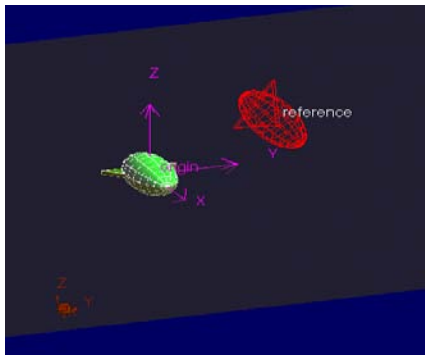
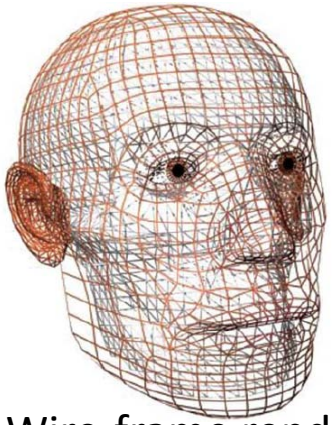
Overview

CG and its applications

- Interactive object modeling



Spaceship modeling, T. Narikyo, TTI-TR 2005.



a) Wire-frame rendering

b) Shading and mesh smoothing

S.L. Davy, Computer graphic facial reconstruction, Elsevier 2005.

- Game and animations
- Special effects on films
- Computer graphic design
- … and so on

CG and its functions(1)

- Make up a picture or a portion of a picture
- Allow the application or user...

  ...to create lines, arcs, symbols, character strings, polygons, circles, ellipses, images, and nonstandard objects (called GDPs)
- Have associated attributes that control the visible appearance

CG and its functions(2)

- Are formed from primitive graphic objects

  ...and may be defined hierarchically

- Are used to create complex pictures in 3D

  ...for example, a cube could be built from multiple polygons (i.e., squares)

- Are useful in determining...

  ...a product's manufacturability

  ...the best shape, color, layout, and orientation

Usefulness

- Are also useful in determining...
  - ...how mechanical parts will fit together
  - ...the quantity of material required
  - ...the internal components of a complex structure
  - ...the cost, area, and volume
  - ...how surfaces & materials will interact with light

Goals

- Understand techniques to draw simple models for 2D and 3D objects
- Improve your programming skills to build a small application of CG by using OpenGL
- Understand the usefulness and importance of CG in industries

Graphic Objects

- Can be defined as...
  - ...surfaces
  - ...implicit surfaces
  - ...polyhedrals
  - ...curved surfaces
  - ...fractals
  - ...ellipsoids
  - ...cylinders

Surfaces

- Surfaces...
  - ...are the simplest complex object
  - ...consist of a collection of 3D points
  - ...may be a simple list, contours, slices, or sections
  - ...require a dense distribution of points for accurate rendering
- Implicit surfaces...
  - ...are defined by algebraic formulas
  - ...include quadrics

Polyhedrals

- Polyhedrals...
  - ...are the most commmonly used complex graphic object
  - ...consist of networks of polygons
  - ...are used to form polygon mesh models
  - ...where polygons are sized, shaped, and positioned to completely tile the surface of an area

Curved surfaces (1)

- Curved surfaces...
  - ...are created by surface patches, obtained using numerical methods to approximate a coarse polygon grid or mesh
  - ...allow the structure of the mesh to define the curvature of the surface
  - ...require that only the vertices of the mesh be stored

Curved surfaces (2)

- Curved surfaces include...
  - ...Bezier
  - ...Hermite
  - ...bicubic
  - ...B-spline
  - ...ß-spline (Beta-spline)
  - ...polynomial
  - ...rational polynomial ...and many more!

Bezier curves

- The most common curves used to generate computer graphics pictures are Bezier and B-spline
- Bezier (curves, surfaces, patches)...
  - ...were developed in the 1960s by Pierre Bezier
  - ...are specified by control points from which a cubic polynomial is derived
  - ...allow the shape to be determined entirely from the position of four control points
  - ...allow the shape to be altered by changing the control points

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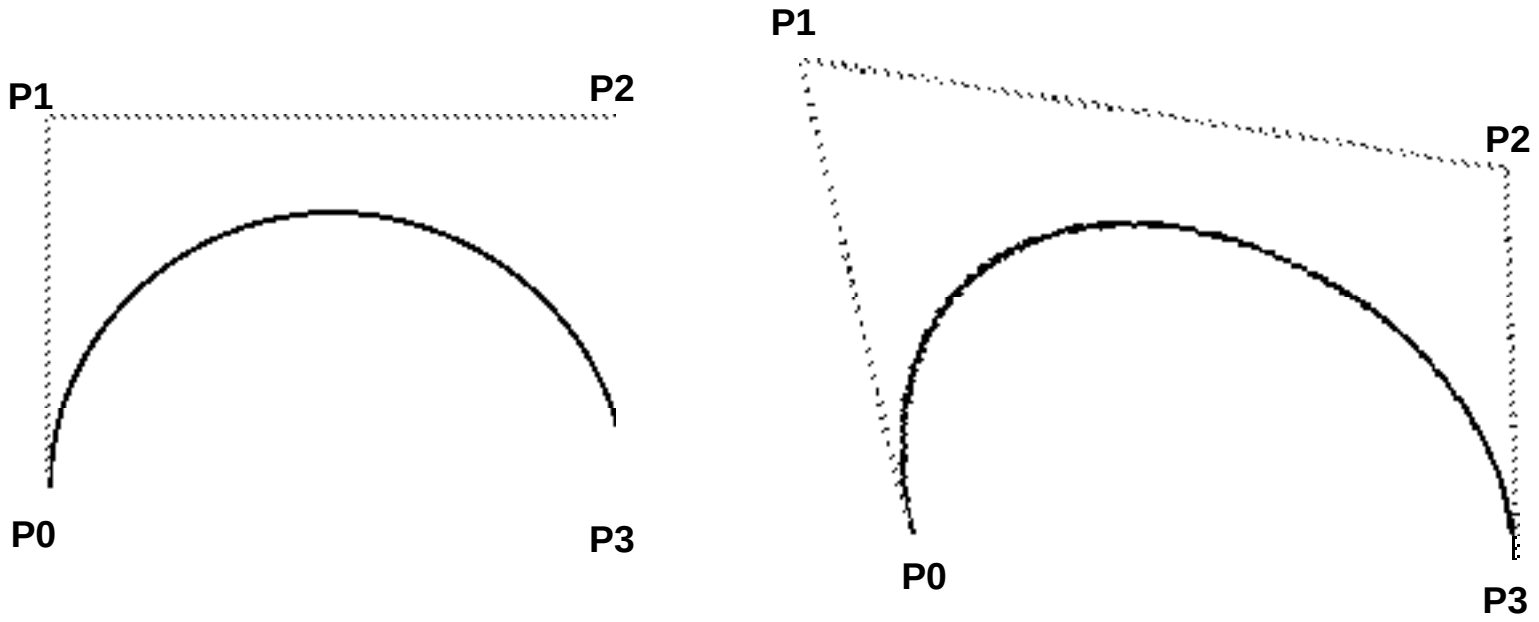
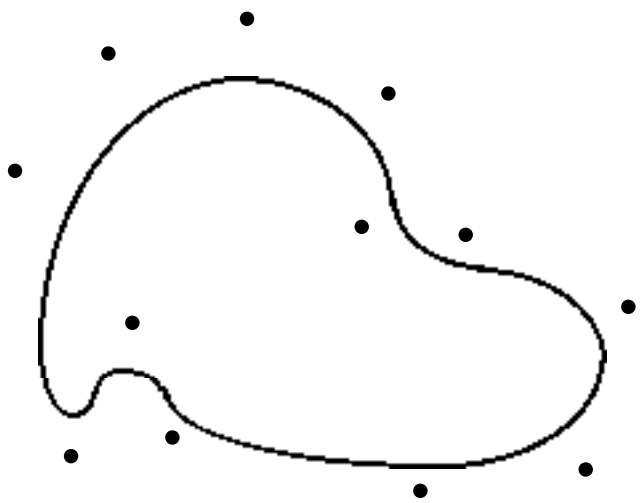
Bezier curve: Example

- **Bicubic Bezier curve examples...**



B-spline curve

- B-spline (curves, surfaces, patches)...
  - ...are also common techniques for generating curves
  - ...allow more than four points to be used
  - ...in their simplest form are considered to be Bezier
  - ...are specified using control points
  - ...have localness...allowing control points to affect only a portion of a curve instead of an entire curve



CG utility and 3D objects

- Complex 3D graphic objects can be modeled, viewed, and displayed using...

  ...polyhedral -- *represents objects as planar polyhedra*

  ...free form -- *represents objects as patches*

  ...solid -- *represents objects as solid primitives*

  ...procedural -- *represents objects using construction rules and procedures for execution*

Modeling

- Modeling...

  ...allows information to be added to produce a better visual effect with finer detail

  ...allows information to be removed to produce a simpler and more efficient picture

  ...allows objects created to be manipulated

  ...provides rotation about an axis

  ...provides translation, keeping a constant orientation

  ...provides scaling to change an object's size

Viewing

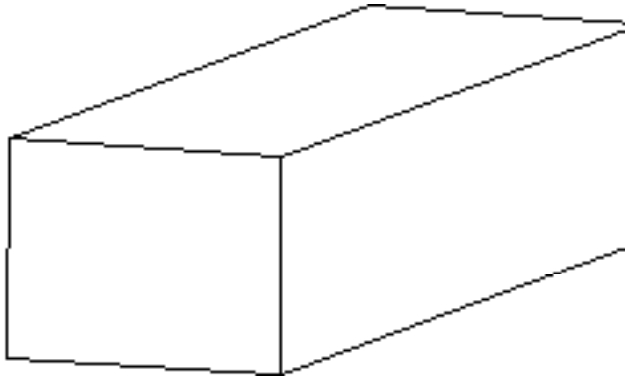
- Viewing...

  ...allows objects created to be prepared for display on a two-dimensional surface

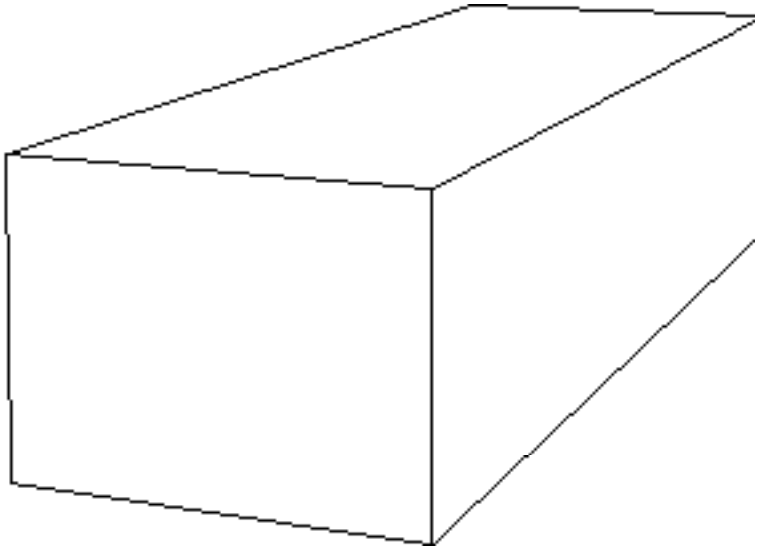
  ...transforms primitive and complex objects using parallel or perspective projections

- Parallel projection...
  - ...collapses all objects to lie in a plane
  - ...the placement of objects relative to the plane is preserved exactly
  - ...the placement of objects perpendicular to the plane is ignored
  - ... objects appear the same size regardless of how far away they really are
  - ...useful for mechanical drawings
- Perspective projection...
  - ...causes objects to be drawn as if viewed from a particular point, called "camera point" or "viewpoint"
  - ...causes objects farther away to be rendered smaller than objects closer
    - ...creates depth perspective
  - ...the closer the camera point is to the object, the more extreme the perspective

Examples



Parallel Projection



Perspective Projection

References

[1] K. S. Fant, CG-Course Slide, Portland State University.

[2] Foley, Van Dam, Feiner, Hughes, Computer Graphics - Principles and Practices 2nd Ed. In C, Addison Wesley, 1997.