Textures

CS 4620 Lecture 21

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Announcements

- Prelim review
  - Monday, 7-9, G01 Gates
- Prelim tomorrow
  - Oct 20th Tuesday 2015, 7:30, Olin Hall 155
  - Prelim makeups: 9am on Tuesday

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Bilinear interpolation

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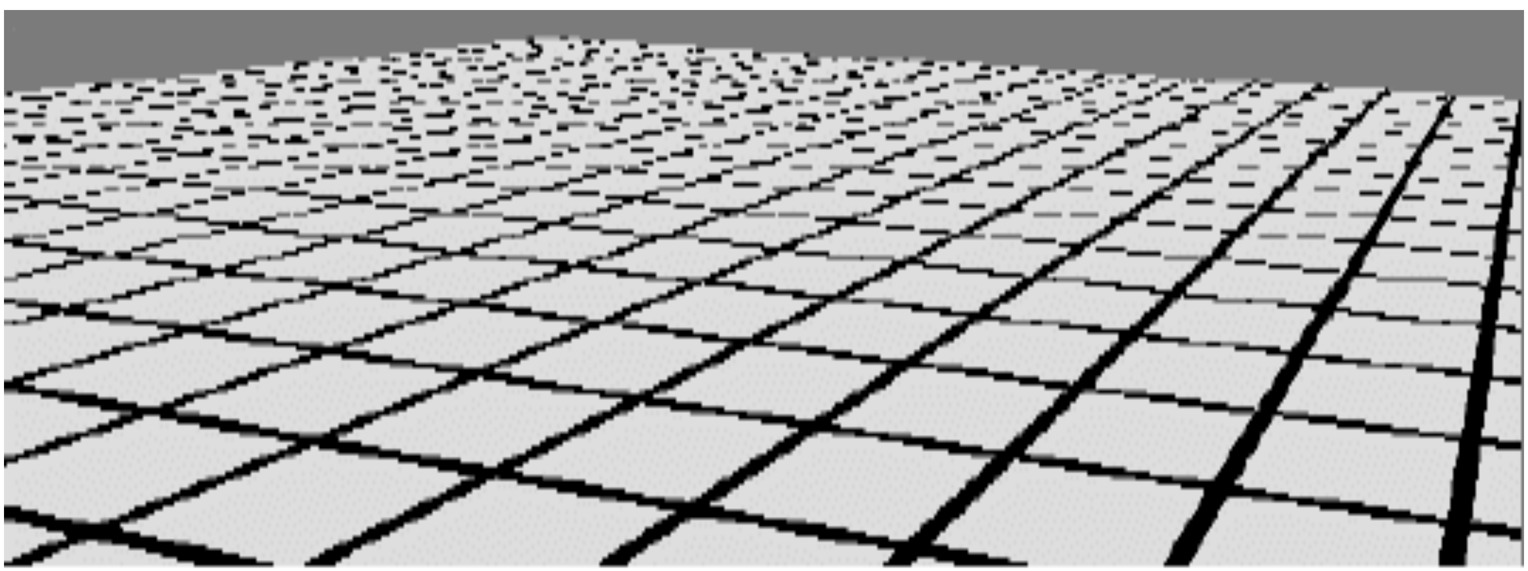
MIP Mapping

- Problem: Texture mapping in perspective



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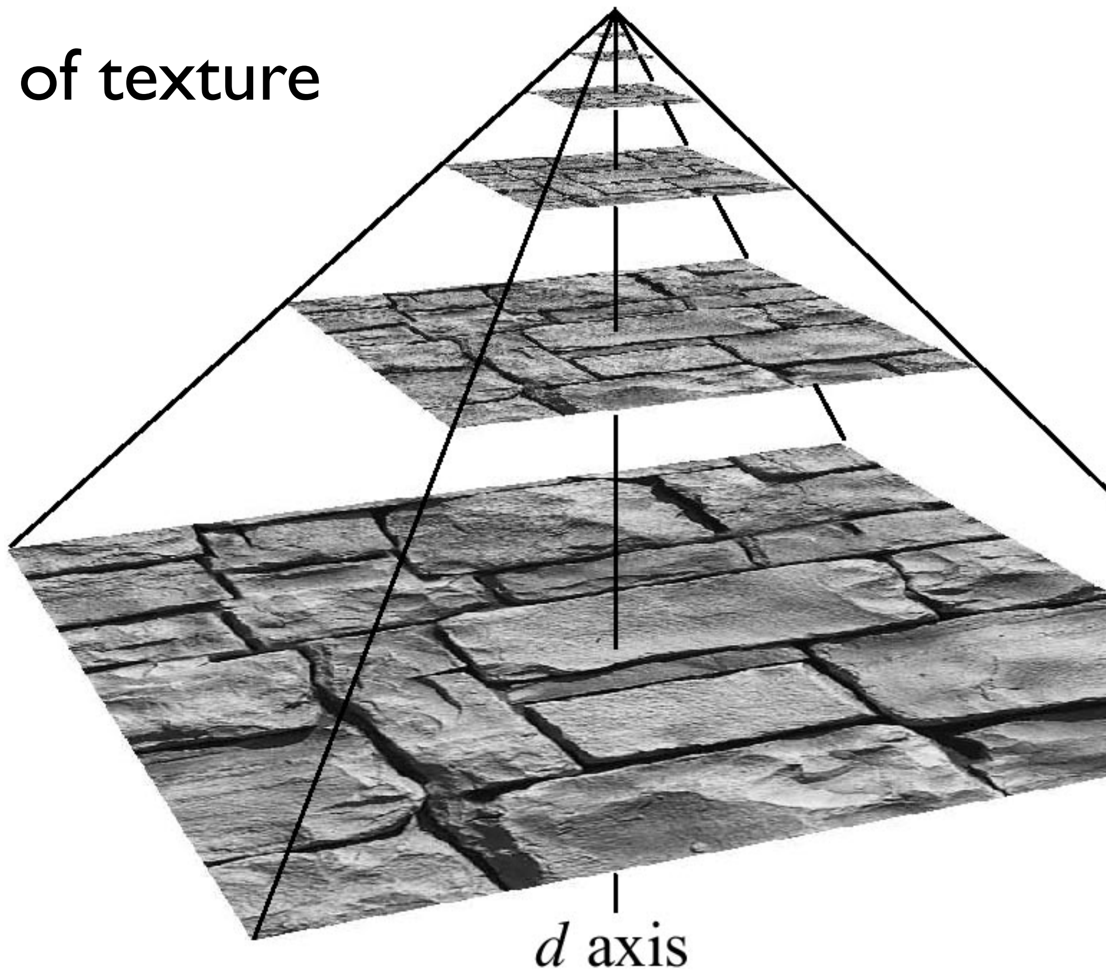
(with previous instructors James/Marschner, and some slides courtesy Leonard McMillan)

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



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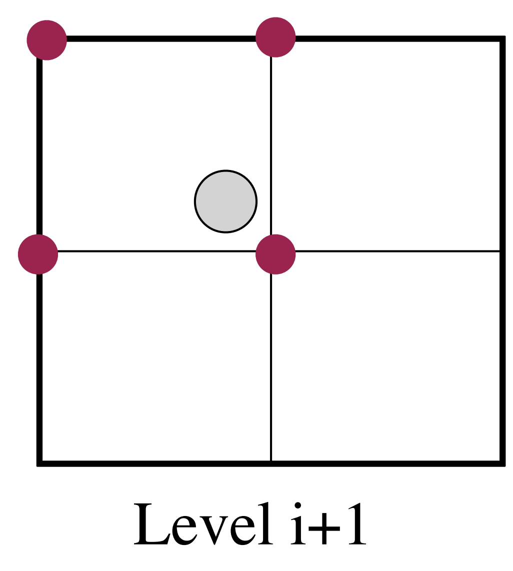
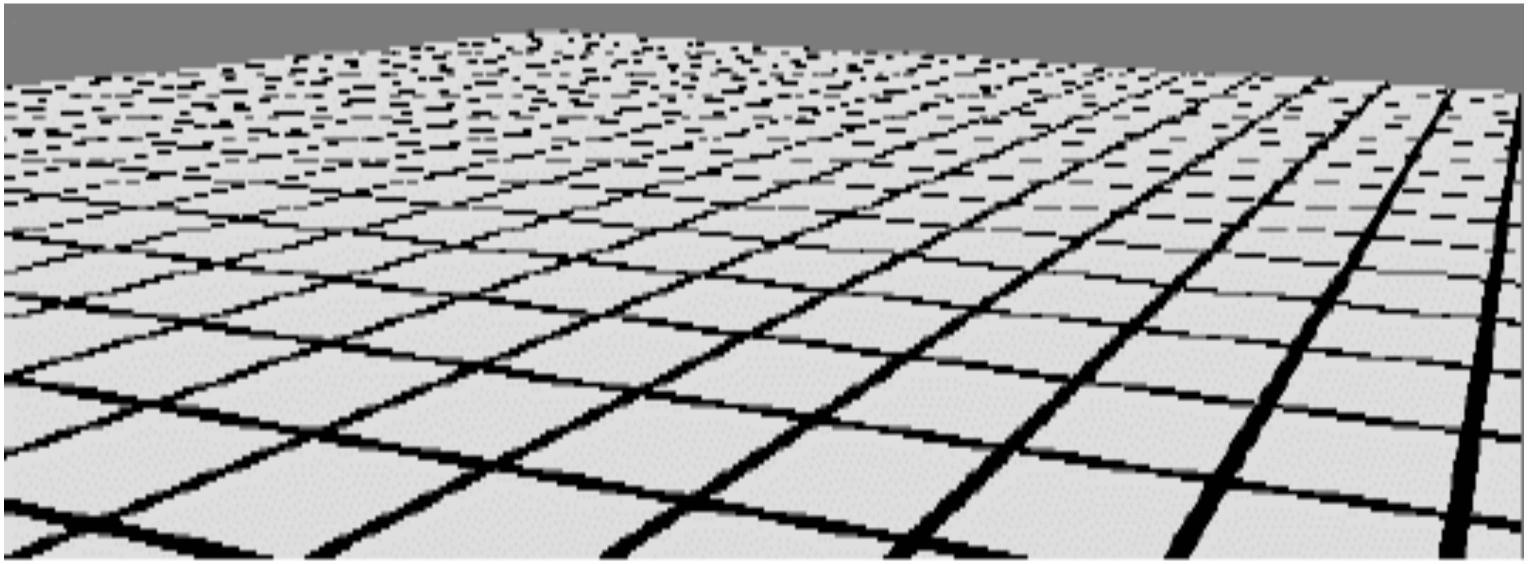
Using the MIP Map

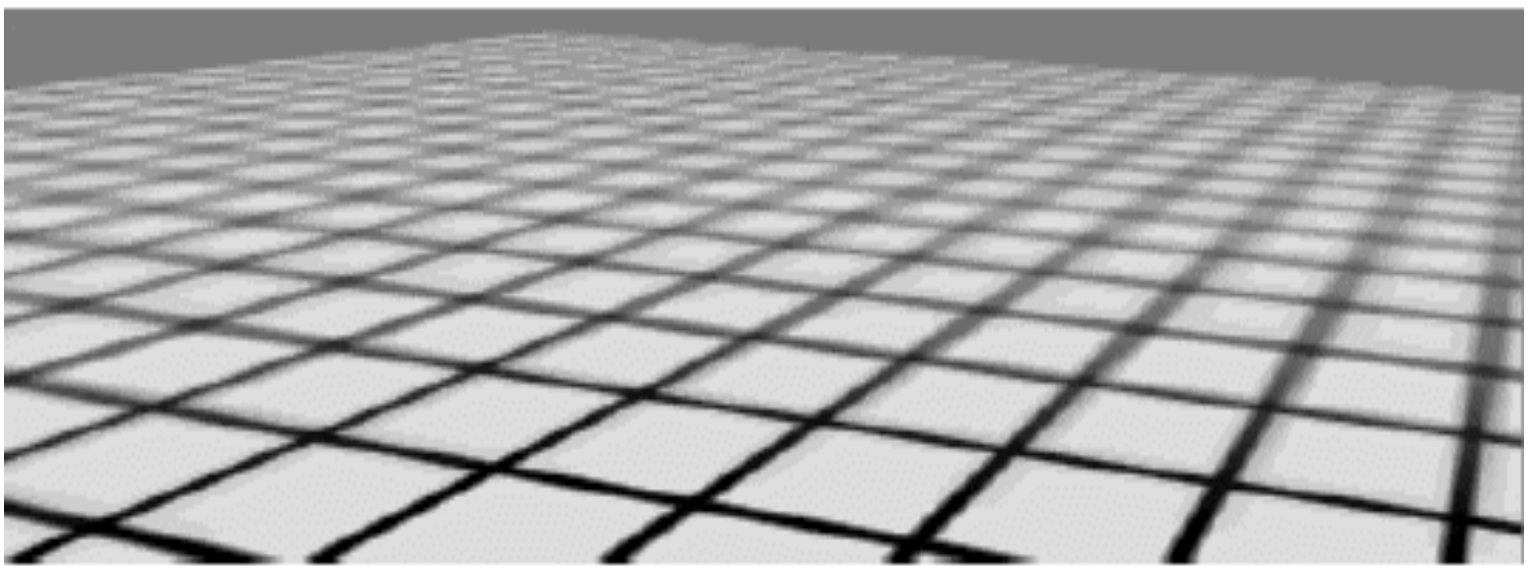
- In level, find texel and
  - Return the texture value: point sampling (but still better)!
  - Bilinear interpolation
  - Trilinear interpolation



Texture minification



point sampled



mipmap
bilinear

[Akenine-Möller & Haines 2002]

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Other uses of texture mapping

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

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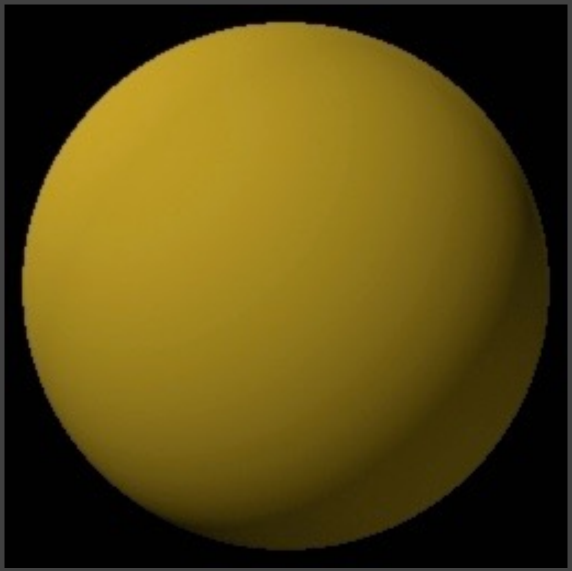
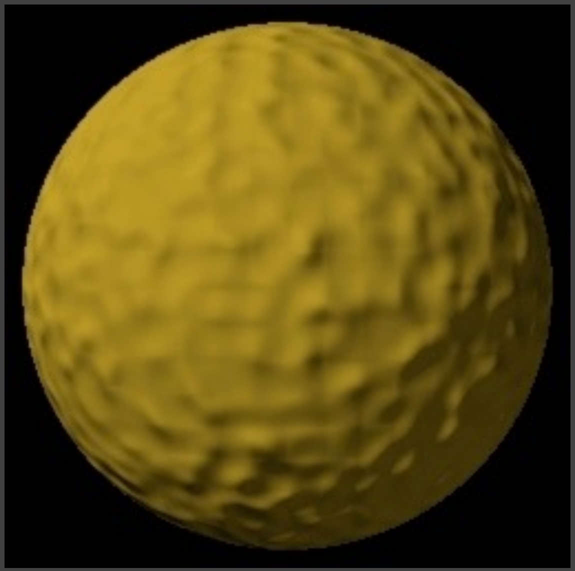
Displacement and Bump/Normal Mapping

- Mimic the effect of geometric detail or meso geometry
  - Also detail mapping



Geometry



Bump mapping

Displacement mapping

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Displacement Maps

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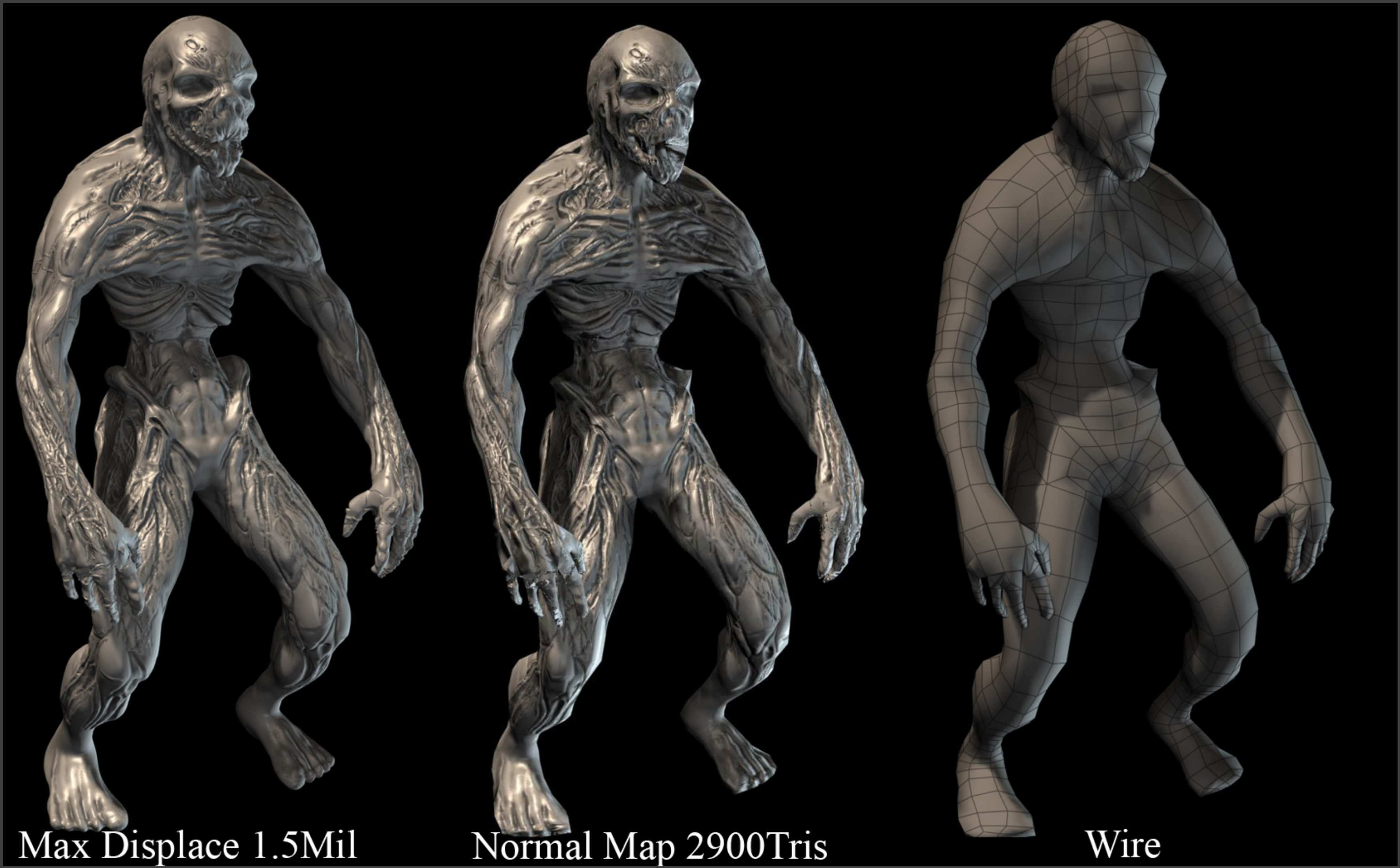
Displacement Maps vs. Normal Maps



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Other uses of texture mapping

- Reflection, Environment maps
- Normal, bump maps
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- ...

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Shadow maps

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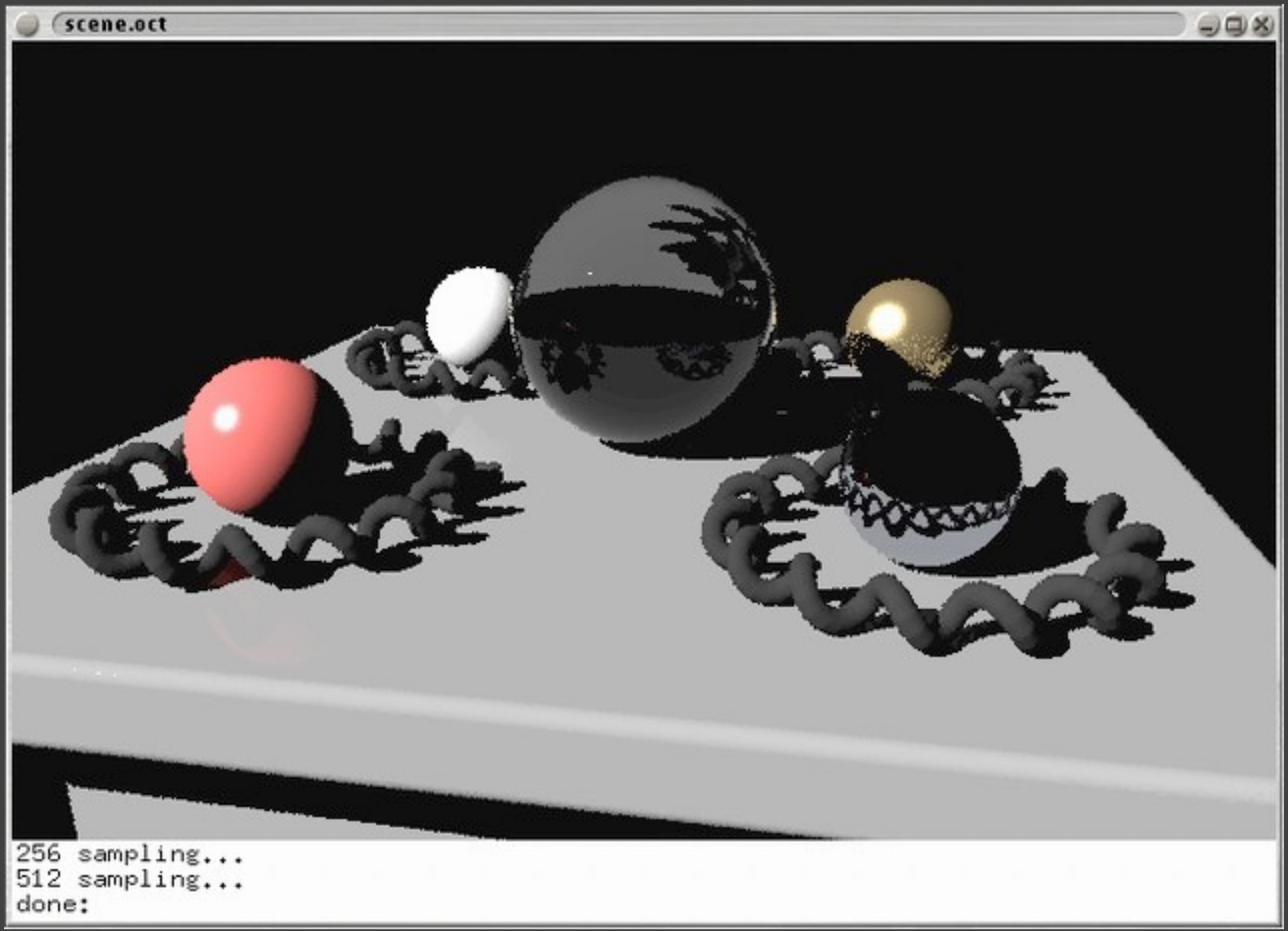
Need better lights

Objects illuminated by a point light source



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Environment Mapping

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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.

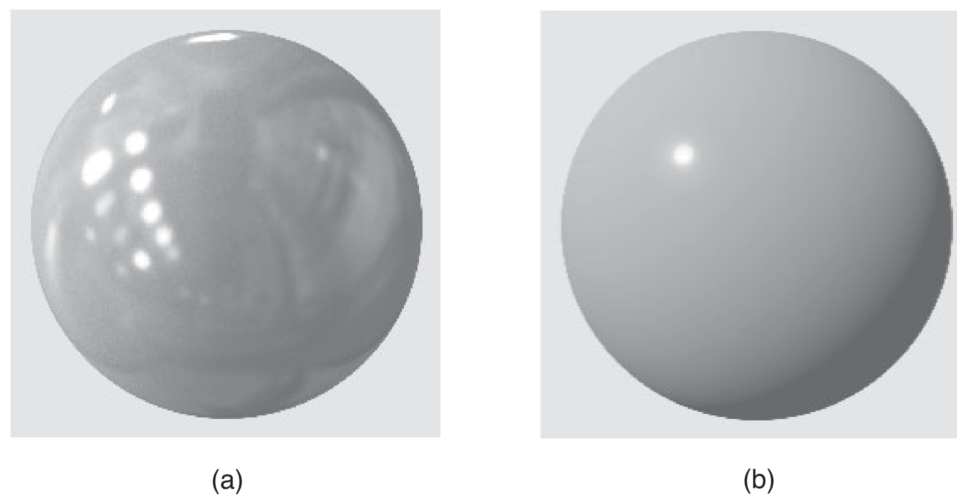

Figure 2. (a). A shiny sphere rendered under photographically acquired real-world illumination. (b). The same sphere rendered under illumination by a point light source.

[Dror, Willsky, & Adelson 2004]

Need to show off materials better

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

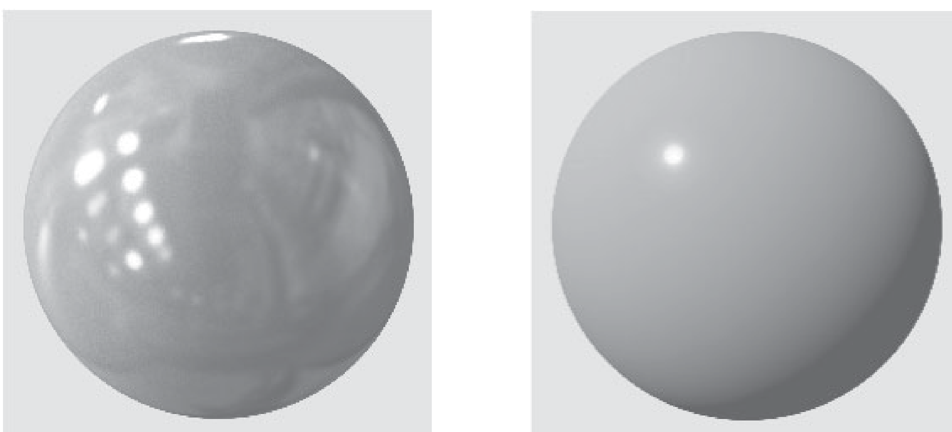

Figure 2. (a). A shiny sphere rendered under photographically acquired real-world illumination. (b). The same sphere rendered under illumination by a point light source.

[Dror, Willsky, & Adelson 2004]

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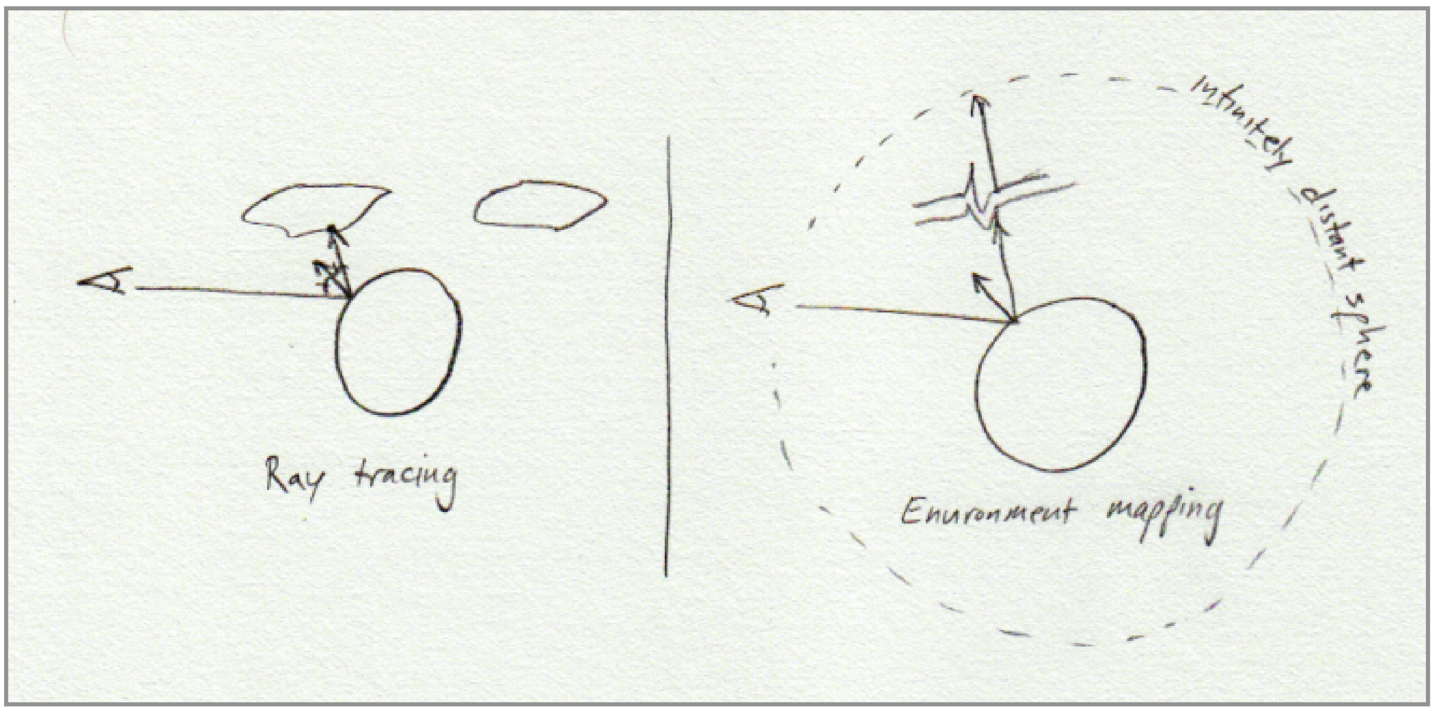
Reflection mapping

- 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



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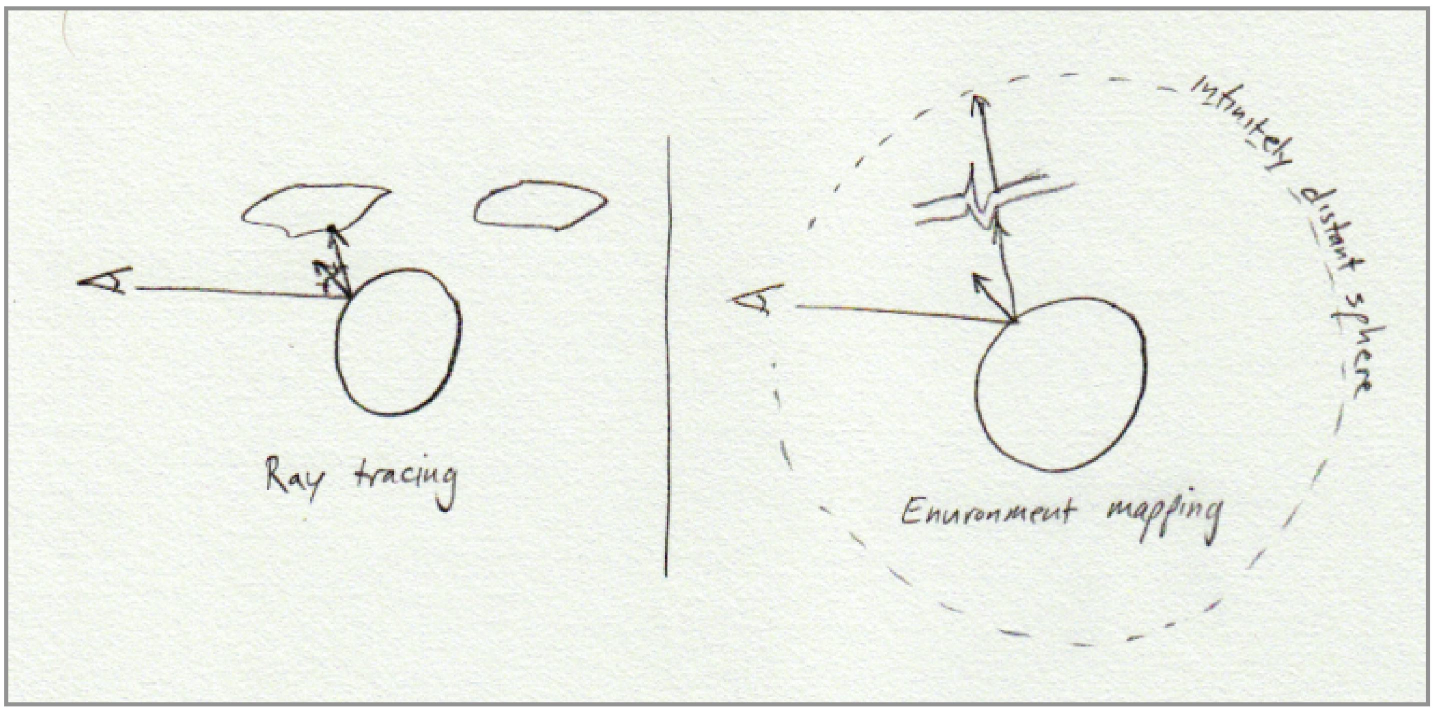
Reflection mapping

- 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



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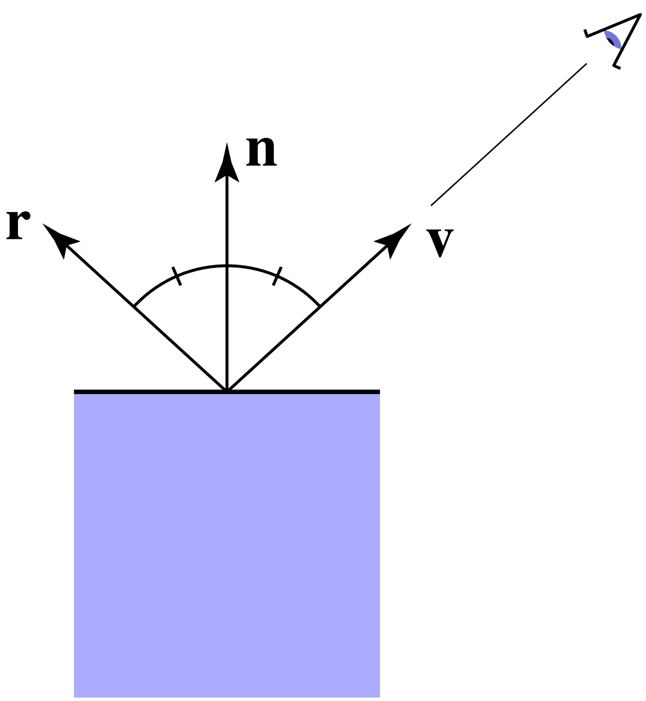
Review: Mirror reflection



$$\mathbf{r} = \mathbf{v} + 2((\mathbf{n} \cdot \mathbf{v})\mathbf{n} - \mathbf{v})$$
$$= 2(\mathbf{n} \cdot \mathbf{v})\mathbf{n} - \mathbf{v}$$

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Environment map

- A function from the sphere to colors, stored as a texture

[Blinn & Newell 1976]

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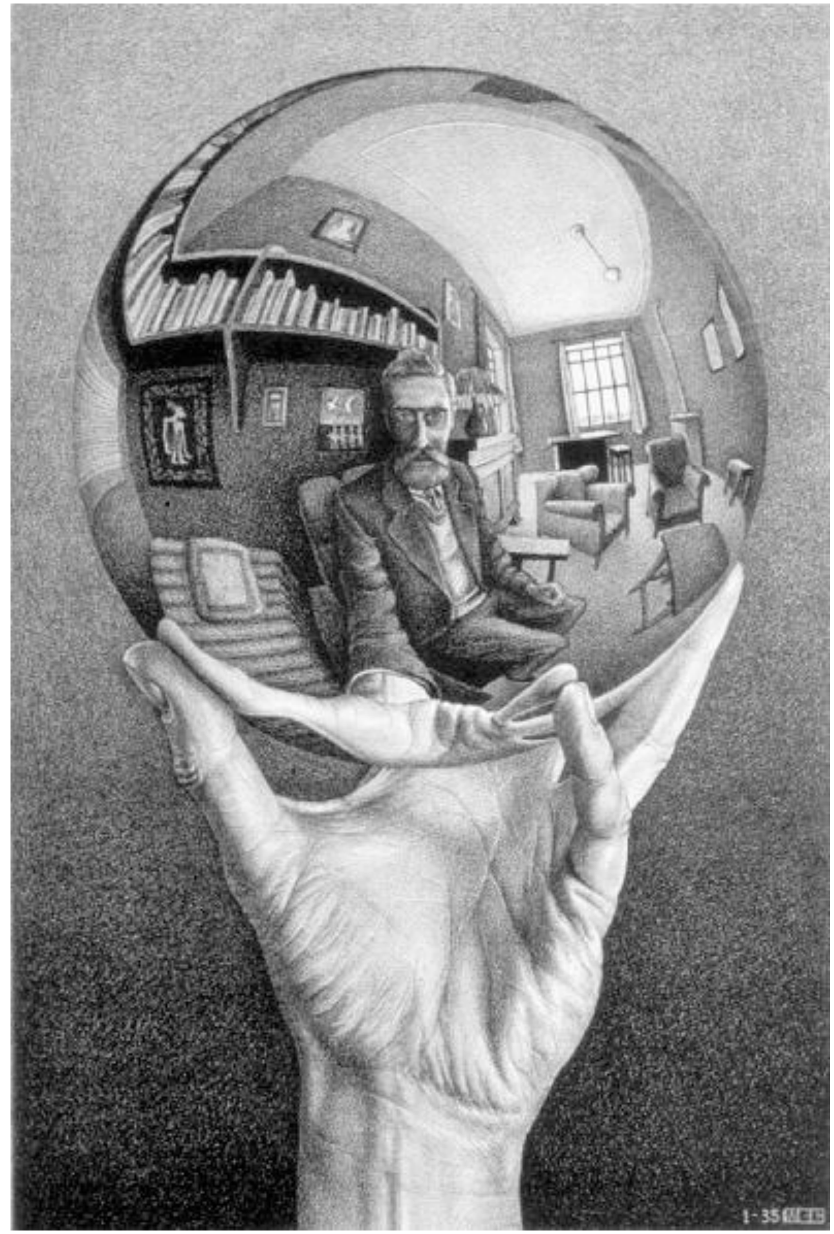
Spherical environment map

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



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Environment Maps

- High lighting complexity

[Paul Debevec]

- Rich: captures real world

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Sphere Mapping Example

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Cube environment map

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

[Ned Greene]

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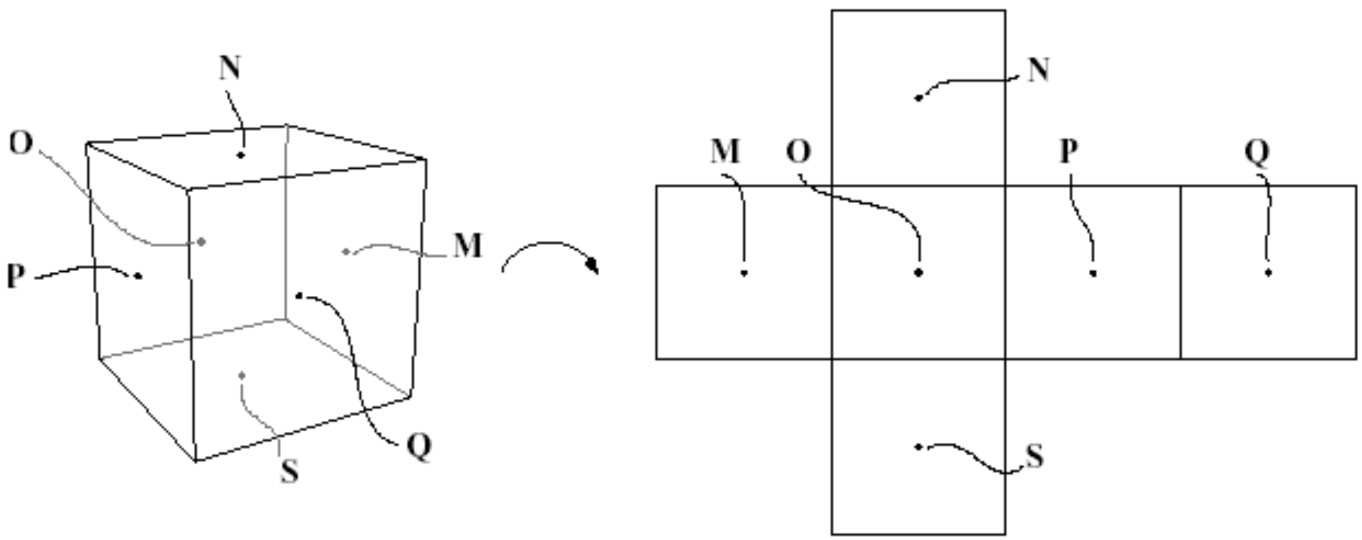
Cube Mapping

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

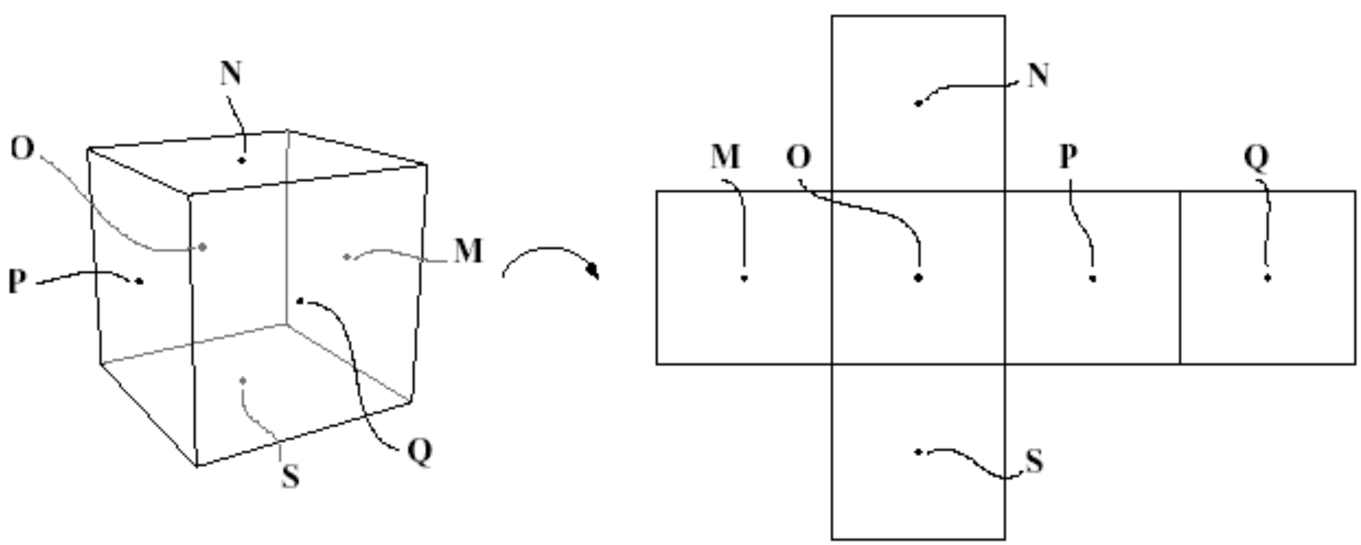


Cube Mapping

- 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]



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