Reminder

☐ Assignment 4 due on Tuesday, 23rd

☐ Project topic presentation Tuesday, 23rd
  ■ Each group has 5 minutes to present
  ■ Everyone must come to class
  ■ Use some slides (send them to me, or bring a flash drive to class, or use your laptop)
  ■ If you are unsure about project topic, come to my office hour today (TA’s office hours are also today)

☐ Quiz 7 due by midnight today.
  ■ There will be one more quiz (available some next week)
CMPSCI 473: Introduction to Computer Graphics (Fall 2010)

Lecture 18: Texture Mapping II

Rui Wang
Topics

- What is texture mapping?
- Defining texture coordinates
- OpenGL example
- Interpolating texture coordinates
  - Perspective Correct Texture Mapping
- Texture filtering
- Texture applications
Texture Filtering

- Texture Aliasing Problem
  - Every pixel gets a color from the texmap
  - When the number of pixels is insufficient, we observe texture aliasing
  - Imagine a texture mapped onto a quad.
    - The details you see depend on how far the quad is from your eyes.
    - Equivalent to image scaling.
Texture Filtering

- $|\text{PIX}| < |\text{TEX}|$
  - Easy: bilinear interpolation
  - Called magnification

- $|\text{PIX}| > |\text{TEX}|$
  - Hard: need to average contribution from multiple texels (pre-blur)
  - Called minification
  - But how do you know how much to blur?
Texture Filtering

- Mipmap
  - Keep textures prefiltered at multiple resolutions

Mipmap  Rendered Image
Mipmap Example

- No filtering:

AAAAAAAAGH
MY EYES ARE BURNING
Mipmap Example

- No filtering:

- With Mipmap filtering:
Topics

- What is texture mapping?
- Defining texture coordinates
- OpenGL example
- Interpolating texture coordinates
  - Perspective Correct Texture Mapping
- Texture filtering
- Texture applications
Modulation Textures

- Directly modulate color

\[ I = T(s,t)(I_E + K_A I_A + \sum_L (K_D (N \cdot L) + K_S (V \cdot R)^n) S_L I_L + K_T I_T + K_S I_S) \]
Modulation Textures

- A texture can modulate any shading parameter in the rendering equation.
  - Modulate Reflectance

Texture as R,G,B:

Texture as diffuse lighting coefficients:
Modulation Textures

- A texture can modulate any shading parameter in the rendering equation.
  - Modulate Phong Glosiness
Bump Mapping

- A texture can be used to manipulate per-pixel normal.

Sphere w/ diffuse texture  Swirly bump map  Sphere w/ diffuse texture and swirly bump map
Bump Mapping

- There is no change to the underlying geometry!
Bump Mapping

How can you tell a bumped-mapped object from an object in which the geometry is explicitly modeled?
Displacement Mapping
Displacement Mapping
Environment Map
Environment Map
Solid Textures

Texture values indexed by 3D location \((x,y,z)\)

- Expensive storage, or
- Compute on the fly, e.g. Perlin noise
Procedural Textures
Procedural Textures
Multipass Rendering

- Shadow Mapping
- Environment Mapping
- Reflection Mapping
- ...

Depth (Shadow) Textures

- Shadow Mapping
  - Lance Williams, 1978

Without Shadow  With Shadow
Depth (Shadow) Textures

- Shadow Mapping – First Pass
  - Create depth map from the light source point of view

Scene rendered from the light source (only for visualization)
Depth map (actually captured)
Depth (Shadow) Textures

- Shadow Mapping – Second Pass
  - Render

Depth comparison result

Final rendering