The Animation of Natural Phenomena

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Questions

• What is your name?
  • Tell us about yourself.

• Experience...
  • OpenGL?
  • C++
  • Math?

• Why did you sign up for this class?
  • What do you hope to learn?
What is Physics-Based Animation?

Physics of our everyday lives...
What is Physics-Based Animation?
What is Physics-Based Animation?

[Baraf 1996]

Data Structures

Mathematical Techniques

Algorithms
Overview The Class

- Will explore various phenomena...
- Questions you should ask:
  - What should we simulate?
  - How do you simulate it?
    - Interactively?
  - How can we break it?
  - How can we control it?
  - How can we couple it with other objects?
  - How do we measure success?
Particles

Data Structures

DiffEQ

Constraints

Hair (1D)

Cloth (2D)

Crowds
Fluids

Particle Fluids

PDE Fluids

Free-surface Fluids
Rigid Bodies

Collisions and Stacking

[Guendelman 2003]
Deformable Objects

[Barbić and James 2008]

Deformable Object Collisions

Animatng Water Bottle Recycling Rates

Doug James
Cornell University
Humans

Performance Capture

Data-Driven Motion

Physical Simulation

[Vlasic et al 2003]
[Treuille et al 2007]
[Lui and Popović et al 2002]
Advanced Optimization

[Fattal and Lischinski et al 2003]

Control

[Twig and James 2007]

Model Reduction

[Treuille et al 2006]
Objectives

Goals
- Learn Techniques
- Fun Coding
- Quick Problem Solving
- Presentation Skills

Methods
- Weekly Lectures
- Paper Presentations
- Projects
- Questions
Logistics

Class n
- Paper Presentation
- Lecture
- Question

Class n+1
- Paper Presentation
- Lecture
- Question

Class n+2
- Paper Presentation
- Lecture
- Question

http://www.cs.cmu.edu/~15869-f10/
# Syllabus

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<td>Final Project Presentations</td>
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Grading

- 24% Project 1: Particles (due 10/12)
- 24% Project 2: Fluids (due 11/04)
- 36% Final Project
  - 5% Mid-point Check (due 11/18)
  - 31% Final Project (due 12/2)
- 16% Class Presentation / Participation
Logistics

Anonymous Feedback:
http://www.cmu.edu/blackboard/

Lab:
WeH 5336
/afs/cs.cmu.edu/project/weh5336/SetupAndrewAccount
Use Caps: hbovik@ANDREW.CMU.EDU

Disk Space:
/afs/cs.cmu.edu/academic/class/15869-f08-users
10GB per user
Name: Jeehyung (Jee) Lee
Office Hours: Monday 3-4pm
NSH 4228
Math Preliminaries

\[ E = \frac{1}{c^2} \frac{\partial \phi}{\partial t} \]

\[ \nabla \times E = -\frac{\partial B}{\partial t} \]

\[ \nabla \cdot B = 0 \]

\[ \nabla \times B = \mu_0 J + \frac{\epsilon_0 \mu_0}{c^2} \frac{\partial \phi}{\partial t} \]
Questions

• What everyday things are we missing here?
  • These could be final projects!

• How can we measure success?
  • How do we measure “success” for chaotic systems can cannot be recreated?

• Can we come up with an objective notion of “visual correctness?”
Class-Generated Ideas

- Melting
- Freezing
- State Changes
- Residues
- Shattering Glass
- Mixing of Fluids
- Paintbrush on Paper
- “Turing test” for physic-based animation
- Interactive “turing test”
- Organic Decay
- Galaxies / Black Holes
- Use statistical tests to see if the output matches the distribution of the observed output
- Flags Fluttering
- Explosions /
- Flow in a flexible pipe
- Repeatability Tests - would it converge to a set of possibilities
Homework 1

Read:

*Differential Equation Basics*

Andrew Witkin and David Baraff
(on the website)