Computational Photography
CS445

Instructor: Derek Hoiem
Today’s Class

• A little about me

• 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

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 2018
My Research

Editing images as if they were 3D scenes

Karsch et al. 2011
My Research

**Question:** Is the light on the train lit?
**Answer:** yes

**Objects:** light, signal, traffic light, eye, wheel
**Attributes:** lit, illuminated, round, glowing, lighted

**Question:** What is the yellow object in the street?
**Answer:** hydrant

**Objects:** hydrant, fire hydrant, post, container, device
**Attributes:** yellow, different, bright yellow, banana, cold

Gupta et al. 2017
My Research

Generating comic videos

Fred wearing a red hat is walking in the living room

Wilma and Betty are seated at a table in the kitchen

Gupta et al. 2018
Reconstruct: vision for construction

Crunchbase top 50 global startups

https://vimeo.com/242479887

https://www.reconstructinc.com/
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.
Depicting Our World: Middle Ages

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)*
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?

Related story: https://www.propublica.org/article/the-toppling-saddam-statue-firdos-square-baghdad
Is reality what we want?

http://www.freephotoediting.com/samples/photo-glamourisation/020_celebrity-skin-retouching.htm
Enter Computer Graphics...
Traditional Computer Graphics

3D geometry

Physics

Simulation

Graphics
What's wrong?
The richness of our everyday world
Which parts are hard to model?
People

From “Final Fantasy”
Faces / Hair

From “Final Fantasy”

Photo by Joaquin Rosales Gomez
Urban Scenes

Virtual LA (SGI)

Photo of LA
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
- very hard to manipulate objects/viewpoint
+ instantly realistic
+ easy to acquire

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

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
FaceApp
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.

• http://www.cs.ubc.ca/~lowe/vision.html
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!
Course outline

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TAs
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Shengyu Fen shengyu8@illinois.edu
Eric Lee kylee5@illinois.edu
Dominic Roberts djrbrts2@illinois.edu
Yuan Shen yshen47@illinois.edu
Grades

• Projects (55%)
  – 5 projects: each with 100 core points with more optional “bells and whistles”
  – 3 credit (ugrad): graded out of 425 points
  – 4 credit (grad): graded out of 500 points
  – Can early 25 additional points for extra credit

• Exams (30%)
  • Midterm 15%: covers first half
  • Final 15%: covers entire semester

• Final Project (15%)
  • 1% for proposal, 14% for final submission
  • 2 page abstract

Late policy
• Up to ten free days total – use them wisely!
• 5 point penalty per day after that
• Project must be submitted within two weeks of due date to receive any points
Project details

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

• Submit PDF, Jupyter notebook, and Python code
Learning resources

Lectures
• Lecture modules on Coursera
• Original full-length recordings: https://ensemble.illinois.edu/Playlist/CS445_Hoiem_FA19
  • Search by lecture date, e.g. 9.06 for Sept 6, based on schedule here: https://courses.engr.illinois.edu/cs445/fa2019/

Slides
• On Coursera

Office hours
• Will be updated on the Coursera page

Discussion board: https://piazza.com/class/kdszesldhqd74g

Readings/textbook: for depth and details not covered in lecture
Academic Integrity

These are OK
• Discuss projects with classmates (don’t show each other code)
• Use Stack Overflow to learn how to use a Python module
• Get images from online (make sure to attribute the source)

Not OK
• Copying or looking at project-specific code (i.e. so that you claim credit for part of an assignment based on code that you didn’t write)
• Using external resources (code, images) without acknowledging them

Remember
• Ask if you’re not sure if it’s ok
• You are safe as long as you acknowledge all of your sources of inspiration, images, code, etc. in your write-up
Other comments

Prerequisites

- **Linear algebra**, plus some basic calculus and probability
- Experience with graphics, image processing, or Python will help but is not necessary

Equipment

- Your own camera, but a smartphone is probably good enough
- A mirrored sphere for project 4 (12 cm or bigger) e.g. [https://www.amazon.com/Stainless-Mirror-Polished-Sphere-Ornament/dp/B01ING7L4U](https://www.amazon.com/Stainless-Mirror-Polished-Sphere-Ornament/dp/B01ING7L4U)
Feedback is welcome