Computer Graphics (Fall 2008)
COMS 4160, Lecture 1: Overview and History
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http://www.cs.columbia.edu/~cs4160

Goals
- **Systems**: Be able to write complex 3D graphics programs (real-time in OpenGL, offline raytracer)
- **Theory**: Understand mathematical aspects and algorithms underlying modern 3D graphics systems

This course is *not* about the specifics of 3D graphics programs and APIs like Maya, Alias, AutoCAD, DirectX but about the concepts underlying them.

Demo: Surreal and Crazy World (HW 3)

Course Outline
- **3D Graphics Pipeline**
  - Modeling (Creating 3D Geometry)
  - Rendering (Creating, shading images from geometry, lighting, materials)

Unit 1: Transformations
Resizing and placing objects in the world, Creating perspective images.
Weeks 1 and 2
Ass 1 due Sep 25

Unit 2: Spline Curves
Modeling geometric objects
Weeks 3, 4
Ass 2 due Oct 7
Course Outline

- **3D Graphics Pipeline**

  **Modeling**  
  (Creating 3D Geometry)

  **Rendering**  
  (Creating, shading images from geometry, lighting, materials)

  **Unit 1: Transformations**  
  Weeks 1, 2. Ass 1 due Sep 25

  **Unit 2: Spline Curves**  
  Weeks 3, 4. Ass 2 due Oct 7

  **Midterm on units 1-3: Oct 20**

  **Unit 3: OpenGL**  
  Weeks 5-7. Ass 3 due Nov 11

  **Unit 4: Shading, Ray Trace**  
  Weeks 8, 9. Ass 4 due Dec 9

Midterm on units 1-3: Oct 20

Image Synthesis Examples

Logistics

- Website http://www1.cs.columbia.edu/~cs4160 has most of information (look at it)
- Office hours: before or after class (or just send me e-mail)
- TA: Dhruv Mahajan, CEPSR 6LE4
- Course bulletin board, cs4160@lists.cs.columbia.edu
- Website for late, collaboration policy, etc
- Questions?

Workload

- Lots of fun, rewarding but may involve significant work
- 4 programming projects; latter two are time-consuming (but you have > 1 month, groups of two, intermediate milestones). START EARLY!!
- Course will involve some understanding of mathematical, geometrical concepts taught (explicitly tested on midterm, open book take home written assignments at end)
- Prerequisites: Solid C/C++/Java programming background. Linear algebra (review on Mon) and general math skills
- Should be a difficult, but fun and generously graded course
To Do
- Look at website
- Various policies etc. for course. Send me e-mail if confused.
- Skim assignments if you want. All are ready
- Assignment 0, Due Sep 9 Tue (see website). Send e-mail to cs4160@lists.cs.columbia.edu telling us about yourself and sending us a digital photo (so we can put names to faces).
- Any questions?

History
- Brief history of significant developments in field
- Couple of animated shorts for fun
- Towards end of course: movie, history of CG

What is Computer Graphics?
- Anything to do with visual representations on a computer
- Includes much of 2D graphics we take for granted
- And 3D graphics modeling and rendering (focus of course)
- Auxiliary problems: Display devices, physics and math for computational problems

The term Computer Graphics was coined by William Fetter of Boeing in 1960
First graphic system in mid 1950s USAF SAGE radar data (developed MIT)

2D Graphics
Many of the standard operations you’re used to:
- Text
- Graphical User Interfaces (Windows, MacOS, ..)
- Image processing and paint programs (Photoshop, …)
- Drawing and presentation (Powerpoint, …)

How far we’ve come: TEXT
Manchester Mark I
Display

From Text to GUIs
Invented at PARC circa 1975. Used in the Apple Macintosh, and now prevalent everywhere.

Xerox Star
Windows 1.0
**Drawing: Sketchpad (1963)**
- Sketchpad (Sutherland, MIT 1963)
- First interactive graphics system
- Many concepts for drawing in current systems
  - Pop up menus
  - Constraint-based drawing
  - Hierarchical Modeling

**Paint Systems**
- Nowadays, image processing programs like Photoshop can draw, paint, edit, etc.

**Image Processing**
- Digitally alter images, crop, scale, composite
- Add or remove objects
- Sports broadcasts for TV (combine 2D and 3D processing)

**3D Graphics**
- 3D Graphics Pipeline
  - Modeling (Creating 3D Geometry)
  - Rendering (Creating, shading images from geometry, lighting, materials)

**Applications**
- Entertainment (Movies), Art
- Design (CAD)
- Video games
- Education, simulators, augmented reality

**Modeling**
- Spline curves, surfaces: 70s – 80s
- Utah teapot: Famous 3D model
- More recently: Triangle meshes often acquired from real objects
Rendering: 1960s (visibility)
- Roberts (1963), Appel (1967) - hidden-line algorithms
- Sutherland (1974) - visibility = sorting

Rendering: 1970s (lighting)
- 1970s - raster graphics
  - Blinn (1974) - curved surfaces, texture

Rendering (1980s, 90s: Global Illumination)
- early 1980s - global illumination
  - Whitted (1980) - ray tracing
  - Goral, Torrance et al. (1984) radiosity
  - Kajiya (1986) - the rendering equation

Related courses
- COMS 4162, follow on to 4160 taught by me alternate years in the spring.
- Many 6000-level courses (e.g. COMS 6160 High Quality Real-Time Rendering, Representations of Visual Appearance)
- Part of Vision and Graphics track in BS and MS programs. Columbia Vision and Graphics Center
- Other related courses: Computer Vision, Robotics, User Interfaces Computational Geometry,...