Computational Photography

End of Semester

• Today is the last lecture!
• Friday is in class final project work day (attendance strongly encouraged)
• Quiz on Tuesday
  – Sample problems are posted on course website
• Final Project Presentations
  Fri May 2\(^{nd}\), Tues May 6\(^{th}\)
  – Attendance mandatory (please don’t be late!)
  – No laptops allowed during your classmates’ presentations
  – You will be giving each other written feedback & peer grade
  – Ask good questions (participation grade)
• Presentation 10pts (peers)
• Project Report 20pts (instructor)

Final Presentation

• Summarize prior work as necessary
  – You don’t need to discuss papers we covered in class
• Be technical:
  – What were the challenges?
  – How did you solve them?
• Live demo / video / lots of images (depends on project)
  – Use plenty of examples (both of success & failure)
• Teams of 2:
  – Both should present & make it clear who did what
• Practice! & time yourself!
  – We have a tight schedule
  – I will stop you midsentence if you run over

Final Presentation Schedule

<table>
<thead>
<tr>
<th>Fri May 2(^{nd})</th>
<th>Tues May 6(^{th})</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 eric &amp; steve</td>
<td>2:00 victor &amp; wesley</td>
</tr>
<tr>
<td>2:25 andrew l. &amp; gerrett</td>
<td>2:25 yuriy &amp; ben</td>
</tr>
<tr>
<td>2:50 max</td>
<td>2:50 rebecca</td>
</tr>
<tr>
<td>3:05 jun &amp; logan</td>
<td>3:05 kevin dimitri</td>
</tr>
<tr>
<td>3:30 zev &amp; meixing</td>
<td>3:30 nathan yumi</td>
</tr>
<tr>
<td>3:55 michael d. &amp; michael l.</td>
<td>3:55 gaby</td>
</tr>
<tr>
<td>4:20 done!</td>
<td>4:10 scott &amp; andy h.</td>
</tr>
</tbody>
</table>

Total time (including setup & questions):
15 min (individual), 25 min (team of 2)

Last Time?

• Texture Synthesis
• Markov Model
• Image Completion
• Volumetric Texture Synthesis

“Fragment-based image completion”, Drori, Cohen-Or, Yeshurun, SIGGRAPH 2003

Reading from last time:

• Coarse to fine completion
• Confidence & traversal order
• Search for best match over different scales, rotations, & resolutions (texture frequency)
• Compositing fragments
Today
• Structure From Motion
• Multi-viewpoint Rendering
• Matting & Compositing
• Helmholtz Reciprocity
• Light Fields

Structure From Motion
• Input: Sequence of frames (e.g., video) of a moving object (or moving camera)
• Output: Approximate geometry of object & camera pose for each frame
• How?
  – Automatically detect features in each frame
  – Determine correspondences between features
  – Infer camera calibration & object geometry
• Humans do it all the time…but it’s a really hard problem!

Photo Tourism
Finding Paths through the World's Photos,
Snavely, Garg, Seitz, & Szeliski, SIGGRAPH 2008
Photo tourism: Exploring photo collections in 3D,
Snavely, Seitz, & Szeliski, SIGGRAPH 2006

“Image Based Tree Modeling”,
Tan et al., SIGGRAPH 2007

“Approximate Image-Based Tree-Modeling using Particle Flows”, Neubert et al., SIGGRAPH 2007

Image-Based Modeling and Photo Editing
Oh, Chen, Dorsey, & Durand, SIGGRAPH 2001
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Multi-Viewpoint Panoramas

“Photographing long scenes with multi-viewpoint panoramas”, Agarwala, Agrawala, Cohen, Salesin, & Szeliski, SIGGRAPH 2006

- Like many non-photorealistic rendering methods, this paper aims to mimic the style of a particular artist or style of art
- Well designed user interface:
  - Most components automated
  - User can adjust dominant plane, view selection, seams, & inpainting
Multi-Perspective Rendering

J. Yu & L. McMillan
“A Framework for Multiperspective Rendering”
Eurographics Symposium on Rendering 2004

Opening Scene from Disney’s Pinocchio

http://disney.wikia.com/wiki/Pinocchio
Gustaf Tenggren

Photo Montage

• David Hockney

http://www.hockneypictures.com/photos/photos_collages_05_large.php

Questions?

Zac Bubnick http://www.princetonol.com/groups/ia/lessons/high/cubismphoto.htm
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“Environment Matting and Compositing”
Zongker, Werner, Curless, & Salesin, SIGGRAPH 1999

Helmholtz Reciprocity

• BRDF is symmetric: % of light reflected from direction $i$ off surface point $p$ to direction $j$ is the same as the % of light reflected from direction $j$ off surface point $p$ to direction $i$

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“Dual Photography”, Sen, Chen, Garg, Marschner, Horowitz, Levoy, & Lensch, SIGGRAPH 2005
“Dual Photography”, Sen, Chen, Garg, Marschner, Horowitz, Levoy, & Lensch, SIGGRAPH 2005

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Light Fields


Unstructured Lumigraph Rendering”
Buehler et al. SIGGRAPH 2001

Light Field Camera

- After taking the photograph, we can:
  - Adjust focus
  - Change viewpoint
  - Change illumination
  - & more?

Light Field Photography with a Hand-Held Plenoptic Camera, Ng, Levoy, Bredif, Duval, Horowitz, & Hanrahan, Stanford Tech Report, 2005
“Coded Rolling Shutter Photography: Flexible Space-Time Sampling” Gu, Hitomi, Mitsunaga, & Nayar, ICCP 2010

• Global Shutter vs. Rolling Shutter plus Coded
• Interlaced vs. Staggered
• Skew Compensation
• High Speed Photography
• Interpolation of High Resolution
• High Dynamic Range
• Adaptive Row-wise Auto Exposure
• Simulation ➔ Prototype Camera Hardware

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• Yeah! Last lecture!!