Computational Photography
CS445

Derek Hoiem (instructor)
Joseph Degol, Aditya Deshpande (TAs)
Today’s Class

• A little about us

• Intro to Computational Photography

• Course outline and logistics
About me

Raised in “upstate” NY
About me

1998-2002
Undergrad at SUNY Buffalo
B.S., EE and CSE

2002-2007
Grad at Carnegie Mellon
Ph.D. in Robotics

2007-2008
Postdoc at Beckman Institute

2009-
Asst/Assoc Prof in CS at UIUC
My research
My Research

- Vehicle
- Animal
- Head
- Leg
- Wheel

Move on road
Facing right

Can run, jump
Is herbivorous
Facing right

Farhadi et al. 2010
My Research

Recovering 3D layout and context

Hedau et al. 2009, 2010
My Research

3D scene model from RGB+D image

RGBD Image

3D Model

Guo, Zou, Hoiem
My Research

Editing images as if they were 3D scenes

Karsch et al. 2011
Reconstruct: vision for construction

https://www.reconstructinc.com/
Aditya Deshpande

Research: Generative models for Colorization

1) **Colorization:** Gray input to one color output [ICCV’15]

2) **Diverse colorization (or Re-coloring):** From gray input to many color outputs [CVPR’16]
Joseph DeGol

B.S. Computer Engineering (2012)
B.S. General Mathematics (2012)

Ph.D. Computer Science (2018)

degol2.web.engr.Illinois.edu
Towards Vision Based Robots for Monitoring Built Environments

**ChromaTag: A Colored Marker and Fast Detection Algorithm**
*2017 International Conference on Computer Vision (ICCV)*

- CCTag: 263 ms
- RuneTag: 51 ms
- AprilTag: 19 ms
- ChromaTag: 3 ms

**Geometry-Informed Material Recognition**
*2016 Computer Vision and Pattern Recognition (CVPR)*

- Paving: Correctly classified with 3D
- Stone - Limestone: Often confused with 2D

**A Passive Mechanism for Relocating Payloads with a Quadrotor**
*2015 International Conference on Intelligent Robots and Systems (IROS)*
Some background to computational photography and ...

The Pursuit of Realism
Depicting Our World: The Beginning

Prehistoric Painting, Lascaux Cave, France
~ 15,000 B.C.
The Empress Theodora with her court.
Ravenna, St. Vitale 6th c.
Nuns in Procession. French ms. ca. 1300.
Depicting Our World: Renaissance

North Doors (1424)

Lorenzo Ghiberti (1378-1455)

East Doors (1452)
Depicting Our World: Renaissance

Paolo Uccello,
Miracle of the Profaned Host (c.1467-9)
Depicting Our World: Toward Perfection

Jan van Eyck, *The Arnolfini Portrait* (1426-1434)
Depicting Our World: Toward Perfection

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

Still Life, Louis Jaques Mande Daguerre, 1837
But is a photo really realistic?
Is reality what we want?

Newlyweds

http://salavon.com
Better than realism?

City (westward)

http://salavon.com
Enter Computer Graphics...
Traditional Computer Graphics

3D geometry

physics

Simulation

projection
Computer graphics

What’s wrong?
The richness of our everyday world

Photo by Svetlana Lazebnik
Which parts are hard to model?
People

From “Final Fantasy”
Faces / Hair

From “Final Fantasy”
Urban Scenes

Photo of LA

Virtual LA (SGI)
Nature

River Cherwell, Oxford
The Realism Spectrum

**Computer Graphics**

- easy to create new worlds
- easy to manipulate objects/viewpoint
- very hard to look realistic

**Computational Photography**

- instantly realistic
- easy to acquire

**Photography**

- very hard to manipulate objects/viewpoint
- very hard to look realistic
How can I use computational techniques to capture light in new ways?

How can I use computational techniques to breathe new life into the photograph?

How can I use computational techniques to synthesize and organize photo collections?
Virtual Real World

Campanile Movie (1997)

http://www.debevec.org/Campanile/
Going beyond reality...

Benjamin Button (2008)

http://www.digitaldomain.com/work/the-curious-case-of-benjamin-button/
Another example of blending reality with fantasy

Samsung Galaxy S6 regular and “beauty” selfie
Galaxy S6 beauty selfie

Reality

Reality++ (?)

Course outline

Prof: Derek Hoiem (dhoiem@illinois.edu), SC 3312
TAs: Joseph DeGol (degol2@illinois.edu)
    Aditya Deshpande (ardeshp2@illinios.edu)

Web page:  
http://courses.engr.illinois.edu/cs445/

Enrollment list:  
https://goo.gl/forms/7nQzBvGxzgzzMBZM2
Course objectives

1. You will have new abilities for visual creation.
Course objectives

2. You will get a foundation in computer vision.
Got job?

- Google, Facebook, Microsoft, Sony, iRobot, Amazon, Snapchat, Ebay, tons of startups, etc.

Course objectives

3. You’ll better appreciate your own visual ability.

Is that a queen or a bishop?
Course objectives

4. You’ll have fun doing cool stuff!
Projects
Project 1: Hybrid Images
Project 2: Image Quilting for Texture Synthesis and Transfer
Project 3: Poisson Editing

Photos from James Hays
Project 3: Poisson Editing

Photos from Evan Wallace
Project 4: Image-Based Lighting
Project 5: video alignment, stitching, and editing
Final Project

Something cool!
Project details

• Implement stuff from scratch and apply it to your own photos

• Reporting via web page (plus e-mail code)

• Software/hardware
  – Matlab!
  – Machines available in EWS labs
Getting help outside of class

Office hours
• See website: Mon 10-11, Tues 11-12:30, Fri 2:30-4
• Let us know if you can’t make any of those times

Matlab + linear algebra tutorial
• Wed 9/6, pick time: https://beta.doodle.com/poll/xz799uch67x6sxsd
• Discussion board: https://piazza.com/class/j6uxw4hazxb1zw

Readings/textbook
Grades

• Written and programming assignments (55%)
  – Core projects worth total of 500 points, “bells and whistles” for additional points
  – Undergrads graded out of 525, grads out of 600
• Exam (25%)
• Final Project (20%)
• Participation

Late policy

• Up to five free days total – use them wisely!
• 10 point penalty per day after that
Academic Integrity

• Can discuss projects, but don’t show/share code

• Don’t look up code (even to get hints) 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 me
Other comments

Prerequisites

• **Linear algebra**, plus some basic calculus and probability

• Experience with graphics, image processing, or Matlab will help but is not necessary

Your own camera

• **Strongly recommended**

• Pro camera apps for smartphones
Feedback is welcome
Final comments

• Reasons to not take the course...

• To do now
  – Any Q’s or concerns, come talk to me!

• To do later
  – Look over syllabus, etc.
  – Sign up for Piazza

• Next class: pixels and basic filtering