CS-184: Computer Graphics

Lecture #11: Texture and Other Maps

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Today

- Texture Mapping
- 2D
- 3D
- Procedural
- Bump and Displacement Maps
- Environment Maps
- Shadow Maps
Surface Detail

- Representing all detail in an image with polygons would be cumbersome

2D Texture Mapping of Images

- Use a 2D image and map it to the surface of an object
2D Texture Mapping of Images

- Example of texture distortion

Texture Coordinates

- Assign coordinates to each vertex
- Within each triangle use linear interpolation
- Correct for distortion!
MIP Map

- Pre-compute filtered versions of the texture
  - A given UV rate is some level of the texture
  - Tri-linear filtering UV × map level

Procedural Textures

- Generate texture based on some function
  - Well suited for “random” textures
  - Often modulate some noise function
Assigning Texture Coordinates

- Map a simple shape onto object by projection
  - Sphere, cylinder, plane, cube
- Assign by hand
- Use some optimization procedure

Repeating Textures

- Image Tiles allow repeating textures
  - Images must be manipulated to allow tilling
  - Often result in visible artifacts
    - There are methods to get around artifacts....
Repeating Textures

• Image Tiles allow repeating textures
  • Images must be manipulated to allow tiling
  • Often result in visible artifacts
    • Artifacts not an issue for artificial textures

Non-Color Textures
Bump Mapping

- Add offset to normal
- Offset is in texture coordinates S,T,N
- Store normal offsets in RGB image components
- Should use correctly orthonormal coordinate system
- Normal offsets from gradient of a grayscale image

$$\mathbf{b}(u,v) = [s,t,n](u,v) = \nabla i(u,v)$$

$$\nabla = \begin{bmatrix} \frac{\partial}{\partial u} & \frac{\partial}{\partial v} \end{bmatrix}^T$$

Images by Paul Baker
www.paulsprojects.net
Bump Map Example

Displacement Maps
- Actually move geometry based on texture map
  - Expensive and difficult to implement in many rendering systems
  - Note silhouette
Environment Maps

- Environment maps allow crude reflections
- Treat object as infinitesimal
  - Reflection only based on surface normal
- Errors hard to notice for non-flat objects
Environment Maps

\[
\begin{align*}
u &= \frac{y + x}{2x} \\
v &= \frac{z + x}{2x}
\end{align*}
\]

- Sphere based parameterization
- Wide angle image or
- Photo of a silver ball

Images by Paul Haeberli
Environment Maps

• Used in 1985 in movie *Interface*
• Effect by group from the New York Institute of Technology

Note errors
Shadow Maps

- Pre-render scene from perspective of light source
  - Only render Z-Buffer (the shadow buffer)
- Render scene from camera perspective
  - Compare with shadow buffer
  - If nearer light, if further shadow

Note: These images don't really go together, see the paper...
# Deep Shadow Maps

- Some objects only partially occlude light
  - A single shadow value will not work
  - Similar to transparency in Z-Buffer

From Lokovic and Veach
SIGGRAPH 2000