Texture Mapping

Map a 2D Texture onto an Object

- How?

Consider a Cylinder

Cylindrical Mapping

parametric cylinder explicit cylinder

$x = r \cos 2\pi u \quad x = r \cos 2\pi$

$y = r \sin 2\pi u \quad y = r \sin 2\pi$

$z = hv \quad z = h$

maps rectangle in u,v space to cylinder of radius $\omega$ and height $h$ in world coordinates

$s = u \quad t = v$

maps from texture space

Make a nice can of soup?

+ 

Cylindrical Mapping

parametric cylinder explicit cylinder

maps rectangle in u,v space to cylinder of radius $\omega$ and height $h$ in world coordinates

$s = u \quad t = v$

maps from texture space

Cylindrical Mapping

parametric cylinder explicit cylinder

maps rectangle in u,v space to cylinder of radius $\omega$ and height $h$ in world coordinates

$s = u \quad t = v$

maps from texture space
Cylindrical Mapping

parametric cylinder   explicit cylinder
\begin{align*}
x &= r \cos 2\pi u \\
y &= r \sin 2\pi u \\
z &= h
\end{align*}

maps rectangle in \( u, v \) space to cylinder of radius \( \omega \) and height \( h \) in world coordinates
\begin{align*}
s &= u \\
t &= v
\end{align*}

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
Spherical Map

Texture Mapping

What if we don’t have a cylinder or sphere?

Two-part mapping

• One solution to the mapping problem is to first map the texture to a simple intermediate surface
• Example: map to cylinder

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 \( \sigma \) and height \( h \) in world coordinates

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

maps from texture space

Texture Mapping during Modeling

• Banana?
Texture Mapping during Modeling

- Banana?

Two-part mapping

- One solution to the mapping problem is to first map the texture to a simple intermediate surface
- Example: map to cylinder

S Mapping

\[ T(s, t) \rightarrow T'(x, y, z): \text{Map texture onto an intermediate surface} \]

O Mapping

\[ T'(x, y, z) \rightarrow O(x, y, z): \text{Map intermediate surface onto the object} \]

S Mapping and O Mapping

\[ T(s, t) \rightarrow T'(x, y, z): \text{Map texture onto an intermediate surface} \]

\[ T'(x, y, z) \rightarrow O(x, y, z): \text{Map intermediate surface onto the object} \]
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

\[ x = r \cos 2\pi u \]
\[ y = r \sin 2\pi u \cos 2\pi v \]
\[ z = r \sin 2\pi u \sin 2\pi v \]

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

Spheres are used in environmental maps

Box Mapping

• Easy to use with simple orthographic projection
• Also used in environment maps

Table 1

<table>
<thead>
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<th>Single Valued</th>
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<tbody>
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<td>Not efficient</td>
<td>If surface normal is</td>
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<tr>
<td>Object Centroid</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intermediate surface</td>
<td>With help</td>
<td>Yes</td>
<td>Rarely</td>
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Table 2

<table>
<thead>
<tr>
<th>Object Normal</th>
<th>Cylinder</th>
<th>Box</th>
<th>Sphere</th>
<th>Plane</th>
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<tbody>
<tr>
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<td>OK</td>
<td>OK</td>
<td></td>
<td>Bad</td>
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<table>
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<th>Object Centroid</th>
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<th>Box</th>
<th>Sphere</th>
<th>Plane</th>
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<td>open cyl</td>
<td>Centroid</td>
<td>Box</td>
<td>Sphere</td>
<td>OK</td>
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<table>
<thead>
<tr>
<th>Intermediate Surface Normal</th>
<th>Cylinder</th>
<th>Box</th>
<th>Sphere</th>
<th>Plane</th>
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</thead>
<tbody>
<tr>
<td>Shrink wrap</td>
<td>ISN/Box</td>
<td>Redundant</td>
<td>Slide Proj</td>
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