Visual Imaging in the Electronic Age

ART 2107, ARCH 3702, CS 1620, ENGRI 1620

Modeling

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Types of Models

• Wire line (Sketches)

• Surface
  – Geometric primitives
  – Polygonal
  – Continuous surfaces
  – Procedural Models

• Solid
Surface vs. Solid Models
Boolean Operations

Fig. 4.3
Application of Boolean operations to a cube and a sphere. For a better understanding, the original painting of both objects has been preserved in these pictures.
Creating Surface Models

Primitives

Rhino
Surface Creation Tools

Rhino
Creating a Cylinder

Extrusion    Revolve
Extrusion

Straight Line

Curved Line
Lofting
Revolve
Geodesic Domes

icosahedron

good sphere level 1

good sphere level 2

good sphere level 3
Outward Pointing Normals
Splines and French Curves
Beziers Curve – Weighting Functions

$$P(u) = \sum_{i=0}^{n} P_i B_{i,n}(u)$$
Cubic Bézier Curve

Example: Blending function for Bezier Curve, $n = 3$

$$B_{i,n}(u) = C(n, i)u^i (1-u)^{n-i}$$

$$C(n, i) = \frac{n!}{i!(n-i)!}$$

number of control points $= n + 1$

$4 = n + 1, \therefore n = 3$
Cubic Bézier Curve (cont’d)

\[ B_{0,3}(u) = C(3,0)u^0(1-u)^3 \]

\[ C(3,0) = \frac{3!}{0!(3-0)!} = \frac{6}{1(6)} = 1 \]

Note that 0! = 1

\[ B_{0,3}(u) = u^0(1-u)^3 = (1-u)^3 \]

<table>
<thead>
<tr>
<th>( u )</th>
<th>( 1-u )</th>
<th>( (1-u)^3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Cubic Bézier Curve (cont’d)

\[ B_{0,3} = (1-u)^3 \]
\[ B_{1,3} = 3u(1-u)^2 \]
\[ B_{2,3} = 3u^2(1-u) \]
\[ B_{3,3} = u^3 \]
Bezier Curve – Weighting Functions

![Bezier Curve Diagram](image)

- $P_0$, $P_1$, $P_2$, $P_3$ are control points.
- $B_{n,k}$ are the basis functions for degree $n$ and order $k$.
- The curves are generated by linearly interpolating between the control points using the basis functions.

```
B_{n,k}(u) = \sum_{k=0}^{n} \binom{n}{k} u^k (1-u)^{n-k} P_k
```

Where $\binom{n}{k}$ is the binomial coefficient.
Beziers Curve – Weighting Functions
Bezier Curve – Weighting Functions
Procedural Modeling
Richard Meier’s Jubilee Church
Sydney Opera House  Utzon
Components from Spheres
Components from Spheres

Solid Model

Surface Model
The control mesh for Geri’s head, created by digitizing a full-scale model sculpted out of clay.
Subdivision surfaces
Clay Model Measurement
Gehry’s Sketch Models

Step 1: Set up & prepare Physical model
Step 2: Selection of points to be digitised
Step 3: An initial mesh is generated
Step 4: 3D view of the first mesh
Step 5: Surfaces are generated
Step 6: 3D view of model with basic materials
Gehry Model and Microscribe
Guggenheim Bilbao

Gehry
Disney Concert Hall

Gehry
Surface Representation
Surface Representation
Surface Representation

[Image: B-Spline Curve Fitting]

[Diagram showing a graph with a peak and a crosshair indicating a point of interest.]
Surface Representation
end