

Introduction to Computer Graphics and Imaging

CS148, Summer 2010

Instructor: Siddhartha (Sid) Chaudhuri
TA: Niels Joubert

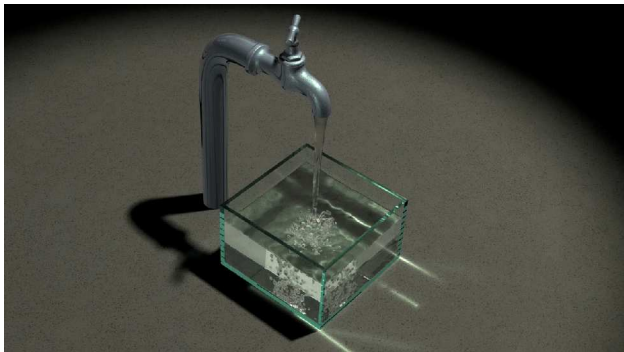
1

What is Computer Graphics?

Study of: digital synthesis and
manipulation of visual content, and
interaction with it

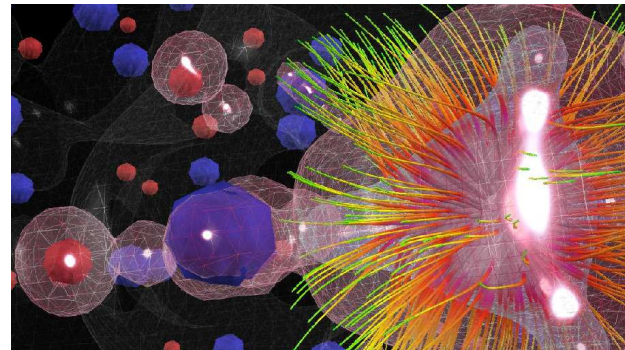
2

(Video: Zhang and James, Harmonic Fluids)



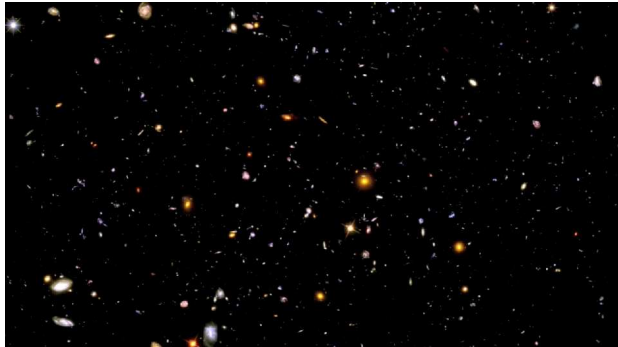
3

(Video: The AlloSphere)



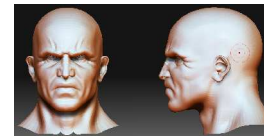
4

(Video: The Hubble Ultra Deep Field in 3D)



5

Graphics is... *Modeling*



Human head modeled in ZBrush (Shon Mitchell)



Trees generated with L-systems (Talton et al., 2010)



Procedurally generated model of Zurich
(Parish and Müller, 2004)



Engine CAD drawing (SolidWorks Corp.)

6

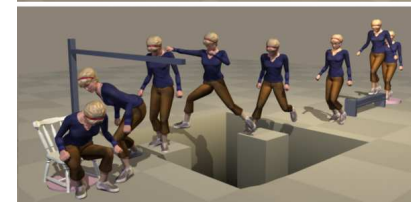
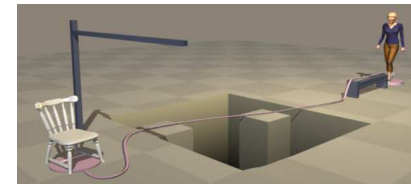
Graphics is... *Rendering*



Rendered in POV-Ray by Gilles Tran

7

Graphics is... *Animation*



Safonova and Hodgins, 2007

8

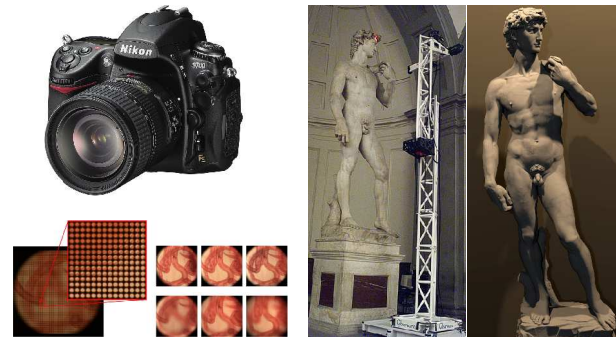
Graphics is...
Physical Simulation



Losasso et al., 2008

9

Graphics is...
Digital Capture



Light Field Microscopy (Levoy et al., 2006, 2007)

Digital Michelangelo Project (Levoy et al., 2000)

10

Graphics is...
Image Processing

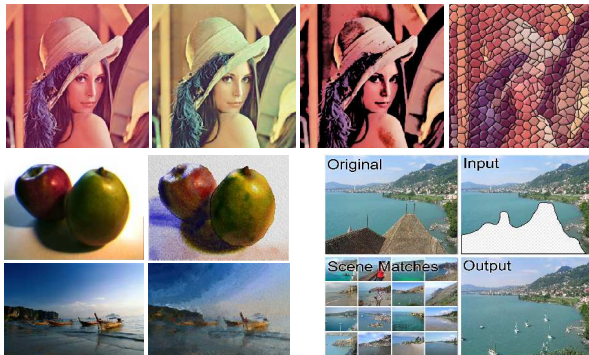
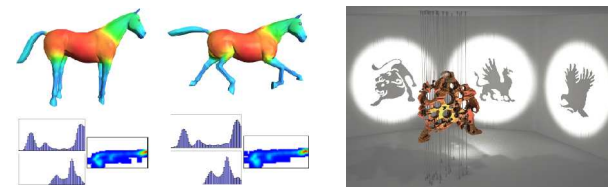


Image Analogies (Hertzmann et al., 2001)

Scene Completion with Millions of Photographs (Hays and Efros, 2007)

11

Graphics is...
Geometric Computing



Pose Oblivious Shape Signature (Gal et al., 2007)

Shadow Art (Mitra and Pauly, 2009)



Discovering Structural Regularity in 3D Geometry (Pauly et al., 2008)

12

Graphics is... *Entertainment and Interaction*



Jurassic Park (Universal Pictures, 1993)



World of Warcraft (Blizzard, 2004)



Toy Story, the first full length film produced entirely on computers (Pixar/Disney, 1995)



Crysis (Crytek/EA, 2007)

13

Graphics is... *Virtual Environments*



Second Life (Linden Research, Inc.)

14

Graphics is... *User Interfaces*



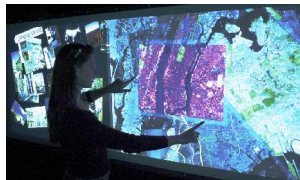
Xerox Star (Xerox, introduced 1981)



Windows 7 (Microsoft, 2009)



iPhone (Apple, introduced 2007)



Wall-mounted multitouch display
(Perceptive Pixel, 2007)



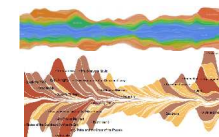
Virtual car design in the CAVE
(U. Mich./Prince, 1996)

15

Graphics is... *Visualization*



Wordle (Feinberg, 2009)



Streamgraphs of listening history & movie sales
(Byron/Wattenberg (t); New York Times, 2008 (b))



Britain from Above (BBC, 2009)



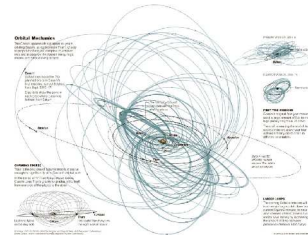
Visualization of traffic conditions (Google, 2009)⁶

Graphics is... Design



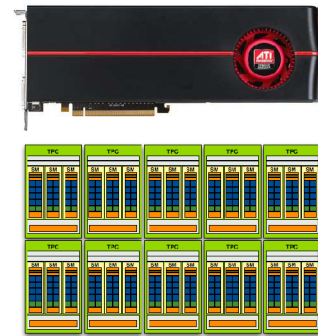
InDesign (Adobe, introduced 1999)

$$F = \frac{Gm_1m_2}{r^2}$$

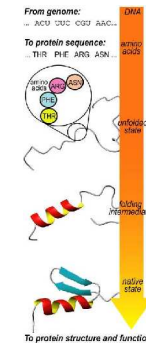


Planned orbits of Cassini spacecraft (New York Times, 2010)

Graphics is... Hardware

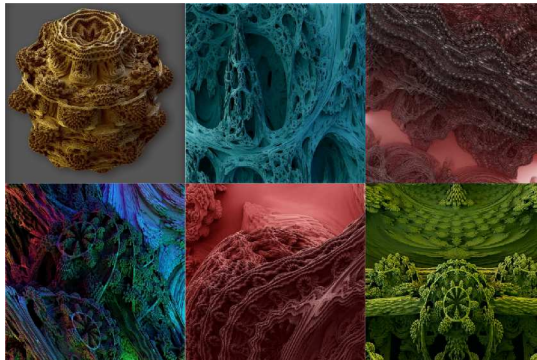


(GPU Images from anandtech.com)



Folding@Home (Pande et al.) 18

Graphics is... Art



The Mandelbulb (Daniel White, 2009)

19

Course Outline

- June 22: Introduction
- June 24: Light and Color
- June 29: Digital Cameras and Displays
- July 1: Image Processing and Compression
- July 6: Drawing and 2D Geometry
- July 8: 3D Geometry
- July 13: Rendering
- July 15: Curves and Surfaces

20

Course Outline

- July 20: Animation and Simulation
- July 22: Interaction
- July 27: *No class*
- July 29: *No class*
- August 3: Visualization
- August 5: Programmable Graphics Hardware
- August 10: Typography and Layout
- August 12: Sampling, Aliasing and Special Topics

21

You should know...

- Basic linear algebra
 - Vectors, matrices, simple coordinate systems (cartesian, polar, spherical, cylindrical)
- Basic calculus
 - Limits, derivatives, integrals, notation
- C/C++
 - Either is ok, but we provide more utility code for C++
 - Please write standards-compliant code
 - Your code should compile with a C89/C++98 compiler

22

How to **pass** this course

- Attend the lectures
 - Yes, attendance is mandatory. You can skip at most 2 lectures unless you're a remote SCPD student or have special circumstances (talk to us this week).
- **Understand the concepts**
- Do the assignments
 - Try to get the bonus credits
- Do the exams
 - Only SCPD students can take the exams remotely

23

How to **fail** this course

- Skip the lectures
- Ignore the concepts and only memorize formulae
- Slack on the assignments
- Miss the exams
- Violate the Honor Code (read it!)

24

Resources

- Course website: <http://cs148.stanford.edu>
 - Lecture slides, assignments, schedule, FAQ etc.
- cs148-sum0910-staff@lists.stanford.edu
- Textbooks
 - **Required:** Shirley and Marschner, *Fundamentals of Computer Graphics*, 3rd ed. (in a pinch 2nd is ok)
 - **Optional:** Shreiner et al., *The OpenGL Programming Guide*, 6th ed. (7th is ok)
 - Pretty much any decent OpenGL guide that covers programmable shaders (GLSL) is also ok

25

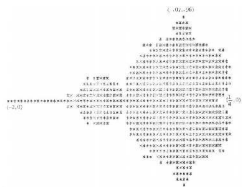
Grading Policy

- Assignments: 60%
 1. Mandelbrot set (due next Monday night)
 2. Image filtering
 3. Raytracing
 4. Interactive game (Quake)
 5. Visualization
- Midterm: 15%
- Final: 25%

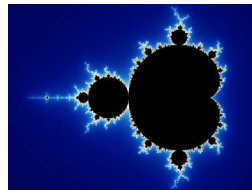
26

AS1: Mandelbrot Set (due Jun 28, 23:59)

- Fractal set embedded in 2D complex plane
- Studied by Brooks, Matelski, Mandelbrot etc.
- Set of complex c s.t. $z \leftarrow z^2 + c$ does not diverge



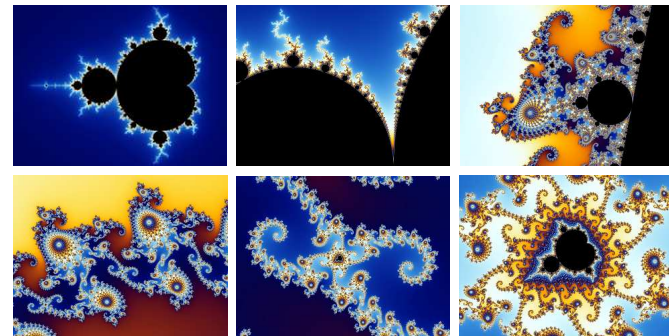
Brooks & Matelski, 1978



Beyer, 2006

27

AS1: Mandelbrot Set (due Jun 28, 23:59)



Wolfgang Beyer, 2006

28