15-462: Computer Graphics

Jessica Hodgins
and Alla Safonova

Introduction

- Administrivia
- Who are we?
- What is computer graphics?
- A few case studies

Administration

- ## Web page
  - www.cs.cmu.edu/~jkh/462_S07
  - Linked from my home page

- ## TA's: Michael de Rosa and Joel Micah Donovan
  - Office hours and contact info on the web

- ## Textbook:
  - Shirley, 2nd edition
  - Open GL (on the web) or order the Red Book

Administration

- Prerequisites (talk to us if you're missing these!)

    15-213: Introduction to Computer Systems

    21-241: Matrix Algebra (matrix & vector algebra)

    21-259: Calculus in Three Dimensions (i.e. planes, quadratic surfaces, basic 3-D geometry, partial derivatives) or equivalent

- Midterm and Final (13% and 22%)
- Four programming assignments (8-13% each)
- Three written assignments (20% total)

We'll do fun things in this class!

Height Fields (starter project in OpenGL)
Spline roller coaster
Ray tracer
Procedural modeling of plants

Warning: mathematical programming may be different than what you've done in the past (and harder to debug)

Administration

Late Policy: 3 late days that you can use for any assignment (programming or written). More than three requires a verifiable good excuse.

Cheating: Please don't! The detailed definition is in the syllabus. Using code from the web is ok as long as it is a SMALL percentage of the code for written the assignment. We will pursue the case if the rules are violated…

Other Graphics Courses

15-463: Computational Photography, Efros (Fall)

15-464: Technical Animation, Pollard (Spring)

15-465: Animation Art and Technology, Hodgins, Duesing (Spring)

15-466: Computer Game Programming, Kuffner (Spring)

Various grad classes in CSD

15-385: Computer Vision

05-331: Building Virtual Worlds, Schell (Fall)

24-384A: Computational Geometry, Shimada

60-415: 3-D Animation, Duesing (Fall)

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Announcements will be added to the web page throughout the semester.

Any questions?

Who am I?

PhD CS, CMU
Legged Locomotion For
Rough Terrain Locomotion

On the faculty at
Georgia Tech from
1992-2000

Joined CMU in fall
2000
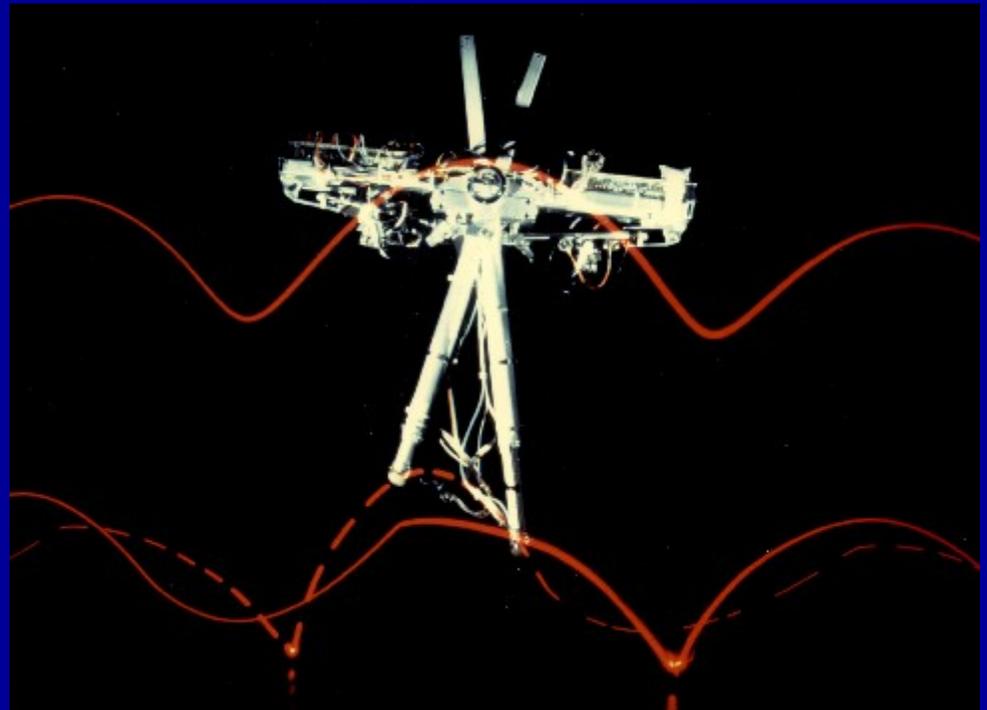
Legged Locomotion

From physical robots to animations

And on to humans

And on to humans

All motion in this animation was generated using dynamic simulation.

Now—Capturing data of humans

Animating Muscle and Skin

And back to robots
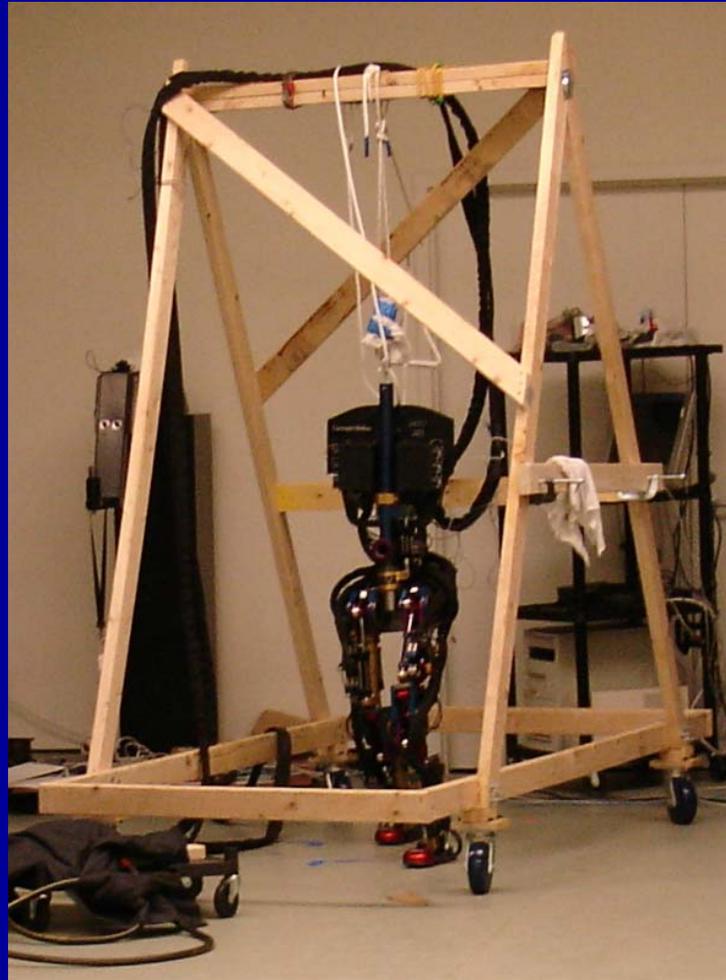
Who is Alla?

PhD CS, CMU

Reducing the search space for physically realistic human motion synthesis
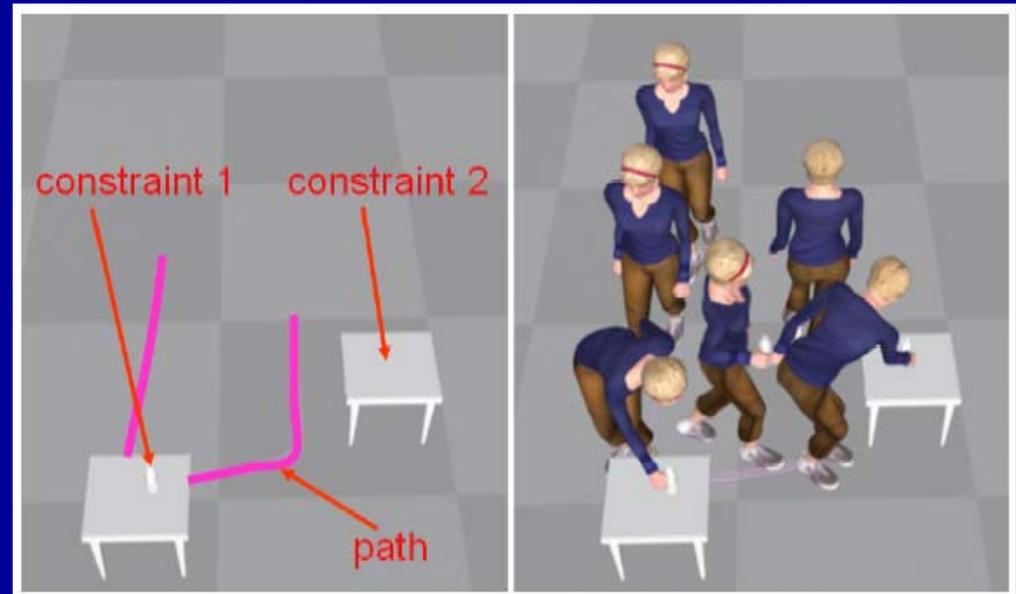
Motion from a few constraints

Physically correct motion for complex character

User only provides a rough sketch
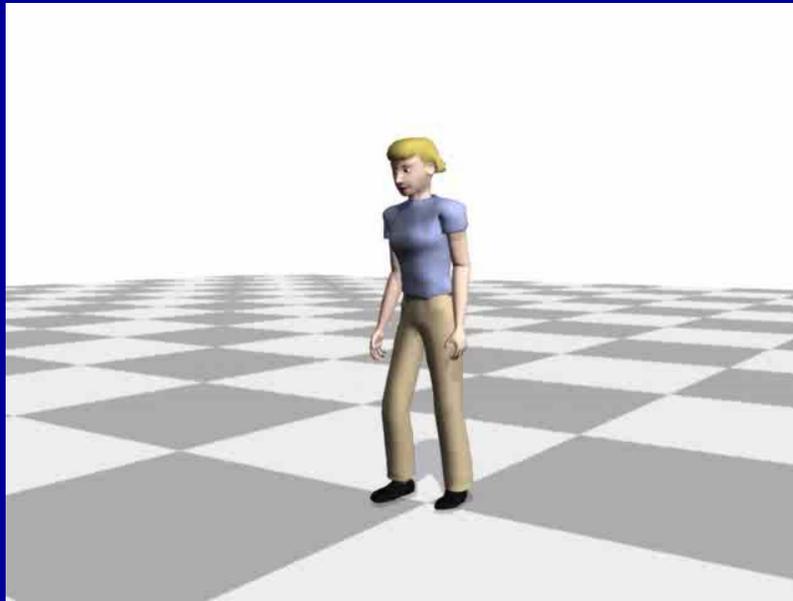
Rough sketch
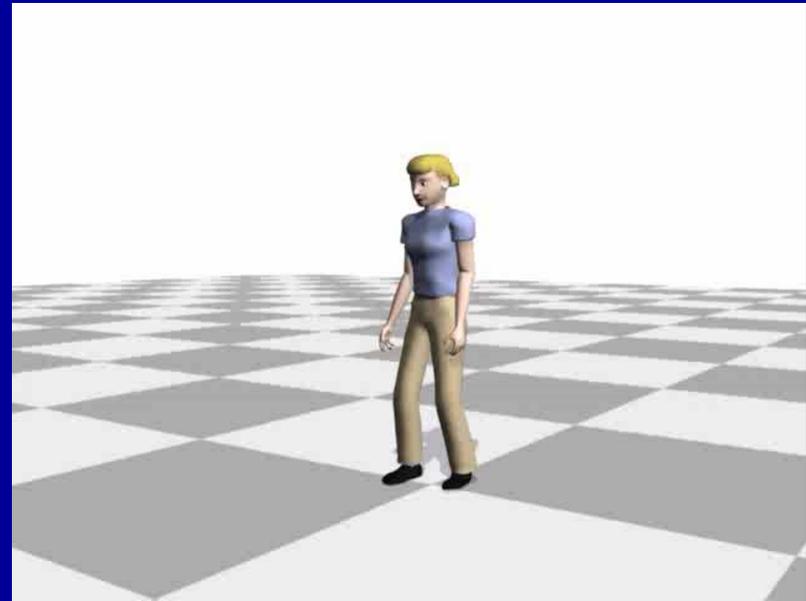
Synthesized motion

What is Computer Graphics?

One agenda: Faking Reality

Make synthetic images that are *indistinguishable* from the real thing

Do it in a way that's both practical and scientifically sound.

Another Agenda:
Create a new Reality

- Modeling, animation, rendering of things that don't exist.

Pirates of the Caribbean

Non-photorealistic Rendering

- Image Analogies A. Hertzmann, C. Jacobs, N. Oliver, B. Curless, D. Salesin. SIGGRAPH 2001 Conference Proceedings.

The three big topics:

- Modeling: how to represent objects; how to *build* those representations
- Animation: representing/controlling the way things move
- Rendering: how to create images

Modeling

- How to represent real environments
  - geometry: modeling surfaces, volumes
  - photometry: light, color, reflectance
- How to *build* these representations
  - declaratively: write it down
  - interactively: sculpt it
  - programmatically: let it grow
  - via 3D sensing: scan it in

Modeling by Sculpting

Freeform from Sensable Technologies

Modeling by Growing

Reproduction of the topiary garden at Levens, England. R. Mech, P. Prusinkiewicz, SIGGRAPH 1994
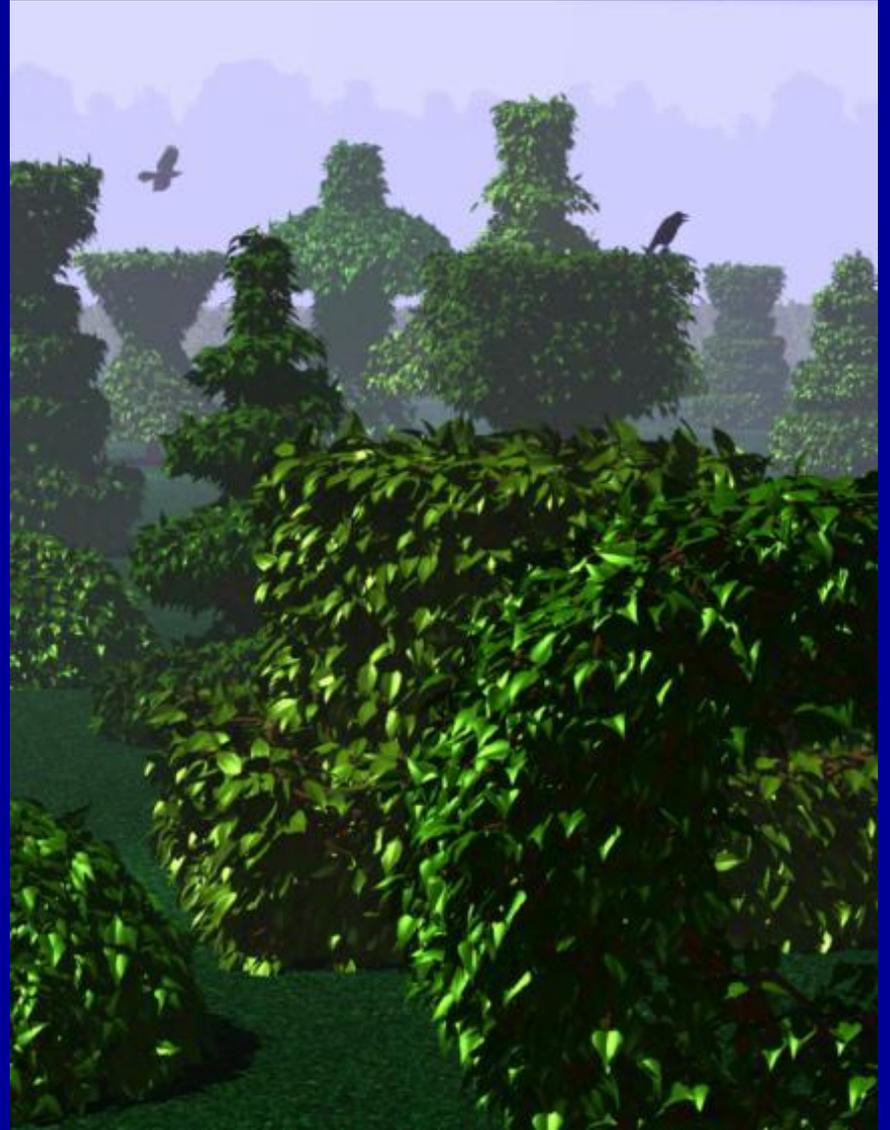
Modeling by Scanning

Cyberware

Animation

- How things *move*
  - Joint angles
  - Vertices
  - Deformations
- How to specify motion
  - by hand (keyframing)
  - rule-based behaviors
  - physics
  - motion capture

Hand Animation
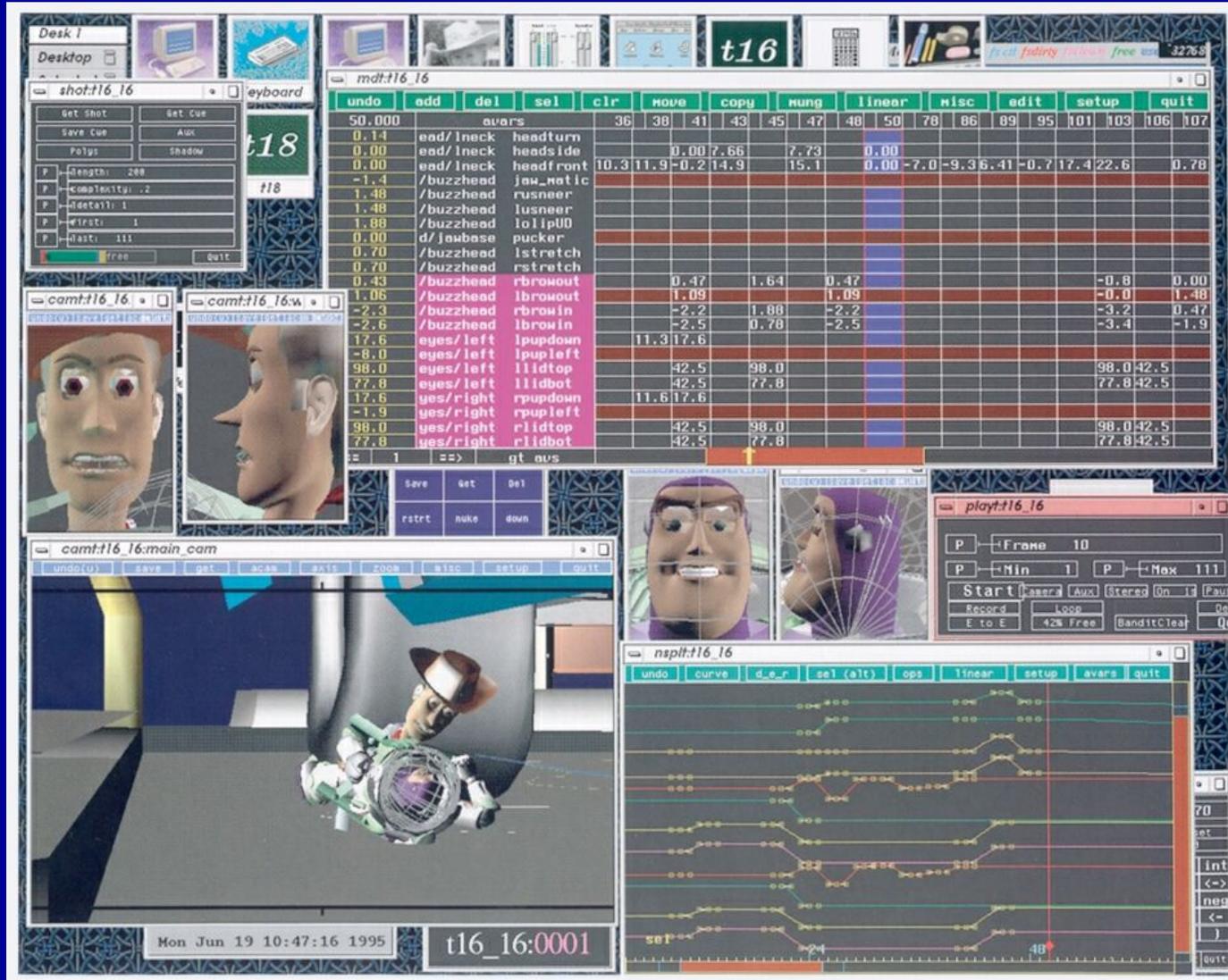
Making of Toy Story

Rule-based Behaviors

Massive Movie
Craig Reynold's Movie

Physics for Natural Phenomena

Poseidon water simulation

http://www.fxguide.com/article350.html
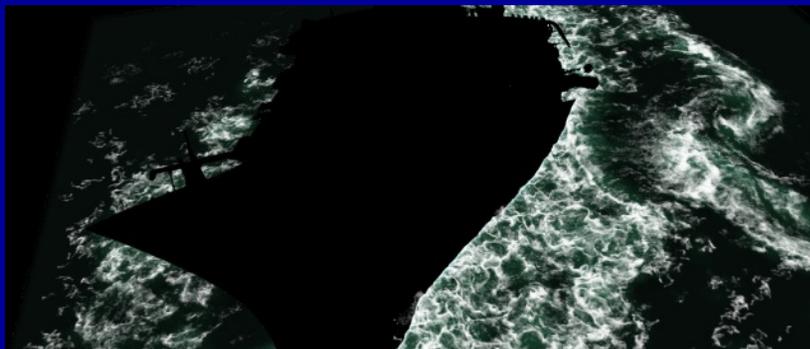
Physics for Natural Phenomena
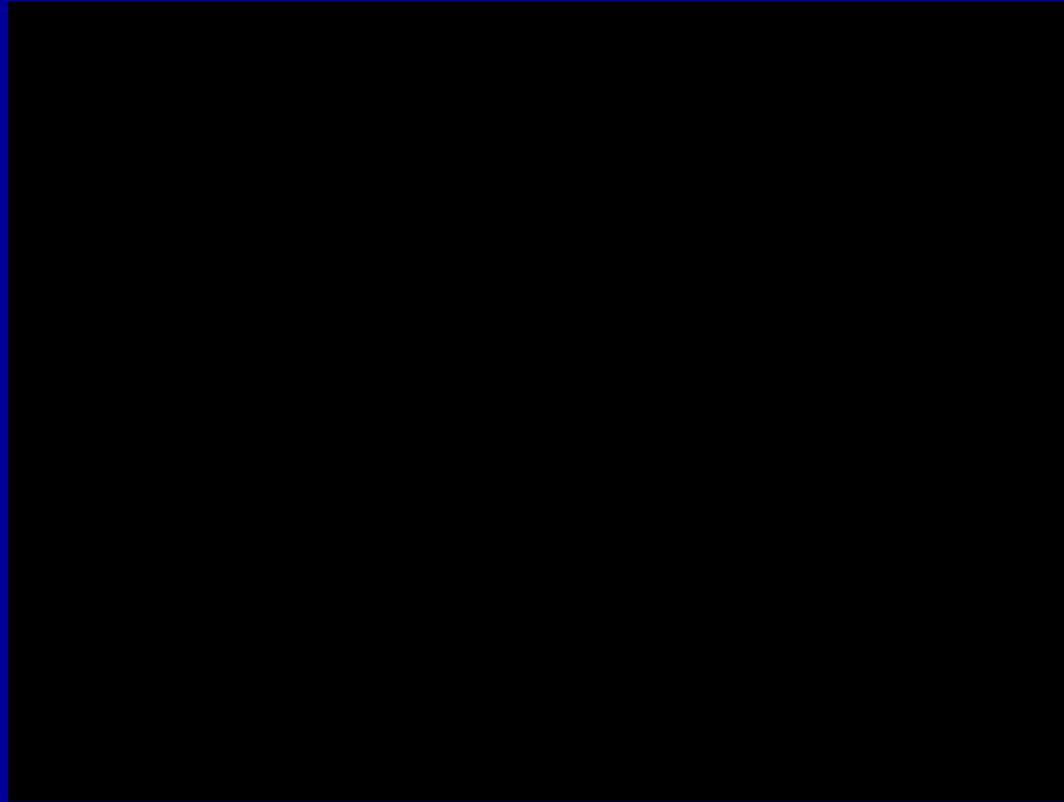
O'Brien, J. F., Hodgins, J. K., (1999) Graphical Modeling andAnimation of Brittle Fracture. The proceedings of ACM SIGGRAPH 99,

Physics for Characters

Motion Capture

Polar Express

Motion Capture

Titanic, House of Moves
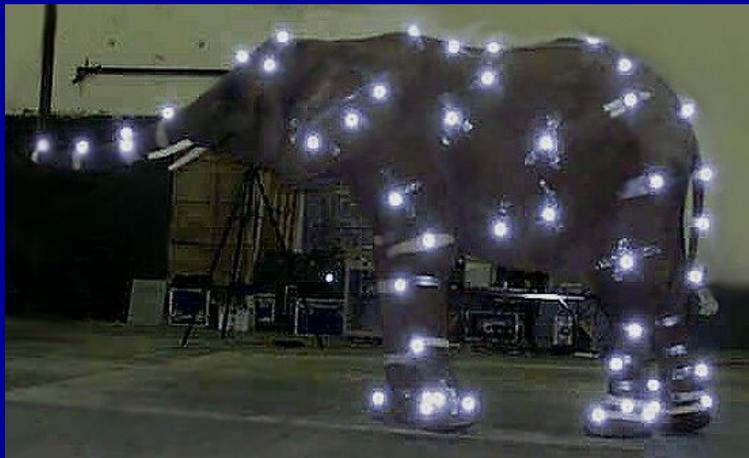
Motion Analysis

Titanic, House of Moves

Rendering

- What's an image?
  - distribution of light energy on 2D "film": $E(x,y,\lambda,t)$ (λ *is wavelength.*)
- How to generate images from scenes
  - input: 3D description of scene, camera
  - solve light transport through environment
    - ray tracing
    - radiosity
  - project to camera's viewpoint

Raytracing

May-June 2001 First Place Winner Internet
Ray Tracing Competition: warm_up by Norbert Kern

Radiosity

Lightscape, Autodesk

Image-based Rendering

UNC Image-based Rendering Project

Case Studies

Realism:

    Panic Room

    Forrest Gump

Imagination:

    Polar Express

    Pirates: http://www.ilm.com/theshow/