Texture Mapping
Three Types of Mapping

- Texture Mapping
- Environment Mapping
- Bump Mapping
Texture Mapping

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Environment Mapping (Reflection Mapping)
Bump Mapping
Modeling an Orange
Modeling an Orange

Still too smooth
- Change local shape
- Bump mapping
Modeling an Orange
Types of Mapping

g geometric model
Is it simple?

2D image

3D surface
Coordinate Systems

• Texture coordinates
  - Used to identify points in the image to be mapped

• Object or World Coordinates
  - Conceptually, where the mapping takes place

• Window Coordinates
  - Where the final image is really produced

• Parametric coordinates
  - *May be used to model curves and surfaces*
Texture Mapping

parametric coordinates

texture coordinates

world coordinates

window coordinates
Mapping Functions

- Basic problem: how to find the maps
- Consider mapping from texture coordinates to a point a surface
- Appear to need three functions
  \[ x = x(s,t) \]
  \[ y = y(s,t) \]
  \[ z = z(s,t) \]
- But we really want to go the other way
Backward Mapping

\[ s = s(x,y,z) \]
\[ t = t(x,y,z) \]
Linear Mapping

\[ u = u_{\min} + \frac{s - s_{\min}}{s_{\max} - s_{\min}} (u_{\max} - u_{\min}), \]

\[ v = v_{\min} + \frac{t - t_{\min}}{t_{\max} - t_{\min}} (v_{\max} - v_{\min}). \]
Two Step Mapping

- Texture → Intermediate Object
  - Box
  - Cylinder
  - Sphere
- Intermediate → Final surface
Box Mapping

- Easy to use with simple orthographic projection
- Also used in environment maps
Cylindrical Mapping

parametric cylinder

\[ x = r \cos (2\pi u) \]
\[ y = r \sin (2\pi u) \]
\[ z = v/h \]

maps rectangle in \( u,v \) space to cylinder of radius \( r \) and height \( h \) in world coordinates

\[ s = u \]
\[ t = v \]

maps from texture space
Spherical Map

We can use a parametric sphere

\[
\begin{align*}
    x &= r \cos 2\pi u \\
    y &= r \sin 2\pi u \cos 2\pi v \\
    z &= r \sin 2\pi u \sin 2\pi v
\end{align*}
\]

in a similar manner to the cylinder but have to decide where to put the distortion

Spheres are used in environmental maps
Second Mapping

- Map from intermediate object to actual object
  - Normals from intermediate to actual
  - Normals from actual to intermediate
  - Vectors from center of intermediate
Where does mapping take place?

- Mapping techniques are implemented at the end of the rendering pipeline
  - Very efficient because few polygons make it past the clipper
Aliasing
Aliasing
Minification/Magnification
Mipmapping
Mipmapping
Mipmapping – RGB
Mipmapping