Overview

Computer Graphics
CSE 167
CSE 167: Computer Graphics

• Today
  – Course overview
  – Logistics
What is computer graphics?

• Everything visual on computers
• The representation and manipulation of image data by a computer
• The various technologies used to create and manipulate images
• The methods for synthesizing and manipulating visual content using a computer
• The manipulation of visual and geometric information using computational techniques that focus on the mathematical and computational foundations of image generation and processing
History

- 1940s: Modern digital computers
- 1950s: High-level programming languages and the integrated circuit
- 1950s: Introduction of the cathode ray tube (CRT) as a viable computer display
- 1960s: Operating systems
- 1960: The phrase “computer graphics” is coined
- 1970s: Microprocessor
- 1980s: Personal computers (PCs)
History

- 1949: Manchester Mark 1
History

• 1963: Sketchpad
  – First interactive graphics system

https://www.youtube.com/watch?v=495nCzxM9Pl
History

• c. 1975: Graphical user interface (GUI)
  – Xerox Palo Alto Research Center (PARC)

Xerox Alto (1976)

Microsoft Windows 1.01 (1985)
History

• History of computer animation (20 min)
  https://www.youtube.com/watch?v=LzZwiLUVaKg
  https://www.youtube.com/watch?v=S3hqS6JlKEc
Rendering: 1960s (visibility)

- Roberts (1963), Appel (1967): hidden line algorithms
- Sutherland (1974): visibility = sorting
Rendering: 1970s (raster graphics, lighting)

- Blinn (1974): curved surfaces, texture
Rendering: 1980s and 90s (global Illumination)

• Whitted (1980): ray tracing
• Goral, Torrance, et al. (1984): radiosity
• Kajiya (1986): the rendering equation
Modern applications

- Movies
- Video games
- Computer aided design
- Visualization
- Virtual reality
- Augmented reality
- Mixed reality
Entertainment

Movies: Brave, Pixar 2012
Entertainment

Games: Halo 3, Bungie 2007
Lighting Simulation

Interior Design

Automobile Visualization
Computer Aided Design

- Mechanical CAD
- Architectural CAD
- Electronics CAD
- Casual Users

- Interiors Professional

- Sketchup
Visualization: Science and Medicine

Visible Human Project: University of Hamburg
Virtual Reality

- VR for design and entertainment
- Simulators: surgical, flight, driving, spacecraft
Major computer graphics areas

Modeling → Animation → Rendering
Modeling

- The mathematical specification of shape and appearance properties
- Basic 3D models consist of arrays of triangles
- Models are created with 3D modeling tools or constructed from 3D scans
- Models can be procedurally generated (e.g., curves)
Animation

• A technique to create an illusion of motion through a sequence of images

• Keyframing
  – Manually animate key frames
  – Inbetweening is performed automatically using interpolation

• Motion capture
Rendering

• The creation of shaded images from 3D computer models
• Photorealistic rendering
  – Physics-based simulation of light
  – Slow (minutes or hours to render an image)
  – Used in movies
• Interactive rendering
  – Often “as photorealistic as possible”
  – Fast (within milliseconds to render an image)
  – Used in games
Why Study 3D Computer Graphics?

• Applications
• Fundamental intellectual challenges
  – Create and interact with realistic virtual world
  – Requires understanding of all aspects of physical world
  – New computing methods, displays, and technologies
• Technical challenges
  – Math of (perspective) projections, curves, and surfaces
  – Physics of lighting and shading
  – 3D graphics software programming and hardware
CSE 167 topics

• Vectors, matrices, and linear algebra
• Geometric primitives
  – points, hyperplanes, and lines
• Geometric transformations
• Coordinate frames
• Viewing
• Surface shading
• Textures
• Curves
• Ray tracing
CSE 167 objectives

• Theory: mathematical aspects and algorithms underlying modern 3D graphics systems
• Systems: write complex 3D graphics programs
• Note: although we’ll be using modern OpenGL (3.3 and later), this course is not about the specifics of 3D graphics programs and APIs like Maya, Alias, DirectX but about the concepts underlying them
Syllabus

• Instructor: Ben Ochoa
• TAs: Yunhan Ma and Varun Syal
• Tutors: Yiming Cai, Renxu Hu, Yunlu Huang, Sung Rim Huh, Ziyang Li, and Hanqing Zhang
• Course website
  – https://cseweb.ucsd.edu/classes/wi18/cse167-a/
• 18 lecture meetings
  – 2 university holidays (Jan 15 and Feb 19)
• Homework discussion: Thursdays 5:00 PM-5:50 PM
• Class discussion
  – Piazza
Syllabus

• Grading
  – 5 homework assignments (80% of grade)
    • Significant amount of work, but rewarding
    • Start early!
  – Midterm exam (20% of grade)
  – No final exam
• Piazza
  • Ask (and answer) questions using Piazza, not email
  • Good participation could raise your grade (e.g., raise a B+ to an A-)
Academic integrity policy

Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind.
Collaboration policy

It is expected that you complete your academic assignments on your own and in your own words and code. The assignments have been developed by the instructor to facilitate your learning and to provide a method for fairly evaluating your knowledge and abilities (not the knowledge and abilities of others). So, to facilitate learning, you are authorized to discuss assignments with others; however, to ensure fair evaluations, you are not authorized to use the answers developed by another, copy the work completed by others in the past or present, or write your academic assignments in collaboration with another person.
Academic integrity violation

If the work you submit is determined to be other than your own, you will be reported to the Academic Integrity Office for violating UCSD's Policy on Integrity of Scholarship. In accordance with the CSE department academic integrity guidelines, students found committing an academic integrity violation will receive an F in the course.
Wait list

• Number of enrolled students is limited by
  – Size of room
  – Number of instructional assistants (TAs and tutors)

• General advice
  – Wait for as long as you can

• Concurrent enrollment (Extension) students have lowest priority