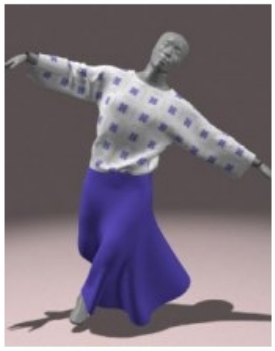
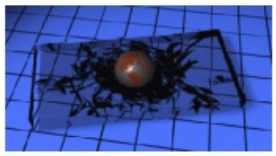
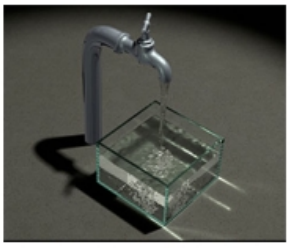
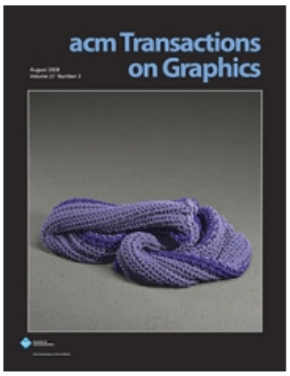
CSCI 520 Computer Animation and Simulation
Spring 2012

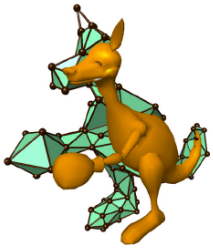
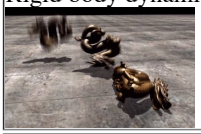
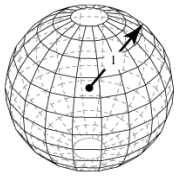
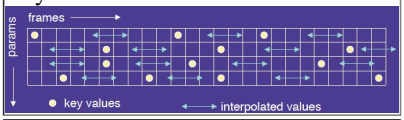
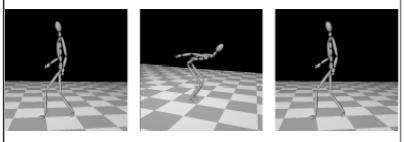
Spring 2012, Monday and Wednesday, **3:30-5:00, WPH B27**	
Instructor: Jernej Barbic Office: SAL 230 Office hours: Monday 5:15 - 6:45 Email: jnb@usc.edu	TA: Yili Zhao Office: SAL 112 Office hours: Thursday 1:00 - 3:00 Email: yilizhao@usc.edu

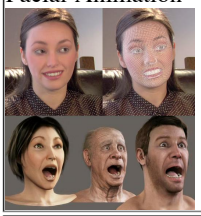
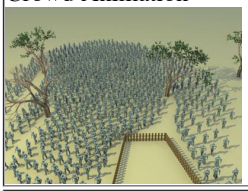
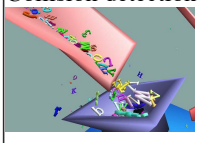
Introduction and Purposes

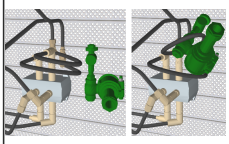
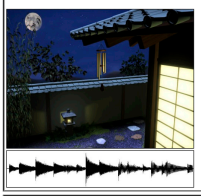
This course introduces students to computer animation and related simulation techniques, as applicable to computer games, virtual reality systems, and film special effects. Efficient numerical methods for simulating a variety of visually interesting physical phenomena will be discussed in the context of both interactive and offline simulation. Topics include deformable objects (solids, cloth), fluids, character rigging, quaternions, inverse kinematics, motion capture, sound simulation, collision detection, haptics, rigid body dynamics, and GPU programming.

Schedule | **Prerequisites** | **Readings** | **Assignments** | **Grading** | **Class participation** | **Academic Integrity**

Date	Topic	Reading, slides, and other material	Notes
Mon Jan 9 2012	Overview of computer animation and simulation 		
Wed Jan 12	Overview of computer animation and simulation		
Mon Jan 16	No class (Martin Luther King Day)		
Wed Jan 18	Primer on numerical simulation and linear algebra for graphics	D. Baraff and A. Witkin: Physically Based Modeling, course notes, SIGGRAPH 2001	**Assignment 1 out**
Mon Jan 23	OpenGL	OpenGL Red Book, Chapters 1-3 CMU slides on OpenGL OpenGL "Hello world" application (with GLUT) Makefile (Mac OS X)	
		OpenGL Red Book, Chapters 4 (Color), 5	

Wed Jan 25		(Lighting), 9 (Texture Mapping) CMU slides on OpenGL shading CMU slides on texture mapping	
Mon Jan 30	Structured deformable objects: cloth 	D. Baraff and A. Witkin: Large steps in cloth simulation, SIGGRAPH 1998	
Wed Feb 1	Structured deformable objects: FEM 	M. Mueller and M. Gros: Interactive virtual materials, Graphics Interface 2004 J. Barbic: Real-time Reduced Large-Deformation Models and Distributed Contact for Computer Gra phics and Haptics, PhD thesis, 2007 (pages 33-42) M. Mueller and co-organizers: Real-time physics, course notes, SIGGRAPH 2008 (pages 43-51) S. Capell, S. Green, B. Curless, T. Duchamp, Z. Popovic: Interactive Skeleton-Driven Dynamic Deformations, SIGGRAPH 2002	
Mon Feb 6	Rigid body dynamics 	D. Baraff and A. Witkin: Physically Based Modeling, course notes (the chapter on Rigid Body Dynamics), SIGGRAPH 2001	**Assignment 1 due**
Wed Feb 8	Quaternions 		
Mon Feb 13	Keyframe Animation 		
Wed Feb 15	Motion capture 	Jessica Hodgins's slides on motion capture J. Lee, J. Chai, P. Reitsma, J. Hodgins, N. Pollard: Interactive Control of Avatars Animated with Human Motion Data, SIGGRAPH 2002 J. Barbic, A. Safonova, J. Pan, C. Faloutsos, J. Hodgins, N. Pollard: Segmenting Motion Capture Data into Distinct Behaviors, Graphics Interface, 2004	**Assignment 2 out**
Mon Feb 20	No class (President's Day)		
	Inverse Kinematics		

Wed Feb 22			
Mon Feb 27	Character Rigging 		
Wed Feb 29	Facial Animation 		
Mon Mar 5	Crowd Animation 		
Wed Mar 7	Guest lecture: TBA		**Assignment 2 due**
Mon Mar 12	No class (spring break)		
Wed Mar 14	No class (spring break)		
Mon Mar 19	Maya 		
Wed Mar 21	Maya		**Assignment 3 out**
Mon Mar 26	Collision detection 	Ming Lin's course notes on collision detection Collision detection at UNC, Chapel Hill The Gilbert-Johnson-Keerthi Algorithm (realtimecollisiondetection.net) Y. Kim, M. Otaduy, M. Lin, D. Manocha: Fast Penetration Depth Computation for Physically-based Animation, ACM SIGGRAPH/Eurographics Symposium on Computer Animation, 2002	
Wed Mar 28	Collision detection	Ming Lin's course notes on bounding volume hierarchies and spatial partitioning S. Gottschalk, M. Lin, D. Manocha: OBB-Tree: A Hierarchical Structure for Rapid Interference Detection, SIGGRAPH 1996	

		S. Quinlan: Efficient Distance Computation between Non-Convex Objects, ICRA 1994	
Mon Apr 2	Haptics 	K. Salisbury and F. Conti: Haptic Rendering: Introductory Concepts, IEEE Computer Graphics, 2004 (a survey) M. Lin and M. Otaduy: Recent Advances in Haptic Rendering & Applications, SIGGRAPH 2005 Course Notes J. Barbic and D. James: Six-DoF Haptic Rendering of Contact between Geometrically Complex Reduced Deformable Models, IEEE Transactions on Haptics 2008	
Wed Apr 4	Sound simulation 	J. O'Brien, C. Shen, and C. Gatchalian: Synthesizing Sounds from Rigid-Body Simulations, SCA 2002	
Mon Apr 9	Fluids (Navier-Stokes) 	J. Stam: Stable Fluids, SIGGRAPH 1999	
Wed Apr 11	Fluids (Navier-Stokes)	N. Foster, D. Metaxas: Realistic animation of liquids, Graphical Models and Image Processing, 58(5), 1996	**Assignment 3 due**
Mon Apr 16	Simulation on programmable graphics hardware (GPUs) 	Slides on shaders and GPUs C. Everitt: OpenGL ARB Vertex Program, E. Hart: OpenGL ARB Fragment Program, Game Developers Conference 2003 L. Wei: A Crash Course on Programmable Graphics Hardware GP-GPU Tutorial OpenGL API OpenGL Shading Language Sample Code & Tutorials Cg (Nvidia)	
Wed Apr 18	Simulation on programmable graphics hardware (CUDA) 	Nvidia's CUDA Trefftz and Wolffe: Tutorial on CUDA OpenCL J. Georgii, R. Westermann: Mass-spring systems on the GPU	
Mon Apr 23	Case study: Havok engine for physics in games 	Slides (ppt) Havok Physics Open Dynamics Engine (ODE)	
Wed Apr 25	Review for exam		

Prerequisites

- A grade of at least B in CS480 or CS580, or explicit permission of instructor. If you took a similar course at another university, contact the instructor.
- Familiarity with calculus, linear algebra, and numerical computation

- C/C++ programming skills

Readings

There is no required textbook. Selected articles and course notes will be made available online.

A good reference on computer animation:

- Rick Parent: **Computer Animation, Second Edition: Algorithms and Techniques**, Second edition, Publisher: Morgan Kaufmann, ISBN: 9780125320009

A reference book on OpenGL is recommended for help with the homeworks:

- Dave Shreiner: **OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 3.0 and 3.1**, Seventh edition, Publisher: Addison-Wesley Professional, ISBN: 9780321552624

Assignments

There will be three programming homework assignments in C/C++ and OpenGL, related to the material covered in class. Please see the schedule for links to assignments and due dates. All assignments must be done **individually.**

Grading

- Assignments: 19% each (57% total)
- Final exam: 33%
- Class participation: 10%

All assignments must be completed to pass the course. The assignments will have a small amount of extra credit.

Late policy: Programming assignments should be turned in by midnight on the day they are due. A total of **three late days** may be taken during the semester on programming assignments. For example, you can use one late day on the second assignment, and two on the third assignment. All days are counted, including any weekends and holidays, as follows:
Less than 24 hours late = 1 late day, 24-48 hours late = 2 late days, 48-72 hours late = 3 late days, and so on.
The flexibility provided by the late days is intended to get you through the time where all your classes just happen to have assignments due on the same day. Beyond the three late days, there will be a penalty of 10% of the value of the assignment / day. Exceptions will be granted only under most dire circumstances and must be discussed with and approved by the instructor at least one week in advance.

Class participation

There will be seven short quizzes, testing the material covered in previous lectures. Quizzes will be given in class and will not be announced in advance. Class participation grade will include the best five quiz scores.

Academic integrity

All students are expected to maintain the utmost level of academic integrity. Do not copy any parts of any of the assignments from anyone. Do not look at other students' code, papers, assignments or exams.

The university policies on academic conduct will be applied rigorously, and the USC Office of Student Judicial Affairs and Community Standards **will** be notified. Please consult the USC Student Guidebook (for example, Section 11.00 in the University Governance chapter) for details on what is and is not appropriate,

and for the possible consequences of violating the rules.

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will b e submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus,* the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations c an be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.-5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.