

**Proseminar Visual Computing
Winter Semester 2022**

CG Assignment 3

Hand-out: December 20, 2022

Hand-in: January 09, 2023



Topics

- Lighting and Materials
- Texturing
- Shader Programming
- Skybox and Environment Mapping

Outline

The goal of the Computer Graphics assignments of the Visual Computing PS is to build an animated helicopter. This work is divided into 3 steps. Each step corresponds to a programming assignment. The objective of this assignment is to implement *Blinn-Phong Illumination* in the *Fragment Shader* in GLSL using material properties encoded in textures. In addition, a *Skybox* should be added and used to apply *Environment Mapping*.

Template code

A template code is provided with this assignment. It loads the helicopter mesh, material properties, and textures given by an .obj file. The helicopter controls from the previous assignment are already implemented. Currently, the fragment shader sets the fragment's color according to the diffuse material colors.



Further, code for loading a cube map is available in the files `src/mygl/cube_map.h` and `src/mygl/cube_map.cpp` which can be used to load a skybox. One example cube map that can be used is available in `assets/Maskonaive2`.

Tasks

1. Implement *Blinn-Phong* illumination in the *Fragment Shader* for a directional light and four spotlights with the material properties (color values and shininess) given in the helicopter model (loaded from an `.obj` (`.mat`) file). You should be able to copy paste the code from the previous assignment.
2. Instead of using constant color values for surface materials, use the loaded texture maps (`map_diffuse`, `map_specular`, `map_emission`, `map_ambient_occlusion`) to retrieve these color values for each fragment.

The value from the ambient occlusion map represents the strength of the ambient light reaching a certain surface position. Use this value to multiply the diffuse material to get the ambient material color.



3. Write shaders to render a *Skybox* using *Cube-Mapping*. Code that can be used to load the textures and create the geometry buffers of a *Cube Map* is available in the template code files `src/mygl/cube_map.h` and `src/mygl/cube_map.cpp`. To switch between day and night, multiply the sampled texture from the cube map with the color of the directional light (e.g., sun color).



Further, extend the *Blinn-Phong* rendering to include reflections of the environment. This is done using *Environment Mapping*. For each fragment, the reflection direction is calculated and then used to sample from the cube map. To adjust the reflection strength of different materials, multiply the specular color (from specular map) with the directional light color (e.g., sun color). Add this resulting fragment color to the color calculated with the Blinn-Phong illumination model to obtain the final color. See the resources below for helpful links.



4. At last, write/draw the names of the group members or something similar somewhere on the helicopter, by modifying the diffuse texture of the helicopter body. It should be visible in the rendering of the scene.

Implementation Remarks

Make sure that your code is clear and readable. Write comments if necessary. Your solution should contain a readme file with names of the team members, list of keyboard controls, and any explanation that you think is necessary for the comprehension of the code.

Submission and Grading

Submission of your solution is due on January 09th, 2023 (23:59). **Submit the sources** (i.e., only the content of the `src` folder) + the modified diffuse texture (or a screenshot of the rendered helicopter with it) in a ZIP archive via OLAT. Do not submit the executable and the content of the `build` folder. Do not submit the external dependencies either. Both folder and archive should be named according to the following convention:

Folder: **CGA3_<lastname1>_<lastname2>_<lastname3>**

Archive: **CGA3_<lastname1>_<lastname2>_<lastname3>.zip,**

where <lastname1>, etc. are the family names of the team members. Development in teams of two or three students is requested. Please respect the academic honor code. In total there are 15 marks achievable in this assignment distributed as follows:

- Blinn-Phong implementation from last assignment (**2 marks**)
- Use textures to map material properties to fragment (**5 marks**)
- Skybox and environment mapping (**5 marks**)
- Draw names of group members to texture (**1 mark**)
- Code readability, comments, and proper submission: (**2 marks**)

Resources

- Lecture and Proseminar slides as well as code and information are available via OLAT.
- OpenGL homepage
<http://www.opengl.org>
- OpenGL 3.3 reference pages
<https://www.khronos.org/registry/OpenGL/specs/gl/glspec33.core.pdf>
- OpenGL Tutorial for Blinn-Phong Illumination with textures
<https://learnopengl.com/Lighting/Basic-Lighting>
<https://learnopengl.com/Lighting/Lighting-maps>
- OpenGL Tutorial for Cube Maps, Skyboxes and Environment Mapping
<https://learnopengl.com/Advanced-OpenGL/Cubemaps>
- GL Framework GLFW
<https://www.glfw.org/documentation.html>

Note: Be mindful of employed OpenGL and GLSL versions!