

## Texture mapping - other methods

Environmental mapping

Bump mapping

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## Review Surface Texturing

- u,v mapping: map 3D point within 3D surface
  - Quadrilateral: inverse bi-linear mapping
  - Spherical: e.g. latitude-longitude
  - Triangulated: barycentric coordinates
- Mip-mapping: pre-filter texture map
  - Average texels, reduce resolution
  - Index into appropriate map based on projected pixel size

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## Environmental Mapping

Reflect the environment off an object

Use normal to index into texture that represents the environment

### Procedurally

- $\text{Reflection\_color} = f(R(u,v))$

### Table look-up

- $\text{Reflection\_color} = \text{table}(R_\theta(u,v), R_\phi(u,v))$

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## Procedural Environmental Mapping

- Simple: ray up is blue, ray down is brown
- Medium: use sinusoidals to interpolate between gray and silver for a chrome effect
- Complex: compute fractal intersection

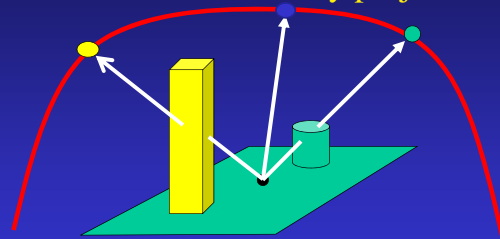
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## Environmental (table-based) Mapping

- Use pre-constructed enclosing volume containing projected environment
- Hemi-cube or hemisphere
- Mip-mapping possible

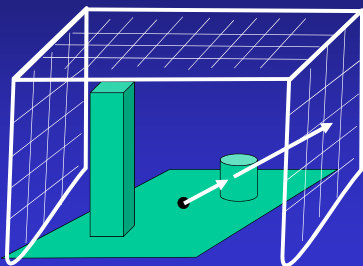
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## Environmental Mapping table construction by projection



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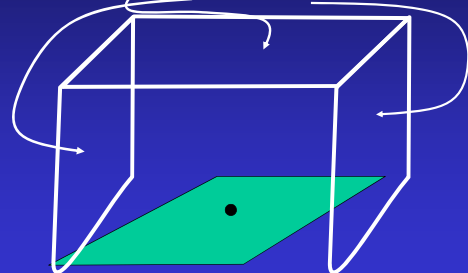
## Hemi-cube projection construction method



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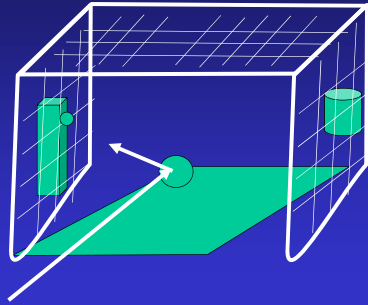
## Hemi-cube image construction method

Use pictures - of sky, mountains, buildings, etc.



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## Hemi-cube reflectance look-up



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## Examples



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## Examples



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## Examples



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## Examples



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## Examples



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## Bump Mapping

- Modulate normals over surface to create visual effect of geometric detail

<http://www.mpi-inf.mpg.de/departments/irg3/ws0506/cg/slides/13-Texturing.pdf>

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## Bump Mapping

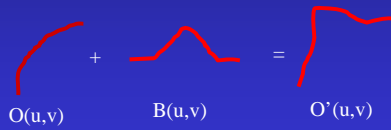
1. Use grey-scale image to define height field
  2. Compute gradient of height field
  3. Use gradient vectors to modify normal
- Don't really modify surface geometry – just pretend we do by modifying normal

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## Bump Mapping

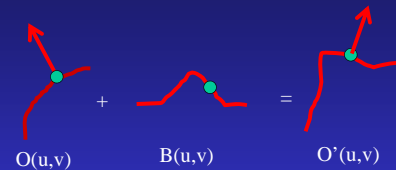
$$O'(u, v) = O(u, v) + B(u, v) \frac{N}{|N|}$$

Surface is displaced in direction of normal according to displacement in bump table,  $B(u, v)$



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## Bump Mapping Normal Vector

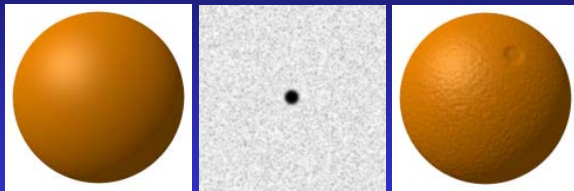


Display:



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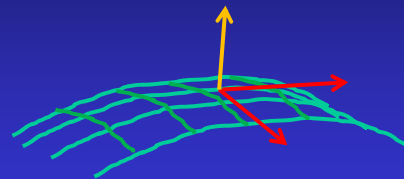
## Bump Mapping



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## Bump Mapping Normal Vector

$$N(u, v) = O_u \times O_v$$



## Bump Mapping Normal Vector

$$O'(u, v) = O(u, v) + B(u, v) \frac{N}{|N|}$$

$$N(u, v) = O_u \times O_v$$

$$N'(u, v) = O'_u \times O'_v(u, v)$$

$$O'_u(u, v) = O_u(u, v) + B_u(u, v) \frac{N}{|N|} + B(u, v) \left( \frac{N}{|N|} \right)_u$$

$$O'_v(u, v) = O_v(u, v) + B_v(u, v) \frac{N}{|N|} + B(u, v) \left( \frac{N}{|N|} \right)_v$$

## Bump Mapping Normal Vector

$$N'(u, v) = O'_u(u, v) \times O'_v(u, v)$$

Assume B is small - too small to deal with

$$O'_u(u, v) = O_u(u, v) + B_u(u, v) \frac{N}{|N|} + B(u, v) \left( \frac{N}{|N|} \right)_u$$

$$O'_v(u, v) = O_v(u, v) + B_v(u, v) \frac{N}{|N|} + B(u, v) \left( \frac{N}{|N|} \right)_v$$

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## Bump Mapping Normal Vector

$$N(u, v) = O_u \times O_v$$

$$N'(u, v) = O'_u \times O'_v(u, v)$$

$$O'_u(u, v) \approx O_u(u, v) + B_u(u, v) \frac{N}{|N|}$$

$$O'_v(u, v) \approx O_v(u, v) + B_v(u, v) \frac{N}{|N|}$$

$$N'(u, v) = \underbrace{O_u \times O_v}_{= N} + \underbrace{B_u \left( \frac{N}{|N|} \times O_v \right) + B_v \left( \frac{N}{|N|} \times O_u \right)}_{= D(u, v)} + \underbrace{B_u B_v \left( \frac{N \times N}{|N|^2} \right)}_{= 0}$$

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## Bump mapping examples



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## Bump Mapping Example



← NVIDIA

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