

Johns Hopkins
Engineering for Professionals
605.767 Applied Computer Graphics

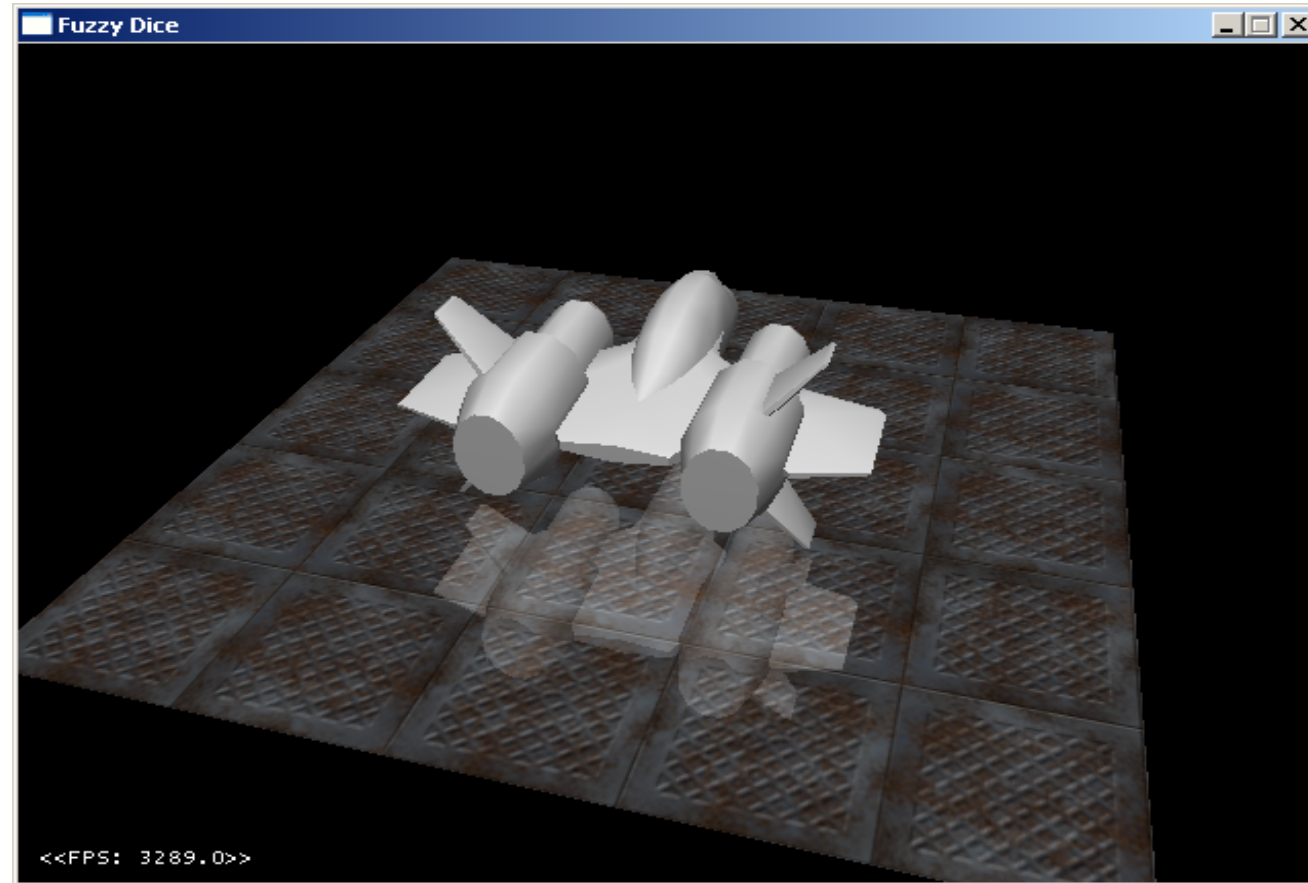
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Module 8G

Reflections



Reflections



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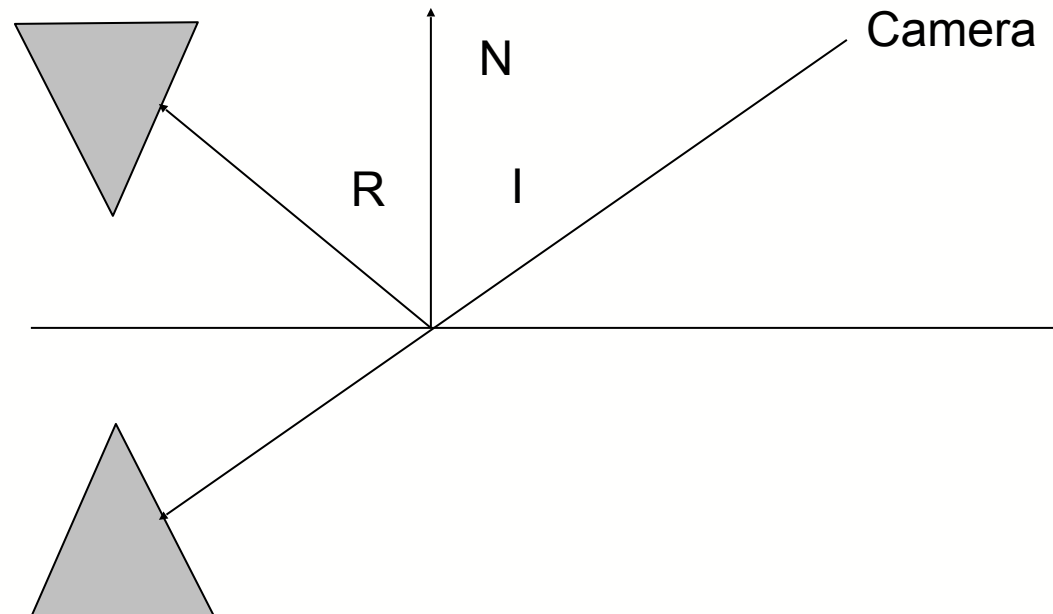
Reflections

- Reflections are an integral part of ray tracing solutions
- Reflections are problematic for real-time rendering
 - Specular reflection handles “reflection” of light off a surface
 - Creates highlight
 - No reflection of objects in each other
- Reflections add to realism of a scene
- Definitions
 - Object with a reflecting surface is called **reflector**
 - Geometry that is reflected in the reflector is called **reflected geometry**
- Methods for adding reflections to real-time rendering
 - Planar reflections
 - Environment mapping



Planar Reflections

- Planar reflection is reflection off a flat surface
 - Reflections follow law of reflection
 - Angle of incidence (I) = Angle of reflection (R)
- Reflected object is simply the object itself reflected through the plane



Constructing Planar Reflection Matrix

- Reflection in the ground plane
 - Simply the mirror scaling matrix
 - If xy is ground plane simply scale by (1, 1, -1)
 - Normal to reflecting plane is (0,0,1)
- Reflection in general plane
 - Construct reflection matrix M by:
 - Translate the reflecting plane to pass through the origin
 - T(-P) where P is a point on the reflecting plane
 - Rotate the normal of the reflecting plane so it aligns with z axis
 - Reflect about the z axis (scale 1, 1, -1)
 - Undo the rotation
 - Undo the translation

$$R = \begin{bmatrix} 1 - 2N_x^2 & -2N_xN_y & -2N_xN_z & 2(P \cdot N)N_x \\ -2N_xN_y & 1 - 2N_y^2 & -2N_yN_z & 2(P \cdot N)N_y \\ -2N_xN_z & -2N_yN_z & 1 - 2N_z^2 & 2(P \cdot N)N_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Code from OpenGL developers code site:

www.opengl.org



Rendering Planar Reflections

- Render the scene as follows:
 - Draw objects to be reflected
 - Transformed by R
 - Draw the rest of the scene with the reflector included
 - Reflector must be partially transparent
 - Reflected geometry color blends with the reflector color/texture



Rendering Planar Reflections (cont.)

- Issues:
 - Reflected objects may not be contained within reflector
 - Solution: use stencil buffer
 - Draw the reflector into the stencil buffer
 - Set to write to framebuffer only where stencil buffer is set
 - Render the reflected geometry with stenciling turned on
 - Reflected geometry will only appear on the reflector
 - Only reflect objects in front of the reflector
 - Otherwise will add geometry not actually present!
 - Solution: use clipping planes to clip geometry on far side of reflector plane
 - Camera control: camera must be on same side of reflector



Environment Map Reflections

- Use a framebuffer object and texture memory
 - Multiple rendering passes
 - Render the scene from the reflected surface point of view
 - Store image in a texture memory
 - Use resulting texture in subsequent passes
- Discussed in Module 9

