

CS-184: Computer Graphics

Lecture #14: Texture and Other Maps

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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 w/ randomness

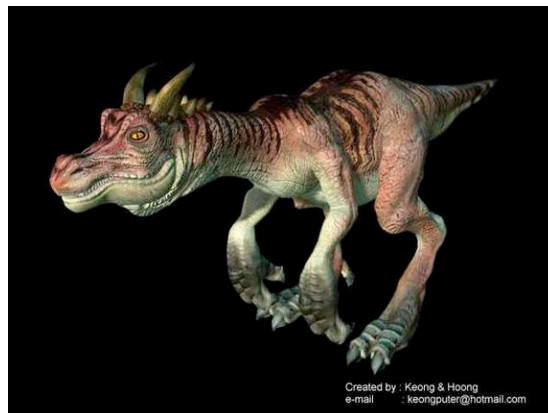
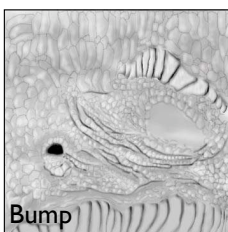
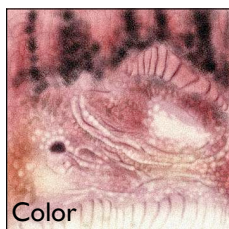
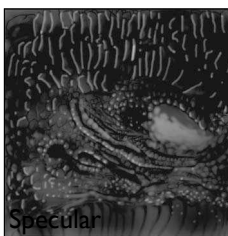
Section through volume

Bumps

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2D Texture Mapping of Images

- Use a 2D image and map it to the surface of an object



Created by : Keong & Hoong
e-mail : keongputer@hotmail.com

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2D Texture Mapping of Images

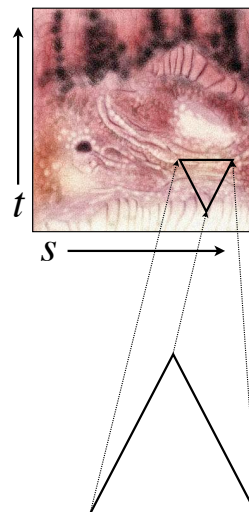
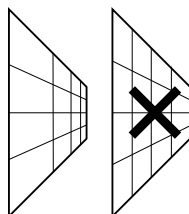
- Example of texture distortion



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Texture Coordinates

- Assign coordinates to each vertex
- Within each triangle use linear interpolation
- Correct for distortion!



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Assigning Texture Coordinates

- Map a simple shape onto object by projection
 - Sphere, cylinder, plane, cube
- Assign by hand
- Use some optimization procedure

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Texture Coordinates - Drop z

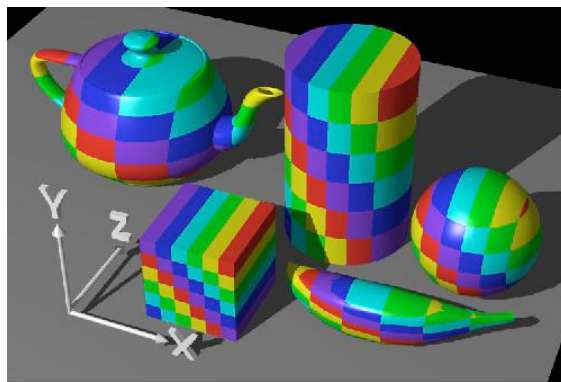


Image From:
Rosalee Wolfe

$$[x,y,z] \longrightarrow [x,y] \longrightarrow [u,v]$$

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Spherical Projection

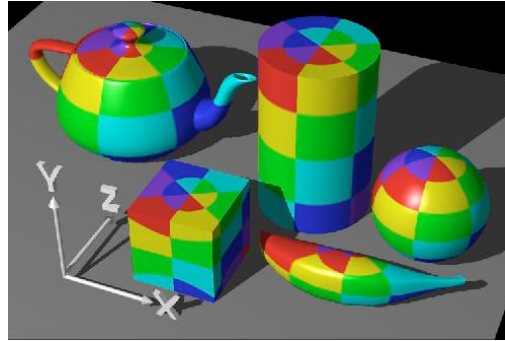
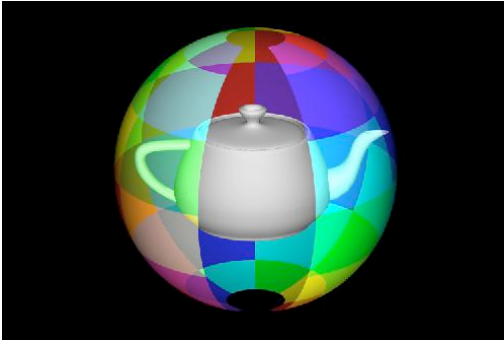


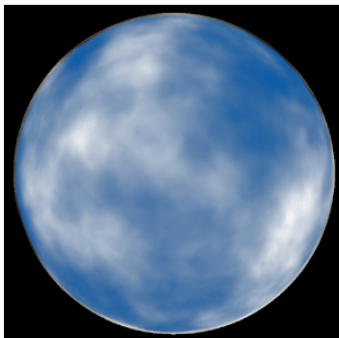
Image From:
Rosalee Wolfe

$$[x,y,z] \rightarrow [\text{rho},\text{phi},r] \rightarrow [\text{rho},\text{phi}] \rightarrow [u,v]$$

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Procedural Textures

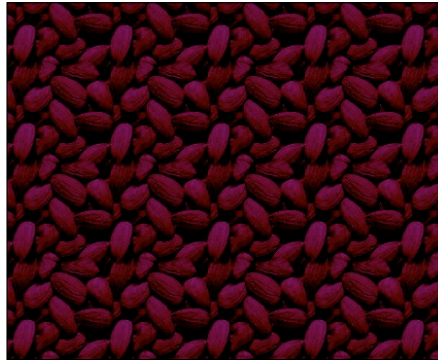
- Generate texture based on some function
 - Well suited for “random” textures
 - Often modulate some noise function



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Repeating Textures

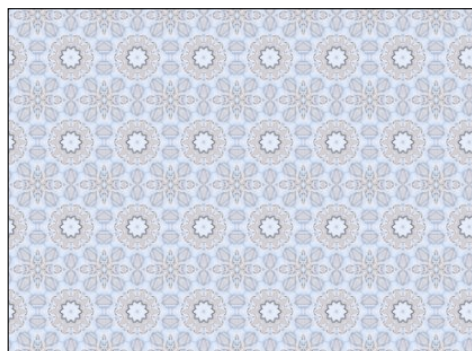
- Image Tiles allow repeating textures
 - Images must be manipulated to allow tiling
 - Often result in visible artifacts
 - There are methods to get around artifacts....



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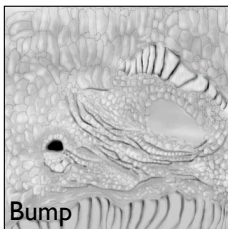
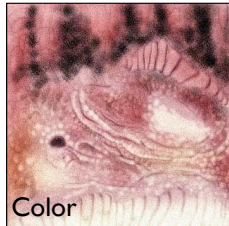
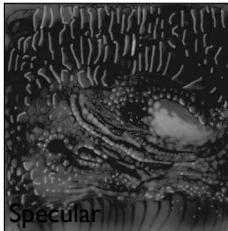
Repeating Textures

- Image Tiles allow repeating textures
 - Images must be manipulated to allow tiling
 - Often result in visible artifacts
 - Artifacts not an issue for artificial textures



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Non-Color Textures

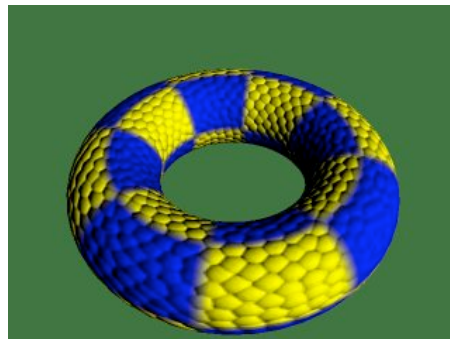


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Bump Mapping



No bump mapping



With bump mapping

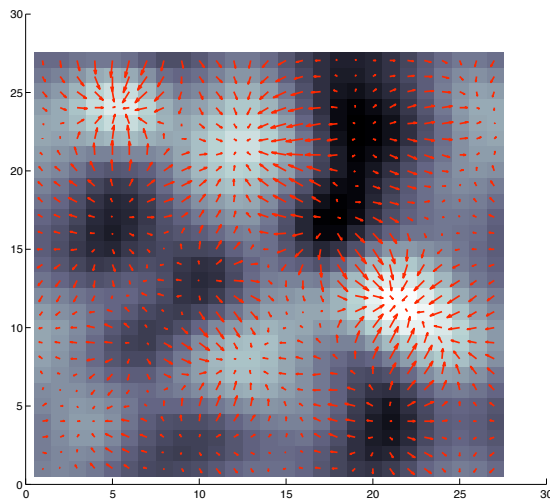
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Bump Mapping

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

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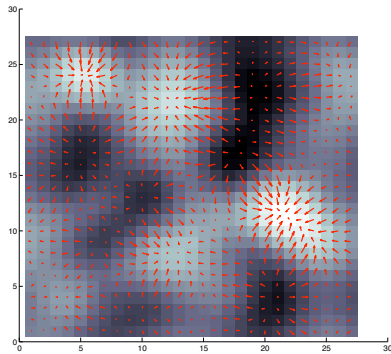
Gradient



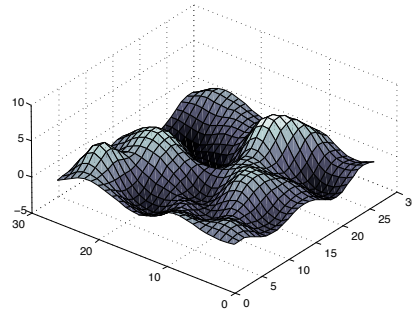
Gradient of Grayscale Image

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Storing Bumps as Image



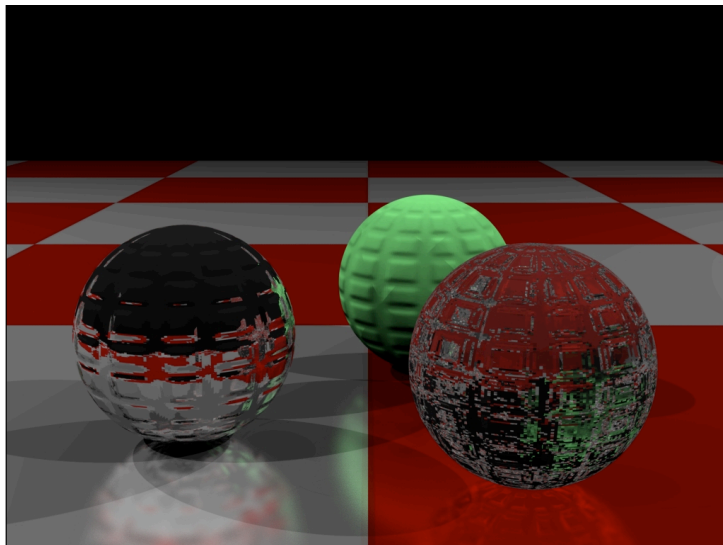
Grayscale Image
& Gradient



Bumps

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Bump Map Example



Catherine Bendebury and Jonathan Michaels
CS 184 Spring 2005

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Displacement Maps

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



Bump



Displacement

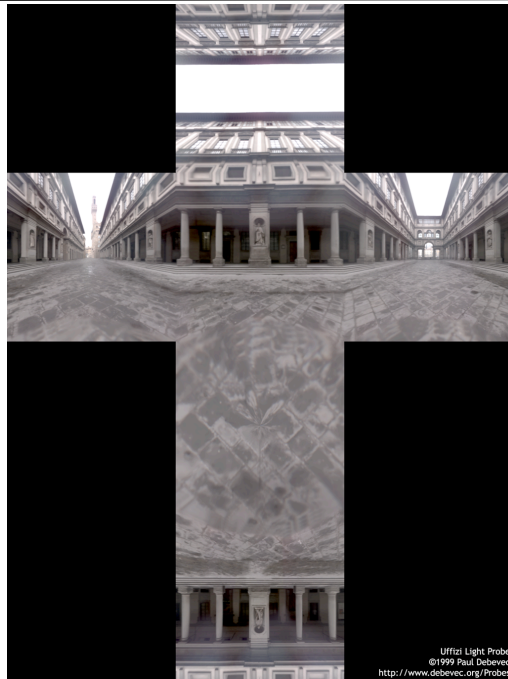
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Environment Maps

- Environment maps allow crude reflections
- Treat object as infinitesimal
 - Reflection only based on surface normal
- Errors hard to notice for non-flat objects

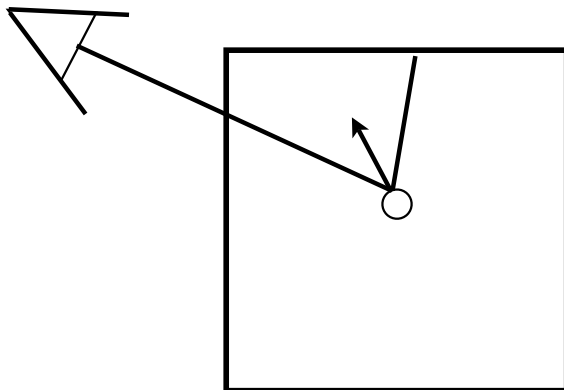
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Environment Maps



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Environment Maps



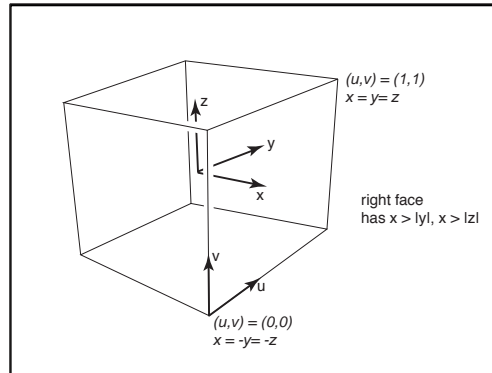
2D schematic

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Environment Maps

$$u = \frac{y+x}{2x}$$

$$v = \frac{z+x}{2x}$$



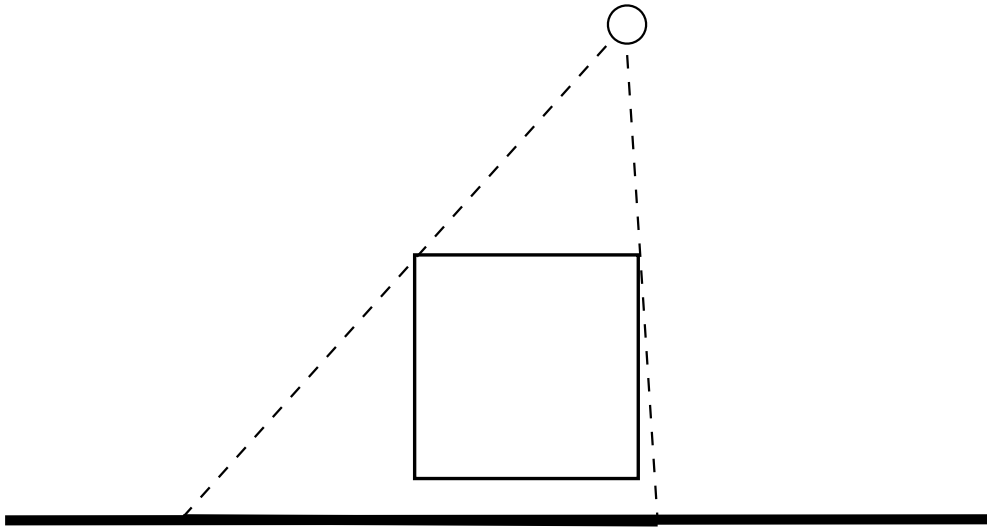
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Shadow Maps

- 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

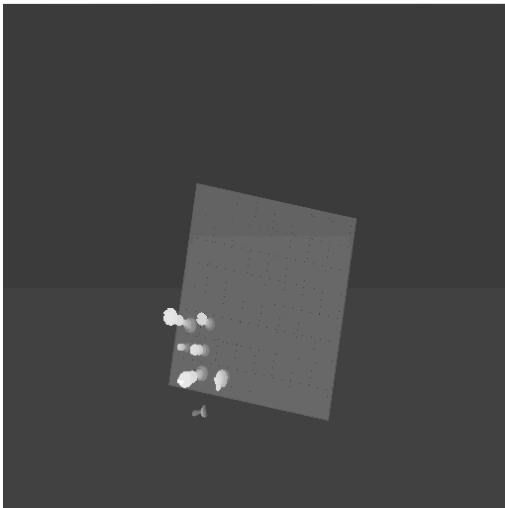
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Shadow Map Example



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Shadow Maps



Shadow Buffer

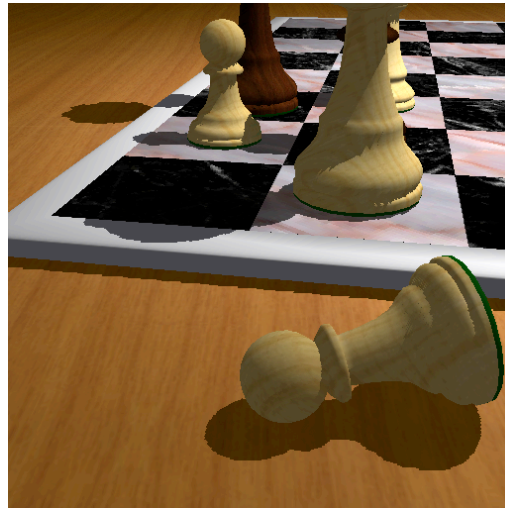


Image w/ Shadows

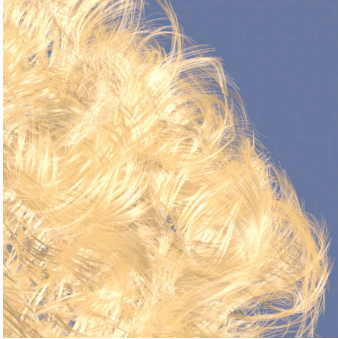
From Stamminger and Drettakis
SIGGRAPH 2002

Note: These images don't really go together; see the paper...

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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