

Computer Graphics

A. Overview

1. We have studied the digitization of natural images (scenes, photos) and how they can be processed
2. Next: study of the creation of artificial images
 - a. Computer *graphics*
3. Different types/applications of graphics
 - a. Bit-mapped (raster) graphics
 - b. Structured (vector) graphics
 - c. 3-D graphics
 - d. Animation
 - e. Virtual Reality

Computer Graphics

B. Bit-mapped graphics

1. The Photoshop images we manipulated were composed of *pixels*
2. This type of graphic is called **bit-mapped** or **raster graphics** and is **pixel-oriented**
3. Graphic laid out over a coordinate (X,Y) system
4. "Brute force" method
5. Explicitly specify location and attributes of each pixel
6. In many *graphic* applications, bit-mapped graphics have serious drawbacks
 - a. Imagine creating an art collage – colored shapes overlapping "artfully"
 - b. Designing a house
 - c. Any application that deals with "objects" wants the graphics to treat them as such.
7. More flexibility / control in what you can create

Computer Graphics

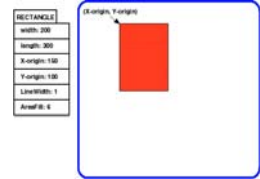
C. Structured graphics

1. **Structured** or **vector** (or **object-oriented**) graphics treat the image as a collection of graphic *objects* such as lines, curves, and figures
2. Represent objects using equations, not pixels
3. Resolution independent and scalable
 - a. No pixelation
4. More easily edited and often more compact in storage
5. Must be converted to bit-mapped images for display (*rasterized*)

Computer Graphics

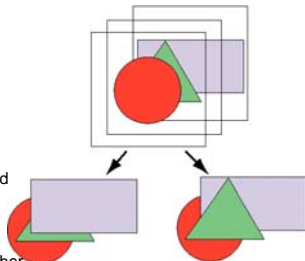
6. Example

- a. Image is composed of graphic objects (lines, curves, figures, etc.)
- b. Each object is defined by its graphic (mathematical) properties / structure
- c. These properties may be changed and scaled easily



Computer Graphics

7. Each object is treated separately – and can overlap others
8. Objects may be easily moved, scaled, and arranged in different orders
9. Objects may be deleted and inserted easily
10. Trade off flexibility for convenience, greater margin for error and other benefits



Computer Graphics

D. Graphic applications

Bit-mapped graphics

- painting programs
- photographic touch-ups and edits

Vector graphics

- drawing programs
- illustration programs
- 3-D modeling and rendering programs

Computer Graphics

1. Painting programs
 - a. Two-dimensional, bitmapped images/files
 - b. Interface based on artist metaphor
 - 1) Image (canvas) painted with brushes, pencils, chalk, etc. (*ambiguity*)
 - 2) Colors, patterns, and textures selected from palettes
 - c. Sometimes introduce artificial "layer" concept to overcome some problems
 - 1) But must be *flattened* for use
 - d. Photoshop is an example
 - 1) Mainly for image editing, but may also be used for creating graphics

Computer Graphics

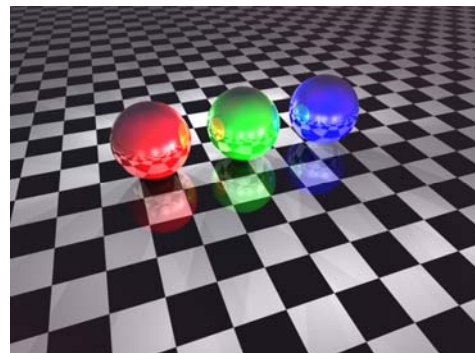
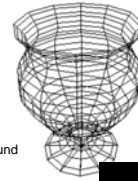
2. Drawing programs
 - a. Vector graphic programs – deal with *objects*
 - b. Best-suited for "formal" drawings, illustrations, logos and engineering applications
 - c. An image is a set of graphic objects that are created individually and composed together
 - d. Macromedia Fireworks and the Microsoft Word drawing tools are examples
3. Illustration programs
 - a. Also vector graphics
 - b. Extensive tools, effects, features
 - c. Used in professional applications
 - d. E.g., Illustrator (Adobe), Freehand (Macromedia)

Computer Graphics

- E. 3-D graphics
1. Employ either **volume-based** or **surface-based** 3-D graphics
 - a. Volume-based uses 3-D pixels or *voxels*
 - 1) Used in scientific simulations (e.g. medical)
 - 2) Shrek example
 - b. Surface-based
 - 1) Displays only the surface pixels
 - 2) Approximate curved surfaces using many small *facets*
 2. Allow for multiple views, perspectives, lighting

Computer Graphics

3. Basic steps
 - a. Model description, or *surface modeling*
 - 1) *Wireframe* gives basic outline of model
 - 2) Various methods of construction
 - b. Scene description
 - 1) Includes determining the background and point of view
 - c. Rendering
 - 1) Adding texture, shading, and lighting effects
 - 2) Based on selected viewing angle and light source(s)
 - 3) Hidden surface removal / shading
 - o Ray-tracing from pt. of view
 - 4) Lighting effects
 - o Ray-tracing from light source(s)



Computer Graphics

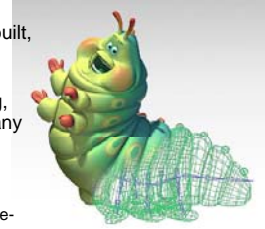
F. Computer animation

1. Key-frames and in-betweens
2. Computer-aided vs. full digital
3. Sampling of methods
 - a. 2-D & 3-D object animation
 - E.g., Flash, Dreamweaver and Toy Story
 - b. Modeling animation
 - E.g., Beauty and the Beast
 - c. Morphing
 - E.g., Terminator 2
 - d. Motion capture (3-D sampling with motion)
 - E.g., Lord of the Rings, The Mummy, Final Fantasy
 - e. Simulation
 - E.g., Shrek, Monsters Inc., Bug's Life, Lord of the Rings

Computer Graphics

4. In general

- a. Once the model is built, director has full flexibility
- b. New angles, lighting, etc. do not require any more artist's time
- c. Very computer intensive
 - 1) Rendering must be re-done at 30 frames per second



Computer Graphics

G. Virtual Reality

1. Adds the element of interaction to 3-D animation
2. Requires **clear graphics** and **fast response time**
 - a. Which is *more* important?
3. Even more computer intensive
4. Specialized equipment available
 - a. Head-mounted displays, gloves, sensors, etc.