Textures

CS 4620 Lecture 21
Announcements

• Prelim review
  – Monday, 7-9, G01 Gates

• Prelim tomorrow
  – Oct 20th Tuesday 2015, 7:30, Olin Hall 155
  – Prelim makeups: 9am on Tuesday
Bilinear interpolation
MIP Mapping

- Problem: Texture mapping in perspective
Mipmap image pyramid

- MIP Maps
  - Multum in Parvo: Much in little, many in small places
  - Proposed by Lance Williams
- Stores pre-filtered versions of texture
- Supports very fast lookup
Using the MIP Map

- In level, find texel and
  - Return the texture value: point sampling (but still better)!
  - Bilinear interpolation
  - Trilinear interpolation

![Diagram](image-url)
Texture minification

[Akenine-Möller & Haines, 2002]

point sampled

mipmap
bilinear
Other uses of texture mapping

- Reflection, Environment maps
- Normal, bump maps
- Displacement maps
- Shadow maps
- Irradiance maps
- ...


Displacement and Bump/Normal Mapping

• Mimic the effect of geometric detail or meso geometry
  – Also detail mapping
Displacement Maps

Without Vertex Textures  With Vertex Textures

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Displacement Maps vs. Normal Maps
Other uses of texture mapping

- Reflection, Environment maps
- Normal, bump maps
- Displacement maps
- Shadow maps
- Irradiance maps
- ...

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Shadow maps
Need better lights

Objects illuminated by a point light source
Reflection mapping

- Early (earliest?) non-decal use of textures
- Appearance of shiny objects
  - Phong highlights produce blurry highlights for glossy surfaces.
  - A polished (shiny) object reflects a sharp image of its environment.
- The whole key to a shiny-looking material is providing something for it to reflect.

Figure 2. (a). A shiny sphere rendered under photographically acquired real-world illumination. (b). The same sphere rendered under illumination by a point light source.
Need to show off materials better

- Want to compute reflections of environment on surfaces
- Makes the material look shiny

Figure 2. (a) A shiny sphere rendered under photographically acquired real-world illumination. (b) The same sphere rendered under illumination by a point light source.
Reflection mapping

- From ray tracing we know what we’d like to compute
  - trace a recursive ray into the scene—too expensive
  - have to model whole scene and then trace
Reflection mapping

• From ray tracing we know what we’d like to compute
  – trace a recursive ray into the scene—too expensive
• If scene is infinitely far away, depends only on direction
  – a two-dimensional function
Review: Mirror reflection

\[ r = v + 2((n \cdot v)n - v) = 2(n \cdot v)n - v \]
Environment map

• A function from the sphere to colors, stored as a texture
Spherical environment map

- Sphere map
- Pro
  - single texture—no seams
  - singularity hidden at back
  - capture via photography
Environment Maps

- High lighting complexity

- Rich: captures real world
Sphere Mapping Example
Cube environment map

- Cube map
- Pro
  - simple, efficient
  - render on hardware
Cube Mapping

- The norm on modern hardware
- Place camera in center of the environment
- Project environment onto cube sides
Cube Mapping

- Project environment onto cube sides
  - 90 degree field of view
  - Cost? (old days: 6 times render of image)
Picking the cube map

- Compute R
  - Don’t need to normalize it
- Pick the largest component (magnitude)
  - What does it mean?
- Scale other two components to [0,1]