Texture Mapping

Overview

• Modeling with textures
  – motivation
  – texture coordinates
• Texture mapping implementation
• Anti-aliasing and level of detail
Texture mapping

- Model surface-detail with images
  - wrap objects with photographs
  - model and render color or “flat” detail
  - does not capture 3D detail

Texture mapping example

- Model t-shirt with logo
  - no need to model the letters and engine with triangles
  - use large base polygon
  - color it with the photograph
Texture mapping example

- Subtle wall lighting
  - no need to compute it at every frame
  - no need to model it with a lot of constant color triangles

Texture mapping example

- Subtle wall lighting
  - paste photograph on large polygon
Texture mapping example

• Non-planar surfaces work also

– subdivide surface into planar patches
– assign photograph subregions to each individual patch
Texture mapping example

- Non-planar surfaces work also
  - subdivide surface into planar patches
  - assign photograph subregions to each individual patch
Texture mapping example

- Generic image to represent material
  - tile pattern to cover big surface

Tiling

- Repeat pattern
Tiling
• Repeat pattern
Tiling

• Repeat pattern
  – reduce seems by mirroring
Tiling

- Repeat pattern
  - reduce seems by mirroring
Tiling

- Repeat pattern
  - reduce seems by mirroring
  - reduce seems by choosing tile that covers one period of repeated texture
Texture mapping limitations

Bricks are similar not identical
Texture mapping limitations

- Shiny floor
  - reflection is view dependent

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
  - texels – color samples in texture maps
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Texture mapping
Find texel for current pixel

Texture mapping
Texture mapping

Problem: compute the texture coordinates for an interior pixel

Solution: interpolate vertex texture coordinates
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Aliasing

- sampling locations (desired image pixel centers)
- texture map
Aliasing

- High frequencies pose as lower frequencies
  - display resolution gives maximum displayable frequency
  - if not sufficient high frequencies are called (aliased as) low frequencies
- Nyquist law
  - max frequency displayable is half the sampling frequency

Nyquist law

for given texture map, one should sample at least this frequently to avoid aliasing
Nyquist law

for given texture map resolution, one should sample at least this frequently to avoid aliasing

Possible Antialiasing Solution

convolution with 2 output-pixel-wide kernel EXPENSIVE
Level of detail

- Adapt texture resolution to desired image resolution
- Mip-mapping
  - texture is filtered as preprocess to several resolutions
  - at runtime
    - find out required resolution
    - use corresponding version of texture map

Mip-mapping: example

256x256 128x128 64x64 ...
Trilinear filtering

- Use two most appropriate resolutions of texture map
  - lookup color values with bilinear interpolation in each texture version
  - linearly interpolate in between the two color values

Trilinear filtering: example
Anisotropic filtering

• Different levels of detail are needed along the two directions in the texture map
  – filter differently along s and t

• Trilinear interpolation between levels 32 and 64 blurs too much along the s direction
• Use levels 256 – 512 for s and 32 – 64 for t