Textures

Fragment shader:
Textures, bump maps, normal maps, parallax mapping

Vertex shader: Displacement maps

http://www.opengl-tutorial.org/intermediate-tutorials/tutorial-13-normal-mapping/

Textures

bump maps

imitate $\mathbf{p}^{\text{new}} = \mathbf{p} + d\mathbf{n}.$

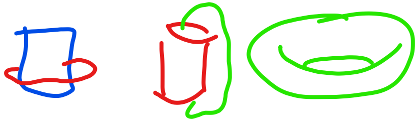
$$\begin{aligned}\frac{\partial \mathbf{p}^{\text{new}}}{\partial u} \times \frac{\partial \mathbf{p}^{\text{new}}}{\partial v} &= \left(\frac{\partial \mathbf{p}}{\partial u} + \frac{\partial d}{\partial u}\mathbf{n} + d\frac{\partial \mathbf{n}}{\partial u}\right) \times \left(\frac{\partial \mathbf{p}}{\partial v} + \frac{\partial d}{\partial v}\mathbf{n} + d\frac{\partial \mathbf{n}}{\partial v}\right) \\ &= \mathbf{n} + \underbrace{\frac{\partial d}{\partial u}\mathbf{n} \times \frac{\partial \mathbf{p}}{\partial v} - \frac{\partial d}{\partial v}\mathbf{n} \times \frac{\partial \mathbf{p}}{\partial u}}_{\partial \mathbf{n}} + O\left(\frac{\partial \mathbf{n}}{\partial u}, \frac{\partial \mathbf{n}}{\partial v}\right).\end{aligned}$$

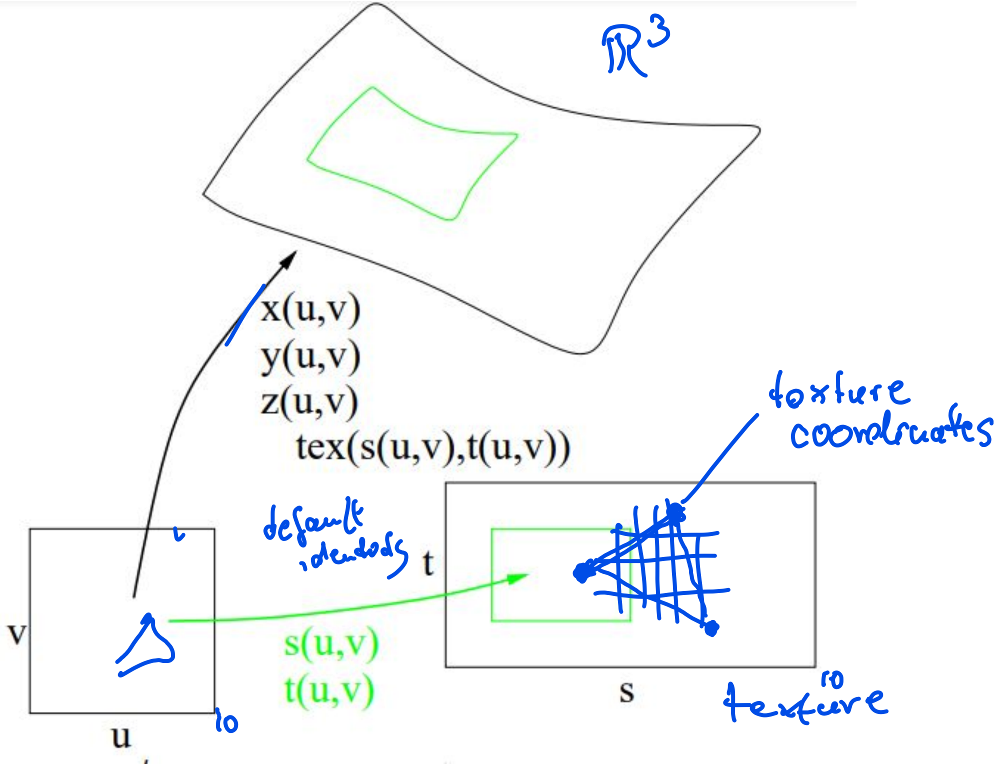
Textures

Fragment shader: Texture mapping

2D texture:
pasting an image onto a surface (challenges: distortion and aliasing)

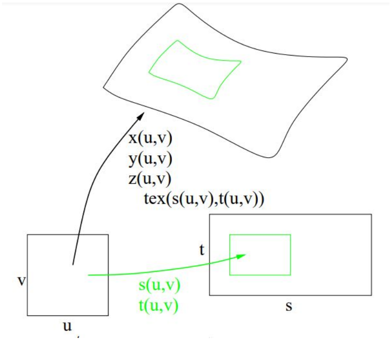
"Gauss curvature" = 0





2D Texture

texels (texture pixels)
fill, by unchangeable default, the unit square
When accessing the texture plane with s, t
outside the unit square, texture wrapping rules
clip s,t back to the unit square.



Many bit patterns (formats) (gimp exports C-arrays!)

Texture wrapping
GL LINEAR, GL NEAREST
Mipmapping

Textures

Fragment shader: Texture mapping

2D texture: pasting an image onto a surface

Transfer texture from an intermediate object (sphere or cylinder) for better parametrization

Video texture

Textures

Fragment shader: Texture mapping

2D texture: pasting an image onto a surface

Environment Map, **cube map**:
place viewer at object center. Transfer resulting image as texture (possibly via intermediate)

3D texture: generated (random), x,y,z direct, discrete grid

Texture Mapping Challenges

- ➢ Distortion (flat → sphere): fundamental!

Peters projection

Other projections

Texture Mapping Challenges

- Distortion
- Want to color pixel
  - map screen coordinates ←→ texture coordinates

http://www.opengl-tutorial.org/beginners-tutorials/tutorial-5-a-textured-cube/

Texture Mapping Challenges

- Distortion
- screen / texture coordinates
- Areas, not points should be mapped →
  bilinear interpolation

- Aliasing (Moire pattern)
  - pointwise: might miss, average, smears out