CS-184: Computer Graphics

Lecture #11: Texture and Other Maps

Prof. James O’Brien
University of California, Berkeley
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.

Specific details
Structured noise
Pattern with randomness
Section through volume
Bumps
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

Specular

Color

Bump

Created by: Keving & Hoong
E-mail: keongputer@hotmail.com
Bump Mapping

No bump mapping

With bump mapping

Images by Paul Baker
www.paulsprojects.net
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

\[ \mathbf{b}(u,v) = [s,t,n](u,v) = \nabla i(u,v) \]
\[ \nabla = \left[ \frac{\partial}{\partial u}, \frac{\partial}{\partial v} \right]^T \]
Bump Map Example

Catherine Bendebury and Jonathan Michaels
CS 184 Spring 2005
Displacement Maps

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

Bump

Displacement
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
Environment Maps


text

\[ u = \frac{y + x}{2x} \]

\[ v = \frac{z + x}{2x} \]
Environment Maps

- 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
Environment Maps

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

Shadow Buffer
From Stamminger and Drettakis
SIGGRAPH 2002

Image w/ Shadows

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