Computer Vision, CS766

Staff

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Today

Introduction
Administrative Stuff
Overview of the Course
About Me

• Li Zhang (张力)
  – Last name pronounced as Jung

• New Faculty
  – PhD 2005, U of Washington
  – Research Scientist 06-07, Columbia U

• Research
  – Vision and Graphics

• Teaching
  – CS766 Computer Vision
  – CS559 Computer Graphics
Previous Research Focus

• 3D shape reconstruction

Four examples of recovered 3D shapes of a moving face from six video streams
Previous Research Focus

- 3D shape reconstruction
- Application

Licensed by SONY for Games

Used by VA Hospital for Prosthetics
Please tell me about you
Prerequisites

• Prerequisites—these are essential!
  – Data structures
  – A good working knowledge of C and C++ programming
    • (or willingness/time to pick it up quickly!)
  – Linear algebra
  – Vector calculus

• Course does not assume prior imaging experience
  – no image processing, graphics, etc.
Administrative Stuff

• **4 programming projects**
  – 15%, 2-3 weeks each

• **1 final project**
  – 40%, 5 weeks, open ended of your choosing, but needs
    – project proposal after 1 week
    – progress report after 3 weeks
    – Final presentation after 5 weeks

• **Computer account:**
  – Everyone registered in this class will get a Computer Systems Lab account to do project assignments.

• **Email list:**
  – compsci766-1-f07@lists.wisc.edu
Questions?
Every picture tells a story

Goal of computer vision is to write computer programs that can interpret images
Can computer match human perception?

- Yes and no (but mostly no!)
  - computers can be better at “easy” things
Can computer match human perception?

• Yes and no (but mostly no!)
  – computers can be better at “easy” things
  – humans are much better at “hard” things
Computer Vision vs Human Vision

• Can do amazing things like:
  • Recognize people and objects
  • Navigate through obstacles
  • Understand mood in the scene
  • Imagine stories

• But still is not perfect:
  • Suffers from Illusions
  • Ignores many details
  • Ambiguous description of the world
  • Doesn’t care about accuracy of world
# Computer vision vs Human Vision

<table>
<thead>
<tr>
<th>What we see</th>
<th>What a computer sees</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="La Gare Montparnasse, 1895" /></td>
<td>![table_image]</td>
</tr>
</tbody>
</table>

Srinivasa Narasimhan’s slide
Components of a computer vision system

- Camera
- Scene
- Lighting
- Computer
- Scene Interpretation

Srinivasa Narasimhan’s slide
Topics Covered
Cameras and their optics

Today’s Digital Cameras

The Camera Obscura

Srinivasa Narasimhan’s slide
Biological vision

Human Eye

Mosquito Eye

Srinivasa Narasimhan’s slide
Project 1: High Dynamic Range Imaging

- Cameras have limited dynamic range

Short Exposure

Desired Image

Long Exposure

Shree Nayar’s slide
Project 1: High Dynamic Range Imaging

Combination Yields High Dynamic Range

Shree Nayar’s slide
Image Processing

Fourier Transform
Sampling, Convolution

Image enhancement
Feature detection

Srinivasa Narasimhan’s slide
Camera Projection

projection perspective

plan image

plan image auxiliaire

projection parallèle

\( \overrightarrow{CM_0} // \overrightarrow{M_aM} \)
Image Transformation

Steve Seitz and Chuck Dyer, View Morphing, SIGGRAPH 1996
Project 2: Panoramic Imaging

Input images:

Output Image:

Steve Seitz’s slide
Projective Geometry
Single View Metrology

- https://research.microsoft.com/vision/cambridge/3d/3dart.htm
Single View Metrology

- https://research.microsoft.com/vision/cambridge/3d/3dart.htm
Shading and Photometric Stereo

http://www.eecs.harvard.edu/~zickler/helmholtz.html
Texture Modeling

repeated

radishes  rocks  yogurt

“Semi-stochastic” structures

stochastic

Alexei Efros’ slide
Project 3: Texture Synthesis

Input

Output

Project 3: Texture Synthesis

Input images:

Output Image:

Graphcut Textures, Kwatra et al., SIGGRAPH 2003.
Multi-view Geometry

- Binocular Stereo (2 classes)
- Multiview Stereo (1 class)
- Structure from Motion (2 classes)

http://phototour.cs.washington.edu/
Face Detection and Recognition
Project 4: EigenFaces

Face detection and recognition
Motion Estimation

Hidden Dragon Crouching Tiger
Motion Estimation

Application

Andy Serkis, Gollum, Lord of the Rings
Segmentation

http://www.eecs.berkeley.edu/Research/Projects/CS/vision/bsds/
Segmentation

Application

Medical Image Processing
Matting

Input

Matting

Composition
Light, Color, and Reflection
Capturing Light Field

Camera Arrays, Graphics Lab, Stanford University
Capturing Light Field

Applications
Structured Light and Ranging Scanning

http://graphics.stanford.edu/projects/mich/
Structured Light and Ranging Scanning

http://graphics.stanford.edu/projects/mich/
Structured Light and Ranging Scanning

http://graphics.stanford.edu/projects/mich/
Novel Cameras and Displays

Course Info

http://www.cs.wisc.edu/~cs766-1/