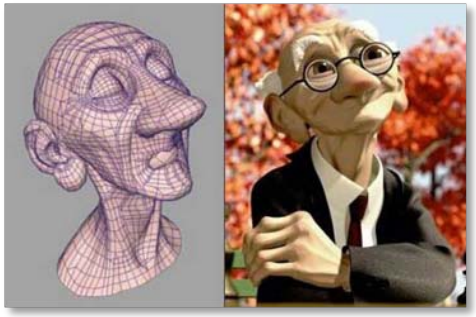
G22.2274-001, Fall 2009

Advanced Computer Graphics

Introduction and Overview

What is this course?

- Capstone course = **projects** course in Computer Graphics
- Each student will do a project in one of the following areas
  - Computer Animation
  - Geometric Modeling
  - Computational Photography/ Image Processing
- Roughly bi-weekly meetings to discuss progress



Organization

- Olga Sorkine
  sorkine@cs.nyu.edu
  http://www.cs.nyu.edu/~sorkine/
- Office hours:
  - Weeks **with** course meeting:
    Mondays, 7-8pm, Room 1204 (i.e. right after class)
  - Weeks **without** course meeting:
    Mondays, 5-6pm, Room 1204 (i.e. during class hours)
  - Other time can be coordinated **via e-mail**

Organization

- Course website http://www.cs.nyu.edu/~sorkine/courses/adv_cg/adv_cg09/pmwiki.php
- Mailing list: g22_2274_001_fa09@cs.nyu.edu
- Check the website often for updates!

Organization

Course materials

- Links to project descriptions, relevant papers, presentations and tutorials on the course website

- Papers from: ACM SIGGRAPH, Symposium on Geometry Processing (SGP), Shape Modeling International (SMI), Eurographics, etc. **http://kesen.huang.googlepages.com/**

Prerequisites

- Basic familiarity with Computer Graphics topics
- Programming knowledge and specifically graphics and GUI programming. If you don’t have those, you’ll have to catch up quickly during the semester.
- Be prepared to research the Internet, read related academic literature and work independently.

Class plan

- First two meetings (9/14, 21/9):
  - Project descriptions by me, questions
- By 9/28 participants study the projects and send me the ranked list
- On 9/28 each participant is assigned a project
- 10/05: everyone presents their project descriptions and tentative work plan

Class plan

- Roughly bi-weekly meetings to discuss progress
- During no-class weeks individual meetings if needed
- Lectures on special issues that arise
- Final project presentations – last two weeks of the semester (12/7, 12/14)

Grading

- 30% interim class presentations and participation
- 70% final project
  - working code
  - final presentation in class with demo
  - final paper

Project Topics

- Computer Animation

- Geometric Modeling

- Computational Photography
  Image processing

Project Topics

- Each project requires:
  - Reading and summarizing relevant academic literature
  - Understanding and implementing some algorithms described in recent research papers
    - Some projects have additional novel research components
  - Running and testing on various example inputs
    - Debugging
    - Critical evaluation of the results
  - Reporting your work in written form and in class presentation

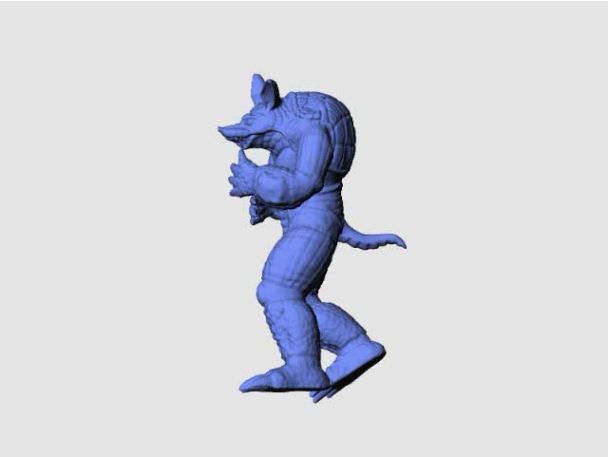
Project Topics

- I will suggest some projects
  - Descriptions and relevant links will be found on the website
  - Basic explanation about the expected work will be given in class
- You are welcome to come up with your own project if you like – must discuss with me and obtain my approval by 9/28.

Computer Animation

Character animation

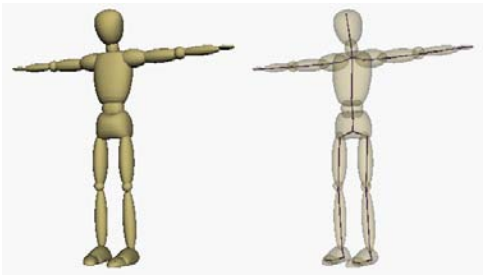
- Create a system for rigging and posing of digital characters (shapes)

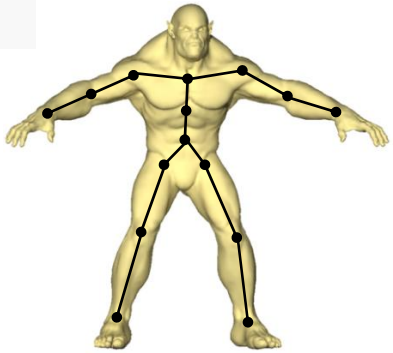


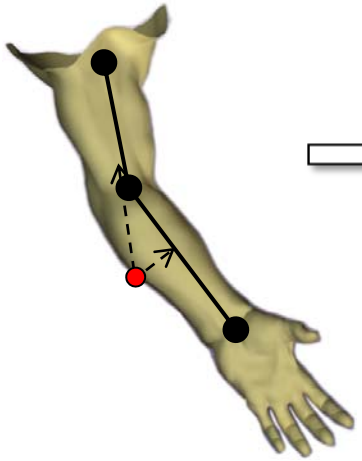
Computer Animation

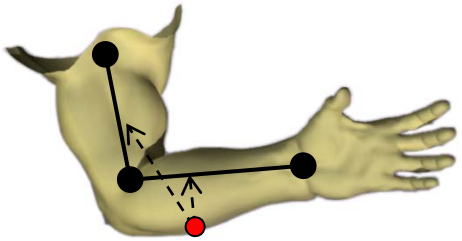
Character animation

- Create a system for rigging and posing of digital characters (shapes)
  - Step 1: compute a skeleton





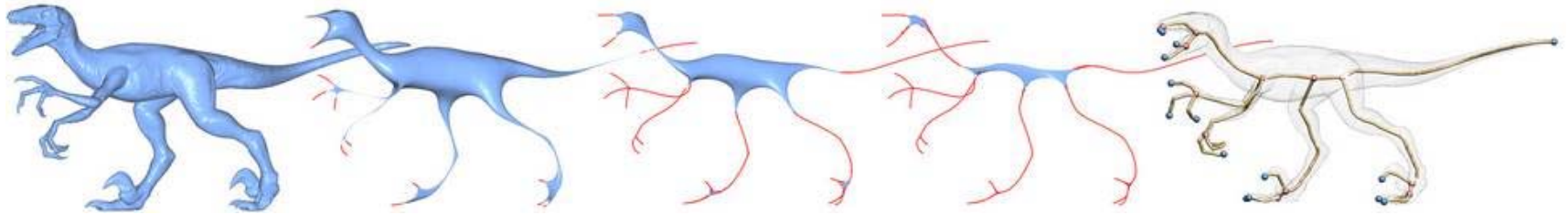




Computer Animation

Character animation

- Create a system for rigging and posing of digital characters (shapes)
  - Step 1: compute a skeleton
    Suggestion: implement the paper “Skeleton Extraction by Mesh Contraction”, SIGGRAPH 2008

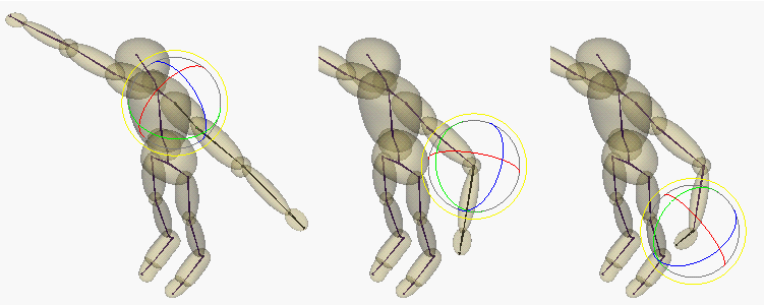


  - also implement GUI to manually create a skeleton

Computer Animation

Character animation

- Create a system for rigging and posing of digital characters (shapes)
  - Step 2: GUI for skeleton posing
    - Forward kinematics – just change joint angles



    - Optional: also add inverse kinematics

Computer Animation

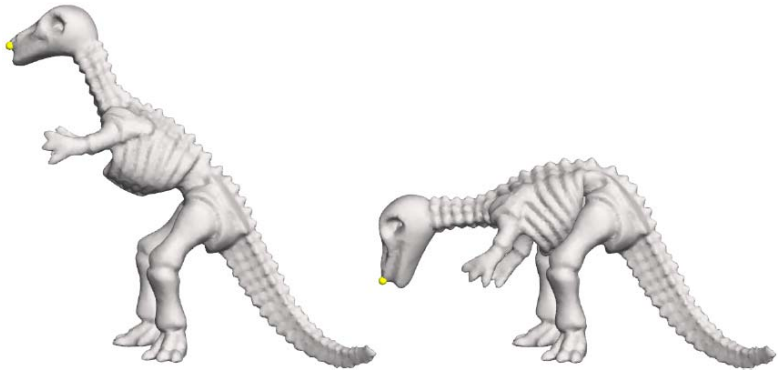
Character animation

- Create a system for rigging and posing of digital characters (shapes)
  - Step 3: implement skinning algorithm
    - Basic linear blend skinning
    - Dual Quaternions (Kavan et al. 2008)
    - Optional: also implement one of the recent optimization-based skinning techniques, such as "Real-Time Enveloping with Rotational Regression", SIGGRAPH 2007

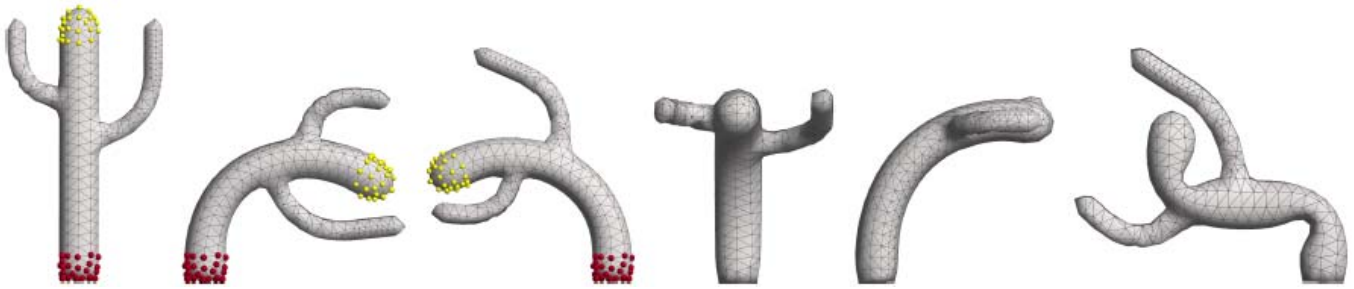
Geometric Modeling

Interactive shape editing system

- A system to edit shapes interactively by “grab-and-drag” interface



show demo



Geometric Modeling

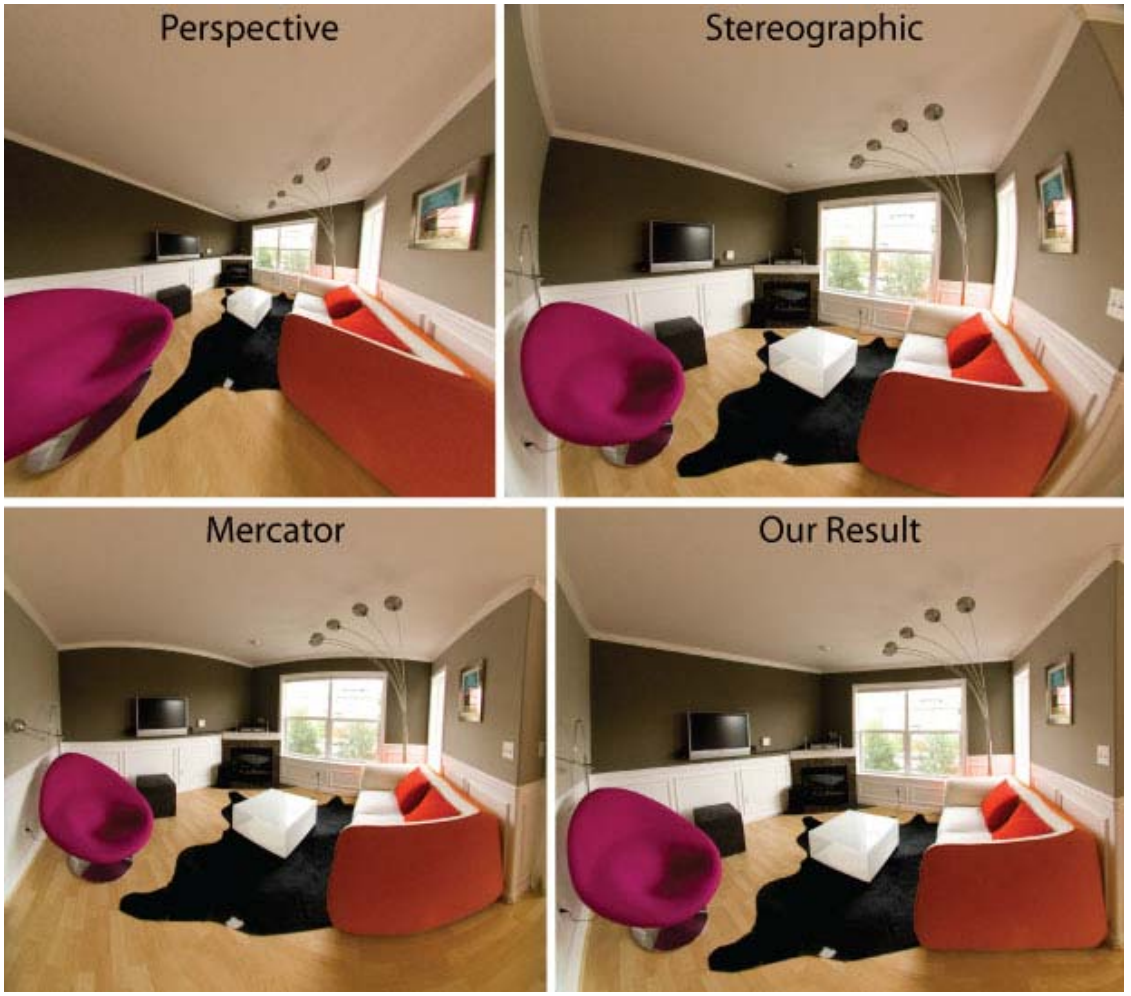
Interactive shape editing system

- Implement one of the recent papers:
  - "PriMo", SGP 2006
  - "As-rigid-as-possible surface modeling", SGP 2007
    - Add multiresolution hierarchy
    - Try both the optimization method in the paper and direct Gauss-Newton optimization, helped by this paper: "Shape Decomposition Using Modal Analysis", Eurographics 2009

PriMo video

Computational Photography

Rectifying fish-eye lens distortion



Computational Photography

Rectifying fish-eye lens distortion

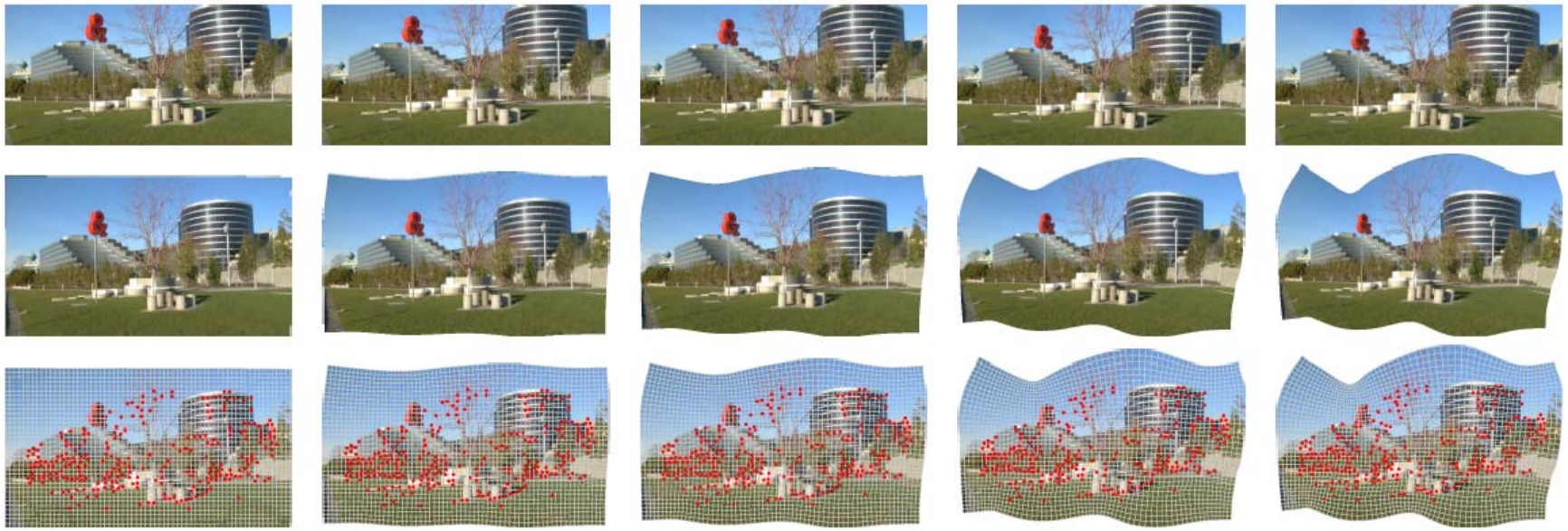
- Implement the paper “Optimizing Content-Preserving Projections for Wide-Angle Images”, SIGGRAPH 2009

Video

Computational Photography

Shaky cam stabilization

- Implement “Content-Preserving Warps for 3D Video Stabilization”, SIGGRAPH 2009



Video

Image Processing

Image retargeting (resizing)

- The problem: resize an image to fit a display device with a different aspect ratio

Image Processing

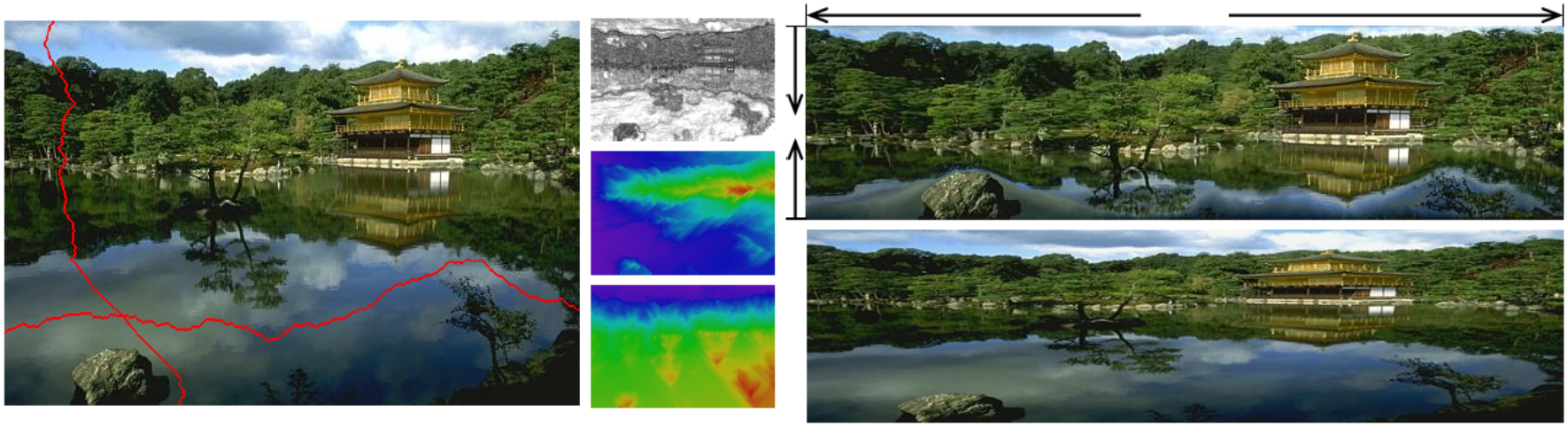
Image retargeting (resizing)

- The problem: resize an image to fit a display device with a different aspect ratio

Image Processing

Image retargeting (resizing)

- The problem: resize an image to fit a display device with a different aspect ratio



Teaser from “Seam Carving”, ACM SIGGRAPH 2007

Image Processing

Image retargeting (resizing)

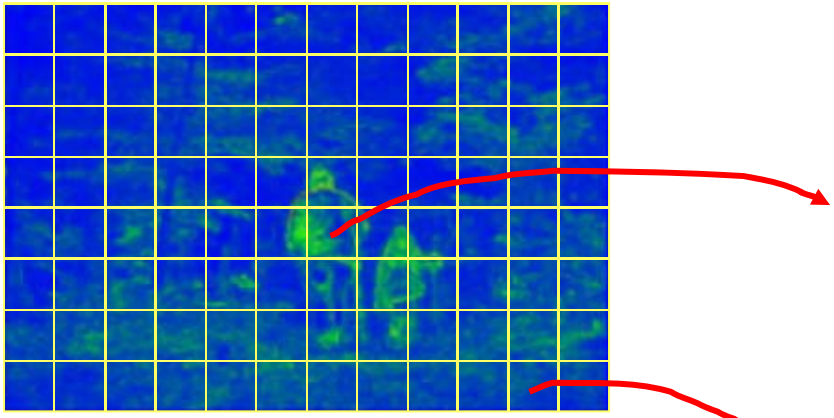
- Approach:
  - Compute an importance map of the image
  - Warp the image such that regions with high importance are preserved at the expense of unimportant regions

importance map

Image Processing

Image retargeting (resizing)

- Grid mesh, preserve the shape of the important quads



quads with high importance:
uniform scaling

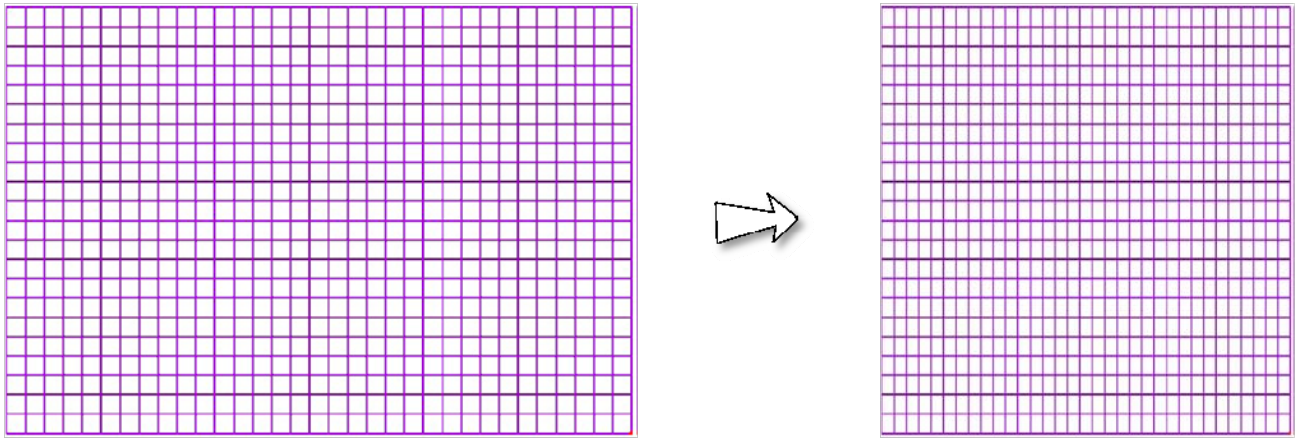
quads with low importance:
allowed non-uniform scaling

- Optimize the location of mesh vertices, interpolate image

Image Processing

Image retargeting (resizing)

- Grid mesh, preserve the shape of the important quads

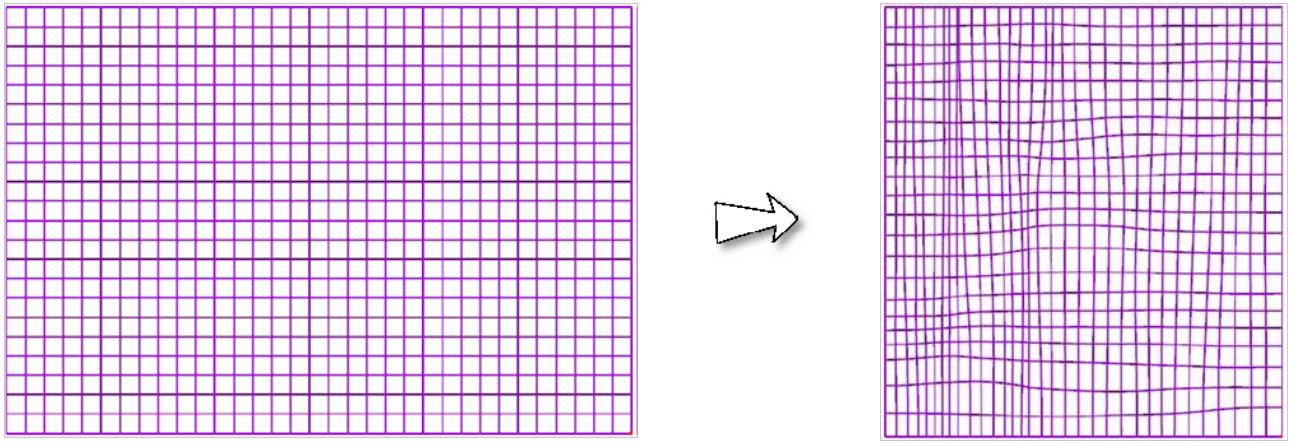


- Optimize the location of mesh vertices, interpolate image

Image Processing

Image retargeting (resizing)

- Grid mesh, preserve the shape of the important quads



- Optimize the location of mesh vertices, interpolate image

Image Processing

Image retargeting (resizing)

- Examples

original

homogeneous resizing

[Wang et al. 08]

Image Processing

Image retargeting (resizing)

- Examples

original

homogeneous resizing

[Wang et al. 08]

Image Processing

Image retargeting (resizing)

- Examples

original

homogeneous resizing

[Wang et al. 08]

Image Processing

Image retargeting (resizing)

- Current approaches have trouble with straight lines in the image

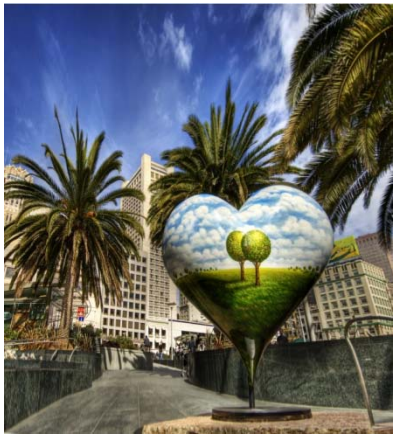


Image Processing

Image retargeting (resizing)

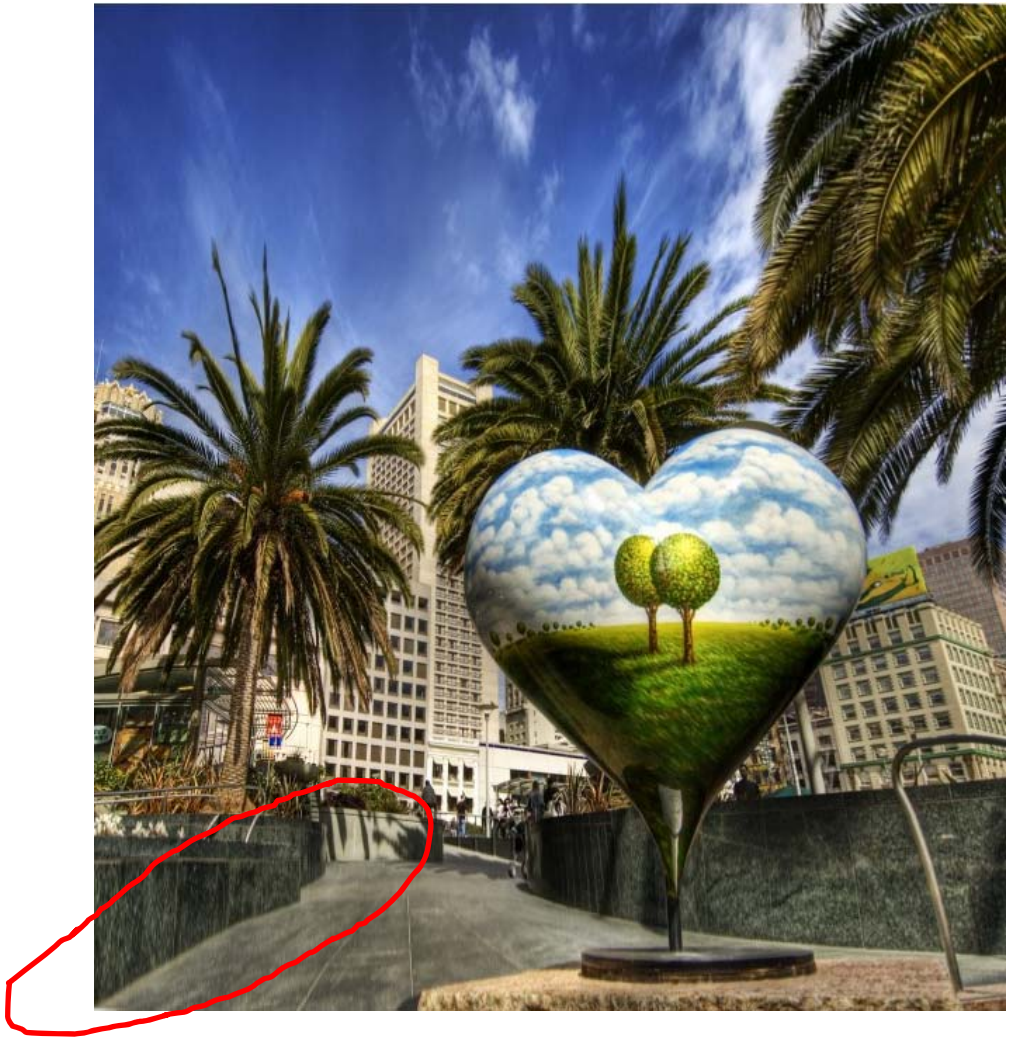


Image Processing

Image retargeting (resizing)

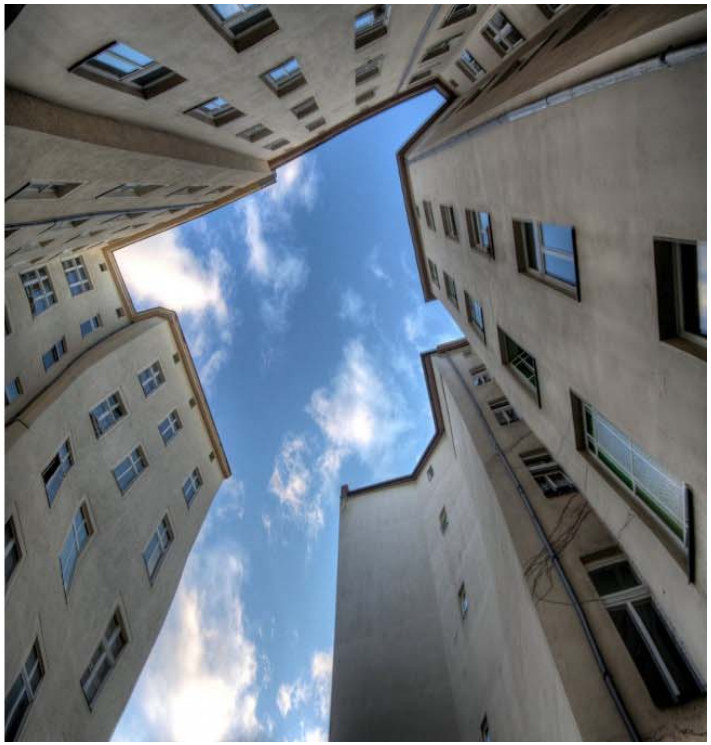


Image Processing

Image retargeting (resizing)

"A System for Retargeting of Streaming Video", SIGGRAPH Asia 2009

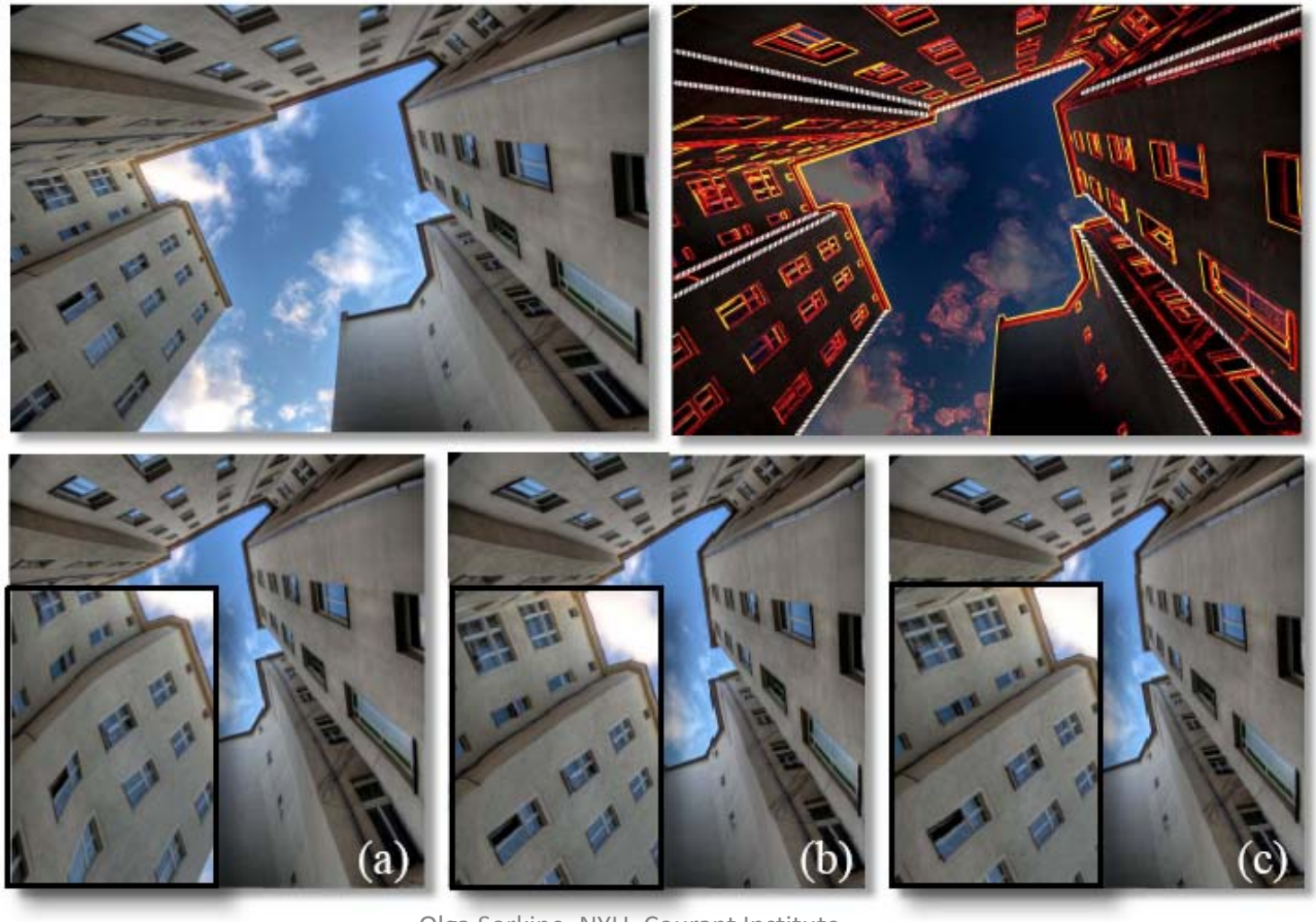


Image Processing

Image retargeting (resizing)

- The project: implement a recent image retargeting and add straight line constraints
  - Option 1: the new paper “A System for Retargeting of Streaming Video”, SIGGRAPH Asia 2009 (only single frame – video processing as an optional bonus!)
  - Option 2: try research! The paper “Image Deformation Using Moving Least Squares”, SIGGRAPH 2006, deals with line constraints. Try adopting that technique for image retargeting. Advantage: no global optimization!

Next week

- More details about the projects
- You are welcome to read the papers and come with questions

Thanks

(and please register if you want to take the course)