02561 COMPUTER GRAPHICS DTU COMPUTE

Worksheet 6: Texture mapping

Reading	Angel: Section 7.4-7.6.
Purpose	The purpose of this set of exercises is to load images and map them onto 3D objects as color textures. This should lead to an understanding of the principles of 2D texture mapping and how it can be used for polygon meshes.
Part 1	Create a rectangle with vertices $(-4,-1,-1)$, $(4,-1,-1)$, $(4,-1,-21)$, $(-4,-1,-21)$. Set up a perspective camera with a $90°$ field of view. Use the default view matrix and draw the rectangle in white on a blue background. Map a procedurally generated checkerboard texture to the rectangle using the following steps. • Create a texture object and bind it as the current 2D texture object. [Angel 7.5.1] • Generate a 64×64 resolution texture image that forms an 8×8 black-and-white checkerboard, and set it to be used with the currently bound 2D texture. [Angel 7.5.2] • Create texture coordinates $(-1.5, 0.0)$, $(2.5, 0.0)$, $(2.5, 10.0)$, $(-1.5, 10.0)$ for your rectangle, such that the texture repeats four times along the width and ten times along the length of the rectangle. Set up the texture coordinates to be received as an attribute in the vertex shader. [Angel 7.5.3] • Set up the texture map as a `uniform sampler2D` in the fragment shader and link this sampler to the default texture (`0`). Pass the texture coordinates to the fragment shader and use them to replace the fragment color with a color from the texture map. [Angel 7.5.3] • Set the texture filtering parameters to use nearest point sampling. This ensures texture completeness. You should now be able to draw the texture mapped rectangle. [Angel 7.5.4]
Part 2	Create buttons and/or selection menus that enable you to switch between different texture wrapping modes (repeat or clamp-to-edge) and all six different texture filtering modes (nearest, linear, nearest mipmap nearest, linear mipmap nearest, nearest mipmap linear, linear mipmap linear). [Angel 3.6, 7.5.3, 7.5.4] Explain the effect of the different filtering modes and their influence on texture magnification and minification issues.

Worksheet 6: Texture mapping

Part 3	Start from a diffuse sphere illuminated by a directional light (Part 3 of Worksheet 4). We will now map a texture depicting Earth onto the sphere. To do this, we load the texture from an image file and calculate the texture coordinates in the fragment shader. Some steps to follow: • When initializing the texture, load the texture image from the file `earth.jpg` (available on CampusNet). [Angel 7.5.2] • The next step is to pass the normal of the sphere to the fragment shader and use it to calculate the texture coordinates. The normals define points on the unit sphere. The unit sphere is then an intermediate surface to which we can map texture coordinates. Use spherical coordinates to define the relation between a surface normal (a point on the unit sphere) and the texture coordinates (u and v). [Angel 7.4] • Invert the relation you found using inverse trigonometric functions. Use the resulting formula in the fragment shader to calculate texture coordinates from the surface normal. An atan2 function is needed to get the signs right. In GLSL, the atan2 function is simply to use `atan(y, x)` instead of `atan(y/x)`. • Use the color found by texture look-up as k_d and k_a of the sphere and illuminate the sphere by a directional source and an ambient source. [Angel 6.3.1, 6.3.2, 7.5.3] • Spin the globe. The earth texture has high resolution leading to minification issues, especially in the mountain ranges during a spin. Choose a filtering option that betters these minification issues without too much blurring of the texture. Explain your choice. [Angel 7.5.4]
Part 4 (optional) **Think of this as a project proposal.**	Create texture coordinates for the triangle mesh that you rendered in Worksheet 5 and include these texture coordinates in the OBJ file when the mesh is exported. Create or find texture images and use them for texture mapping of your triangle mesh. Modify your rendering of the triangle mesh such that it includes texturing of the object surfaces.