Introduction

CS 543 - Computer Graphics

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(with help from Emmanuel Agu ;-)

IIIT WPI
This course is mainly about how to create pretty pictures.

The really interesting jobs will ask you to extend it.

In industry, you may only use OpenGL. We use OpenGL as one example of how things could be done.

Today, a big chunk is available off the shelf. Over 30 years of research.

Algorithms, mathematics, data structures.

What to Expect

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What to Expect (cont.)

This course is about Computer Graphics, not OpenGL.

Focus on underlying methods

How would one build OpenGL?

Efficiency (speed & space)

Other methods besides OpenGL

C/C++

Coding

Pretty pictures

This course is heavy on coding.

C/C++
Summary of Syllabus

2 Exams (50%), 5 Projects (50%)

Projects will use OpenGL

Project 4: Extend home-grown library, minigl

Encouraged to use MinGW (www.mingw.org)

Must run on CCC machines

Can discuss with others, turn in unique project

Program in C/C++

Write code on any platform that has OpenGL

All material on class website

(www.cs.wpi.edu/~emmanuel/courses/cs543/)

All material on class website

WPI
Assignments

Many phases to homework:

1. Do the assigned reading
2. Come to class
3. Ask questions (class, office hours, MyWPI discussions)
4. Make sure you understand before coding
5. Don't share your code with others!

Advice for doing well:

- Immediate 'F' in the course
- Many reasons not to do it!
- Cheating:
- Must hand in your own work only
- Encouraged to discuss approaches
- Understand/design/code/debug/test/eat/test/some more

Many phases to homework:

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What is Computer Graphics?

Use computer resources to generate pictures

Started in early 1960s

Some Pioneers:

- Ivan Sutherland - Overall vision of CG/VR
- Ed Catmull - Animation and surface descriptions
- Jim Blinn - Computational models
- MANY OTHERS!

Ivan Sutherland demonstrates Sketchpad (1961)

Image: www.pbs.org
What is Computer Graphics?

ACM SIGGRAPH Conference

Many programs are for artists. Here we focus on CG tool smiths. CS types create tools that artists use to create compelling content.
Related Areas to CG

- Shading & Lighting: Surface & Environmental effects
- Computer Vision: Extracting info from images
- Scientific Visualization: Making sense of data
- Animation: Making things move over time and space
- Post Production: Tweaking the images
- HCI: Incorporating user interaction
- Take animation course after CS 4731!

Modeling: Shape of objects in a scene

WPI
CG Tools

Software Tools

- Graphics libraries
- Debugger
- Compiler (g++)
- Editor (emacs)

Output devices

- Monitors, projection systems, VR helmets, print
- Graphics accelerators

Input devices

- Mouse/trackball, pen/tablet, keyboard, other

Hardware Tools

Your eyes
What is a CG Library?

Low-level routines
Points, lines, circles, text, etc.

High-level routines
Pull-down menus, window management, etc.

Some of this has traditionally been device dependent

Now we have device/platform independence
(almost)

Difficult to port, error prone
dependent

XBOX, PS1/2/3/P, Revolution, GB Advance, etc.
OpenGL, DirectX, Java3D, etc.
Motivation for CG

- Appealing pictures produced
- Humans respond better to pictorial information
- Human brain recognizes visual patterns
- "If it looks right, it is right."

Jim Blinn, CG Pioneer
Reasons You Are Here

- Gluttons for punishment?
- Get a grade (just one of your MS courses)
- Do research in graphics
- Take advanced graphics or visualization course
- Communicate your ideas
- New medium for artistic expression
- Instant gratification
- Games, film, Web
- Want to work in CG field
2D vs. 3D Graphics

**2D Graphics**
- (x, y) color values on screen
- Orthographic: objects have no depth or distance from viewer

**3D Graphics**
- (x, y, z) values on screen
- Perspective: objects have depth or distance from viewer

Image: Human Brain Project, Denmark

Image: Matt Ward
3D Content Creation

Create 3D objects in the scene (modeling)

- Basic shapes (cube, sphere, etc.), meshes, etc.
- Scale them (may also stretch them)
- Position them (rotate, translate, etc.)

Then, generate the picture (rendering)

- Environment mapping (e.g., fog)
- Texture mapping
- Shadows
- Color and shading
- Perspective

Numerous packages to help do these!

- Anti-aliasing
- Transparency and blending
Modeling Example

Why might we need multiple object representations?

Original: 424,000 triangles
60,000 triangles (14%)
1,000 triangles (0.2%)

(courtesy of Michael Garland and Data courtesy of Iris Development.)
In a scene, need to simulate the movement of light and shadows and lighting.
Uses of Computer Graphics

Post-Production
Uses of Computer Graphics (cont.)

Post-Production (green screens)

Sample CG: Environments

Image: www.doom3.com
Sample CG: Fractal Mountains

No atmospheric correction

Image: Ken Musgrave - www.kenmusgrave.com
Sample CG: Fractal Mountains (cont.)

Atmospheric correction only

Image: Ken Musgrave - www.kenmusgrave.com
Fractal Mountains (cont.)

Sample CG:

Image: Ken Musgrave - www.kenmusgrave.com

Atmospheric and color correction
Fractal Mountains - No Atmospheric Correction

Image: Ken Musgrave - www.kenmusgrave.com
After Atmospheric Correction
Fractal Mountains -

Image: Ken Musgrave - www.kenmusgrave.com
Sample CG: Characters
Sample CG: Objects

Image: marsrovers.jpl.nasa.gov/gallery/artwork/