CS-184: Computer Graphics

Lecture 1: Introduction

Maneesh Agrawala
University of California, Berkeley

Slides based on those of James O'Brien and Adrien Treuille

Why Study Computer Science?

Money!

Beautiful Images

What is Computer Graphics?

Elements in This Video

3D Modeling / Geometry

Simulation / Animation / Character Animation

Lighting / Light Transfer

Textures and Color

Post-Processing: Image Processing

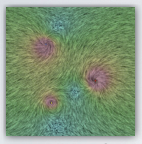
Camera position / Optics

What Is Computer Graphics?

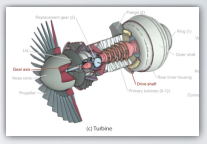
Using computers to generate and display images

- Visual Perception
- Modeling
- Rendering
- Animation
- Image Processing

What *Else* Is Computer Graphics




Scientific Visualization



Illustration

NPR / Art

Computational Photography

Virtual Life

and much more....

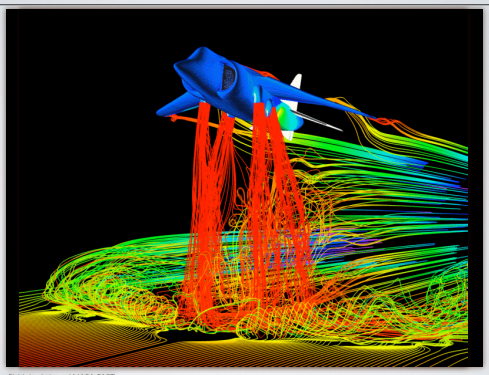
Why Do We Care?

Why Do We Care?

Why Do We Care?

Carlo Sequin

Why Do We Care?



Fluid simulation w/ NASA FAST

Why Do We Care?

Image from CAE Inc.

Why Do We Care?

Voxel-Man 3D [Höhne et al.]

Today

Motivation - What is Computer Graphics?

Course Mechanics and Overview

- Who is teaching this class anyway?
- Wiki
- Course Topics
- Assignments - including assignment of assignments #1 and #2

Course Overview

Digital Images

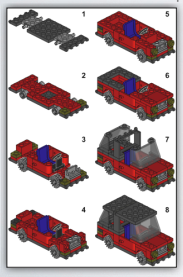
Course Mechanics and Overview

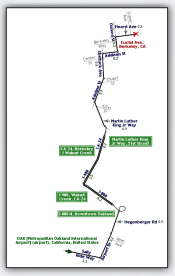
Who am I?

Maneesh Agrawala

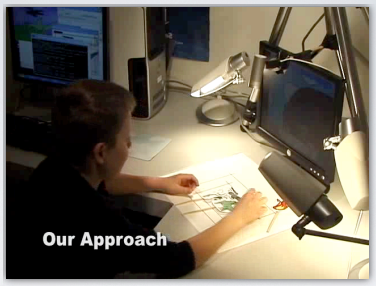
- Professor since 2006
- Ph.D. 2002 (from another bay area school)

Research Areas: Graphics, Visualization, HCI

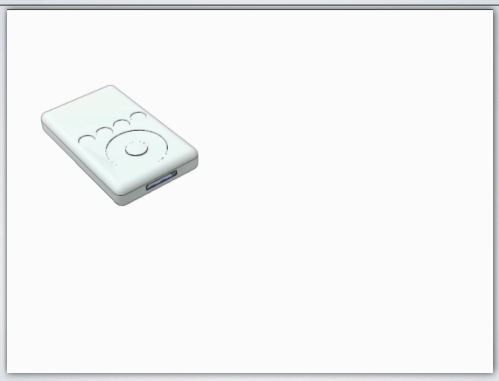




Video Puppetry



Exploded Views



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Photomontage

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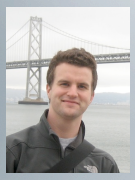
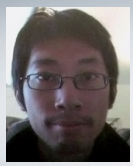
Graduate Student Instructors



Robert Carroll
Ph.D. student

Computational Photography, Graphics, Vision

Office hours: T 3-4pm, F 1-2pm, 514 Soda Hall



Fu-Chung Huang
Ph.D. student

Real-Time Rendering, Animation, Vision/Learning, Modeling

Office hours: W 2-3pm, 535 Soda Hall

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Contact With Teaching Staff

Maneesh's Office Hours: MW 12-12:30pm, T 4-5pm, by appt.

Email: cs184@imail.eecs.berkeley.edu
- Do ***not*** email teaching staff directly unless absolutely necessary

Wiki: http://vis.berkeley.edu/courses/cs184-fa10/wiki
- All class related materials, handouts, schedule, readings posted there
- Will ***not*** distribute paper handouts
- Lecture notes posted there (***hopefully***) before classes

Google group: http://groups.google.com/group/ucb-cs184-fall-2010
- Send email to cs184@imail.eecs.berkeley.edu requesting invitation
- Will post bug announcements, fixes for assignments and lectures there
- Not reading group... bad idea

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Wiki

http://vis.berkeley.edu/courses/cs184-fa10/wiki

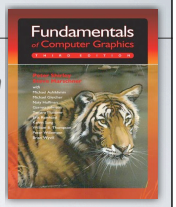
Computing Resources

Class accounts handed shortly

Can also use CS Labs

- Linux
- Windows
- Mac

Text Book



Fundamentals of Computer Graphics. 3rd Edition
by Peter Shirley and Steve Marschner

Today's readings: 1
Review readings: 2, 5
Weds readings: 21, 22

Supplemental material may also be provided

See other books listed on wiki

Course Topics

Visual Perception
Modeling
Rendering
Animation
Image Processing

Grading

Assignments: 40%
- Mix of written and programing (about 5 of them)
- Average 1 or 2 weeks to do them

Final Project: 20%
- Presentation: TBD prior to midterm

Midterm: 20%
- Wednesday, October 13, In class

Final: 20%
- Monday, December 13 8:00-11:00am

Check ***now*** for conflicts!

Prerequisites

You must know how to program C or C++
- Big final project, several programing assignments
- No hand holding

Data structures (CS61B)

Math: linear algebra, calculus, trigonometry

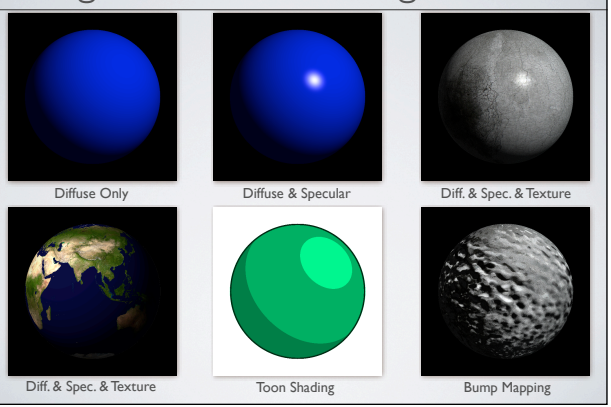
Assignments #1 and #2

Assignment #1: Getting Started
- Setup CS184 account and let us know who you are
- Get very simple OpenGL program working
- Due: Sat Sep 4 by 11pm

Assignment #2: Math Review
- Tests math prerequisites
- Due: Fri Sep 10 by 11pm

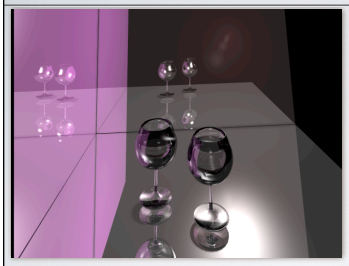
Assignment #3: Shading

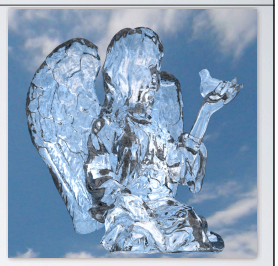
[Ritchie & Cho, F08]



Assignment #4: Ray Tracing

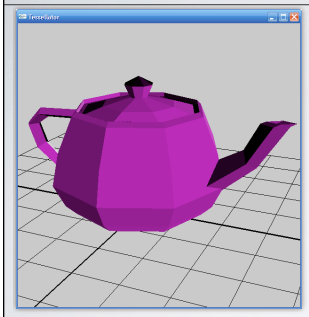
[Ritchie & Cho, F08]

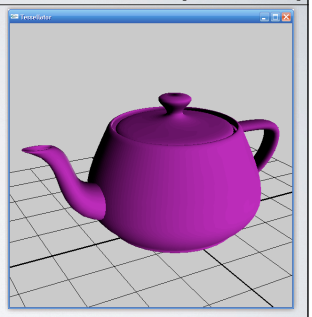




Assignment #5: Parametric Surfaces

[Ritchie & Cho, F08]





Final Project: Open Ended

Your image/animation/game here!

Waitlist

Relax for now... there is lots of space.

Class Participation

Reasons to participate

- More fun for me and you
- You learn more
- I won't give stupid little annoying quizzes in class

How to participate

- Ask questions
- Make comments

Stupid questions/comments

- That's okay

Academic Honesty

If you use an external resource cite it clearly!

Don't do things that would be considered dishonest...

- If in doubt ask

Cheating earns you:

- An 'F' in the class and
- Getting reported to the University
- No exceptions.

Questions?

Let's Have Fun!

Images

Images

Something that represents a ***pattern of light*** that will be ***perceived*** by something

Computer representations

- Sampled (pixel based)
- Object based
- Functional

Images

Something that represents a ***pattern of light*** that will be ***perceived*** by something

Computer representations

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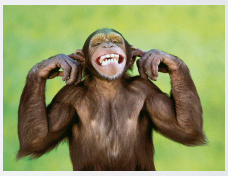

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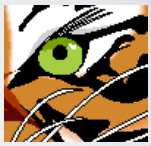

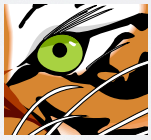

PS Type 1 font →

← Vector or stroke-based

Images

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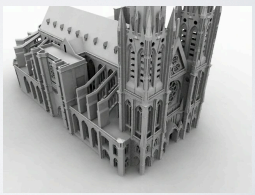
This ***used*** to be in an object based representation...



Olkan Arikan

Images

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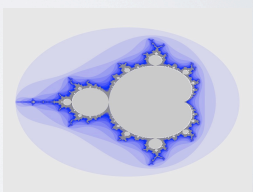

Mandelbrot Fractal Plot by Vincent Stahl

Images

Something that represents a ***pattern of light*** that will be ***perceived*** by something

Computer representations

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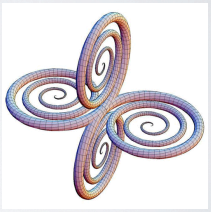
Function→**Polygons**→**Pixels**



"Spiral Crossed" by Sandor Kabai

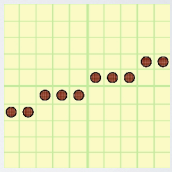
Think about making edits...

Storing Images

Object and Function representations basically arbitrary ...later...

Raster Images

- 2D array of memory
- Pixels store different things
  - Intensity
  - RGB color
  - Depth
  - Others...
- May be mapped to special HW

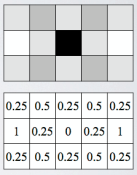


Storing Images

Object and Function representations basically arbitrary ...later...

Raster Images

- 2D array of memory
- Pixels store different things
  - Intensity (scalar value, **e.g.** float, int)
  - RGB color (vector value)
  - Depth
  - Others...
- May be mapped to special HW



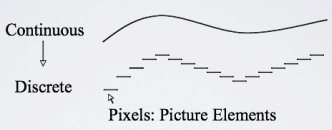
0.25	0.5	0.25	0.5	0.25
1	0.25	0	0.25	1
0.25	0.5	0.25	0.5	0.25

Stephen Chenney

Discretization

Real world and "object" representations are continuous.

Raster images have discrete pixel ***locations*** and discrete pixel ***values***



Stephen Chenney

We will see problems from this soon...

Monitor Intensity and Gamma

Monitors convert **pixel value into intensity level**

- 0.0 maps to zero intensity = black (well not quite)
- 1.0 maps to full intensity = white

Monitors are not linear

- 0.5 does not map to "halfway" gray, (e.g. 0.5 might map to 0.217)
- Nonlinearity characterized by exponential function

$$I = a^{\gamma}$$

where I = displayed intensity and a = pixel value (between 0 and 1)

- For many monitors γ is near 2 (often between 1.8 and 2.2)

Determining Gamma $I = a^{\gamma}$

Suppose I know displayed intensity of a patch $I = 0.5$

$$0.5 = a^{\gamma}$$

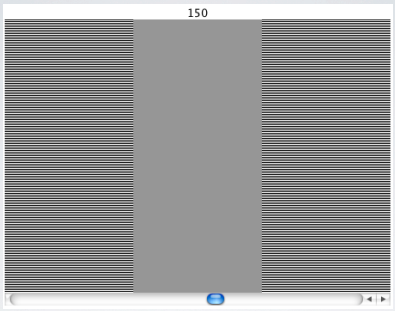
Let viewer adjust pixel value a of nearby patch until match

$$\gamma = \frac{\ln 0.5}{\ln a}$$

Patch of known $I = 0.5$	Viewer adjusts pixel values a until this patch visually matches

How do we make a patch of known intensity?

Determining Gamma

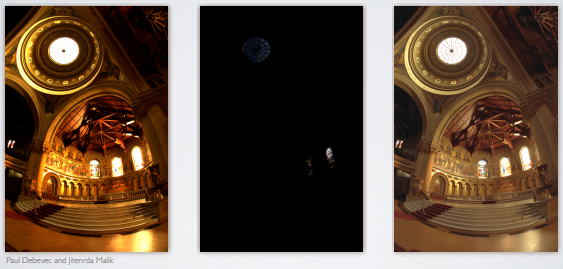


http://www.cs.cornell.edu/Courses/cs4620/2008fa/homeworks/gamma.htm

High Dynamic Range Images

Dynamic range of the human eye >> range of standard monitors

Eye adjusts as we look around



Paul Debevec and Jitenrda Malik

Tone Mapping

Jack Tumblin