Basic Info

• Instructor: Svetlana Lazebnik (lazebnik@cs.unc.edu)

• Office hours: By appointment, FB 244

• Class webpage: http://www.cs.unc.edu/~lazebnik/fall08
Today

• What is computational photography?
• Course overview
• Course requirements
What is Computational Photography?

- Definition 1: the use of photographic imagery to create graphics content
Traditional Computer Graphics

3D geometry → projection → simulation

physics
State of the Art

- Amazingly real
- But so sterile, lifeless, *futuristic*

Slide credit: A. Efros
The richness of our everyday world

Pavia, Italy

Slide credit: A. Efros
Beauty in complexity
Which parts are hard to model?
People

From “Final Fantasy”
Faces / Hair

From “Final Fantasy”

Slide credit: A. Efros

Photo by Joaquin Rosales Gomez
Urban Scenes

Virtual LA (SGI)

Photo of LA

Slide credit: A. Efros
Nature

River Cherwell, Oxford

Slide credit: A. Efros
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
- very hard to manipulate objects/viewpoint

**Photography**
- real manipulation
- ease of capture

Slide credit: A. Efros
What is Computational Photography?

- Definition 1: the use of photographic imagery to create graphics content

- Definition 2: The use of computational techniques to overcome limitations of conventional photography
Limitations of traditional photography

- Blur, camera shake, noise, damage
Limitations of traditional photography

- Limited resolution
Limitations of traditional photography

- Bad color / no color
Limitations of traditional photography

• Unwanted objects
Limitations of traditional photography

- Unfortunate expressions
Limitations of traditional photography

- Limited dynamic range
Limitations of traditional photography

- Single viewpoint, static 2D picture
Limitations of traditional photography

- Single depth of focus
Course overview

• Data-driven image synthesis
• Image enhancement and restoration
  – Removing camera shake and motion blur
  – Color image manipulation
  – Image completion
• Combining multiple images
  – Compositing
  – Panoramas, mosaics, collages
  – Warping and morphing
• From 2D to 3D
  – Single-view reconstruction
  – Multiple-view reconstruction
• Beyond conventional cameras
  – High dynamic range imaging
  – Light field cameras, coded apertures
• Digital image forensics
Data-driven image synthesis

Texture synthesis

Image analogies
Hertzmann et al. (2001)

Unfiltered source ($A$)
Filtered source ($A'$)

Unfiltered target ($B$)
Filtered target ($B'$)

Image super-resolution
Removing Camera Shake and Motion Blur

- Fergus et al. (2006)
- Levin (2006)
- Yuan et al. (2007)
Color image manipulation

**Colorization**
- Levin et al. (2004)

**Color Harmonization**
- Cohen-Or et al. (2006)

**White Balance Adjustment**
- Hsu et al. (2008)
Image completion

Inpainting

Hays and Efros (2007)

Image completion using millions of photographs

Sun et al. (2005)

Image completion with structure propagation

Bertalmio et al. (2000)

Since 1698, when French explorers landed at the great sand bar of the Mississippi River and celebrated the first landfall in North America, New Orleans has been a fascinating melting pot. As a French colony, it was a home forhtub to French culture and sold to the United States. Through these years, and over time, the Louisiana Creoles arrived from everywhere—Acadians (Cajuns), Africans, Inc.
Image compositing

Interactive Digital Photomontage

Agarwala et al. (2004)

Face Swapping

Bitouk et al. (2008)
Panoramas, collages, etc.

Panorama stitching

AutoCollage

Rother et al. (2006)

Multi-viewpoint panoramas

Agarwala et al. (2006)
Image deformation using moving least squares

Warping and morphing

Face morphing

Schaefer et al. (2006)
From 2D to 3D: Modeling and Rendering Architecture from Photographs

Debevec et al. (1996)

Photo Pop-up

Hoiem et al. (2005)

Photo Tourism

Snavely et al. (2006)
Beyond conventional cameras

High Dynamic Range Imaging
Kopf et al. (2007)

Gigapixel Images

Light Field Photography
Ng et al. (2005)
Image Forensics

• How to detect manipulated images?
What will not be covered

• Advanced image-based modeling and rendering
  – View interpolation
  – Relighting
  – Combining photographic imagery with standard graphics imagery
Course requirements

• Paper presentation: 30%
  – Think of yourself as “professor” for one class
  – Make sure you understand all the important techniques in the paper
  – Integrate related papers, other material covered in the course
  – Try to encourage discussion

• Participation: 20%
  – Read all papers
  – Come to class
  – Ask and answer questions
  – Talk to me about your presentation or project

• Final project: 50%
  – Implementation
  – Grading is based primarily on effort and initiative – so try to be creative!
  – Brief project presentation at the end of the course
Project Ideas

• “Straightforward” ideas: implement texture synthesis, panorama stitching, etc.
Texture transfer
Tour into the Picture

Horry et al. (1997)
Creating “Joiners”

David Hockney

Flickr “Hockneyesque” pool

Face Morphing
Playing around with faces on hotornot.com

Face beautification

T. Leyvand, D. Cohen-Or, G. Dror and D. Lischinski, Data-Driven Enhancement of Facial Attractiveness, SIGGRAPH 2008
Background Replacement

(a) input  (b) result 1  result 2

Preliminary results by Sashi Kumar Penta
“Infinite Panoramas”

J. Sivic, B. Kaneva, A. Torralba, S. Avidan, and W. Freeman,
Creating and Exploring a Large Photorealistic Virtual Space,
Internet Vision Workshop, 2008
Creating unlikely juxtapositions
Creating unlikely juxtapositions
Creating unlikely juxtapositions

Jeff Wall, *Flooded Grave*

Scott Mutter, *Escalator*
Class projects: Policy

- Feel free to use code or software you find on the web, provided it does not make your project trivial.

- All outside sources should be fully documented in the final project report.

- Feel free to talk to other people about the project, but do your own implementation.

- By default, I expect projects to be individual. In special cases, collaboration is possible, but each person should have a clearly identifiable part that they are responsible for. If you are thinking of collaborating on a project, come and talk to me.
For next time

• Send four paper preferences by the end of the week

• Start thinking about final project ideas (feel free to talk to me)

• Read papers on texture synthesis