ETH zürich

computer graphics laboratory

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Visual Computing
Exercise 10: Lighting and Shading
Solution

Exercise 1) Phong Reflection Model

See source code.

Exercise 2) Reflective Material

See source code.

Exercise 3) Normal Mapping Material

See source code. Note that in the vertex shader the vertex normal is transformed using the inverse of the transposed model matrix ($\boldsymbol{n}' = \boldsymbol{M}^{-T}\boldsymbol{n}$). If **n** is considered to be the normal vector of a plane, this ensures that **n'** will be orthogonal to the *transformed plane*. On the other hand, the vertex tangent and bitangent vectors are transformed using the model matrix **M** without its translational part. Using these transformations, the transformed normal vector will remain orthogonal to both transformed tangents, even if the model matrix contains non-uniform scaling and shearing.

Exercise 4) Skybox

The geometry of the 'skybox' is a single triangle defined in normalized device coordinates. It covers the whole far side of the clipping volume, which ensures that it fills the whole screen (see picture below), and every pixel is located at depth *zFar* in camera coordinates.

The lookup direction for the cube map texture is found by transforming the triangle from device coordinates back to world coordinates using the transformation $(\boldsymbol{PV}')^{-1}$ where **P** is the projection matrix and **V'** is the view matrix without its translational part.