

Texture mapping

mar 27

To represent "spatially varying surface properties"
surface attributes that vary from place to place
don't change the "shape" of the surface

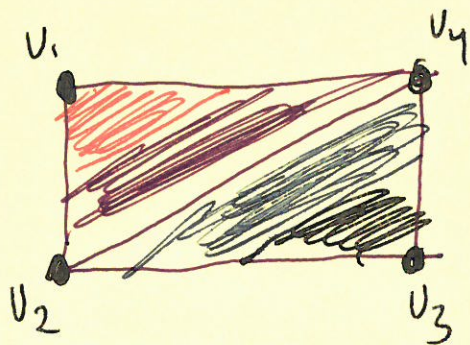
Other applications:

- shadows
- reflections
- illumination
- GPGPU

2 major challenges:

- mapping w/o major distortion
- anti-aliasing to reduce artifacts

Image



Shape



If you were to start implementing where would you put texturing

(1) vertex shader

(2) fragment shader

(3) GPU

In fragment shader, we want to look up some color for a pixel

def texture lookup: in the coordinate system of the texture, find the location of the point that is being shaded

def texture sample: value read during texture look up


```
Color texture_lookup(Texture t, float u, float v)
{
    i = round(u * t.width)
    j = round(v * t.height)
    return t.get_pixel(i, j)
}
```

```
Color shade_surface_point(Surface s, Point p, Texture t){
    normal = s.get_normal(p)
    (u, v) = s.get_texture_coord(p)
    texture_sample = texture_lookup(t, u, v)
    // use phong shading w/ texture and other info
    return color_from_shading
}
```

looking up textures

$$\phi: S \rightarrow T$$
$$(x, y, z) \mapsto (u, v)$$

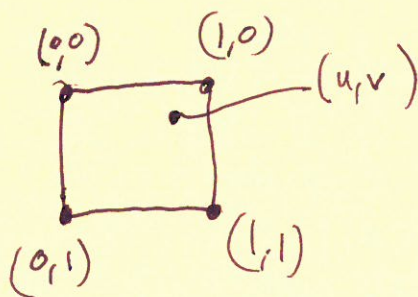
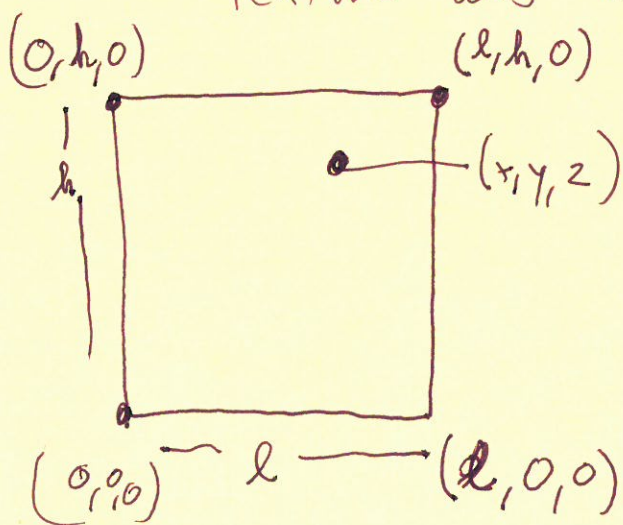
often T is called the texture space
and almost always represented as $[0, 1]^2$

Usual have 1 texture per object

ex: a face of a square (represents a floor)

Floor was made of wood

texture was a picture of a planks of wood



$$\phi: (x, y, z) \rightarrow (u, v)$$

$$(x, y, z) \mapsto \left(\frac{x}{l}, 1 - \frac{y}{h}\right)$$

what is this map?

Props of mappings for texturing

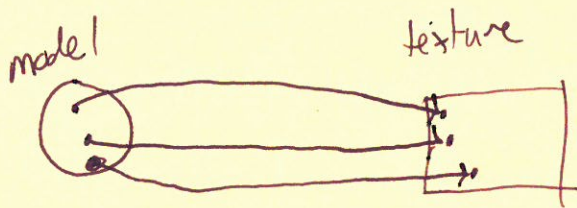
- Bijection:

one-to-one

injective

and onto

surjective



- Size distortion: scale of texture approx is const across surface

e.g.: points that are close on surface should map to texture coordinates about same dist apart

e.g. magnitude of derivative of ϕ ~~is~~
doesn't vary too much

- Shape distortion: shape is not distorted

e.g. circles on surface ~~are~~ map to approx circles in texture

eg directional derivative of ϕ should be about the same in each direction

- Continuity: not show too many "seams"

- ϕ should be cts

In general this is challenging so artists tend to hide discontinuities

Eg:

$$f: [0, 1]^2 \rightarrow [0, \pi] \times [0, 2\pi]$$

$$(u, v) \rightarrow (\pi u, 2\pi v)$$

$$g: [0, \pi] \times [0, 2\pi] \rightarrow S^2$$

$$(\alpha, \beta) \mapsto \begin{pmatrix} \cos(\alpha)\sin(\beta) \\ \sin(\alpha)\sin(\beta) \\ \cos(\beta) \end{pmatrix}$$

$$(g \circ f): T \rightarrow S^2 \quad \phi = (g \circ f)^{-1}$$

$$\phi(x, y, z) = ([\pi + \arctan(y, x)] / 2\pi, [\pi - \arccos(z/|x|)] / \pi)$$