CMSC 335
COMPUTER GRAPHICS

LECTURE 9

• EXTRA LIGHTING DETAILS
• ENVIRONMENTAL EFFECTS
• SKYBOXING
EMISSION MAPPING

• Often, lighting includes an emission component, e.g., an object that emits light.

• A model will come with an extra emission texture map to look up a value $k_e$ for any point on the model.

• This becomes an additive component to the ADS lighting model:
  $$L_{tot} = L_{ADS} + k_e$$

• For ray tracing, this implies the model itself is a light source
FOG EFFECTS

• Basic idea is to add a fog color $c_f$ to ADS lighting (object) color $c_{ADS}$ that attenuates based on how far away from the camera you are $d$.

• Simple fog "box", defined by a start/end distance ($f_s/f_e$) (linear attenuation):
  \[
  f = \frac{f_e - d}{f_e - f_s}
  \]

• Density based fog ($\rho$):
  \[
  f = e^{-\rho d} \text{ or } f = e^{-\rho d^2}
  \]

• Final color is blended by $f$:
  \[
  c = c_f (1 - f) + c_{ADS} f
  \]
SKY AND BACKGROUND
ENVIRONMENTAL MAPPING

• Key idea of environmental mapping is that the illumination color for an object is based on light coming from far away. This is dependent on a direction to the far away background.

• Further, we can explore simple techniques for modeling an intricate background.

• Techniques extend easily to both ray tracing and rasterization.
SKYBOXES

A simple technique for adding a background is called **skyboxing**

- Instantiate a cube object surrounding the scene
- Texture the inside of the cube with the desired environment (texture cube map)
SKYBOX DETAILS

• The texture coordinate values are well defined
  • Note they "wrap around" the camera

• Textures themselves need to ensure seams are seem-less
SKYBOX DETAILS

• How can we make a box avoid distortion but appear distant?

• Basic idea:
  • Disable depth testing and render the skybox first (allows the box to physically be close and of high resolution, but isn’t close in the depth buffer)
  • Translate the box with the camera eye
SKYDOMES

• A **skydome** is similar to a skybox, but use a half-dome (half-sphere) instead as the outer model for rendering.
SKYBOX VS SKYDOME

• Skydomes are less susceptible to distortion and seams
• Skyboxes have less complex geometry and are faster to render
• Skyboxes are still more common – easier for artists and advantageous in environment mapping.
IMPLEMENTATION DETAILS

• Method 1 – geometric method
  • To view the interior of the cube:
    `glFrontFace(GL_CCW);`
  • To disable depth testing:
    `glDisable(GL_DEPTH_TEST);`
  • To enable depth testing:
    `glEnable(GL_DEPTH_TEST);`
  • Use correct texture coordinates and draw the cube translated at the camera eye
  • The texture coordinate is used to look up the color in the fragment shader

• Method 2 – Using a cube map
  • Use SOIL or Qt to read in the texture as a cube map (3D texture map storing the sides of the cube)
  • Use the position of the fragment as the texture coordinate that is looked up in a fragment shader (uses `samplerCube` type)
  • Better for reducing seams (clamping parameters)
ENVIRONMENT MAPPING

• In environmental mapping, or reflection mapping, the background is reflected onto the surface of an object

• This is a simple trick on texture mapping: use the reflection vector of light to look up a texel from a cube map
SUMMARY

• Adding background detail to scenes is relatively cheap and simple to implement with modifications to standard texture mapping

• As you can see the use of multiple shader programs is extremely useful
  • Background shader
  • Shadow shaders
  • Object shaders vs reflection shaders