CS148: Introduction to Computer Graphics and Imaging

Drawing

Electric Sheep screensaver by Scott Draves
Image created collectively by users on the internet

Today’s Outline

- OpenGL introduction
  - OpenGL primitives
  - Demos / code
- Rasterization rules
- The OpenGL graphics pipeline
- Graphics hardware

Goal: Understand the graphics pipeline and learn how to create pictures using OpenGL
OpenGL Demonstrations

rect.c
reshape1.c, reshape2.c, reshape3.c
rules.c
primitives.c, concave.c

Viewports and Coordinate Systems

Each window has a user coordinate system
A 2D coordinate system is specified by assigning coordinates to the edges of the window
left need not be less than right ...
Framebuffer and Viewport

My Macbook Pro Framebuffer: 1440 x 900

The window is the portion of the display usable by the application (under control of the "window system")
The viewport is the portion of the window that can be drawn in, no pixels will appear outside the viewport

All coordinates are integers; they refer to pixels in the framebuffer

Two Interpretations of Window

http://www.imaginativeinteriors.co.uk/trompe.shtml

Window on the Display (Virtual Framebuffer)  Window into a Virtual World

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Pixel Coordinates

Viewport/Window edges at integers

Pixels inside window

OpenGL: Pixel centers correspond to half-integer coordinates

Note: Other graphics packages may use a different convention
**Rasterization Rules: Area Primitives**

Output fragment if pixel center is **inside area**

Need rules for breaking when centers are on an edge
(only "left" and "bottom" edges are drawn)

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**Rasterization Rules: Lines**

Output fragment if line intersects diamond

Better is to use line segment to define quadrilateral
OpenGL Shape Primitives

OpenGL Drawing Primitives

Geometric Shapes

Bitmaps

Images
Simplified Pipeline

- Vertices
- Transformed vertices
- Fragments
- Shaded fragments

OpenGL commands → Per-vertex ops → Rasterizer → Texturing → Per-fragment ops → Frame buffer ops → Pixels

OpenGL Architecture

- Vertex data
- Display lists
- Rasterization
- Per-fragment operations
- Framebuffer
- Per-pixel operations
- Texture assembly
- Pixel data
**Modern PC**

- **3.0 Ghz Intel Core2 Duo**
  - Core 1
  - Core 2
  - 4MB L2 Cache

- **2GB main memory (DDR2)**

- **NVIDIA GeForce 8800 GTX (575 MHz)**
  - (16 cores)

- **System board (Intel D975)**

- **PCle Bus (v1 = 4 GB/sec)**

- **512MB video Memory (GDDR3)**

- **84 GB/sec**

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**Game Machines – Xbox 360**

- **3.2 Ghz PowerPC CPU**
  - Core 1
  - Core 2
  - Core 3
  - L2 Cache

- **500 Mhz ATI GPU**
  - 48 3D Cores
  - Frame buffer
  - Video out

- **512 MB memory**

- **Display (TV)**

- **IO Chip**

- **controllers/ethernet/audio/DVD/etc.**

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Game Machines – PS3

Summary

Graphics state stores attributes
Graphics commands output primitives
   Shapes (points, lines, triangles, quads, etc.)
   Bitmaps (fonts)
   Images
Different coordinate systems
   User coordinates
   Pixel coordinates
Know how to GL commands and use GLUT for windowing/interaction