CSE291
Topics in Computer Graphics
Mesh Animation

Matthias Zwicker
University of California, San Diego
Fall 2006

Overview
- Introductions
- Course organization
- Course format
- Syllabus

Questions?

Course format
- First 2 weeks
  - Lectures on background material
- Week 3 to 10
  - Paper presentation and discussion sessions
  - Class project

Organization
- Class sessions
  Tuesdays, Thursdays, 9 30am - 10 50am,
  MCGIL 2342
- Office hours
  Mondays, 2pm - 4pm, EBU3B 4114

Organization
- Course webpage
  http://graphics.ucsd.edu/courses/cse291_f06/
- Mailing list
  cse291@graphics.ucsd.edu
**Class sessions**
- Summary of last session, instructor, 10 min.
- Paper presentation, class participant, 45 min.
- Discussion, class participant, 25 min.

**Paper presentations**
- Pick a topic from the reading list [http://graphics.ucsd.edu/courses/cse291_f06/](http://graphics.ucsd.edu/courses/cse291_f06/)
- Choose *one* paper
- Present in class
- Deadline for choosing topic/paper September 28

**Lead discussion**
- Prepare questions
- Lead discussion
- Assigned by instructor

**Class participation**
- Read paper for each session
- Show up in class
- Participate in discussions

**Class project**
- Pick an area of your interest
- Implement a paper
- Modify, experiment
- Discuss progress with instructor
- Project proposal by October 5
- Project presentations November 30

**Questions?**
### Credits
- 2 units
  - Class participation
  - Paper presentation/discussion
- 4 units
  - Class project
  - Need to take for 4 units to use towards credit requirements

### Grading
- 4 units
  - 25% class participation
  - 25% paper presentation
  - 50% class project
- 2 units
  - 50% class participation
  - 50% paper presentation

### Questions?

### Syllabus
- Background material
- Overview of readings

### Background material
- Differential geometry
- Non-linear optimization
- Rotations
- Numerical solution of PDEs using finite element methods

### Overview of readings
[http://graphics.ucsd.edu/courses/cse291_f06/](http://graphics.ucsd.edu/courses/cse291_f06/)
### Multiresolution editing

**Goal:** efficient editing of detailed meshes
- Multiresolution mesh representation
- High resolution mesh is sum of coarse mesh and details
- Edit coarse mesh, automatically add detail back in
- No need to manually edit every vertex at high resolution

[Kobbelt et al.]

---

### Advanced skinning

**Goal:** compute character skin (surface) based on skeleton
- Basic approach: linear blending of vertices attached to bones
- Fast, but hard to make look good for all character poses

[Zorin et al.]

---

### Advanced skinning

**Goal:** intuitive editing of detailed meshes without multiresolution representation
- Use derivatives instead of absolute vertex positions
- Editing is done by setting boundary conditions
- Mesh reconstruction involves solution of system of equations
- Two sessions

*EigenSkin: Real Time Large Deformation Character Skinning in Hardware*

Paul G. Kry  
Doug L. James  
Dinesh K. Pai  
University of British Columbia
Shape deformation using diff. coords.

Subspace Gradient Domain
Mesh Deformation
papers_0271

Animation from examples

Goal: use examples to guide mesh animation
- Set of example shapes as input
- Examples shapes guide interactive animation
- Based on inverse kinematics techniques

Animation from examples

Inverse Kinematics for Reduced Deformable Models
Kevin G. Der
Robert W. Sumner
Jovan Popović

Data-driven bodies and faces

Goal: model and animate human faces and bodies based on data acquired from real people
- Scan 3D shape of real people
- Use statistical techniques to build a parametric model
- Generate new shapes by specifying parameters
- Two sessions

Data-driven bodies and faces

The space of human body shapes: reconstruction and parameterization from range scans
Beert Allen
Brian Curless
Zoran Popović
<table>
<thead>
<tr>
<th><strong>Pseudo physics</strong></th>
<th><strong>Physics-based methods</strong></th>
</tr>
</thead>
</table>
| **Goal:** interactive, physically plausible simulation of dynamically deforming shapes  
  • Geometric hacks to make it look good  
  • Extremely fast  
  • Video | **Goal:** interactive dynamic simulation of elastic bodies  
  • Based on physical models, generalized springs  
  • More realistic than pseudo physics approaches  
  • Interactive rates |

<table>
<thead>
<tr>
<th><strong>Physics-based methods</strong></th>
<th><strong>Thin shells and cloth</strong></th>
</tr>
</thead>
</table>
| ![Image](Irving.png) | **Goal:** physical simulation of thin shells and cloth  
  • Based on physical models |

<table>
<thead>
<tr>
<th><strong>Thin shells and cloth</strong></th>
<th><strong>Model reduction</strong></th>
</tr>
</thead>
</table>
| ![Image](Greenspun.png) | **Goal:** accelerate physical simulations by reducing the dimensionality of the problem  
  • “Factor out” the most important deformation modes  
  • Solve reduced problems |
<table>
<thead>
<tr>
<th>Plasticity and fracturing</th>
<th>Meshless methods</th>
</tr>
</thead>
</table>
| **Goal:** physical simulation of plastic deformation, fracturing  
  - Video | **Goal:** physical simulation of solids and fluids without using meshes  
  - Simulate solids and fluids in unified framework |

<table>
<thead>
<tr>
<th>Questions?</th>
<th>Next time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Differential geometry</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Meshless methods</th>
<th>Deadlines</th>
</tr>
</thead>
</table>
| ![Point Based Animation of Elastic, Plastic and Melting Objects](image) | - September 28: presentation topic and paper  
  [http://graphics.ucsd.edu/courses/cse291_f06/](http://graphics.ucsd.edu/courses/cse291_f06/)  
- October 5: class project proposal |