Homework 2
Path tracing

Advanced computer graphics 2020/21

1 Introduction

The goal of this homework is to get familiar with path tracing and the use of different light sources and materials in physically based rendering. Your task is to extend the path tracing framework provided with the homework and implement a basic path tracing algorithm (section 3), spherical lights (section 4) and the Oren-Nayar material (section 5). The homework also has some optional extensions. The homework must be turned in before April 30, 2021. You will have to defend the homework at the laboratory exercises. The homework is worth 10 % of the final grade. The defense of the homework after the deadline lowers the maximum worth: 1-week extension: 7 %, 2-week extension: 5 %.

2 The path tracing framework

For implementation of the homework you may use the provided framework. The framework is developed in C# and includes basic math and support for easier implementation of a path tracer. It is loosely based on the PBRTv3 rendering framework,[1] developed by authors of book Physically Based Rendering.[2]

Optional: You can create your own Path tracing framework to implement the homework.

3 Implementation of path tracing

Implement the main path tracing method in the framework (within PathTracer.cs), which uses Russian roulette for stopping and importance sampling for choosing ray directions.

Optional: Provide appropriate support for light sampling with specular materials, such as the provided SpecularReflection.cs.

4 Lights

Extend the framework with support for spherical light sources. The source of the light is a surface of a sphere positioned within the scene. The user must be able to set the radius of the sphere and the side of light emission (outside, inside). Implement uniform sampling of light rays from the surface. An example of a light is already provided by the disk light (Disk.cs).

5 Materials

Implement the Oren-Nayar material in the framework. The template file is Lambertian.cs. The BRDF is defined as

$$f_r(\omega_o,\omega_i) = \frac{k_d}{\pi}(A + B\max(0,\cos(\phi_i-\phi_o))\sin\alpha\tan\beta),$$

$$A = 1 - \frac{\sigma^2}{2(\sigma^2+0.33)},$$

$$B = 0.45\frac{\sigma^2}{\sigma^2+0.09},$$

$$\alpha = \max(\theta_i,\theta_o),$$

$$\beta = \min(\theta_i,\theta_o),$$

[1] `https://github.com/mmp/pbrt-v3`
[2] `http://www.pbr-book.org/`

where k_d is albedo, σ is the roughness parameter, and (ϕ_i, θ_i) and (ϕ_o, θ_o) are the spherical parametrizations of ω_i and ω_o, respectively.

Optional: Implement a new BSDF material (Glass) with support for Specular Transmission for transparency and caustics. Use Fresnel's equations for determining the amount of transmitted light and Implement Snell's Law for refraction. You can look at the implementation of SpecularReflection.cs. Implement a new BRDF material (Aluminum). You can find the appropriate BRDF properties online.[3]

6 Outputs

The expected outputs of this homework are example renderings (images), displaying the implemented features.

7 Grading

This assignment is worth 10 points:

- 4 points for the implementation of path tracing,
- 3 points for the spherical light, and
- 3 points for the Oren-Nayar material.

[3] `https://www.merl.com/brdf/`