CS335 Fall 2007
Graphics and Multimedia

2D Graphics – Introduction
Computer Graphics Research

Sketchpad, 1963 Ivan Sutherland

Shrek, 2001 PDI/Dreamworks
Real-time Rendering

From NVIDIA
Two-Dimensional (2D) Graphics

- Computer Graphics Pipeline
- Graphics Systems
  - Display
  - Rendering
- Interactive Techniques
Introduction to Two-Dimensional Computer Graphics

- What is computer graphics
- Enrich the human/machine interface
- Provide digital accuracy ("idealized" or "enhanced" views)
- Visualization of weird phenomena
Why Graphics Is Hard

- Modeling realistic-looking things
- Manipulating models with fidelity
- Generating pictures or “graphic”
Graphics Primitives: Models

- Representation of visual “primitives”:
  - lines
  - shapes
  - textures
  - colors

- Mathematical definitions/accuracy

- Fidelity to “real-world” constructs
Manipulation of Models

- Transformations:
  - translation
  - rotation
  - shearing
  - ...

- Composition of primitives into organized high-level models
Scene Rendering

- **Render**: produce a picture from a representation of primitives
- Must reconcile differences between internal representation and final display device
  - lines: continuous representation vs. pixel-based screen
  - scenes: large scene vs. portion that is visible
Representation + Attributes

- **Representation**: primitives (points/lines/regions) must satisfy desired goals
- **Manipulation**: need a mathematical framework to describe a scene, a construct, an attribute
- **Rendering**: need algorithms to convert a representation into an “image” on a final output display device

Graphics objects: fit well into object-oriented paradigm
Example: The Chain Code

- Want to represent a curve
- Need
  - representation (curve structure of some kind)
  - method for manipulating the structure
  - algorithm to convert structure into an image
- Choices determine practicalities of computation time, fidelity, size, etc...
Chain Code

Cartesian Coordinates define an overall scheme:

- Curve: sequence of directions on a Cartesian grid
Chain Code

Chain code:

(startx, starty): (4, 7)  code: 4323455677711711
Chain Code: Manipulation and Rendering

- Algorithms for:
  - Translation
  - Rotation
  - Scaling

- Algorithm for Rendering
Graphics Applications

- presentation graphics
- computer art
- entertainment
- education and training
- visualization
- image processing / medical analysis
Two-Dimensional (2D) Graphics

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Graphics Systems

- Primary components:
  - main processor (model, rendering engine)
  - video controller
  - monitor/display device

- Raster Scan Systems:
  - display represented as framebuffer/pixels
  - hardware supports continuous display of frame buffer
CRT-CATHODE RAY TUBE

Mechanism: Shoot electrons with varying energy through vertical & horizontal deflectors to hit spot on screen **Phosphors** on screen jump to excited state when hit by electrons, emit **monochromatic** light when they drop to rest state.

*Figure 2-4*
Electrostatic deflection of the electron beam in a CRT.
Display Devices

- raster scan displays
  - color CRT
  - flat-panel displays

- random-scan systems
3-D Viewing

- Stereopsis
  - Anaglyph (red/blue stereo)

From http://cprr.org/Museum/Stereo/#Hart_44
3-D Viewing

- Other Display Devices
  - head-mounted VR
  - rotating helix screen
  - deformable mirrors
  - 3D layered panels

From www.felix3d.com
Raster Scan Systems: Details

- CPU
- System Memory
- Video Controller
- System bus
- I/O devices
- Monitor
Raster Scan Systems: Display Processor

- CPU
- System Memory
- Display Processor
- System bus
- Display Processor Memory
- Frame buffer
- Video Controller
- Monitor
- I/O devices
Large Format Displays

- The CAVE
- Panoram systems
- Power Wall, Video Wall, Data Wall, Omni Wall...
- Tele-presence, Office of the Future
- Office of the “real soon now”
- Multi-projector scalable systems
Examples
I/O Devices

Input:
- Mouse
- Joystick
- Tablet
- Touch-sensitive screens
- Scanner
- Head tracking

Hardcopy:
- Printers
- Plotters
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Interactive Computer Graphics

- Primary consideration: user input
- Tied to animation:
  - Rubber-banding
  - User interface design
- Raises performance requirements
The Event Loop

- Draw initial layout
- Wait for user response ("events")
- Respond to events and return to wait state