CS380: Computer Graphics
Applications of Texture Mapping

Sung-Eui Yoon
(윤성의)

Course URL:
http://sgvr.kaist.ac.kr/~sungeui/CG

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Class Objectives (Ch. 9)

- **Various applications of texture mapping**
  - **Add details to scenes**

- **At the last class:**
  - **Texture mapping overview**
  - **Texture filtering for undersampling and oversampling**

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Questions

- Last week, description <u>for Unreal Engine 5</u> has been released, and the new feature holds "Nanite", which <u>allows millions and billions of polygons to be imported directly</u> to Unreal Engine in real time. Although Unreal Engine uses virtual texturing to assist in real-time high quality texturing, it feels like if the technology (software and hardware: gpu) improves, <u>will we provide colors for each triangles instead of using textures?</u> … <u>Or is there a more specific reason to keep using texture mapping?</u>

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Uses of Texture Maps

- **Texture maps are used to add complexity to a scene**
  - **Easier to paint or capture an image than geometry**
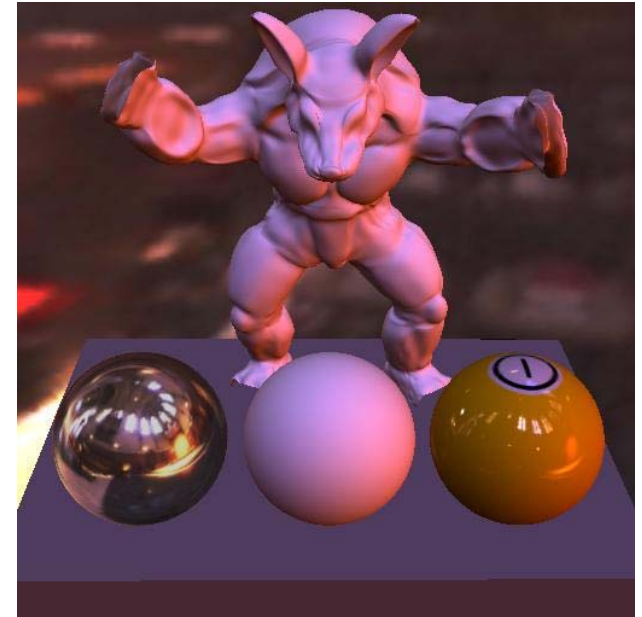- **Model light**
- **Model geometry, etc**

One of key techniques to overcome various problems of rasterization techniques!

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Modeling Lighting

- ## Light maps
  - **Supply the lighting directly**
  - **Good for static environments**

- ## Environment maps
  - **A representation of the scene around an object**
  - **Support reflection**

Light Maps in Quake

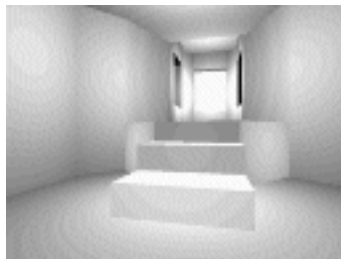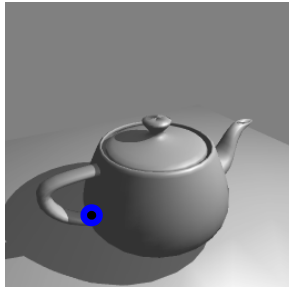- **Light maps are used to store pre-computed illumination**
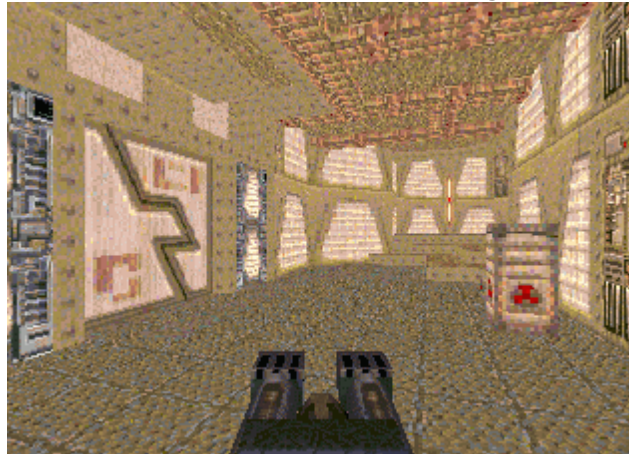
	Texture Maps	Light Maps
Data	RGB	Intensity
Resolution	High	Low

Light map image by Nick Chirkov

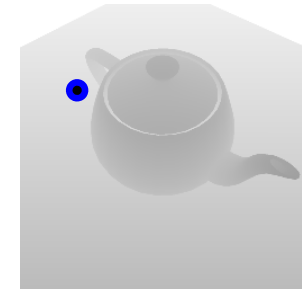**Textures Only**
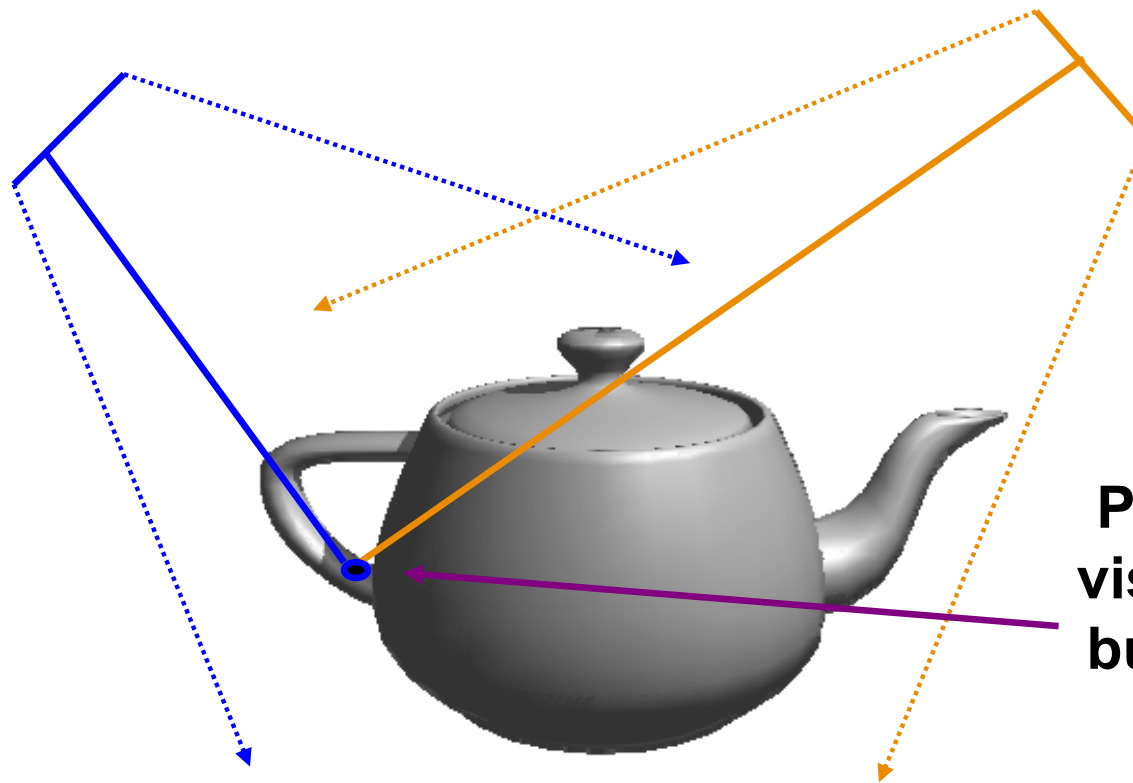
Textures & Light Maps

Shadow Maps

Depth map from eye

Use the depth map in the light view to determine if sample point is visible
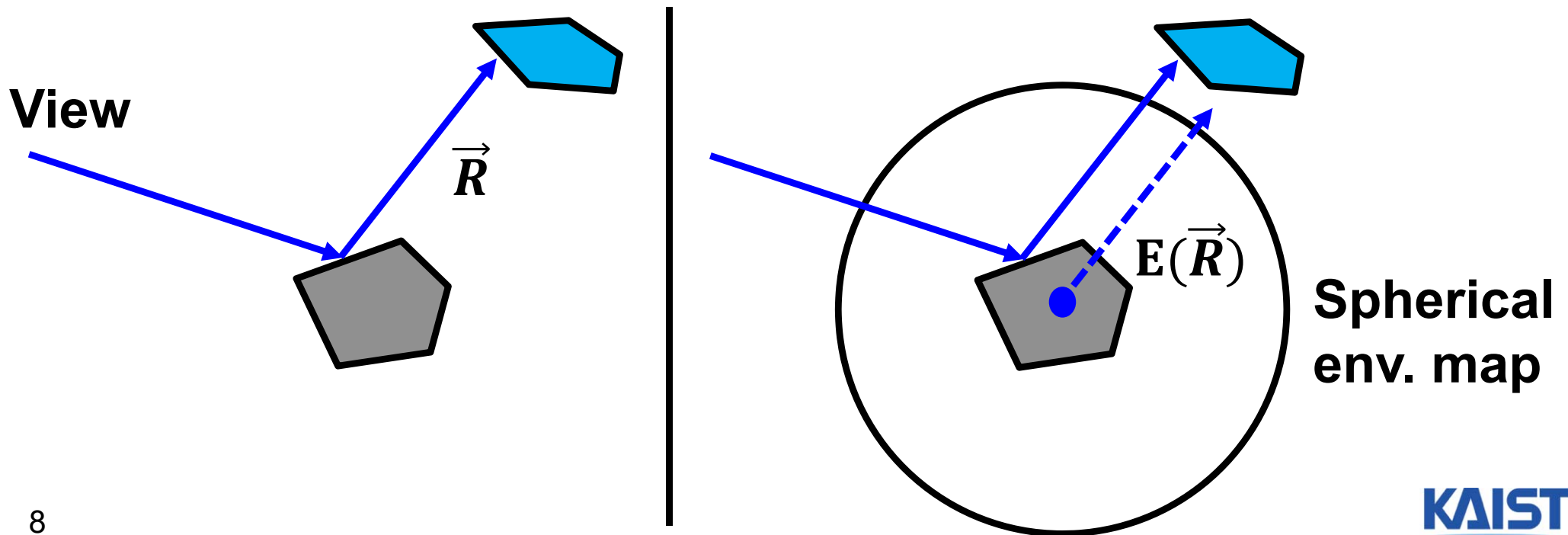

Depth map from light

Point in shadow visible to the eye, but not visible to the light

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Environment Maps

- **Simulate complex mirror-like objects**
  - **Use textures to capture environment of objects**
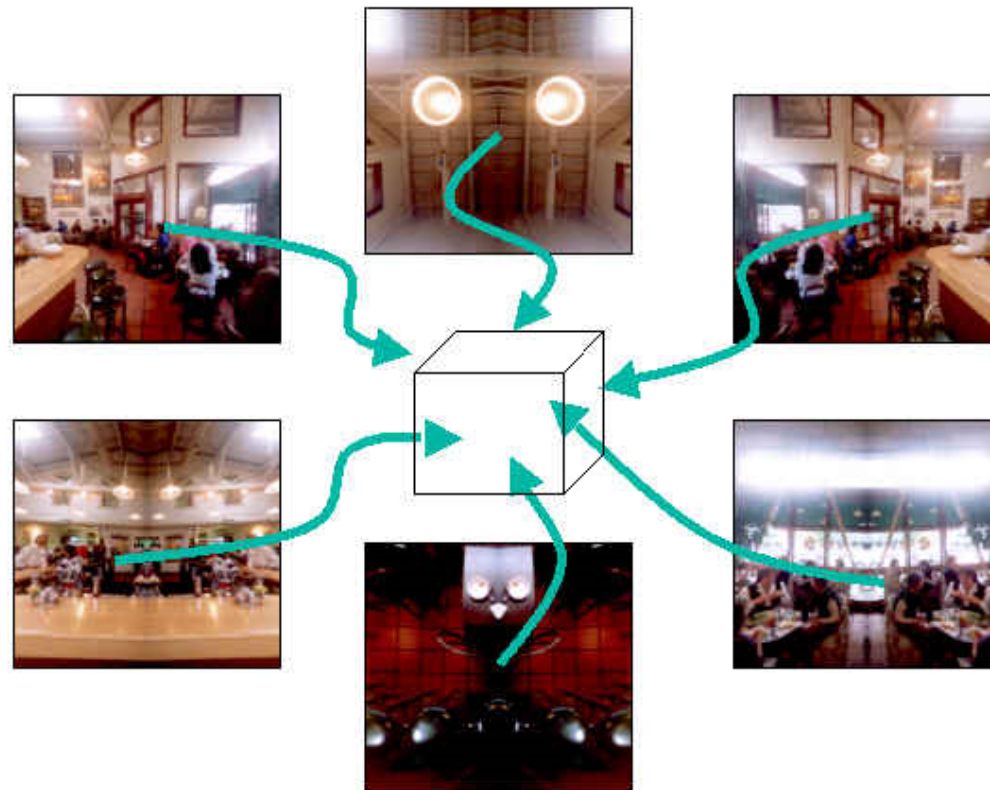 - **Use surface normal to compute texture coordinates**

View

$\vec{R}$

$E(\vec{R})$

Spherical env. map

Environment Maps - Example

T1000 in Terminator 2 from Industrial Light and Magic

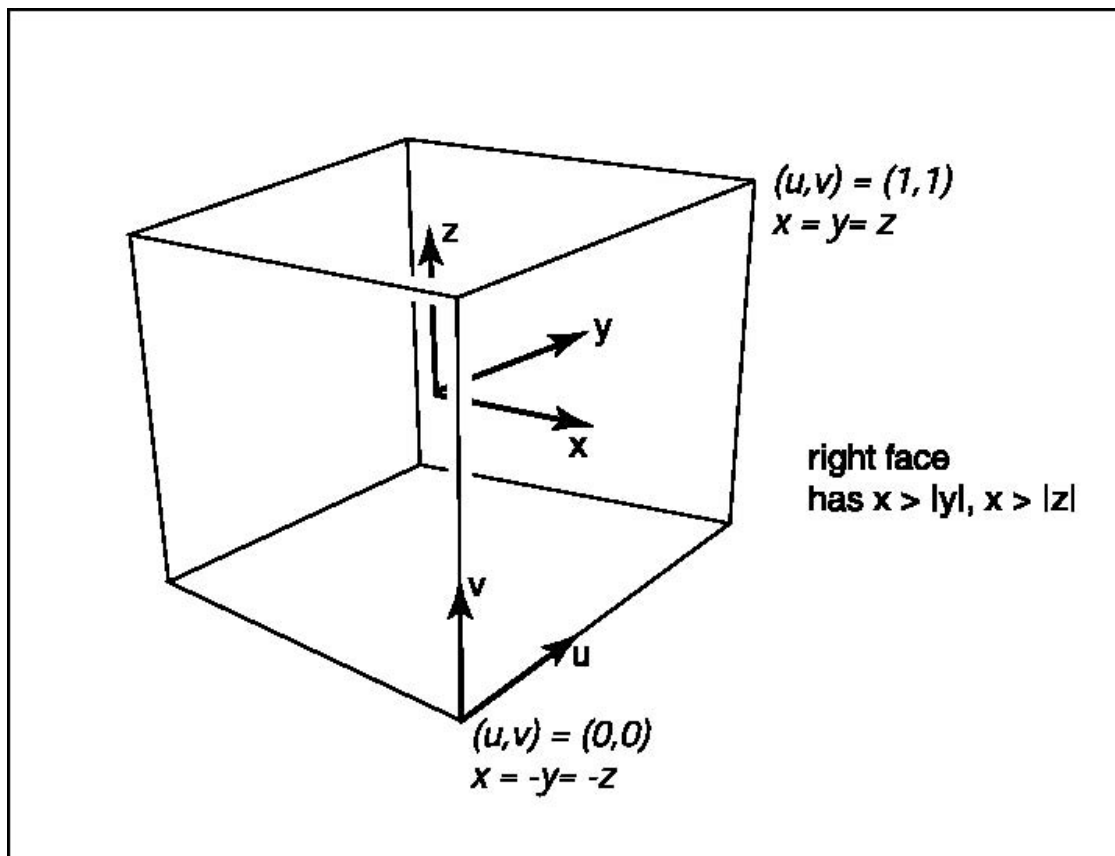# Cube Maps

- **Maps a viewing direction b and returns an RGB color**
  - **Use stored texture maps**

Cube Maps

- **Maps a viewing direction b and returns an RGB color**
  - **Assume b = (x, y, z),**

- Identify a face based on magnitude of x,y,z

-For the right face, compute texture coord. (u,v)

$u = (y+x)/(2x)$
$v = (z+x)/(2x)$

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Environment Maps - Problems

- **Expensive to update dynamically**
- **Not completely accurate**
  - **One of main reason that Cars (Pixar movie of 2006) used ray tracing**


images from NVIDIA

Reflection of swimming pool is wrong

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Environment Maps - Problems

- **Expensive to update dynamically**
- **Not completely accurate**
  - **One of main reason that Cars (Pixar movie of 2006) used ray tracing**

Modeling Geometry

- **Store complex surface details in a texture rather than modeling them explicitly**
- **Bump maps**
  - **Modify the existing normal**
- **Normal maps**
  - **Replace the existing normal**
- **Displacement maps**
  - **Modify the geometry**
- **Opacity maps and billboards**
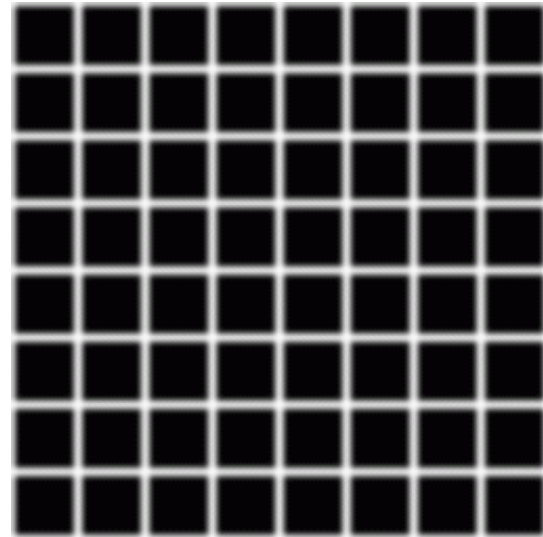 - **Knock-out portions of a polygon using the alpha channel**

Bump Mapping

- **Modifies the normal not the actual geometry**
  - **Texture treated as a heightfield**
  - **Partial derivatives used to change the normal**
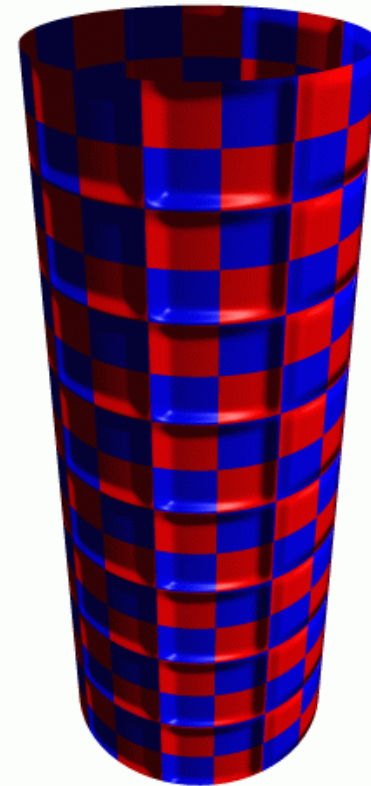 - **Causes surface to appear deformed by the heightfield**
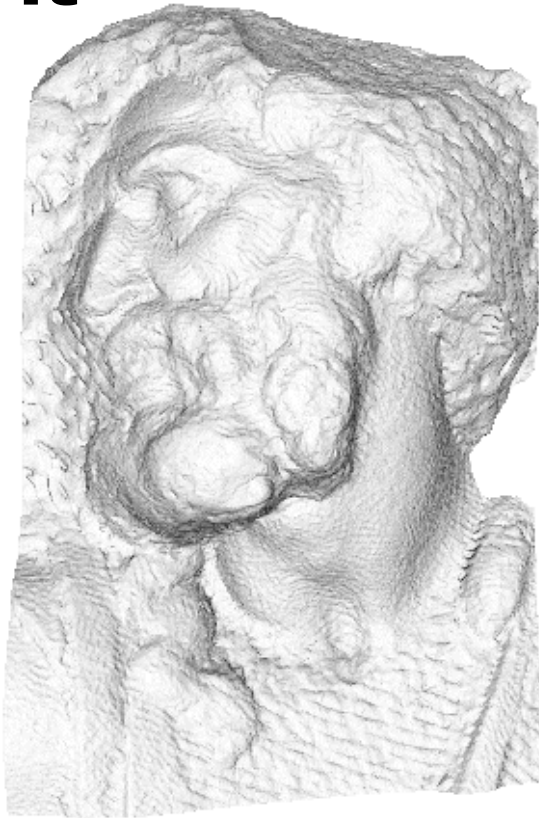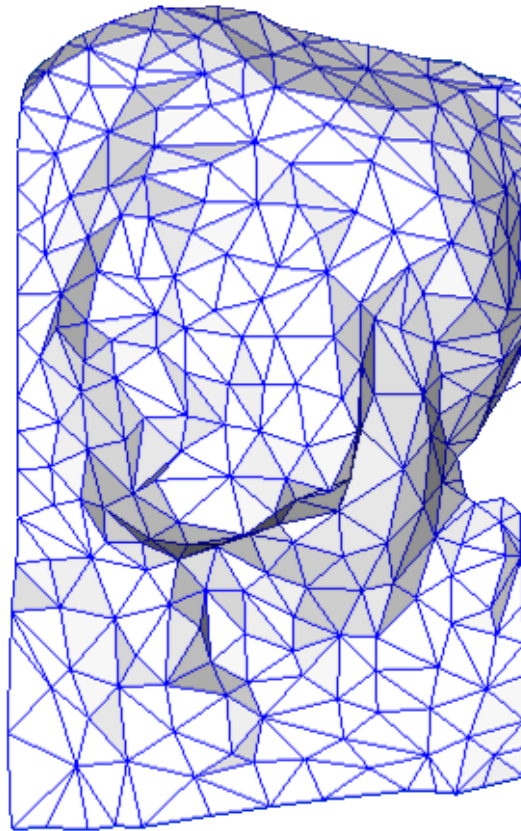

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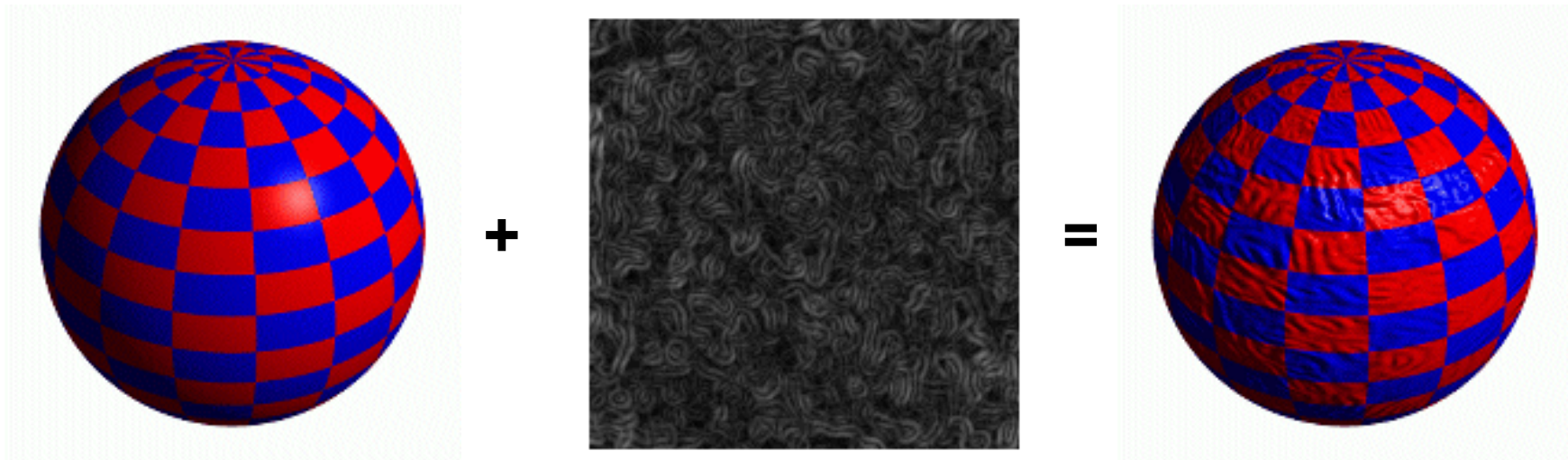
More Bump Map Examples
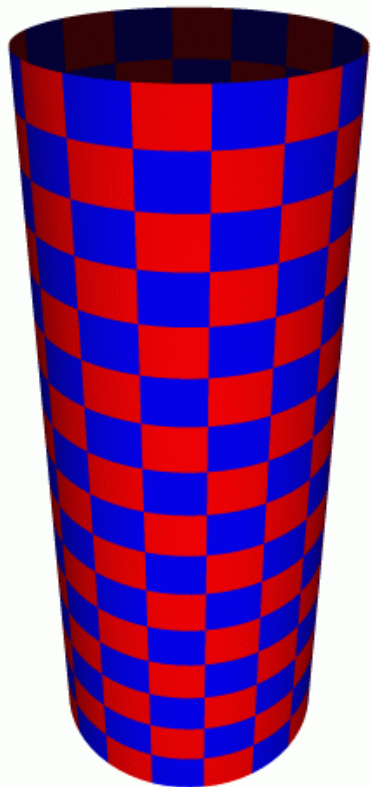
Note that silhouette edge of the object not affected!
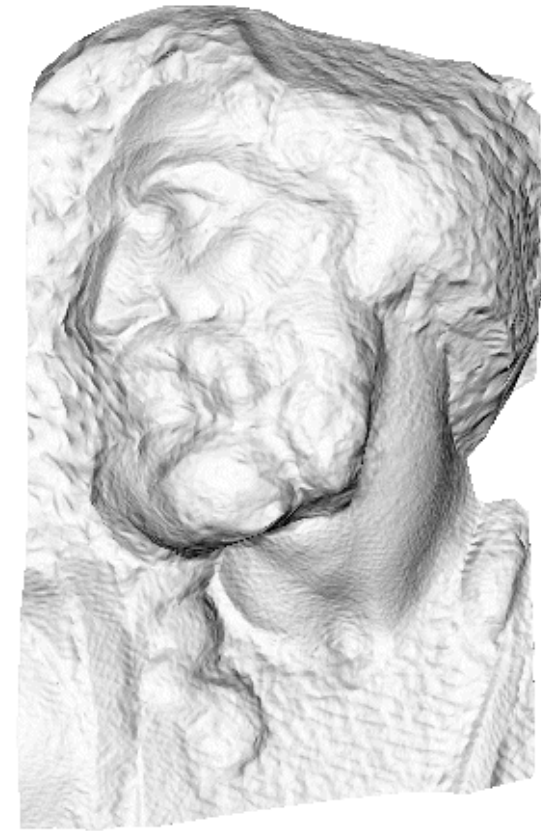
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Normal Mapping

- **Replaces the normal rather than tweaking it**
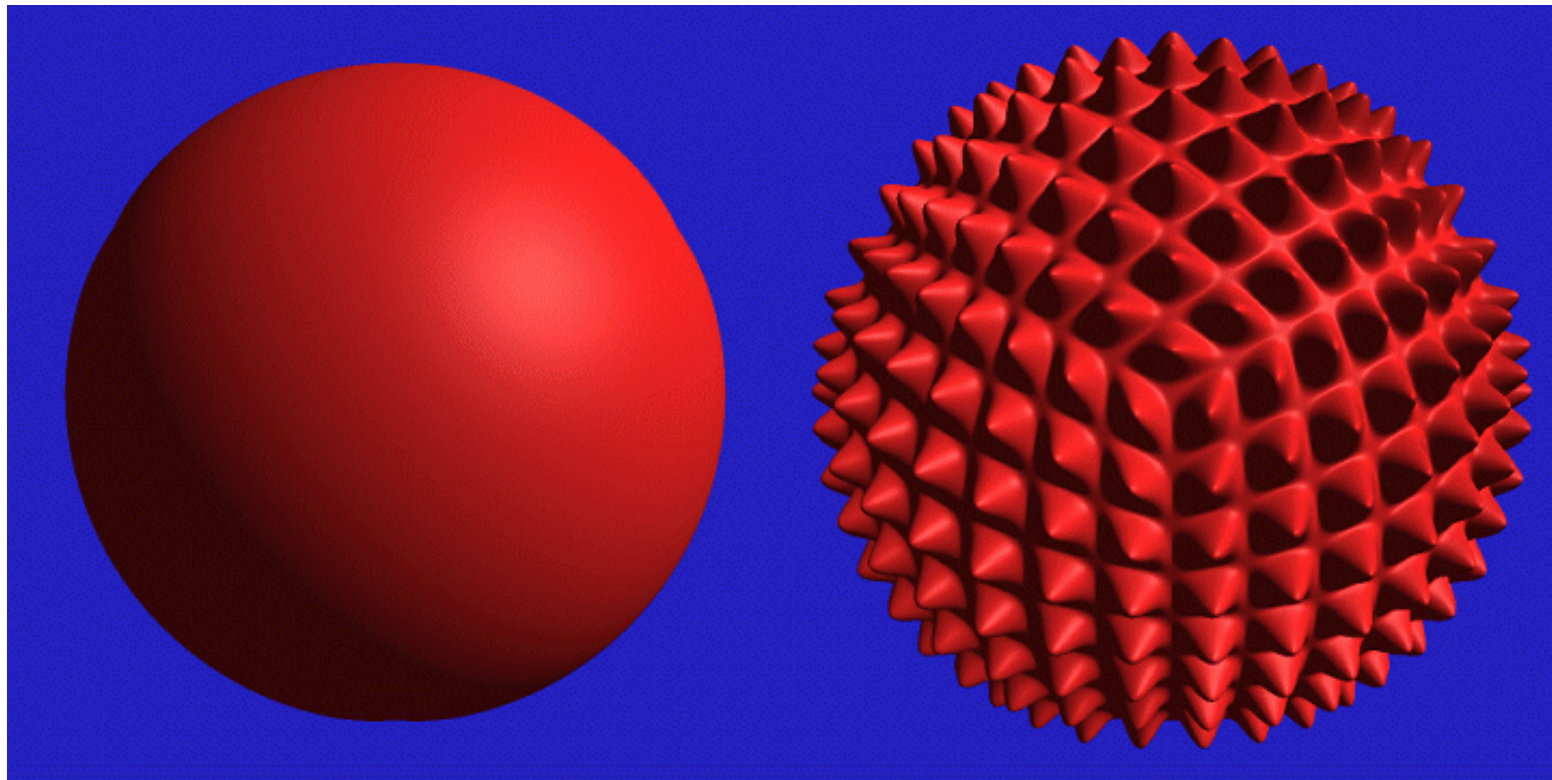

original mesh
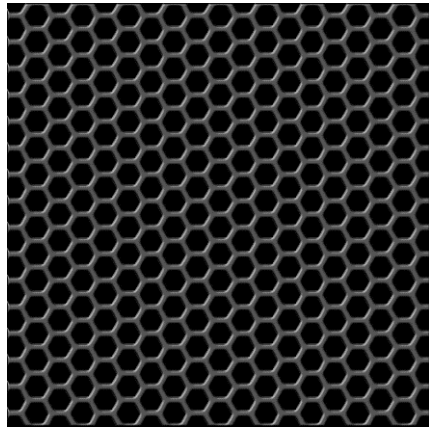4M triangles

simplified mesh
500 triangles

simplified mesh
and normal mapping
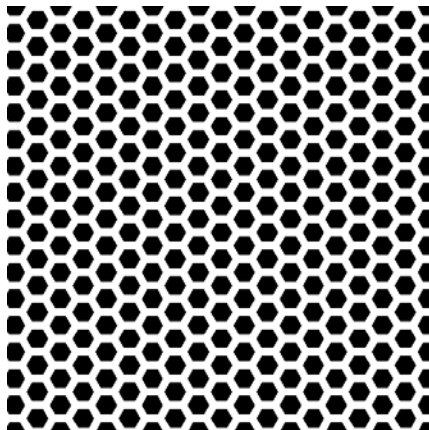500 triangles

Displacement Mapping

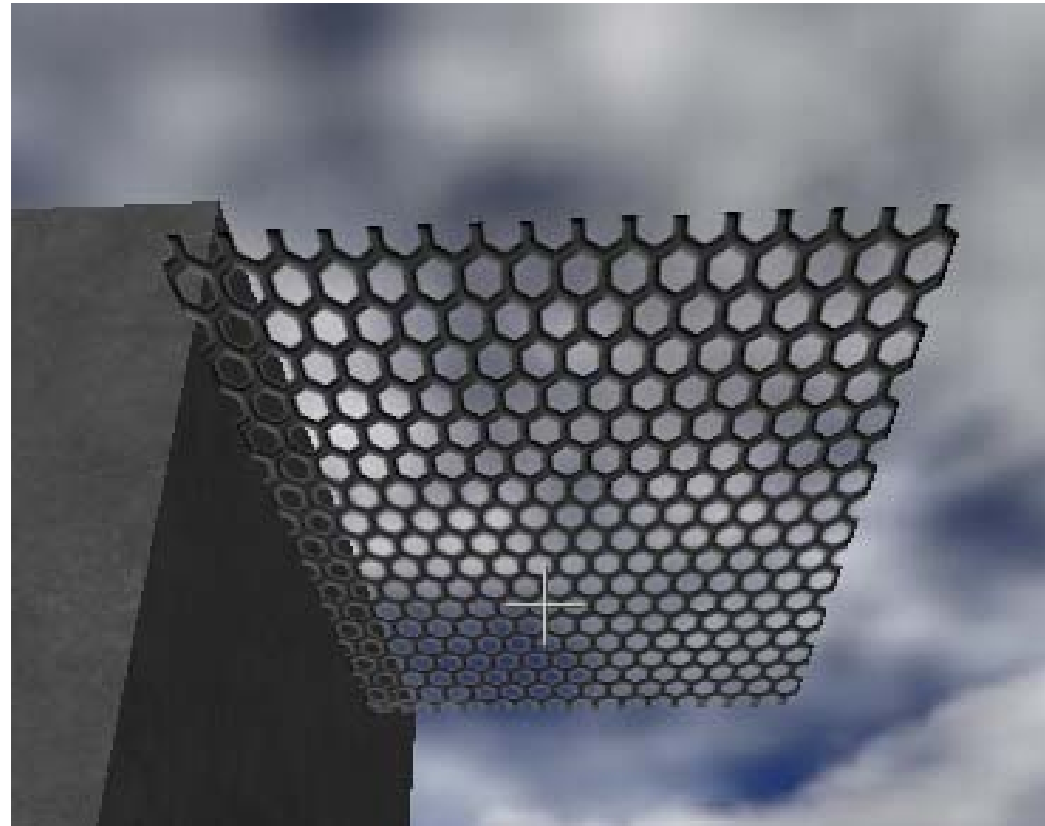- **Texture maps can be used to actually move surface points**

Opacity Maps

RGB channels

alpha channel

Use the alpha channel to make portions of the texture transparent

3D or Solid Textures

- **Solid textures are three dimensional assigning values to points in 3 space**
  - **Very effective at representing some types of materials such as marble and wood**
- **Generally, solid textures are defined procedural functions rather than tabularized functions as used in 2D**
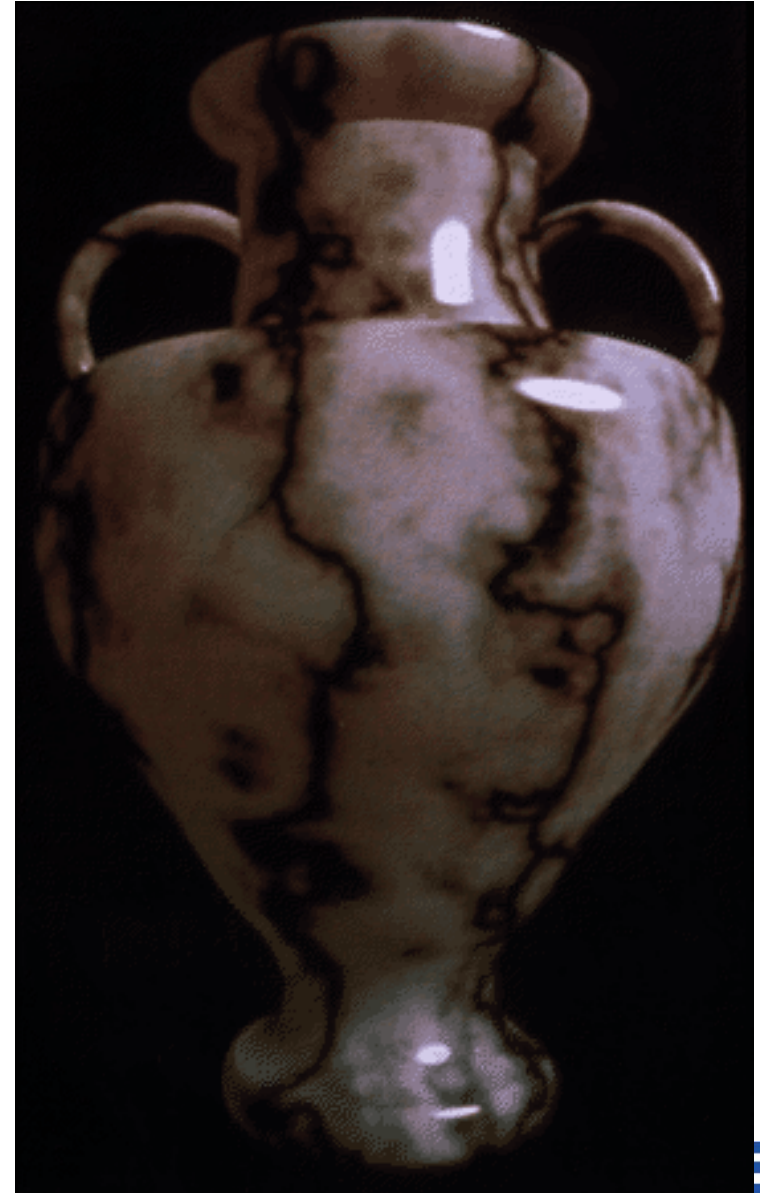
Class Objectives were:

- **Texture mapping overview**
- **Texture filtering**
- **Various applications of texture mapping**

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Next Time

- **Visibility and ray tracing**

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Homework

- **Go over the next lecture slides before the class**
- **No more video summary submission**
- **Submit questions two times during the whole semester**