CS 599
Physically Based Modeling for Interactive Simulation and Games

Spring 2010, 3 units
Tue Thu 12:30pm-1:50pm VHE 210
CS 599
Physically Based Modeling for Interactive Simulation and Games

http://www.jernejbarbic.com/cs599-s10/

Office hours: Tue Thu 1:50pm - 2:35pm
Physically Based Modeling for Interactive Simulation and Games
About the teacher

• Assistant professor in CS
• Post-doc at MIT (2 years)
• PhD, Carnegie Mellon University
• jnb@usc.edu
About the teacher

• Background:
  BSc Mathematics
  PhD Computer Science

• Research interests:
  graphics, animation, real-time physics, control, sound, haptics
Who is the course for

• PhD students
• MSc students
• Advanced undergraduates
• CS 580 background will be very helpful!!
Why take this course

• Opens the door to jobs in computer graphics

• Make better games

• Put math and physics to use in the real world

• Real-time graphics is cool

• Impress your friends with demos
Applications

- Virtual reality
- Interactive computer animation
- Surgical simulation; preoperative planning
- Computational robotics; manipulation
- Video games
- Assembly planning
- Scientific visualization
- Education
- E-commerce
Fluids

Source: Stanford University
Deformations

Vertices: 45882
Triangles: 105788

Source: CMU
Cloth

Source:
ACM SIGGRAPH
Simulating Large Models

Source: Cornell University
Simulating Large Models
Sound

Modal renderer

Source: CMU
GPU programming

- Vertex shader
- Fragment shader
- CUDA
- OpenCL
Physics in games

Real-Time Deformation and Fracture in a Game Environment

Eric Parker
Pixelux Entertainment

James O'Brien
U.C. Berkeley

Video Edited by Sebastian Burke

From the proceedings of SCA 2009, New Orleans
Force-feedback Rendering
Haptic Interfaces

- hap·tic ('hap-tik) adj. Of or relating to the sense of touch; tactile.

[Photographs of haptic devices]
Surgical Simulation

Source: Cornell University
Motion Capture
Multibody dynamics

Figure 1: *Avalanche*: 300 rocks tumble down a mountainside.
TOPICS TO BE COVERED:
Depending on time and class interest we will cover topics from:

- Overview of physical simulation in computer graphics and interactive applications
- Primer on numerical linear algebra
- Dynamical systems, numerical integration of ODEs
- Constraints and contact
- Rigid body dynamics
- Collision detection
- Structured deformable objects (solids, cloth, hair)
- Fracture and cutting
- Fluids (Navier-Stokes)
- Multiresolution geometric and physical modeling
- Haptics
- Sound simulation (acoustics)
- Programmable graphics hardware (GPUs)
- Case study: Havok engine for physics in games
- Data-driven approaches to simulation (motion capture)
Evaluation

- Assignments: 2 x 20%
- Project: 50%
- Class participation: 10%
Class goals

• Gain ability to create interactive 3D simulations

• Learn how to read research papers

• Learn a 3D graphics API (or improve skills)

• Improve code optimization skills
The project

• Implement a SIGGRAPH paper of your choice

• Implement an elaborate demo using a physics game engine (e.g., Havok)

• Fluid solver

• Collision detection algorithm
The project

• Robotic rigid multi-body system
• Real-time sound simulator
• Fast FEM deformable object simulation
• Simulation in CUDA
The project

Majority of grade!

Schedule:

– Immediately: Start researching possible project areas
– Feb 16: Project proposal
– Mar 23: Progress report
– Apr 1: Progress milestone
– Apr 27: Project due; presentations
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