

Texture Mapping

Map a 2D Texture onto an Object

- How?

Consider a Cylinder



Make a nice can of soup?



Make a nice can of soup?



Cylindrical Mapping

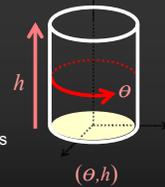
parametric cylinder explicit cylinder

$$\begin{array}{ll} x = r \cos 2\pi u & x = r \cos 2\pi \\ y = r \sin 2\pi u & y = r \sin 2\pi \\ z = hv & z = h \end{array}$$

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

$$\begin{array}{l} s = u \\ t = v \end{array}$$

maps from texture space



Cylindrical Mapping

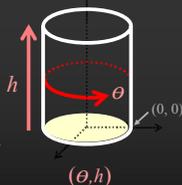
parametric cylinder explicit cylinder

$$\begin{array}{ll} x = r \cos 2\pi u & x = r \cos 2\pi \\ y = r \sin 2\pi u & y = r \sin 2\pi \\ z = hv & z = h \end{array}$$

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

$$\begin{array}{l} s = u \\ t = v \end{array}$$

maps from texture space



Cylindrical Mapping

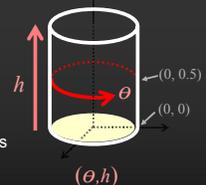
parametric cylinder explicit cylinder

$$\begin{array}{ll} x = r \cos 2\pi u & x = r \cos 2\pi \\ y = r \sin 2\pi u & y = r \sin 2\pi \\ z = hv & z = h \end{array}$$

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

$$\begin{array}{l} s = u \\ t = v \end{array}$$

maps from texture space



Cylindrical Mapping

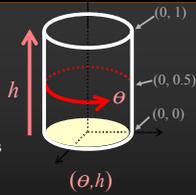
parametric cylinder explicit cylinder

$$\begin{aligned} x &= r \cos 2\pi u & x &= r \cos 2\pi \\ y &= r \sin 2\pi u & y &= r \sin 2\pi \\ z &= hv & z &= h \end{aligned}$$

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

$$\begin{aligned} s &= u \\ t &= v \end{aligned}$$

maps from texture space



Cylindrical Mapping

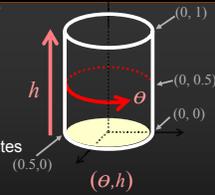
parametric cylinder explicit cylinder

$$\begin{aligned} x &= r \cos 2\pi u & x &= r \cos 2\pi \\ y &= r \sin 2\pi u & y &= r \sin 2\pi \\ z &= hv & z &= h \end{aligned}$$

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

$$\begin{aligned} s &= u \\ t &= v \end{aligned}$$

maps from texture space



Cylindrical Mapping

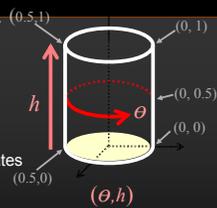
parametric cylinder explicit cylinder

$$\begin{aligned} x &= r \cos 2\pi u & x &= r \cos 2\pi \\ y &= r \sin 2\pi u & y &= r \sin 2\pi \\ z &= hv & z &= h \end{aligned}$$

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

$$\begin{aligned} s &= u \\ t &= v \end{aligned}$$

maps from texture space



Cylindrical Mapping

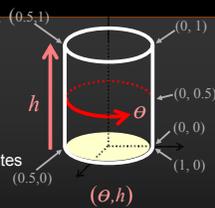
parametric cylinder explicit cylinder

$$\begin{aligned} x &= r \cos 2\pi u & x &= r \cos 2\pi \\ y &= r \sin 2\pi u & y &= r \sin 2\pi \\ z &= hv & z &= h \end{aligned}$$

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

$$\begin{aligned} s &= u \\ t &= v \end{aligned}$$

maps from texture space



Cylindrical Mapping

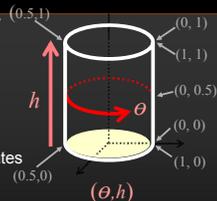
parametric cylinder explicit cylinder

$$\begin{aligned} x &= r \cos 2\pi u & x &= r \cos 2\pi \\ y &= r \sin 2\pi u & y &= r \sin 2\pi \\ z &= hv & z &= h \end{aligned}$$

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

$$\begin{aligned} s &= u \\ t &= v \end{aligned}$$

maps from texture space



Spherical Map

We can use a parametric sphere

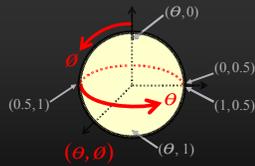
$$\begin{aligned} x &= r \cos 2\pi u \\ y &= r \sin 2\pi u \cos 2\pi v \\ z &= r \sin 2\pi u \sin 2\pi v \end{aligned}$$

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

Spheres are used in environmental maps



Spherical Map



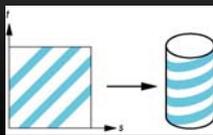
Texture Mapping

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

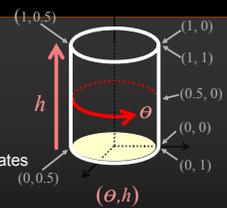
parametric cylinder

$$\begin{aligned}x &= r \cos 2\pi u \\y &= r \sin 2\pi u \\z &= v/h\end{aligned}$$

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

$$\begin{aligned}s &= u \\t &= v\end{aligned}$$

maps from texture space



Texture Mapping during Modeling

- Banana?



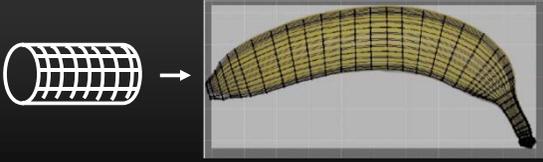
Texture Mapping during Modeling

- Banana?



Texture Mapping during Modeling

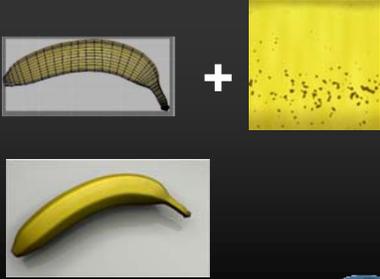
- Banana?



The diagram shows a white wireframe cylinder on the left. An arrow points to a yellow wireframe banana on the right, illustrating the process of mapping a simple shape onto a more complex one.

Texture Mapping during Modeling

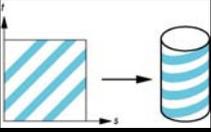
- Banana?



The diagram shows a yellow wireframe banana mesh on the left, followed by a plus sign and a yellow texture map with black speckles. Below this is an equals sign and a rendered yellow banana, showing the final result of texture mapping.

Two-part mapping

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



The diagram shows a 2D rectangle with blue and white diagonal stripes on the left. An arrow points to a cylinder with the same stripes on the right, illustrating the two-step mapping process.

S Mapping

$T(s,t) \rightarrow T'(x,y,z)$: Map texture onto an intermediate surface

O Mapping

$T'(x,y,z) \rightarrow O(x,y,z)$: Map intermediate surface onto the object

S Mapping and O Mapping

$T(s,t) \rightarrow T'(x,y,z)$: Map texture onto an intermediate surface

$T'(x,y,z) \rightarrow O(x,y,z)$: 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 θ 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

Spherical Map

Box Mapping

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

Table 1

	Single Valued	Invertible	Continuous
Object Normal	Yes	Not efficient	If surface normal is
Object Centroid	Yes	Yes	Yes
Intermediate surface Normal	With help	Yes	Rarely

Table 2

	Cylinder	Box	Sphere	Plane
Object Normal	Bad	OK	OK	Bad
Object Centroid	Bad open cyl	Centroid Box	Centroid Sphere	OK
Intermediate Surface Normal	Shrink wrap	ISN/Box	Redundant	Slide Proj

OpenGL

Table 2

	Cylinder	Box	Sphere	Plane
Object Normal	Bad	OK	OK	Bad
Object Centroid	Bad open cyl	Centroid Box	Centroid Sphere	OK
Intermediate Surface Normal	Shrink wrap	ISN/Box	Redundant	Slide Proj

OpenGL

