Prerequisites	
Reading Materials	Textbook: Algorithms and Applications, by Richard Szeliski: On-line copy available here I do NOT recommend buying the textbook unless you want it for your own purposes. We will use it some in this course, but not a lot. You should be able to get by the the on-line version.
Resources	MATLAB Tutorial
Interesting Links	Movie shown in class on optical illusions Checker shadow illusion Early color photographs by S. M. Prokudin-Gorsky Flower Garden movie. Non-lambertian reflectance functions Explanation of hexagonal sampling efficiency
Problem Sets	Homework 3 Sample Solution
Description	
Schedule	

Date	Lecture topic	New assignments	Assignments due	Reading
Jan. 19	Introduction. What is Computer Vision?	Assignment 1: Read Lightness Perception and Lightness Illusions Come up with five questions relevant to the paper. These can be things you didn't understand after a careful reading of the paper, or questions which the paper raises. Turn in the answer written up as a .pdf file. You will be graded on the depth of your questions and how much thought you were judged to have put into them.	As. 1 due Jan. 26	Handout: Introduction to Computer Vision
Jan. 24	Introduction to using MATLAB for Computer Vision. Matlab Session Transcript from Lecture	Assignment 2: Colorizing the Prokudin-Gorsky photo collection	As. 2 due Feb. 2	
Jan. 26	Formalizing the decision making process. Minimizing error. Maximizing utility. Review of basic probability theory. You will be responsible for all of the basic probability theory in this handout.			Probability handout (see lecture description).

Other stuff

- Textbook
  - free, on-line. see web page
- Programming Language: Matlab
  - Very good for images.
  - Will cover in class.
  - Not too difficult to learn if you know Java or C++.

Options for Matlab (or Octave)

1. Recommended:
   - Buy student version of Matlab: $99.00.
     - Highest convenience factor.
     - Use on your own machine (laptop, desktop).

2. Use open source package Octave
   - Almost identical to Matlab
   - Can be tricky to install
   - No fancy user interface

3. Use Departments EdLab Computers
   - Must be used remotely (with remote login), which can be slow.
   - If too many people use this, it will be slow (only 5 different computers).

First assignments

- Prokudin-Gorsky photos (will discuss at end of class).
  - Follow instructions on web page to do write up.
  - Due on Wednesday, Jan. 29th at 11:59 pm.
    - 10% deduction for every day late (12:01 am counts as 1 day late).
  - Email Cheni your assignment (usually includes some code and some results and discussion).
    - .pdf is preferred for write-up part.

- Also read: Intro to Comp. Vision, available on web page. Look in right column under first lecture. (please send me emails if there are errors)
  - Due in next class. Possible quiz.

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Here we go...

The Checker Shadow Illusion
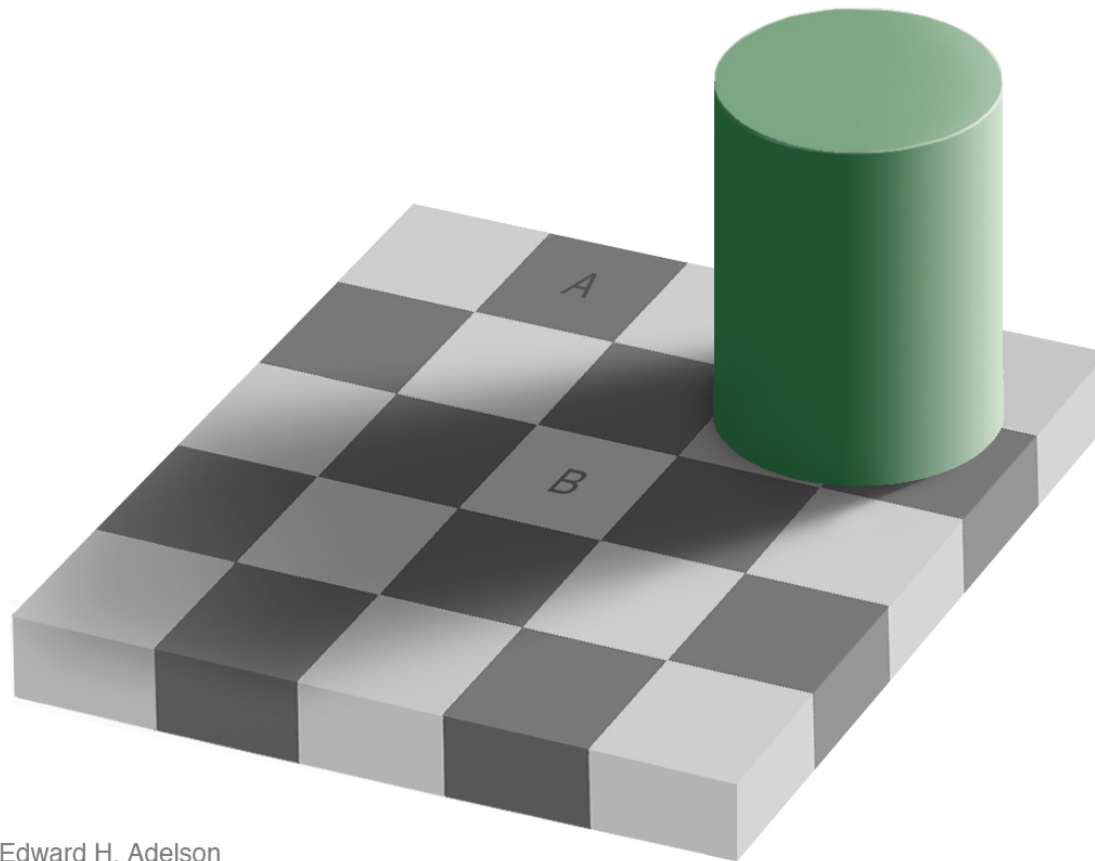
Edward H. Adelson

The "Proof"
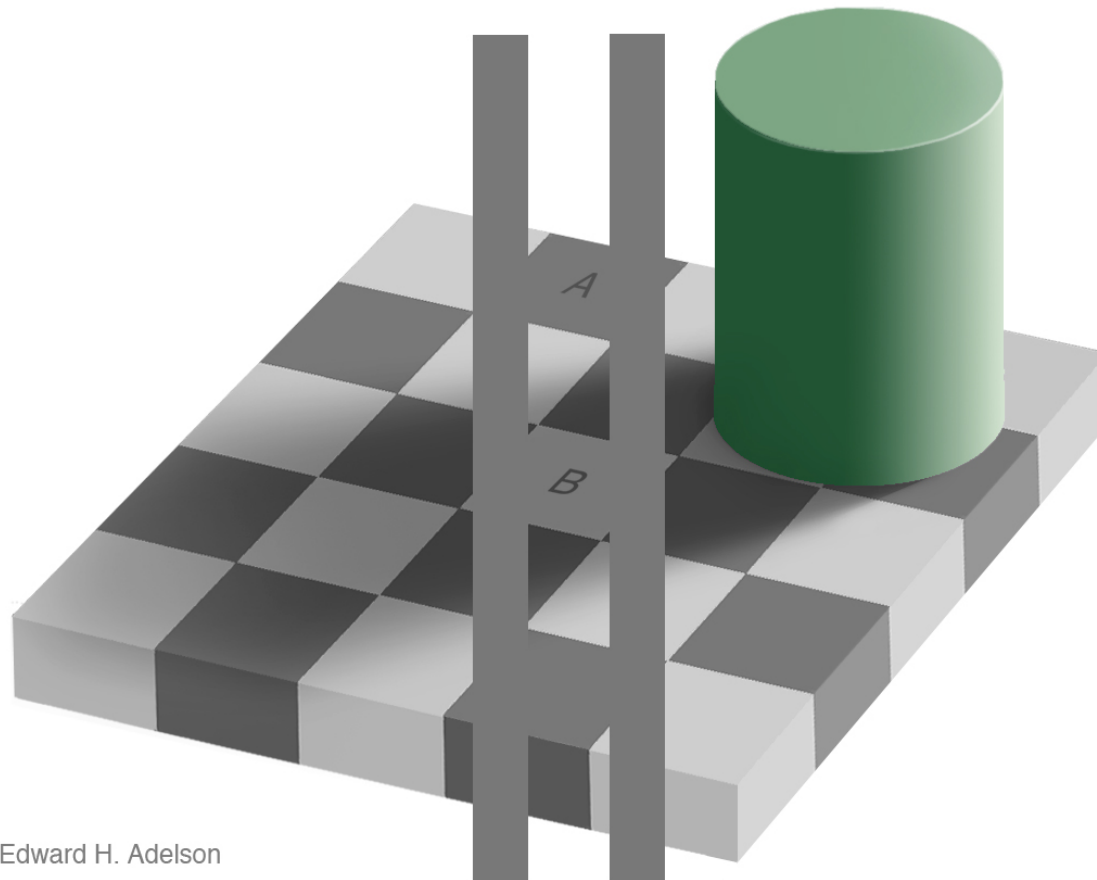
Edward H. Adelson

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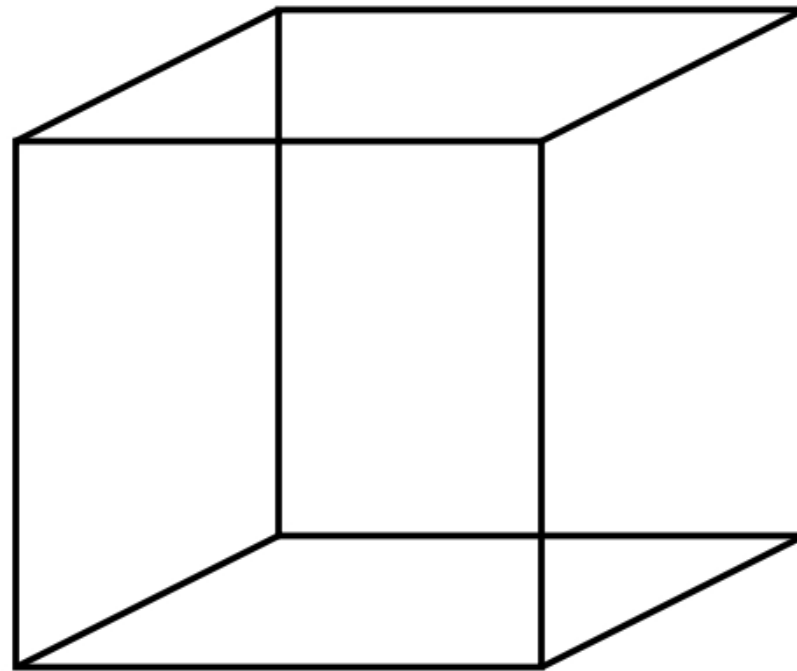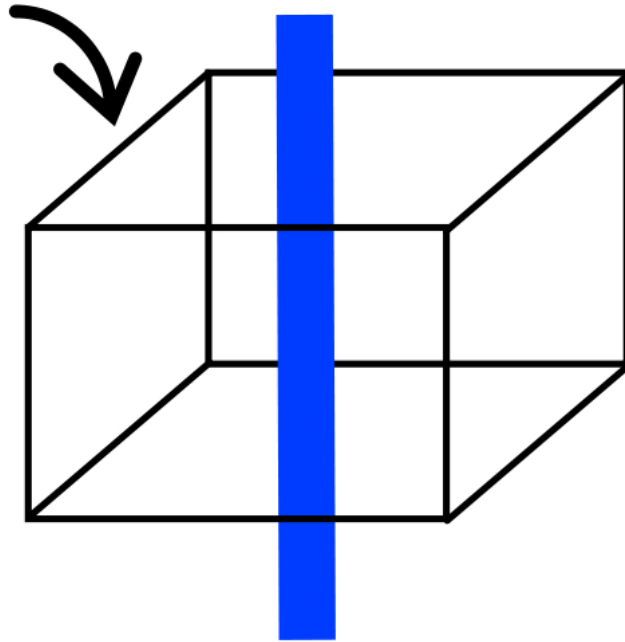
Takeaways

- The human vision system is not designed to measure absolute values of light.

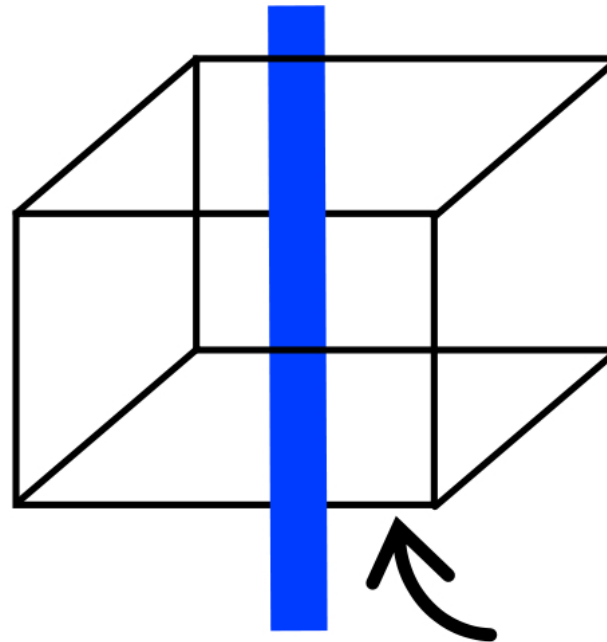- It is designed to try to understand "what's there" in the world.
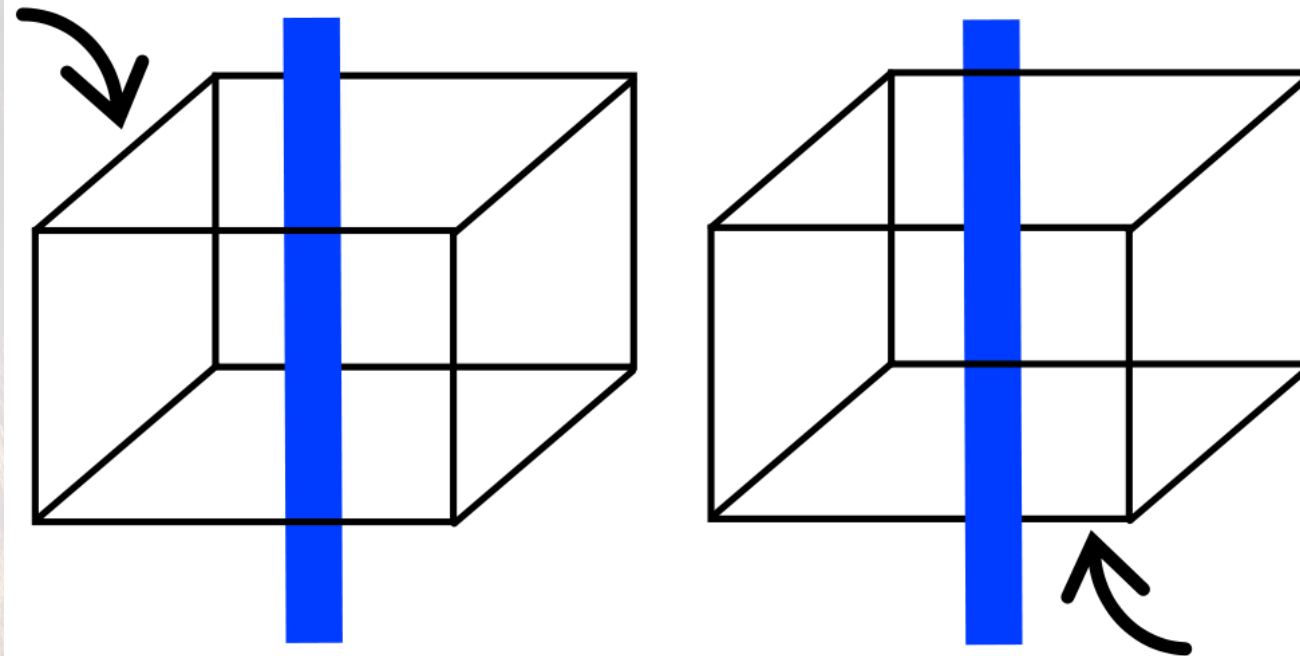
Ambiguity: The Necker Cube

Ambiguity: The Necker Cube

Ambiguity: The Necker Cube

Ambiguity: The Necker Cube

The Bas-Relief Ambiguity

Sculpture by Amy Kahn

Takeaway

- Images are fundamentally ambiguous:
  - Computer vision is *ill-posed.*
- We cannot be sure about what is there
- We use as many cues as we can to make our best guess as to what is there.
- *Amazingly, the human visual system usually guesses correctly.*
  - Or does it?
  - When do we make a guess?

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Related Fields

- Optics, Photography, Photogrammetry
  - Optics: study of light
  - Photogrammetry: practice of determining *geometry from images*
- Computer Graphics and Art
  - Computer graphics: forward
  - Computer vision: backwards

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More Related Fields

- Neuroscience and Physiology
- Psychology and Psychophysics
- Probability, Statistics, and Machine Learning

Goals

- Engineering
- Basic Science

Reminder

- Check web page for current reading assignment and homework assignment.
  - Get started now!
    - Make sure you get a copy of matlab running as soon as possible. Don't wait until day before assignment is due to figure out how to get matlab. It could take a couple of days.

Matlab demo

- By the way, there is a link to a matlab tutorial on the course web page under "Resources".
  - highly recommended.

Assignment 1

The Time Traveler's Camera

The Time Traveler's Camera

The Time Traveler's Camera

The Time Traveler's Camera

- As it turns out...
  - *Displaying* holograms is very difficult, BUT...
  - *Recording them* is EASY

The Time Traveler's Camera

- As it turns out...
  - *Displaying* holograms is very difficult, BUT...
  - *Recording* t

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Sergey Prokudin-Gorsky

- Russian chemist and photographer
- 1909-1915: toured Russia for the czar to record pictures of Russia
- Took color "negatives" even though there were only extremely crude ways to reproduce them!

Some dude with a big sword
actually the Emir of Bukhara

Some dude with a big sword

Some dude with a big sword

!!!

Assignment

- You will be given images like this:

Next:
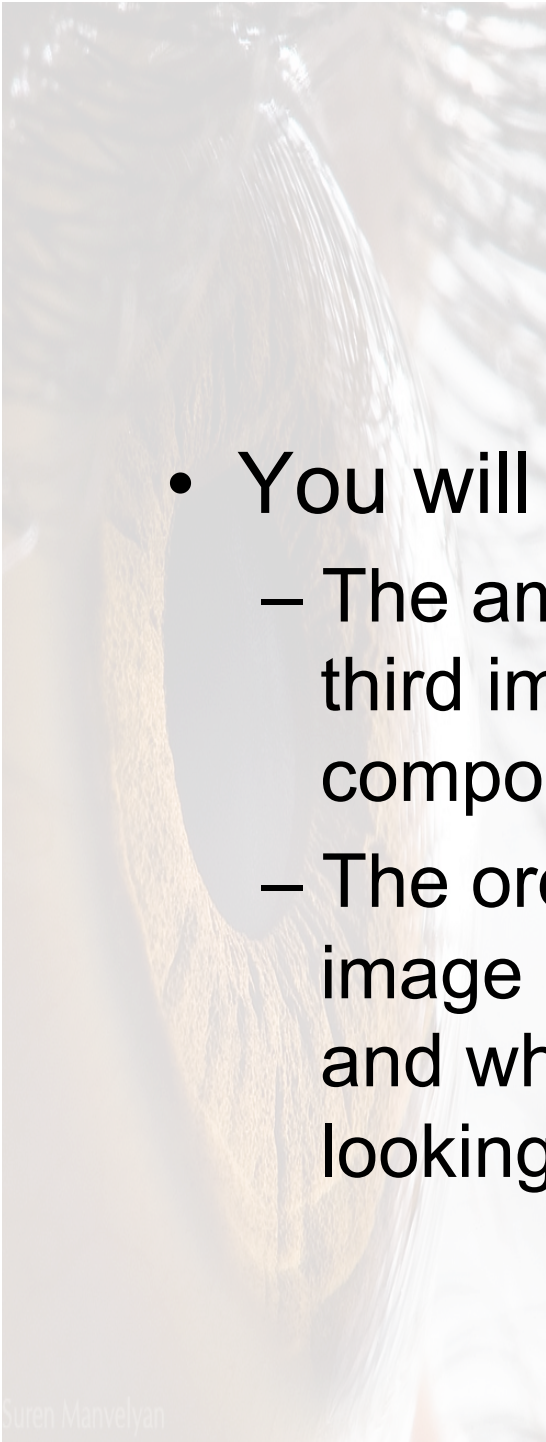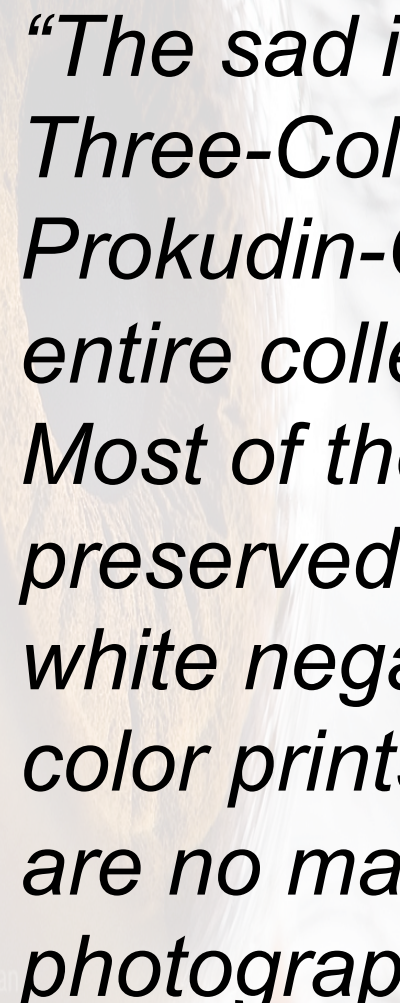
- Chop them up into thirds of the same size:

then...

- Pick one as the "base image", and shift the other two relative to that image, using the MATLAB command circshift.

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finally...

- Assemble them into an 3-channel (RGB) image and display.

- You will need to experiment with:
  - The amount of shift for the second and third images to best align them with the first component, and
  - The order of the images in the final RGB image (which image is "R", which is "G", and which is "B") to get the most realistic looking image.

"The sad irony of the technique of the Three-Color Photography was that Prokudin-Gorsky himself never saw the entire collection of his images in color. Most of the surviving images are preserved in the form of triple black and white negatives and only rarely as historic color prints or slides which in any case are no match to present day color photographs."

End