Computer Graphics

Prof. Dr. F. Sadlo, M.Sc. Y. Agapov, M. Tabachnik · *Heidelberg, October 29, 2019*

Exercise Sheet 3

Assignment 2.1 Preprocessor [2 Points]

Both C and C++ use a so-called preprocessor which executes actions before the actual compilation process starts. The preprocessor can be controlled by using preprocessing directives which start with a '#'. Consider a preprocessor macro `#define SQUARE(a) a*a`, which should square a given value a.

a) Given the macro, write a program that calculates the following function values for $f(x) = x^2, g(x) = (1 - x)^2$, and $h(x) = 1/x^2$ with input values $x = 1, ..., 10$. [*1 Point*]

b) Why do you get correct results for the function f, but not for g and h? [*0.5 Points*]

c) Alter the macro in a way that all functions return the correct result. [*0.5 Points*]

Assignment 2.2 Output Devices [2.5 Points]

Consider a display with a UHD resolution (3840×2160 pixels), with a refresh rate of 60 Hz.

a) How much time may the generation of a single pixel at most take? For the sake of simplicity, ignore any potential overhead in the process of the pixel generation. [*1 Point*]

b) For the signal transmission from the graphics card to the monitor, assume a data load of 24 bit per pixel, and shortly explain why this assumption is meaningful. Afterwards, determine the bandwidth (in GB/s) of a cable that connects such a monitor. [*1.5 Points*]

Assignment 2.3 Basic Concepts [3 Points]

Explain the following concepts and, if applicable, their difference in a few sentences.

a) Rasterization and raytracing [*0.5 Points*]

b) Image-based and object-based rendering [*0.5 Points*]

c) Implicit and parametric representation [*0.5 Points*]

d) Barycentric coordinates: How are they computed? How can they be used to determine whether a point is located within a triangle? What properties do they have? [*1.5 Points*]

Assignment 2.4 Lighting Models [3 Points]

Explain in your own words:

a) What are the roles of the three different parts in the Phong shading model (ambient, diffuse, specular)? [*1 Point*]

b) What is the role of the exponent in the specular component? [*0.5 Points*]

c) Why do we sometimes use multiple face normals per vertex, while sometimes we only use one? How are vertex normals computed from face normals and why is a subsequent normalization of the result necessary? [*1 Point*]

d) How can Phong shaded surfaces appear smooth, but their silhouettes appear sharp?
[*0.5 Points*]

Submission: November 5, 2019, 14:15 CEST, via Moodle