CSE 457: Computer Graphics

Offered: Spring 2020
Instructor: Adriana Schulz

Objectives:

• Broad introduction to the field of computer graphics
• Combination of
  – underlying theoretical principles
  – technical implementation
  – artistic expression
• Many demonstrations of concepts in class
Great Group of TAs
Plan for Today

• Zoom Test
• What is Computer Graphics?
• Plan for Lecture Topics
• Administrative Things
• Projects and Homework
Zoom Test

• Can you hear me well (Yes/No)
• How many seniors? (Say Yes)
• How many juniors? (Say Yes)
• Other? (Say Yes)
• Previous experience with Graphics?
  – raise hands to speak or type on chat
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Slides adapted from Keenan Crane
Probably an image like this comes to mind:
Q: ...ok, but more fundamentally: what is computer graphics (and why do we need it)?
Early computer (ENIAC), 1945

punch card (~120 bytes)
There must be a better way!
Credit: PC World, “A Brief History of Computer Displays”
Sketchpad (Ivan Sutherland, 1963)
2018: Dell 8k monitor 7680x4320 (~95MB)
Coming down the pipe...

2018 Google/LG display: 2x 4800x3480 @ 120Hz => 11.2GB/s
Why visual information?

About 30% of brain dedicated to visual processing...

...eyes are highest-bandwidth port into the head!
What is computer graphics?

**computer graphics** /kəmˈpyʊdər ˈɡrafɪks/ n.
The use of computers to synthesize visual information.
Graphics has evolved a lot since its early days... no longer just about turning on pixels!
What is computer graphics?

computer graphics /kəmˈpyoʊdərˈɡrafiks/n.
The use of computers to synthesize visual information.

Why only visual?
Information into sensory stimuli

Sound

Touch
Information into physical mater
Definition of Graphics, Revisited

**computer graphics** /kəmˈpyoʊdər ˈɡrafiks/ n.
The use of computation to turn digital information into sensory stimuli.
Even this definition is too narrow...
SIGGRAPH Technical Papers Trailer

• SIGGRAPH 2019
  https://www.youtube.com/watch?v=EhDr3Rs5fTU

• SIGGRAPH 2018
  https://www.youtube.com/watch?v=t952yS8tcg8

• SIGGRAPH 2017
  https://www.youtube.com/watch?v=5YvIHREdVX4

• SIGGRAPH 2016
  https://www.youtube.com/watch?v=dQBJ0r5Pj5s

• SIGGRAPH 2015
  https://www.youtube.com/watch?v=XrYkEhs2FdA
Computer graphics is everywhere!
Entertainment (movies, games)
Entertainment
Not just cartoons!
Art and design
Industrial design
Computer Aided Engineering (CAE)
Scientific/mathematical visualization
Medical/anatomical visualization
Navigation
Communication
Interdisciplinary!

- Algorithms
- Hardware
- Compilers
- HCI
- Visualization
- Image processing
- Computer vision
- Machine learning
- Computer Science
- Mathematics
- Physics
- Engineering
- Biology
- Psychology
- Art
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Displays

On State

Off State
Image processing
Geometric transformations

1. Model or object space
   - Scale, translate, rotate, ...
2. World space
   - Rotate, translate
3. Eye or camera space
   - Project, scale, translate
4. Normalized device space
   - Screen space
   - Raster space
5. Image space
   - Window space
   - Device space
   - Projective transformation, scale, translate
Shading
Graphics Processing Units
Curves
Surfaces

(a-d) Loop’s subdivision scheme: control mesh, meshes after 1 and 2 subdivision steps, and smooth limit surface

(e-h) Our piecewise smooth subdivision scheme: tagged control mesh, meshes after 1 and 2 subdivision steps, and piecewise smooth limit surface
Hierarchical modeling
Animation

- Keyframing
- Physical simulations
Principles of character animation
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Prerequisites

• Data structures
• C (C++) programming
• Linear algebra (very basic)
• Some mathematical sophistication
• No prior knowledge of graphics is assumed
Communication

- Announcements: email
- Everything else: **main website**
  - Discussion Board
  - Canvas for Lectures/Grades/Submitting
    - Homeworks
  - Gitlab for Projects
  - Calendar (office hours, help sessions, etc)
Deliverables

• 4 Projects + Artifacts and 2 HWs
• No final
• Check calendar (main website)
• Released on Website (all info/or links)
• Late Policy:

All assignments (projects, artifacts, and homework) must be submitted by 10pm on the due date. Late assignments are marked down at a rate of 25% per day (not per lecture), meaning that if you fail to turn in an assignment on time it is worth 75% for the first 24 hours after the deadline, 50% for the next 24 hours, 25% for the next 24 hours, and then it is worth nothing after that. 

Exceptions will be given only in extreme circumstances with prior instructor approval.
Projects

• Done in Pairs
  – You can pick or be auto-assigned
• Help Session (will be recorded)
• Virtual “in person” grading
• Artifact
• Opportunity for extra credit
Summary

Broad view of graphics
Hands-on experience with focus on ideas and algorithms
Structured to allow you to budget time according to your interests and constraints
Balance of technical and artistic expression
You will see the world in a different way,