Texture Mapping

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(slides mostly thanks to Voicu Popescu)
Texture mapping

• Model surface-detail with images
  – wrap object with photograph(s)
  – graphics object itself is a simpler model but “looks” more complex
Texture mapping

• Model surface-detail with images
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Texture mapping

- Generic image to represent material
  - e.g., tile pattern

- bark

- veneer

- bricks
Tiling

• Repeat pattern
Tiling

• Repeat pattern
Tiling

- Repeat pattern
- How can we improve?
Tiling

- Repeat pattern
  - reduce seems by mirroring
Tiling

• Repeat pattern
  – reduce seems by mirroring
Tiling

• Repeat pattern
  – reduce seems by mirroring
Tiling

• Repeat pattern
  – reduce seems by mirroring
  – How we can further improve?
Tiling

- Repeat pattern
  - reduce seems by mirroring
  - reduce seems by choosing tile that covers one period of repeated texture
Tiling
Texture mapping limitations do exist...
Bricks are similar not identical
Solution?
Solution: Texture synthesis...
Texture coordinates

• Mechanism for attaching the texture map to the surface modeled
  – a pair of floats \((s, t)\) for each triangle vertex
  – corners of the image are \((0, 0), (0, 1), (1, 1),\) and \((1, 0)\)
  – tiling indicated with tex. coords. > 1
  – \textit{texels} – color samples in texture maps
Texture coordinates

P_2(0, 0)  P_3(0, 1)  P_4(1, 1)  P_1(1, 0)
Texture mapping

- $P_2(0, 0)$
- $P_1(1, 0)$
- $P_3(0, 1)$
- $P_4(1, 1)$

Points on a grid and their corresponding points on a plane.

- $P_1'$, $P_2'$, $P_3'$

3D coordinate system: $O$, $x$, $y$, $z$.
Texels: texture elements

\( P_1'(u_1, v_1, s_1, t_1) \)

\( P'(u, v, s, t) \)

\( P_3'(u_3, v_3, s_3, t_3) \)

\( P_2'(u_2, v_2, s_2, t_2) \)
Problem: how to compute the texture coordinates for an interior pixel?
Texture mapping

Solution: interoplate vertex texture coordinates
Parameter Interpolation

- Texture coordinates, colors, normals, etc.
Interpolation Problem:

- Flat
- Affine
- Correct
Solution: Perspectively Correct Interpolation

• Normally:

\[ u = (1 - \alpha)u_0 + \alpha u_1 \]

Instead:

\[ u = \left[ \frac{(1 - \alpha)u_0}{z_0} + \frac{\alpha u_1}{z_1} \right] / \left[ \frac{(1 - \alpha)}{z_0} + \frac{\alpha}{z_1} \right] \]
Level of detail problem

If curious, you can read more on this subject!