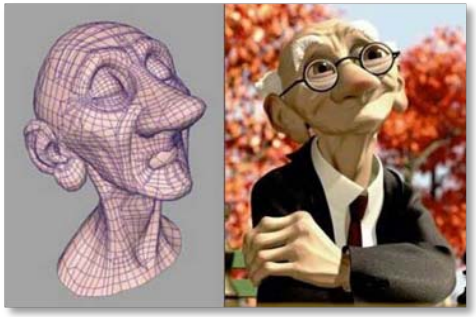
G22.2274-001, Fall 2010

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
  - Interactive Shape Modeling
  - Image Processing/ Computational photography
- 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, 6-7pm, Room 1204 (i.e. right before class)
  - Weeks **without** course meeting:
    Mondays, 5-6pm, Room 1204
  - **Other meeting times** can be coordinated **via e-mail**

Organization

- Course website http://www.cs.nyu.edu/~sorkine/courses/adv_cg/adv_cg10/pmwiki.php
- Mailing list: g22_2274_001_fa10@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 (9/13, 20/9):
  - Project descriptions by me, questions
- By 9/27 participants study the projects and send me a ranked list of preferences
- On 9/28 each participant is assigned a project
- 10/04: everyone presents their project descriptions and tentative work plan

Class plan

- After the preliminary meetings:
  - roughly bi-weekly class meetings to discuss progress
  - Each student presents the current state of her/his project, with live demo and slides if necessary
- During no-class weeks: individual meetings if needed
- Lectures on special issues that arise
- Final project presentations – last two weeks of the semester (12/6, 12/13)

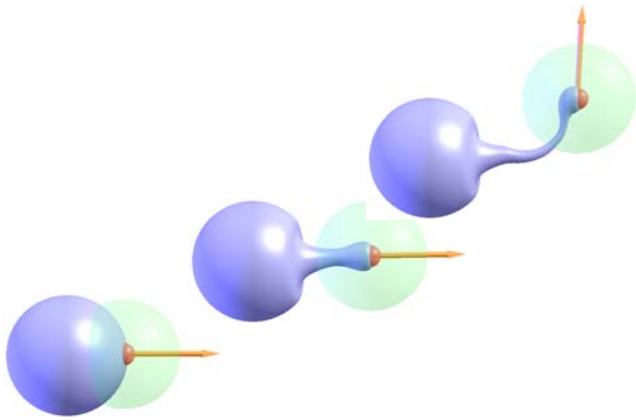
Grading

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

Project Topics

- Computer Animation

- Interactive Shape 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

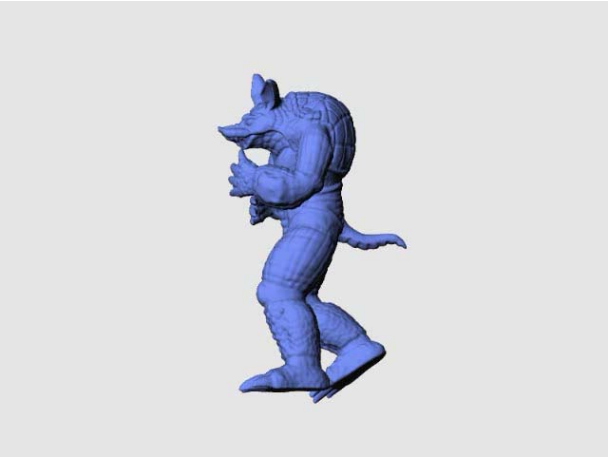
Project Topics

- 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 next week
- You are welcome to come up with your own project if you like – must discuss with me and obtain my approval by 9/27.

Computer Animation

Character animation

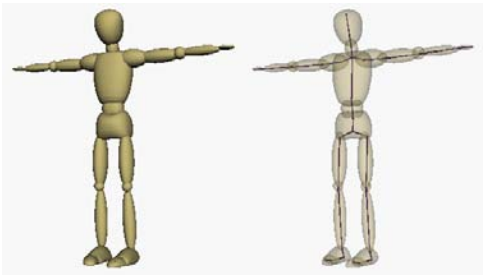
- Create a system for rigging and posing of digital characters (shapes)

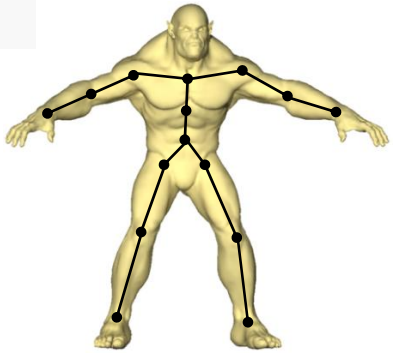


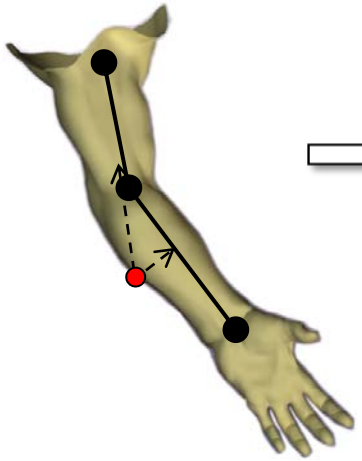
Computer Animation

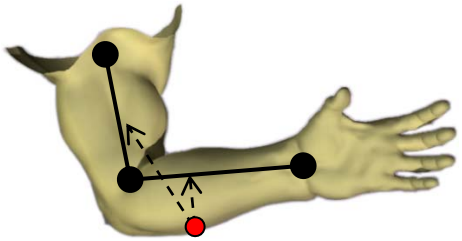
Character animation

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





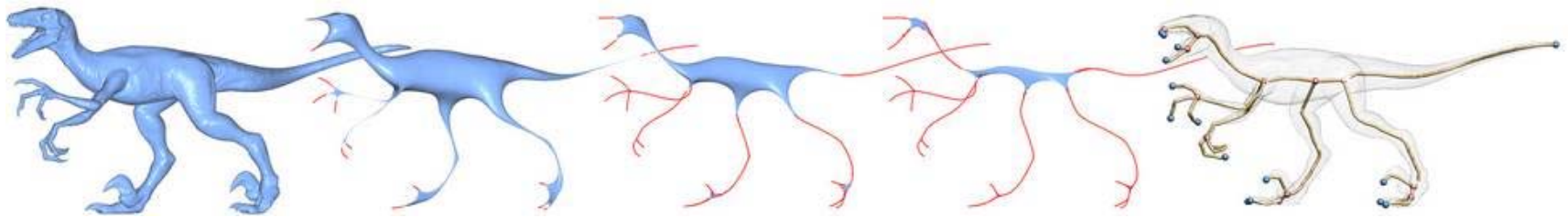




Computer Animation

Character animation

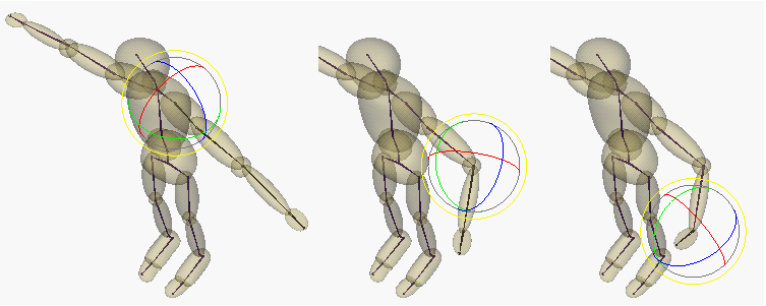
- Create a system for rigging and posing of digital characters (shapes)
  - Step 1: compute a skeleton
    - Implement GUI to manually create a skeleton
    - Automatic (bonus): implement the paper "Skeleton Extraction by Mesh Contraction", SIGGRAPH 2008



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

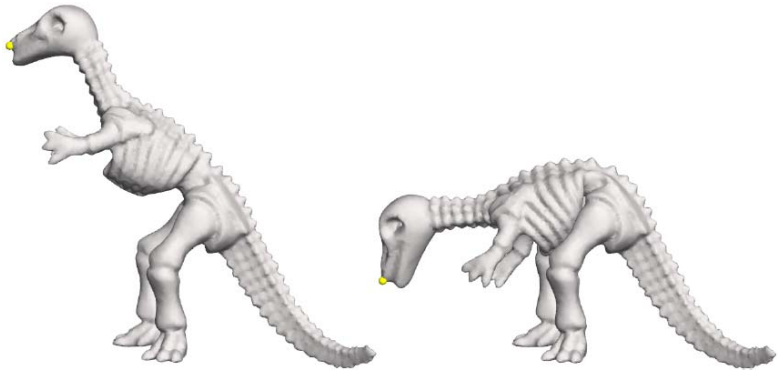
Character animation

- Create a system for rigging and posing of digital characters (shapes)
  - Step 3: implement skinning algorithms
    - 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

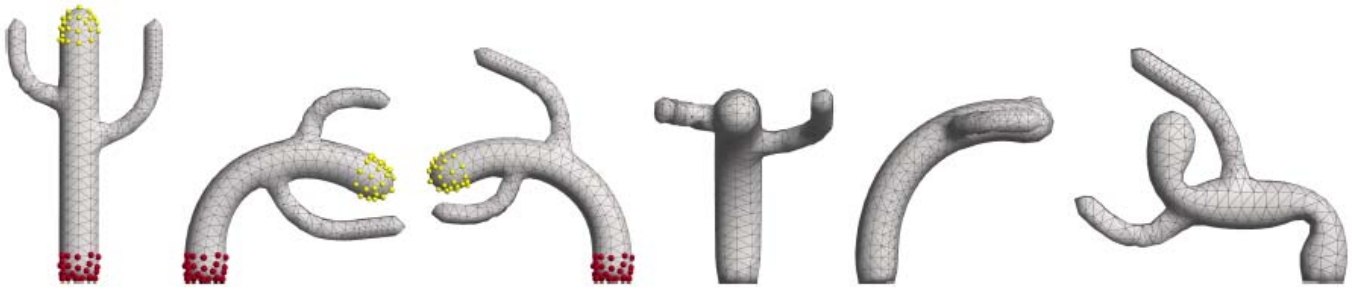
Interactive Shape Modeling

Interactive shape editing system

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



show demo



Interactive Shape Modeling

Interactive shape editing system

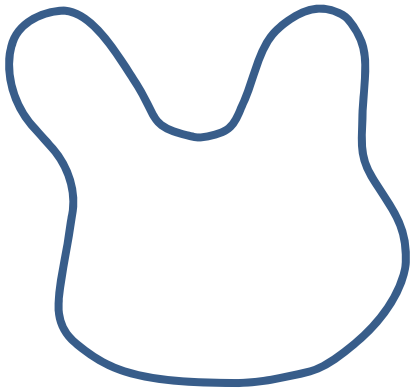
- Implement a recent paper:
  - "PriMo", SGP 2006
  - Accelerate by multiresolution hierarchy

PriMo video

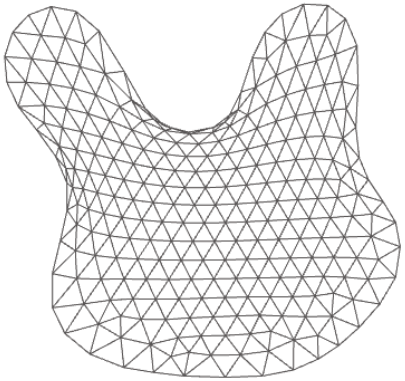
Interactive Shape Modeling

Sketch-based modeling

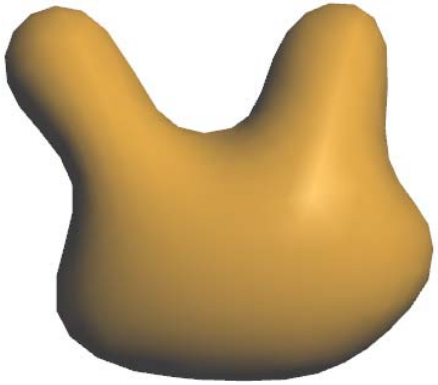
- Inflation of 2D sketches into a 3D shape



User draws
the silhouette



System meshes
the interior



System inflates
the shape

FiberMesh demo | Inflate demo

Interactive Shape Modeling

Sketch-based modeling

- Experiment with different inflation techniques, will be detailed in the project description

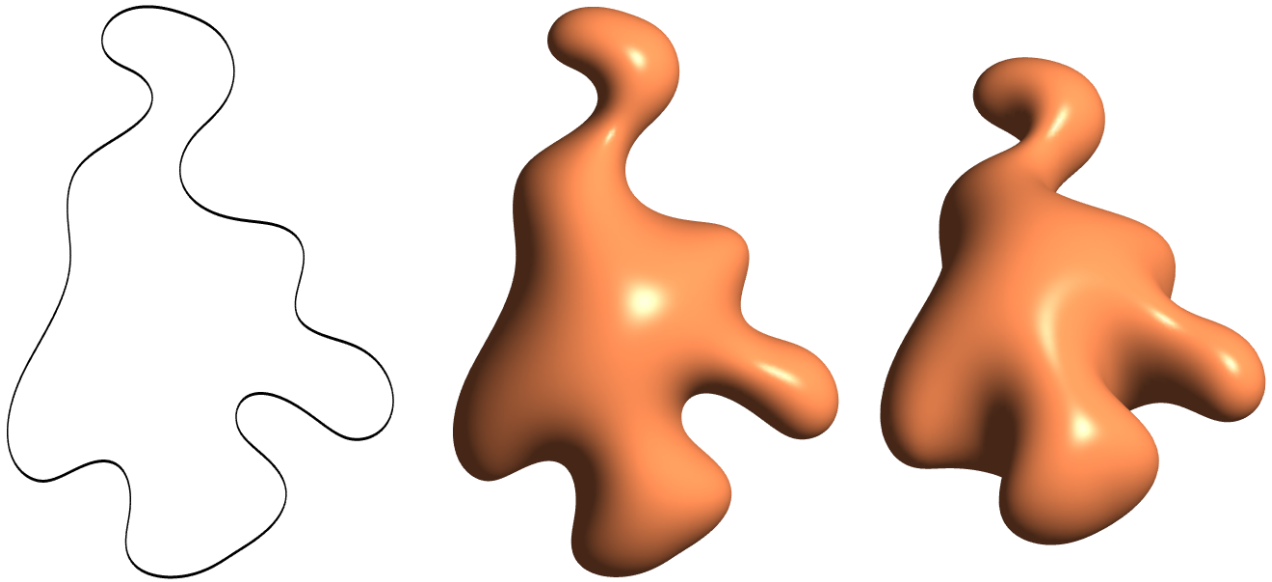


Image courtesy of Ilya Baran

Interactive Shape Modeling

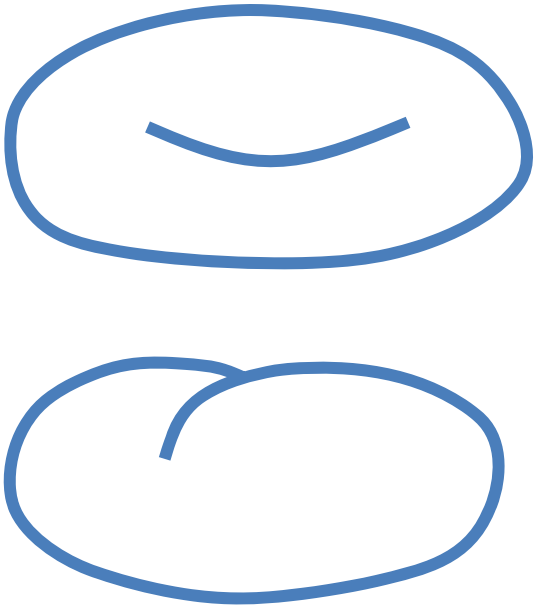
Sketch-based modeling

- Variation on the topic: don't necessarily compute a coherent 3D surface, but just a **normal field instead**
  - Good for illuminating drawings

Interactive Shape Modeling

Sketch-based modeling

- Variation on the topic: don't necessarily compute a coherent 3D surface, but just a **normal field instead**
  - Good for illuminating drawings
  - Extra challenge here: interior silhouettes!



Interactive Shape Modeling

Sketch-based painting: diffusion curves on surfaces

- Implement a system for 3D painting on **surfaces**

Inspiration from 2D: **Diffusion Curves**, SIGGRAPH 2008

Interactive Shape Modeling

Sketch-based painting: diffusion curves on surfaces

- Implement a system for 3D painting on **surfaces**
- Color from a curve is diffused by means of the Poisson equation

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Interactive Shape Modeling

Sketch-based painting: diffusion curves on surfaces

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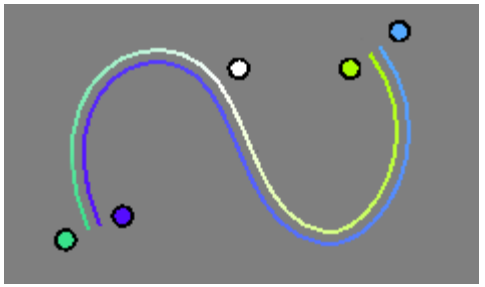

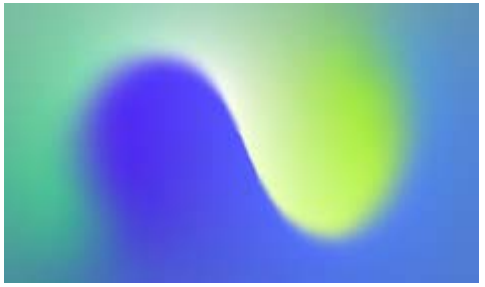

Inspiration from 2D: **Diffusion Curves**, SIGGRAPH 2008

Interactive Shape Modeling

Sketch-based painting: diffusion curves on surfaces

- Implement a system for 3D painting on **surfaces**
- Color from a curve is diffused by means of the Poisson equation
- Bonus: higher-order diffusion with “speed” (tangent) constraints

Image Processing

Image retargeting (resizing)

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

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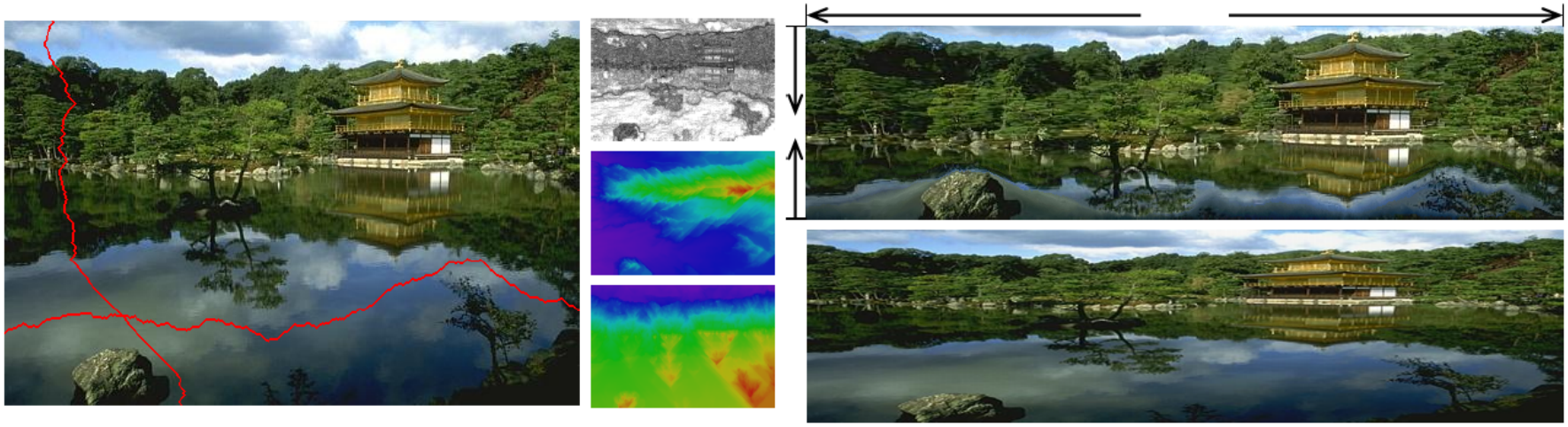


Teaser from “Seam Carving”, ACM SIGGRAPH 2007

Image Processing

Image retargeting (resizing)

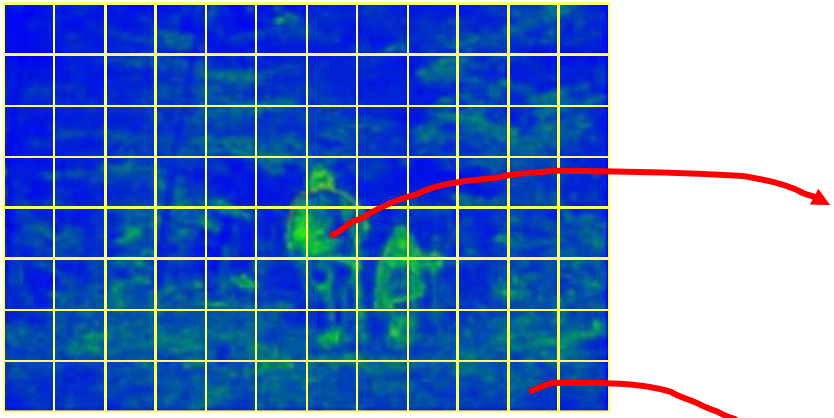
- Approach:
  - Compute an importance map of the image
  - Warp the image such that regions with high importance are preserved at the expense of unimportant regions

importance map

Image Processing

Image retargeting (resizing)

- Grid mesh, preserve the shape of the important quads



quads with high importance:
uniform scaling

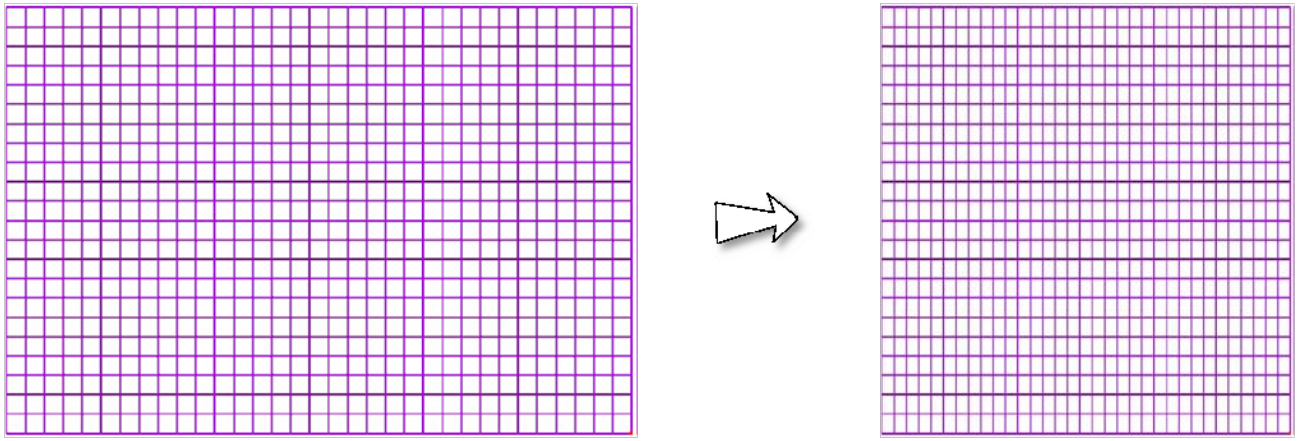
quads with low importance:
allowed non-uniform scaling

- Optimize the location of mesh vertices, interpolate image

Image Processing

Image retargeting (resizing)

- Grid mesh, preserve the shape of the important quads



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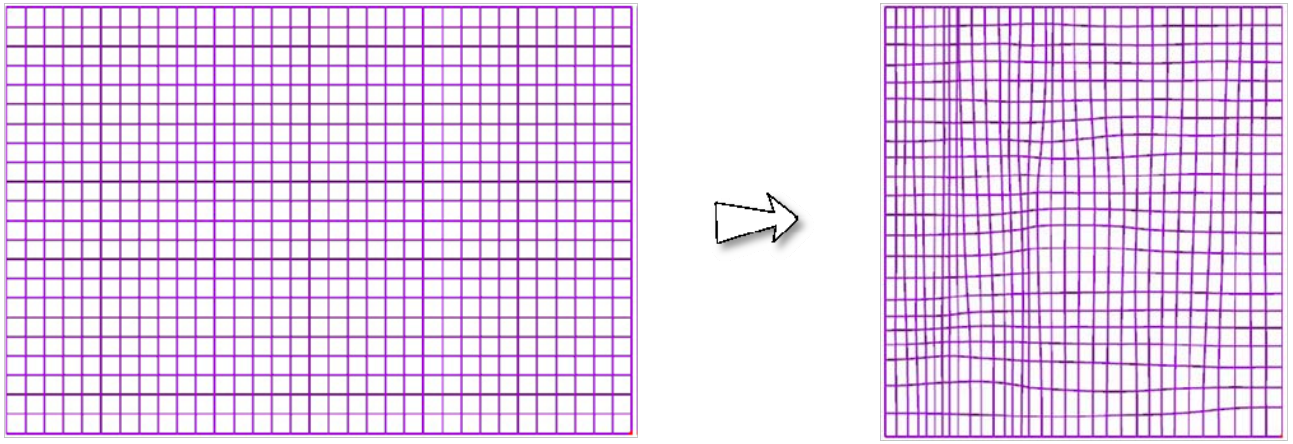

- Optimize the location of mesh vertices, interpolate image

Image Processing

Image retargeting (resizing)

- Examples

original

homogeneous resizing

[Wang et al. 08]

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- Problem: often there is too much content and one has to crop, otherwise the warp is too distorting

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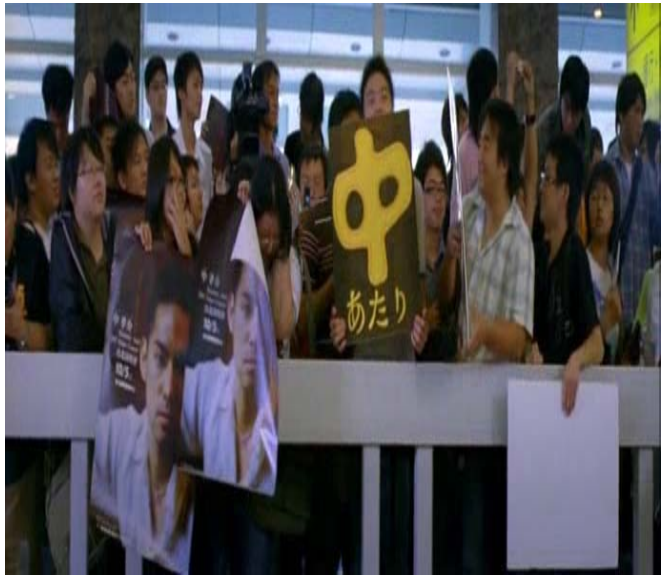


Image Processing

Image retargeting (resizing)

- Problem: often there is too much content and one has to crop, otherwise the warp is too distorting

Image Processing

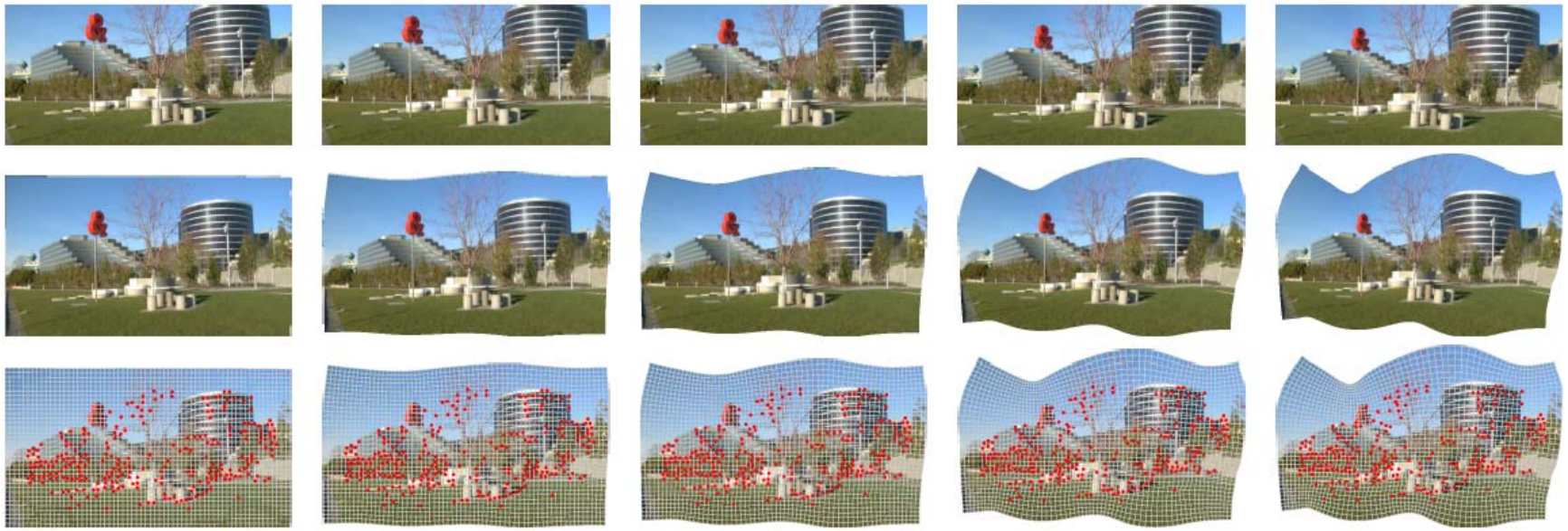
Image retargeting (resizing)

- The project:
  - Implement the technique from "**Motion-based Video Retargeting with Optimized Crop-and-Warp**", SIGGRAPH 2010, **on images only**
    - The method combines cropping and warping
    - User-parameter: how much of the salient regions one is allowed to remove
  - Bonus: for saliency computation, implement a recent interesting paper: Context-aware Saliency
  - Extra-bonus: run a user study of the method! Compare against the benchmark

Computational Photography

Shaky cam stabilization

- Implement "**Content-Preserving Warps for 3D Video Stabilization**", SIGGRAPH 2009



Video

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)