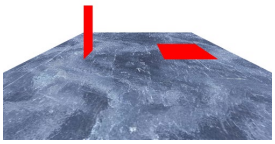
02561 COMPUTER GRAPHICS DTU COMPUTE

Worksheet 8: Projection shadows and render pipeline

Reading	RTR: 7-7.1, 6.6
Purpose	The purpose of this set of exercises is to produce simple shadows using projection matrices. As a byproduct, the aim is to get a better understanding of the rasterization pipeline. We are only concerned with generating the shadows – this means that the Phong illumination model is not needed for this set of exercises.
Part 1 Scene 	The scene to be rendered consists of three quadrilaterals (quads). One is a large texture mapped quad in the plane $y = -1$ ($x \in [-2, 2], z \in [-1, -5]$), the others are smaller quads colored red. Let us refer to the large quad as the ground. One of the two smaller quads should be parallel to $y = -1$, but placed above the ground ($y = -0.5, x \in [0.25, 0.75], z \in [-1.25, -1.75]$). The other should be perpendicular to $y = -1$ with two vertices intersecting the ground ($x = -1, y \in [-1, 0], z \in [-2.5, -3]$). Create a WebGPU program that draws this scene. Here are some steps: • Start from Part 1 of Worksheet 6. Use the coordinates given above to set the vertex coordinates of the ground. Adjust the texture coordinates of the ground so that the texture fills out the square without being repeated. • Replace the checkerboard texture by the texture image in `xamp23.png` (available on DTU Learn). • Create a new texture of 1×1 resolution, where you store just a single red color: `Uint8Array([255, 0, 0, 255])`. • Add the two smaller quads to your vertex and texture coordinate buffers. Draw the ground quad with the texture image and the smaller red quads with texture the texture that is just red. Hints: Create two different bind groups: one using the marble texture loaded from `xamp23.png` and one using the red texture. In the render pass, set the first bind group when drawing the ground quad and the second bind group when drawing the two red quads. For Part 2, create a third bind group that uses the red texture but a new uniform buffer for the model matrix to be used for the projection shadows. Use the third bind group when drawing the shadow polygons.

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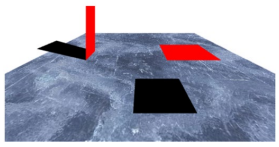
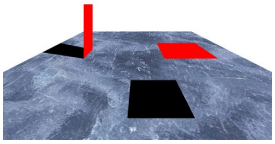
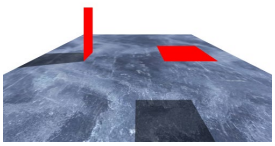
Part 2 Projection shadows 	A light source position is needed to cast shadows. Introduce an animated point light that moves in a circular path parallel to the xz-plane with circle center $(0, 2, -2)$ and radius 2. Implement projection shadows using the following steps. • Create a projection matrix $\boldsymbol{M}_s$ that projects geometry onto the ground plane $y = -1$. This means that the normal of the plane is $\boldsymbol{n} = (0,1,0)$ and $d = -\boldsymbol{p} \cdot \boldsymbol{n} = 1$ in the equation of the plane, where $\boldsymbol{p}$ is a point in the plane. • Use this projection matrix as the model matrix for shadows and draw the smaller quads again but as shadow polygons. Note that drawing order is important. Ensure that the shadow polygons are in front of the ground polygon, but behind the smaller quads. • Introduce a uniform visibility variable in your shaders. Use this variable as a multiplication factor to draw the shadow polygons in black.
Part 3 Shadow polygon culling using the z-buffer 	One problem with shadow polygons is that they are drawn even if there is no ground polygon. Use the depth buffer with a depth test function that accepts fragments with greater depth values to draw shadow polygons only if there is also a ground polygon. Handle z-fighting using a small offset of the plane that the shadows are projected to. Hint: Create two pipelines: one for the normal depth test (`"less"`) and one for the depth test to be used for the shadow polygons (`"greater"`). In the render pass, set the second pipeline when drawing the shadow polygons.
Part 4 Ambient light in shadows using transparency 	The black shadows seem too dark. We would like to see a darker version of the ground texture in the shadows. Semi-transparent shadow polygons can achieve this effect. Enable alpha-blending with an appropriate blending function in the pipeline used for drawing the shadow polygons. Select an alpha value of 0.6 for the shadow polygons such that a darker version of the ground texture is seen in the shadows.