CS 194/294-26: Intro to Computer Vision and Computational Photography

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Tutors: Kamyar Salahi
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Covid Precautions
Today

Introductions
Why this Course?
Administrative stuff
Brief History of Visual Data
Teaching Team: professors

Angjoo Kanazawa

Alexei Efros
Teaching Team: GSIs

Vickie Ye

Tim Brooks
Teaching Team: Tutors

Kamyar Salahi
Lily Yang
Violet Yao
Why This Course?
Visual Computing in the old days...

Image Processing
EECS 225B

Computer Graphics
CS 184

Computer Vision
CS 280
Visual Computing gets interconnected

**Image Processing**
EECS 225B

**Art History**
ART 10

**Computer Graphics**
CS 184

**Visual Perception**
PSYCH

**Computer Vision**
CS 280

**Computational Photography**
Visual Computing gets interconnected

Image Processing
EECS 225B

Art History
ART 10

Computer Graphics
CS 184

Visual Perception
PSYCH

Computer Vision
CS 280

THIS CLASS
CS194-26
Course objectives

1. You will get a foundation in image processing and computer vision

- Camera basics, image formation
- Convolutions, filtering
- Image and Video Processing (filtering, anti-aliasing, pyramids)
- Image Manipulation (warping, morphing, mosaicing, matting, compositing)
- Projection, 3D, stereo
- Basics of recognition
- …
Course objectives

2. You will get a more intuitive understanding of important mathematical and computational concepts

- Gradients
- Change of basis, interpolation, extrapolation, PCA
- FFT
- Dynamic programming, recursion
- Machine learning, Convolutional Neural Networks
- ...
Course objectives

3. You will have new abilities for visual creation.
3. You’ll better appreciate your own visual ability.
Seeing less than you think...
Seeing less than you think…
But actually…

Video by Antonio Torralba (starring Rob Fergus)
Course objectives

4. You’ll have fun doing cool stuff!
Programming Project #1

Prokudin-Gorskii’s Color Photography (1907)
Programming Project #1
Project 2: Fun with frequencies
Project 2: Fun with frequencies

Prof. Christos Papadimalik
Project 2: Fun with Frequencies
Project 3: Face modeling and morphing
Project 4: Mystery GAN Project
Project 5: Panorama Stitching

Photo Mosaics
Project 5++ project

Tour Into the Picture
Paper Pop-up

Step 1: define planes

Step 2: rectify each plane

Step 3: compute 3D box coords
Final Project

Something cool!!!

• We will have some pre-canned projects
• Will also have some suggestions, cool datasets, etc
• Or you can do whatever you want!

(can be done in groups of 2 or 3)
Sample final project in my class
Everybody Dance Now

https://www.youtube.com/watch?v=PCBTZh41Ris&feature=youtu.be
For each project:

Derive the **math**, implement stuff **from scratch**, and apply it to your **own** photos

Every person does their own project (except final projects)

Reporting via web page (plus submit code)

Afterwards, vote for class favorite(s)!

Programming Language:
- Python or Matlab
- you can use other languages, but you are on your own
Textbook

http://szeliski.org/Book/
Class Organization / Administrivia
General Comments

Prerequisites

- Linear algebra!!! (EE16A, Math 54, or Math 110)
- Good programming skills (at least CS61B)
- Deep Learning (CS182) strongly recommended!

Emphasis on programming projects!

- Building something from scratch

Graduate Version:

- Final project required (not pre-canned), including conference-style report paper

This will be a “live” class:

- We expect out to come to class
Getting help outside of class

Course Web Page
  • http://inst.eecs.berkeley.edu/~cs194-26/

Discussion board:
  • piazza.com

Office hours
  • TBA… see webpage and piazza
Administrative Stuff

Grading

- Programming Project (60%)
- Exam + possible popup quizzes (20%)
- Final Project (20%)
- Class Participation: priceless

Late Policy

- Five (5) emergency late days for semester, to be spent wisely
- Max 10% of full credit afterwards

Extra Points

- Most projects will have optional “bells & whistles”
- These extra points could be used to pad scores on other projects (but not exams!)
Academic Integrity

• Can discuss projects, but don’t share code
• Don’t look up code or copy from a friend
• If you’re not sure if it’s allowed, ask
• Acknowledge any inspirations
• If you get stuck, come talk to us
Waitlists

• To keep this course live, we are limited by room size (199 people)

• However, I expect 30-50 people to drop after the first two projects 😊
  • So, if you are on waitlist, etc, you have good chance to get into class
  • But need to start doing projects
Why you should NOT take this class

- Project-based class
  - No canned problem sets
  - Not theory-heavy (but will read a few research papers)
  - No clean rubrics
  - Open-ended by design
  - Will not copy advanced topics, but will try to make sure everyone understands the basics super-well

- Need time to think, not just hack
  - Creativity is a class requirement
  - Not a class to learn about Deep Learning!

- Lots of work…There are easier classes if
  - you just need some units
  - you care more about the grade than about learning stuff

- Not worth it if you don’t enjoy it
Now… reasons TO take this class

- It’s your reward after 3 grueling years 😊
- You get to work with pictures, unleash your creative potential
- Interested in grad school? 😊
A Brief History of the Visual Data
Depicting Our World: The Beginning

Prehistoric Painting, Lascaux Cave, France
~ 13,000 -- 15,000 B.C.
Prehistoric Cave Painting, Altamira
~ 20,000 – 15,000 B.C.
The Empress Theodora with her court.
Ravenna, St. Vitale 6th c.
Nuns in Procession. French ms. ca. 1300.
Beginnings of the Renaissance

Giotto, *The Mourning of Christ*, c.1305
Depicting Our World: Renaissance

North Doors (1424)  Lorenzo Ghiberti (1378-1455)  East Doors (1452)
Depicting Our World: Renaissance

Piero della Francesca, 
The Flagellation (c.1469)
Jan van Eyck, *The Arnolfini Marriage* (c.1434)
Depicting Our World: Toward Perfection

Lens Based Camera Obscura, 1568
Depicting Our World: Perfection!

Boulevard du Temple, Louis Daguerre, 1838
Depicting Our World: Realism?
Paris, according to Flickr
Paris, according to Google StreetView

Knopp, Sivic, Pajdla, ECCV 2010
Paris, according to me
After realism...

Monet,
La rue Montorgueil
Depicting Our World: Ongoing Quest

Pablo Picasso

David Hockney
Better than realism?

David Hockney, Place Furstenberg (1985)
Which one is right?

**Multiple viewpoints**

David Hockney, Place Furstenberg, 1985

**Single viewpoint**

Alyosha Efros, Place Furstenberg, 2009
Depicting Our World: Ongoing Quest

Enter Computer Graphics...
Traditional Computer Graphics

3D geometry

physics

Simulation

projection
Modern Computer Graphics

- Amazingly real
- But so sterile, lifeless, *futuristic* (why?)
The richness of our everyday world

Photo by Svetlana Lazebnik
Beauty in complexity

University Parks, Oxford
Which parts are hard to model?

Photo by Svetlana Lazebnik
People

From “Final Fantasy”

On the Tube, London
Creating Realistic Imagery

**Computer Graphics**
- great creative possibilities
- easy to manipulate objects/viewpoint
- Tremendous expertise and effort to obtain realism

**Photography**
- instantly realistic
- easy to acquire
- very hard to manipulate objects/viewpoint

**Computational Photography**
- Realism
- Manipulation
- Ease of capture
Mechanical creation of a perspective image,
Albrecht Dürer, 1525
Measurement vs. Understanding
Understanding why vision is so hard…

Pablo Picasso
The Guitar Player (1911)
Questions?