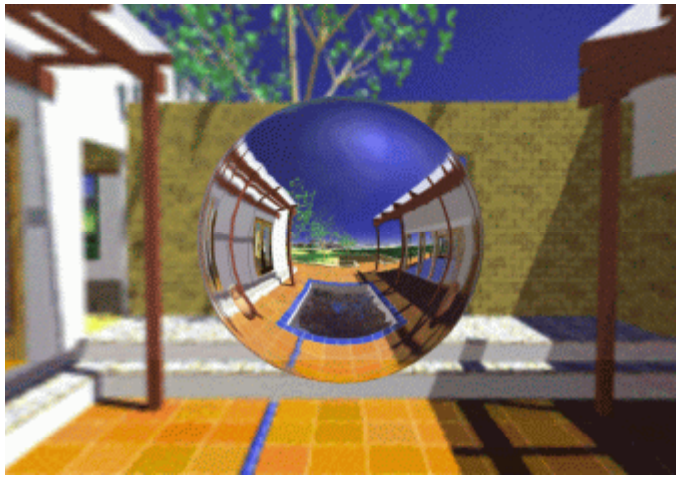
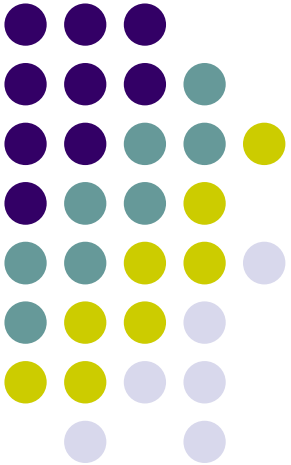
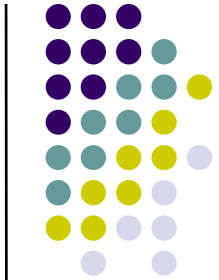
Environment Mapping



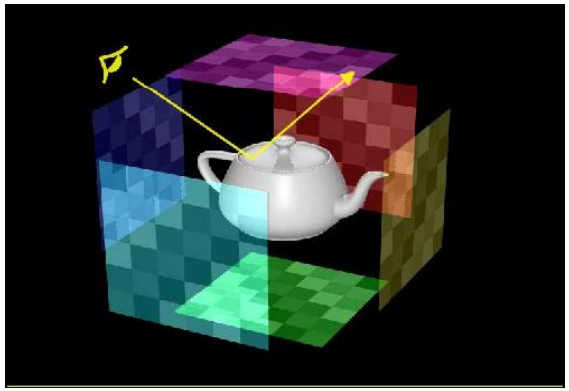


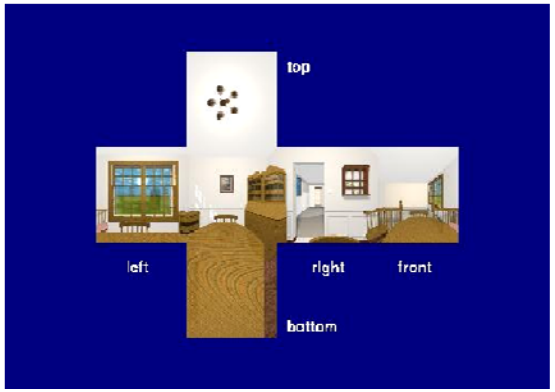
Han-Wei Shen

Environment Mapping

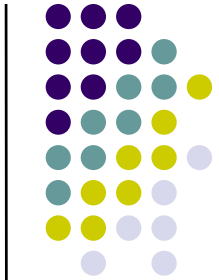


- Also called reflection mapping
- First proposed by Blinn and Newell 1976
- A cheap way to create reflections on curved surfaces – can be implemented using texture mapping supported by graphics hardware

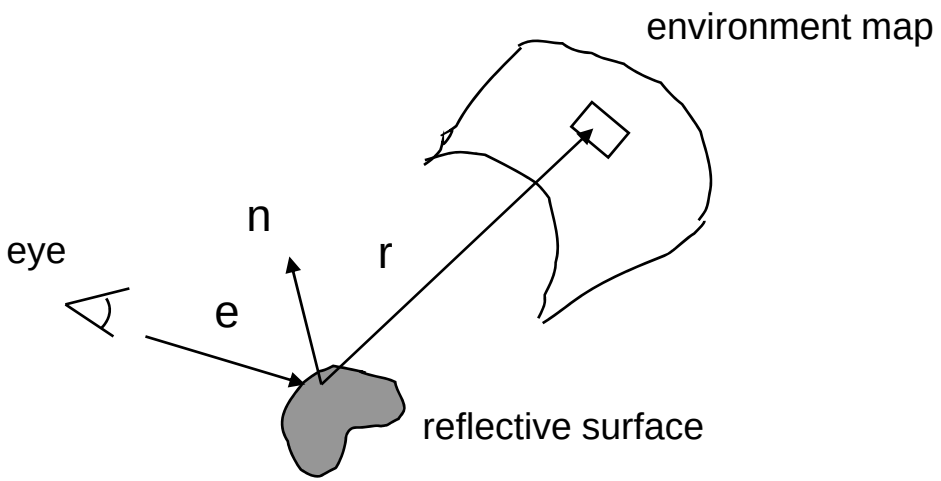


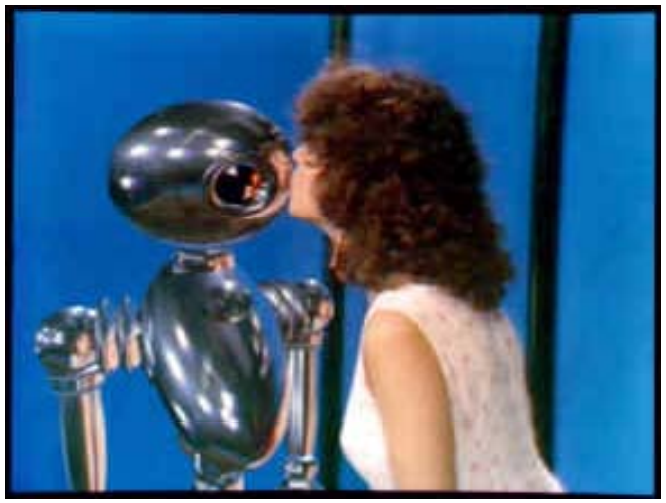


Basic Idea

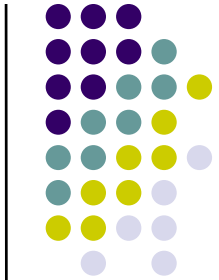


- Assuming the environment is far away and the object does not reflect itself – the reflection at a point can be solely decided by the reflection vector





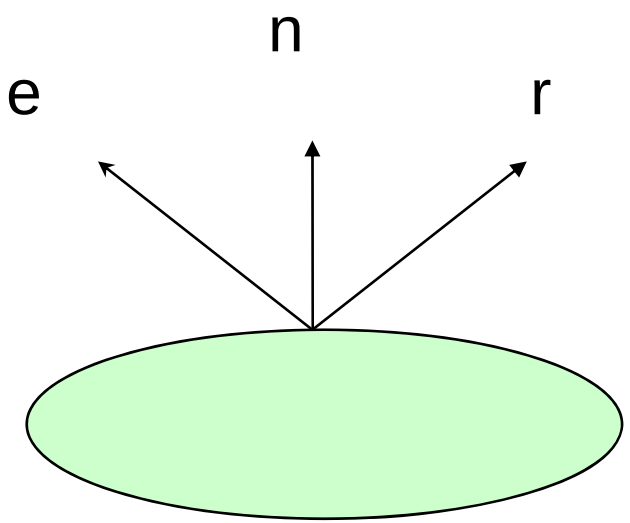
Basic Steps



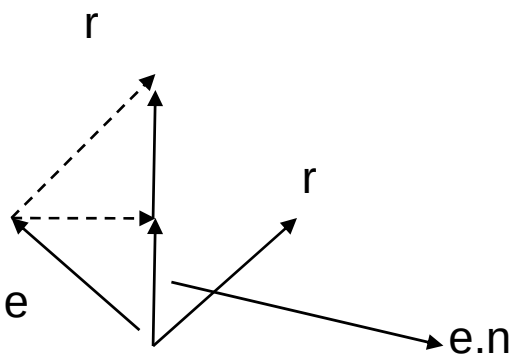
- Create a 2D environment map
- For each pixel on a reflective object, compute the normal
- Compute the reflection vector based on the eye position and surface normal
- Use the reflection vector to compute an index into the environment texture
- Use the corresponding texel to color the pixel

Finding the reflection vector

- r = 2 (n.e) n - e

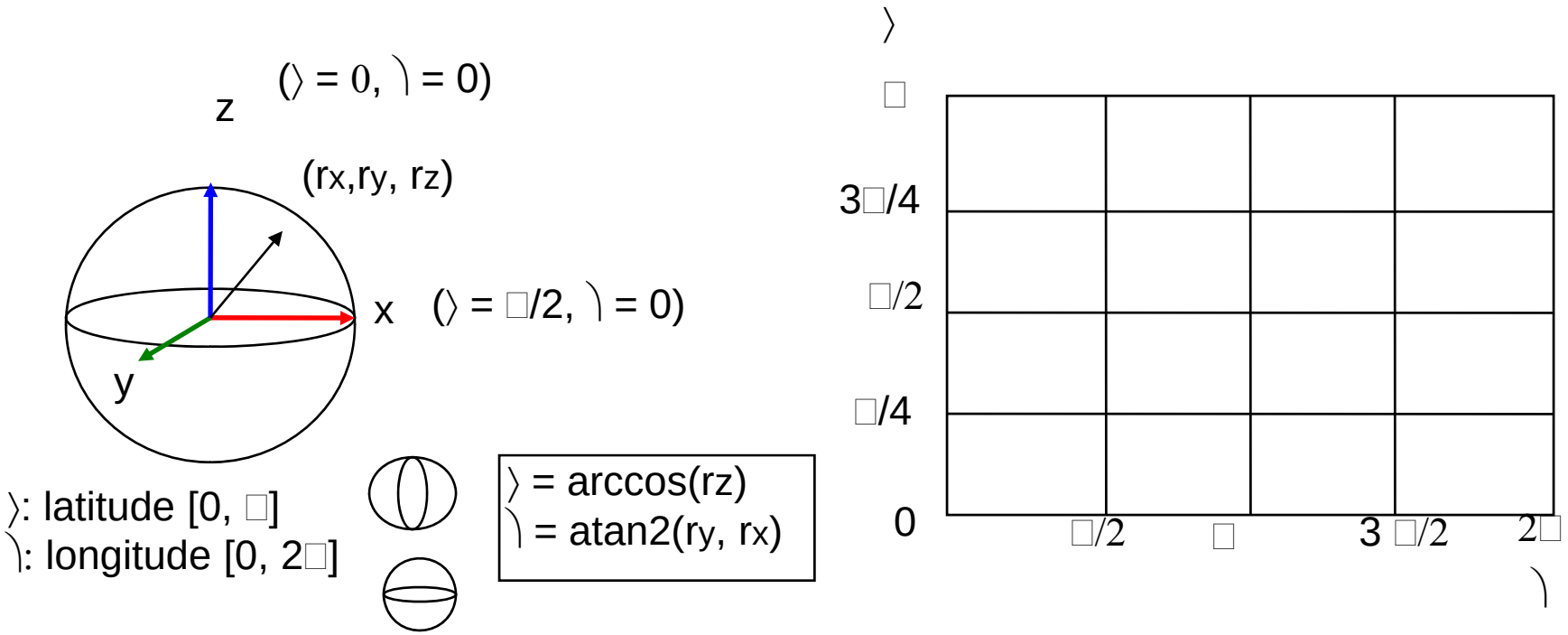


Assuming e and n are all normalized

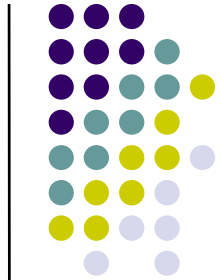


Blinn and Newell's

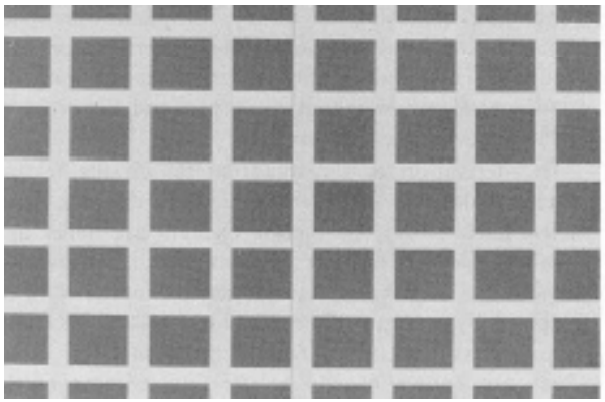
- Blinn and Newell's Method (the first EM algorithm)
- Convert the reflection vector into spherical coordinates (⟩,⟨), which in turn will be normalized to [0,1] and used as (u,v) texture coordinates

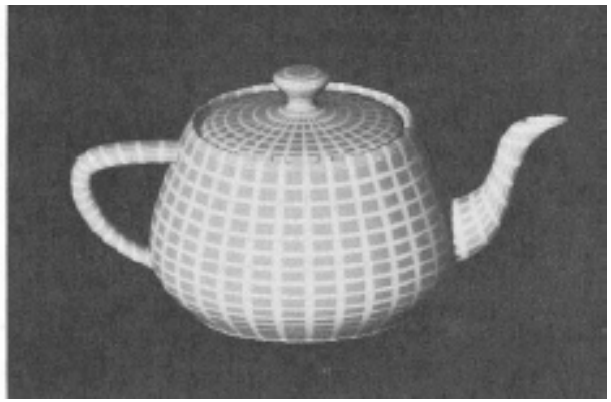


Issues

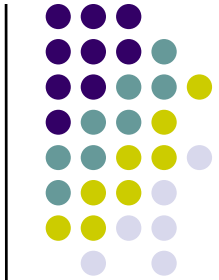


- Seams at $\theta = 0$ when the triangle vertices span over
- Distortion at the poles, and when the triangle vertices span over
- Not really been used much in practice

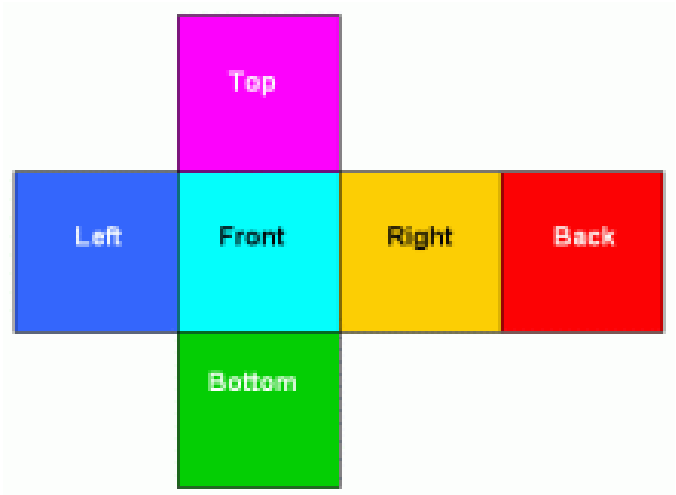


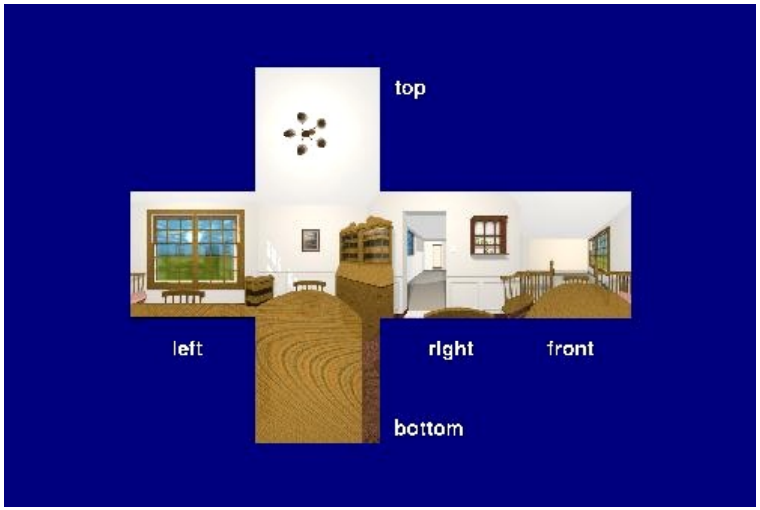


Cubic Environment Mapping

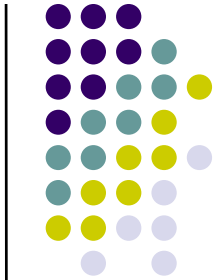


- Introduced by Nate Green 1986 (also known as environment cube map)
- Place the camera in the center of the environment and project it to 6 sides of a cube



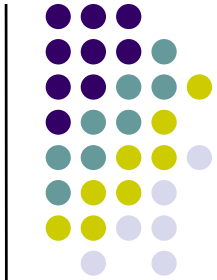


Cubic Environment Mapping (2)

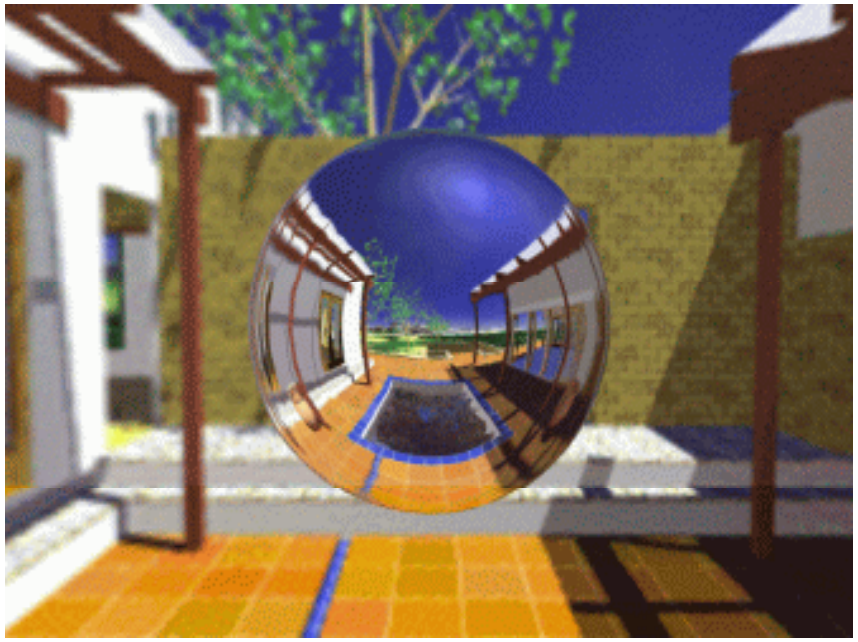


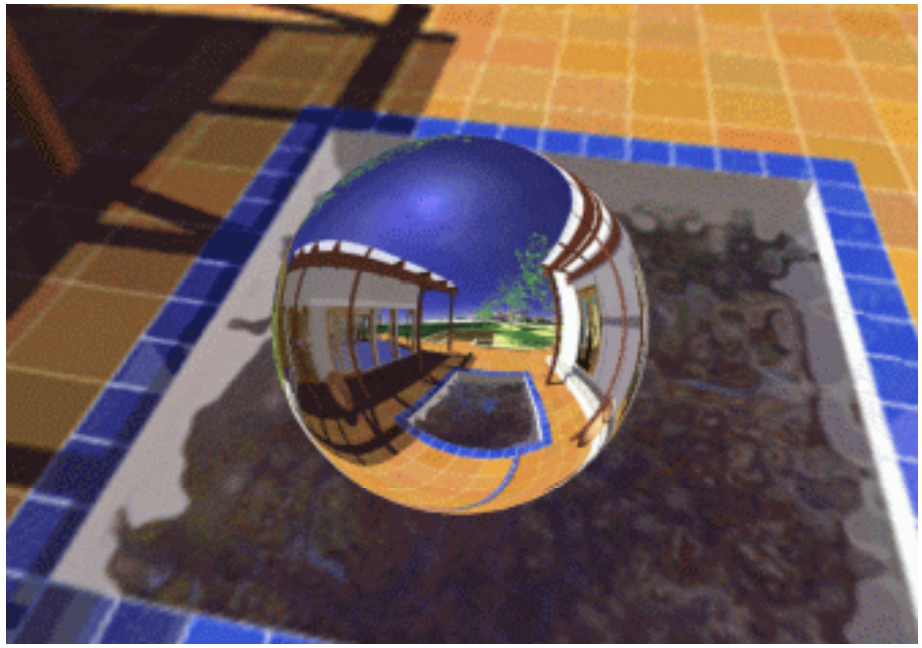
- Texture mapping process
  - Given the reflection vector (x,y,z), first find the major component and get the corresponding plane. (-3.2, 5.1, -8.4) -> -z plane
  - Then use the remaining two components to access the texture from that plane.
    - Normalize them to (0,1)
    - (-3.2, 5.1) -> ((-3.2/8.4)/2+0.5, (5.1/8.4)/2+0.5)
    - Then perform the texture lookup
- No distortion or seam problems, although when two vertices of the same polygon pointing to different planes need to be taken care of.

Environment Cube Map



- Rendering Examples





Sphere Mapping

- The image texture is taken from a perfectly reflective sphere, which is viewed from the eye orthographically.
- Synthetic scene can be
- generated using ray tracing

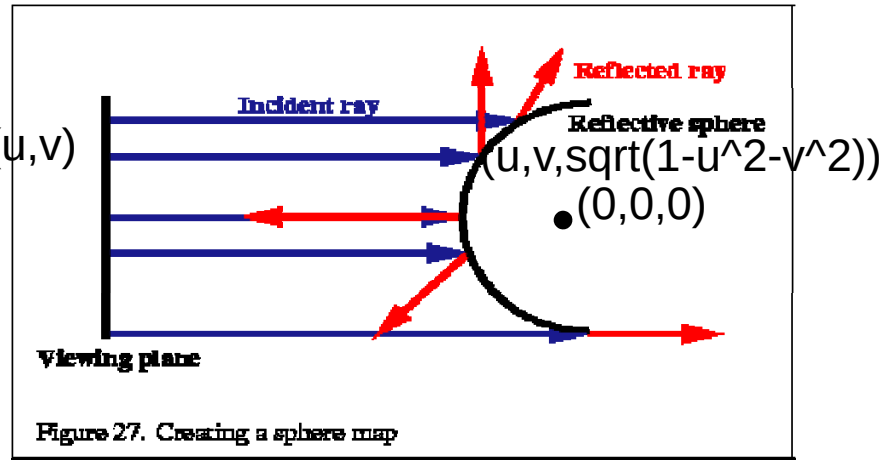
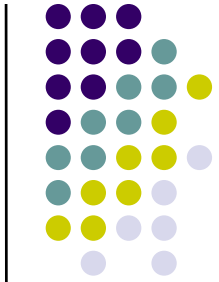


Figure 27. Creating a sphere map

Sphere Mapping (2)



- To access the sphere map texture
  - The surface normal (n) and eye (e) vectors need to be first transformed to the eye space
  - Then compute the reflection vector as usual
  - (r = (rx,ry,rz) = e'-2(n'.e')n')
  - Now, compute the sphere normal in the local space n = (rx,ry,rz) + (0,0,1)

reflection vector Directoin to the eye in local space

  - Normalize it and use x and y to access the sphere texture map: u = rx / M + ½ ; v = ry /M + ½;
  - where M = 2 sqrt(rx^2 + ry^2 + (rz+1)^2)