

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



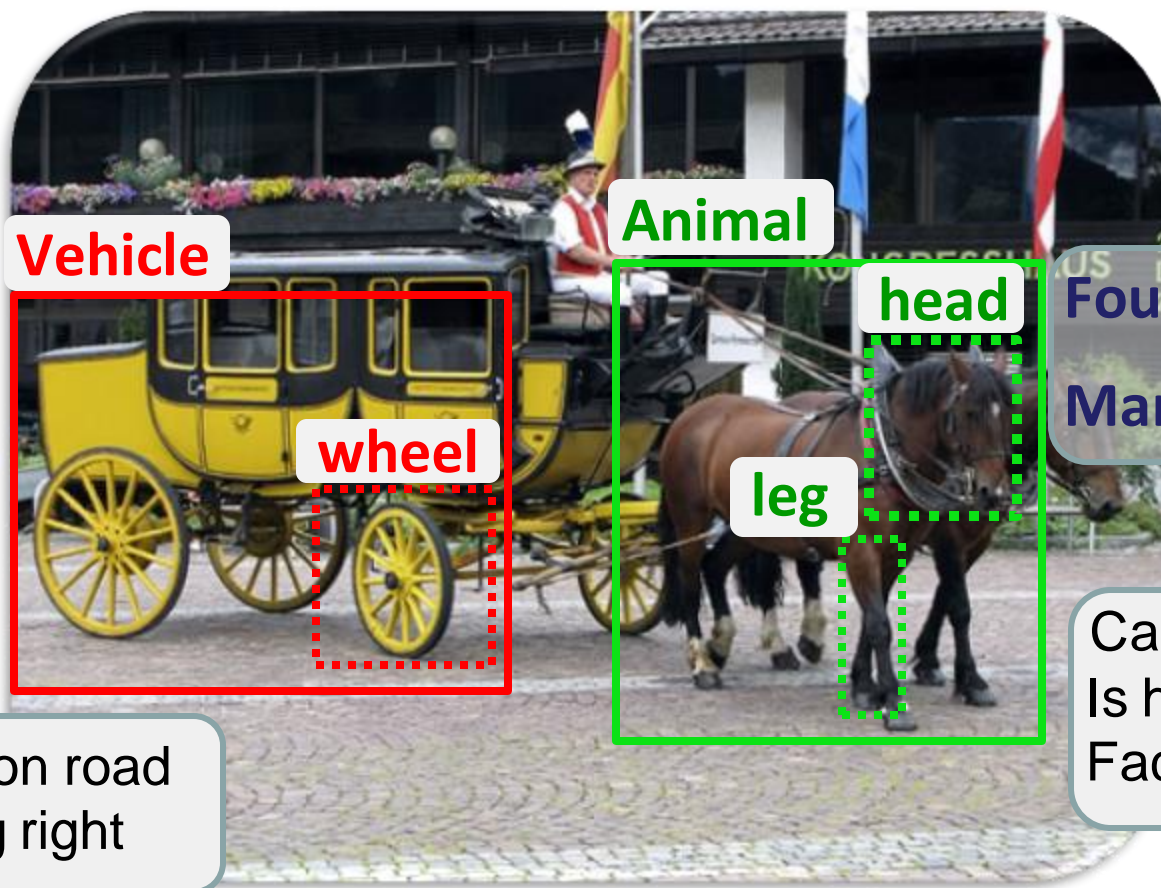
2009-

Asst/Assoc Prof in CS at UIUC

My research



My Research



Vehicle

Animal

wheel

head

leg

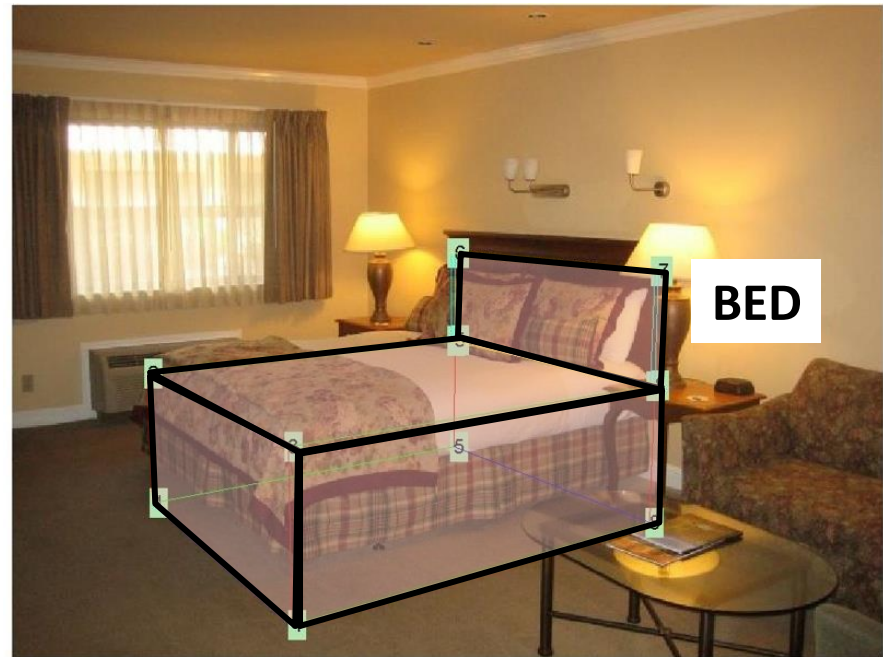
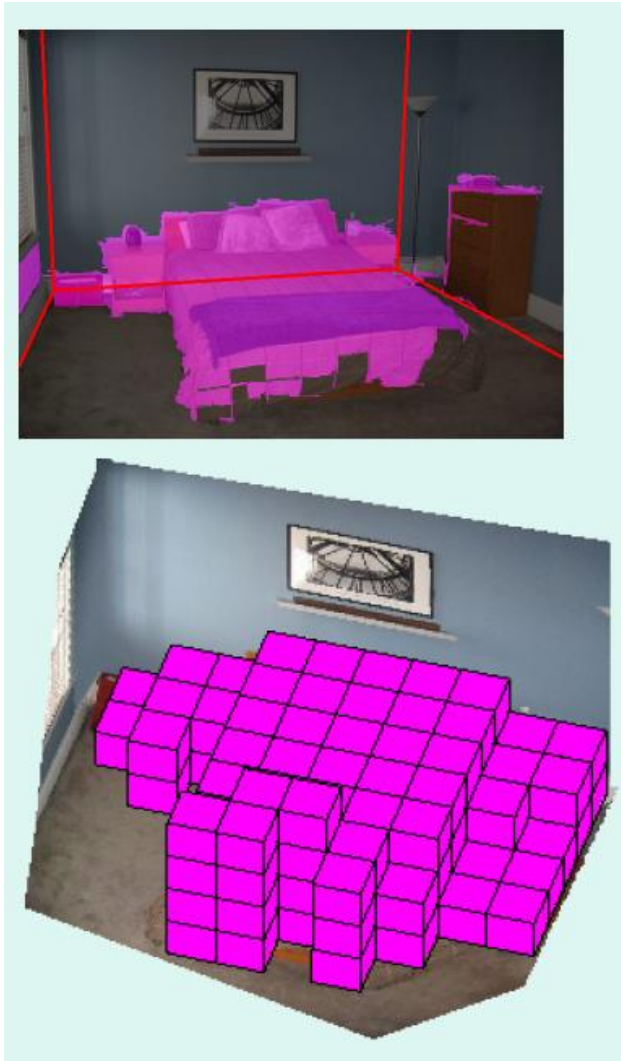
**Four-legged
Mammal**

Move on road
Facing right

Can run, jump
Is herbivorous
Facing right

My Research

Recovering 3D layout and context

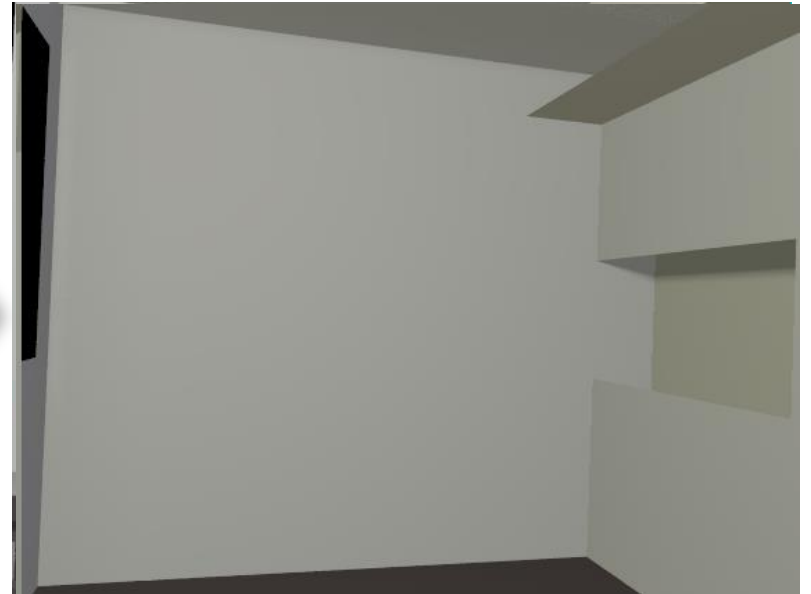


My Research

3D scene model from RGB+D image



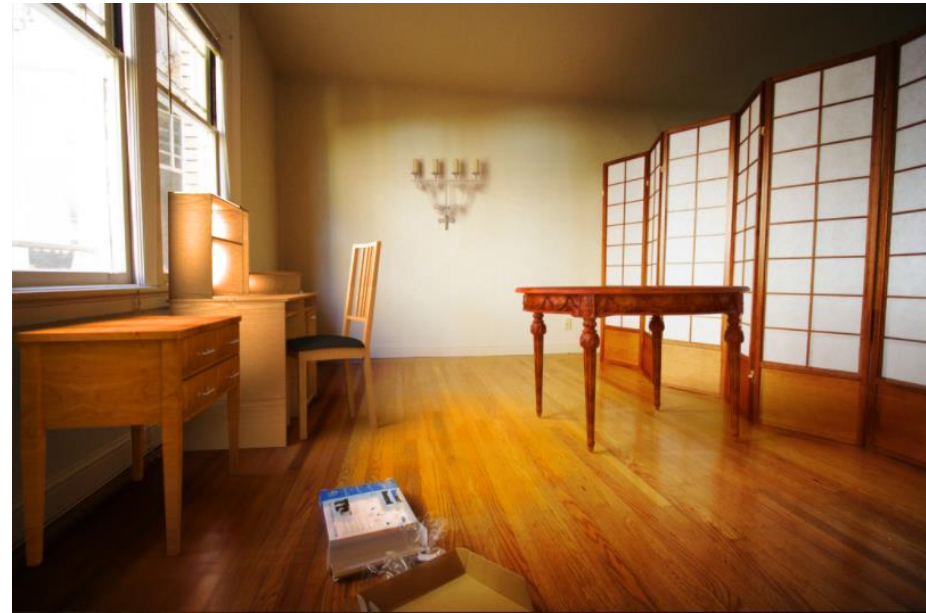
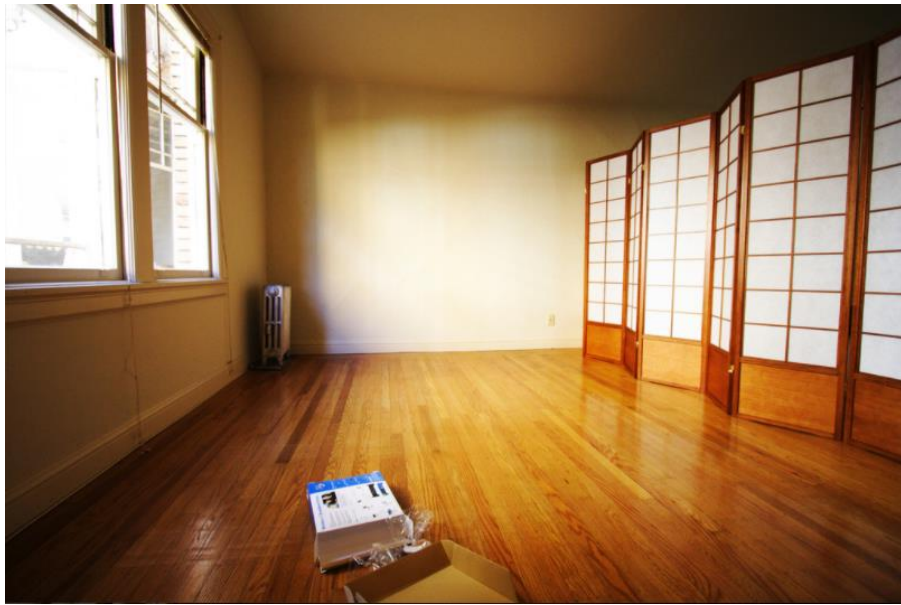
RGBD Image



3D Model

My Research

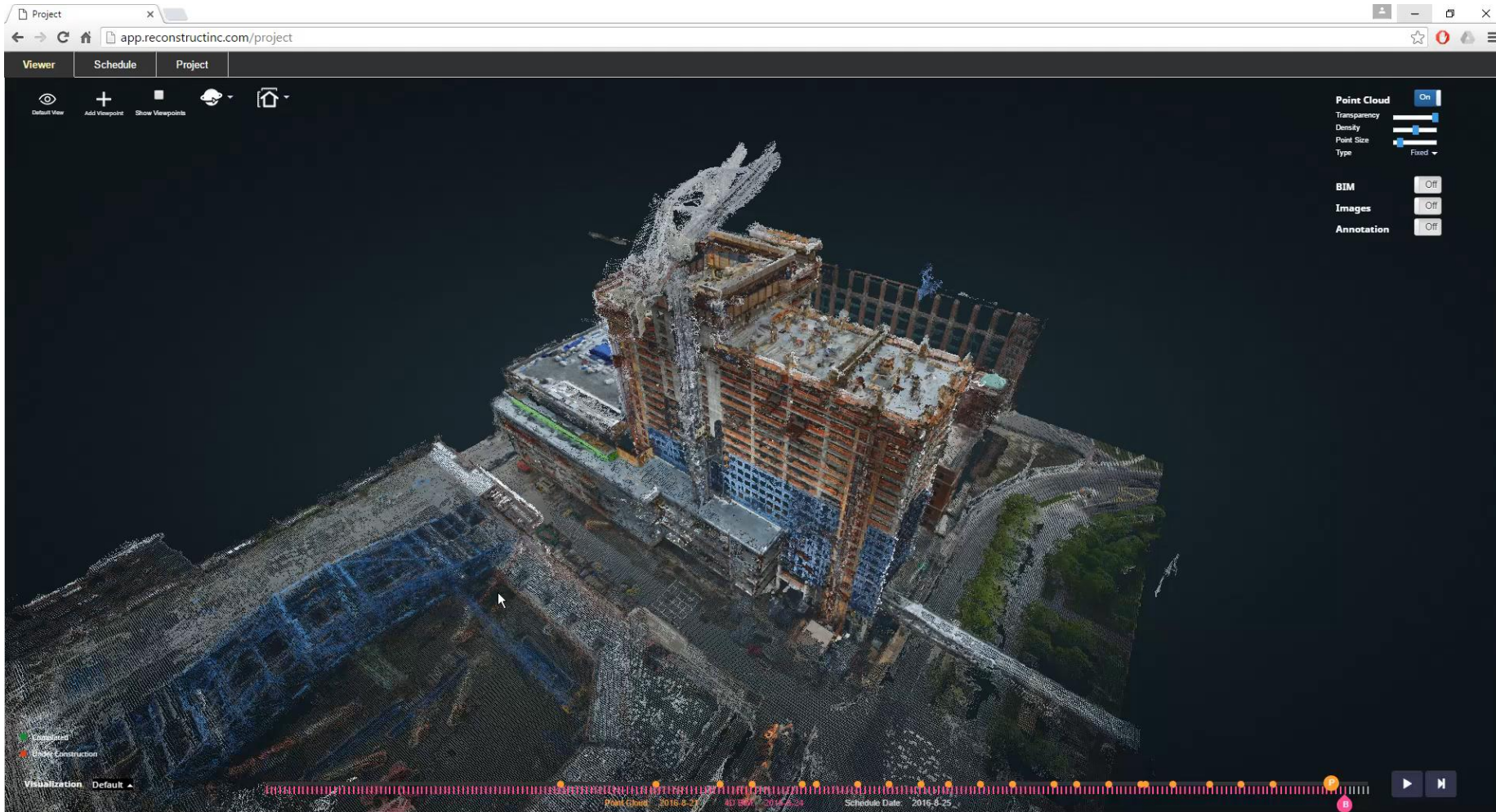
Editing images as if they were 3D scenes







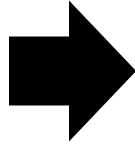
Reconstruct: vision for construction



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]



PhD Candidate (4th Year)
Computer Vision

Joseph DeGol

degol2.web.engr.illinois.edu



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



Ph.D. Computer Science
(2018)



Towards Vision Based Robots for Monitoring Built Environments

ChromaTag: A Colored Marker and Fast Detection Algorithm

2017 International Conference on Computer Vision (ICCV)

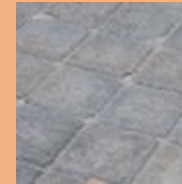


CCTag	263 ms
RuneTag	51 ms
AprilTag	19 ms
ChromaTag	3 ms

Geometry-Informed Material Recognition

2016 Computer Vision and Pattern Recognition (CVPR)

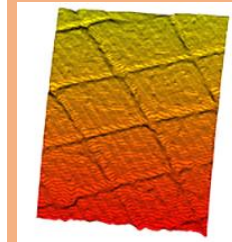
Paving



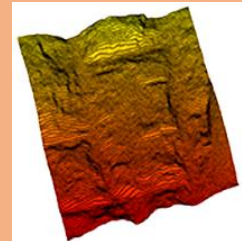
Stone - Limestone



Often
confused
with 2D

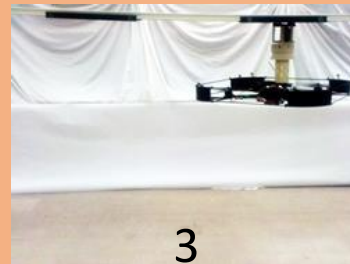
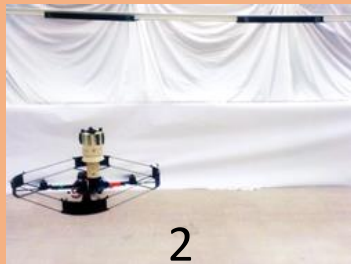
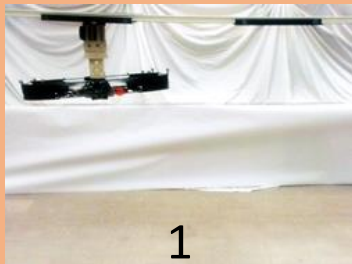


Correctly
classified
with 3D



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



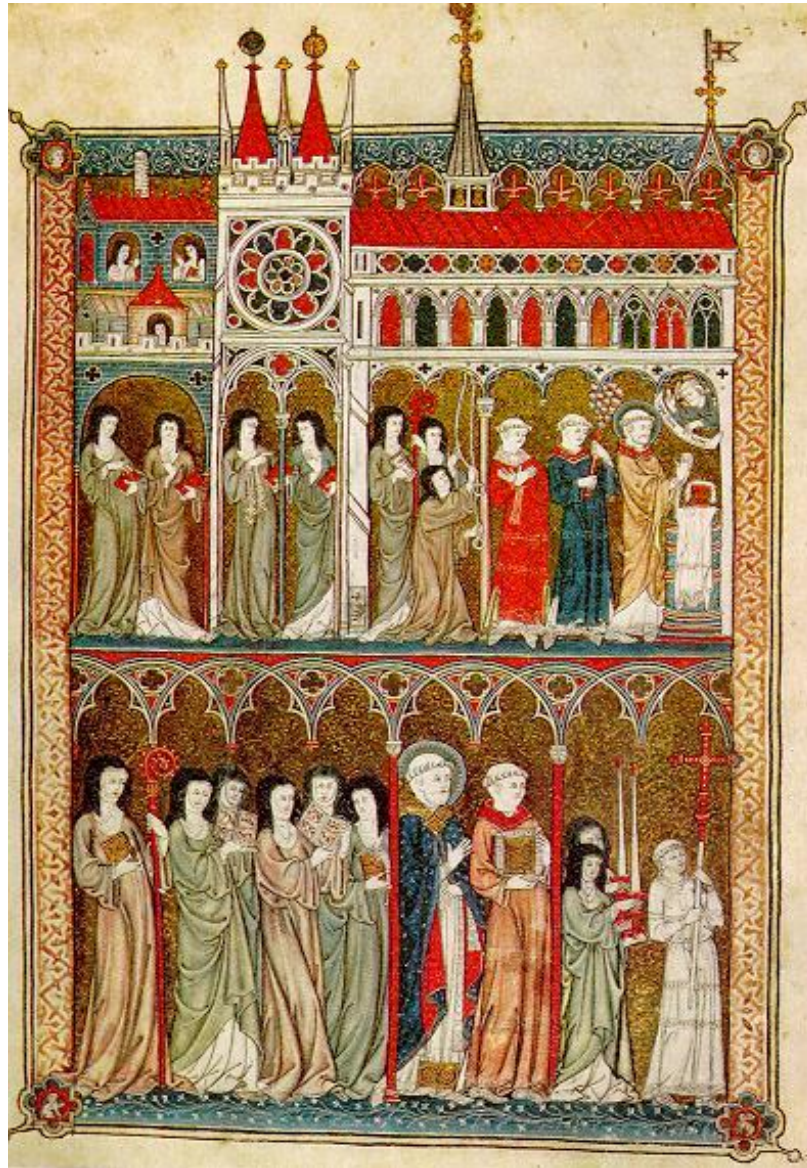
Prehistoric Painting, Lascaux Cave, France
~ 15,000 B.C.

Depicting Our World: Middle Ages



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



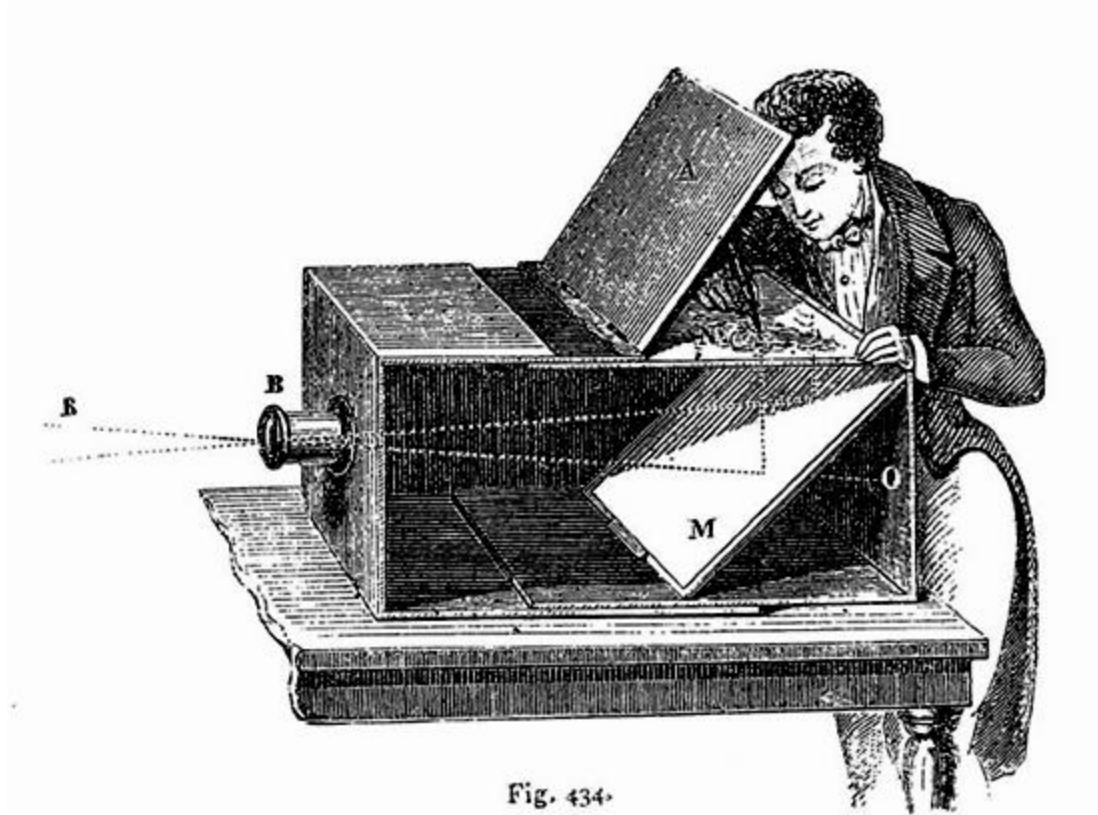
*Paolo Uccello,
Miracle of the Profaned Host (c.1467-9)*

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!

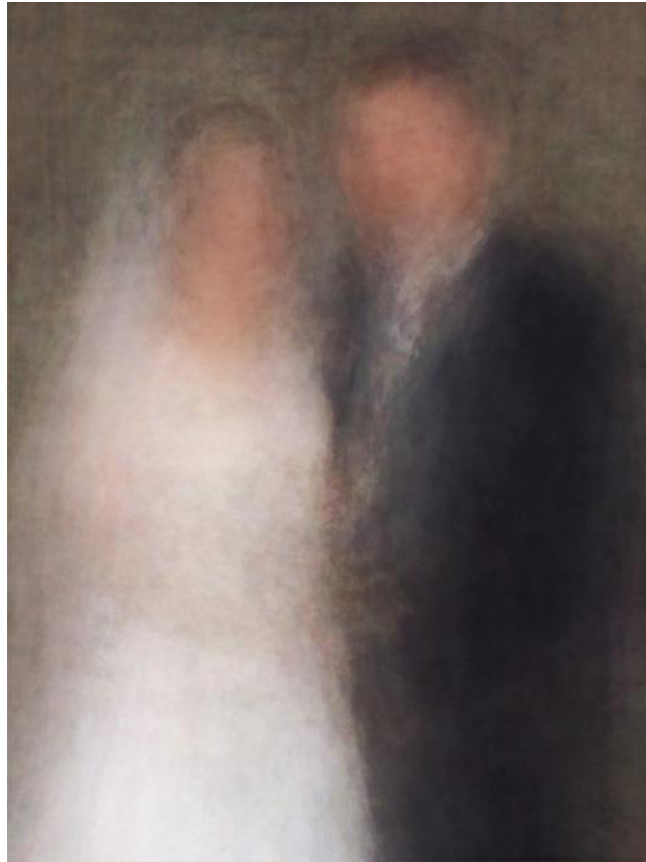


Still Life, Louis Jaques Mande Daguerre, 1837

But is a photo really realistic?



Is reality what we want?



Newlyweds

Better than realism?

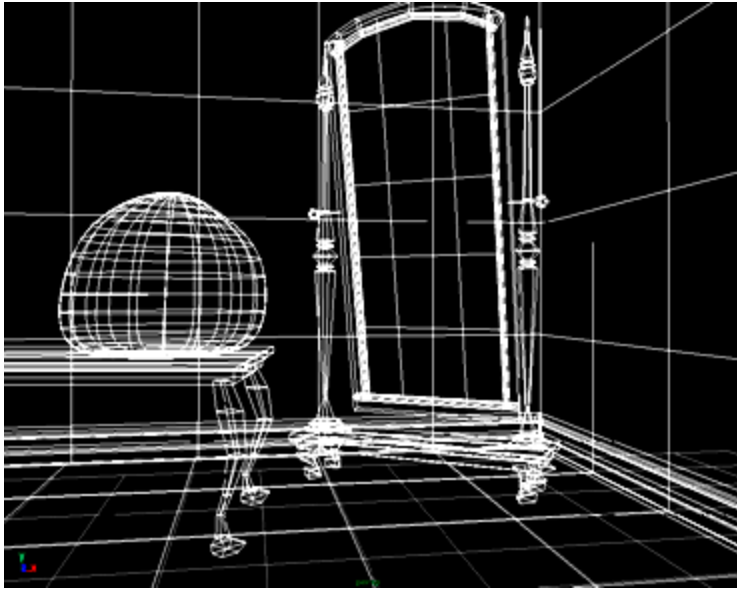


City (westward)

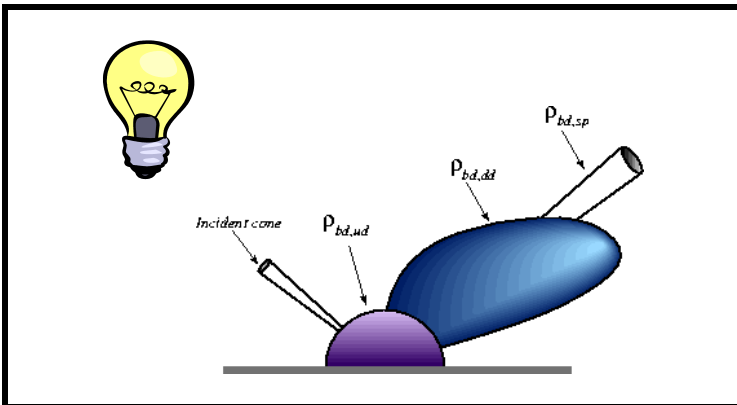


Enter Computer Graphics...

Traditional Computer Graphics



3D geometry



physics



projection

Simulation

GRAPHICS

Computer graphics



What's wrong?

The richness of our everyday world



Photo by Svetlana Lazebnik

Which parts are hard to model?



Photo by Svetlana Lazebnik

People



From "Final Fantasy"

Alyosha Efros - On the Tube, London



Faces / Hair



From "Final Fantasy"



Photo by Joaquin Rosales Gomez

Urban Scenes



Virtual LA (SGI)

Photo of I 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

➔ Realism
Manipulation
Ease of capture

Photography



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

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)

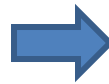
<http://www.debevec.org/Campanile/>

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

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@illinois.edu)

Web page:

<http://courses.engr.illinois.edu/cs445/>

Enrollment list:

<https://goo.gl/forms/7nQzBvGxgzgzMBZM2>

Course objectives

1. You will have new abilities for visual creation.

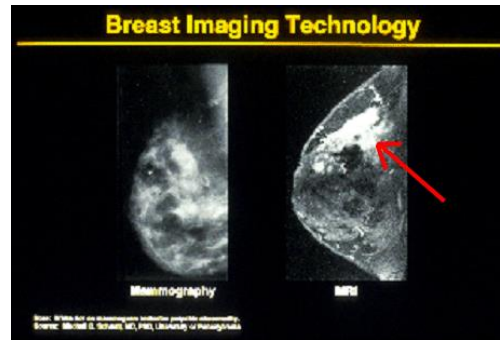


Course objectives

2. You will get a foundation in computer vision.



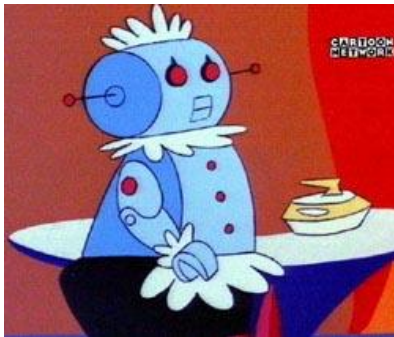
Safety



Health



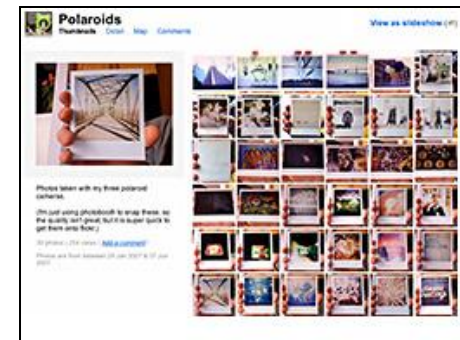
Security



Comfort



Fun



Access

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!

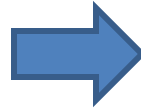
Projects

Project 1: Hybrid Images

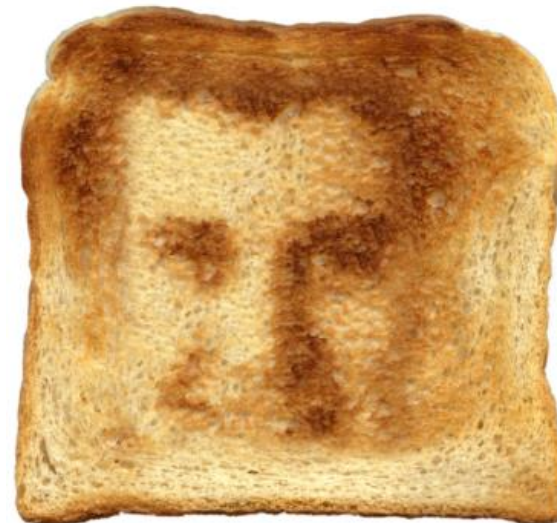
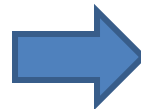
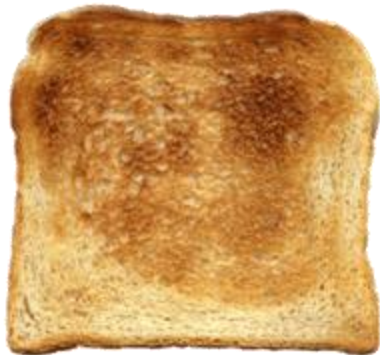


Project 2: Image Quilting for Texture Synthesis and Transfer

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at he left a ringing questi
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Political comedian Al Fra
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Project 3: Poisson Editing



Project 3: Poisson Editing



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