Leopold-Franzens-Universität Innsbruck

Institute of Computer Science
Interactive Graphics and Simulation Group

Raytracing Project

Advanced Computer Graphics
Documentation

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1 Introduction

For this project we had to implement certain advanced features based on smallPT. Every student in one group had to implement at least one main feature. In our group we chose Motion Blur (by Cem Okulmus), Depth of Field (by Stefan Spiss) and Specular/Texture/Normal Mapping (by Philipp Mildenberger). Additionally in our project extra features were implemented, such as: Acceleration Structures (by Philipp Mildenberger), simple Camera Control (by Stefan Spiss).

2 Technical Overview

SmallPT was extended by .obj import and complex geometry now supporting triangle meshes. Additionally a bounding volume hierarchy (BVH) is used to speed up the calculation of complex scenes. Texture-/normal- and specular-mapping is implemented to generate more realistic images. Furthermore to simulate a camera, Depth of Field provides correct blurring of objects that are not in focus. It's now also easy possible to move the camera around, change it's focal distance, it's field of view and it's aperture size. To capture movements in still pictures the effect of Motion Blur is approached by simulating the aperture shutter speed.

3 Implementation Detail

In this section we will give a short explanation on every implemented feature. All of these are extensions of the smallPT code.

3.1 Motion Blur

As was explained during the lecture, the basic idea behind this effect is that we want to distribute the rays not in space but in time. For this we usually also want to have some sort of animation, otherwise the effect wouldn't show. This method was first detailed by Cook et ali. [] Since smallPT also uses a distribution over space, only an extension of this was needed. The rays are uniformally distributed over time, with equal weight for all time steps.

3.2 Depth of Field

In standard smallPT the pinhole camera model is used. So everything in the scene is in focus. Normal cameras always have a Depth of Field, which means that only objects in a specific distance are in focus. Everything else is blurred depending on the distance to the focal point. In the project implementation the Thin-Lens model is used. For this the ray direction is changed. Rays are shot not only from one camera position, but distributed over the aperture circle. As target for the rays, the focal plane is used instead of the image plane.

3.3 Specular/Texture/Normal Mapping

UV mapping from obj-files is supported, including import of color, specular and normal data. For specular mapping a new material had to be created: Glossy surface. It's used to supply specular data with a texture. The normal mapping is changing the intersection normal for depending on the texture for the surface. For every intersection we return a special intersection structure, additionally containing the needed data for specular/normal/texture mapping.

3.4 Acceleration Structures

To accelerate the intersection of complex triangle-meshes in smallPT, we implemented different acceleration structures. The first is just simple approach: A bounding box is put around every object, and the intersection function first checks every bounding box and only continues if one was hit. The second is a Bounding Volume Hierarchy (BVH). An octree is used to build up the hierarchy recursively: Every object is inserted using its centroid. From these objects, using bottom-up traversal, the BVH is constructed.

4 Discussion

An example image is provided in Fig. 1. Equation (1) and equation (2) are further examples. Finally, on page 2 is an example of a table.

Using the definition of

$$\sum_i x_i = 0, \tag{1}$$

we can define

$$f_{int} + f_{ext} = 0. \tag{2}$$

A figure follows.

LaTeX

Figure 1: Text describing the figure.

Random text: Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

5 Conclusion

Example literatur is available in [2] and [1].

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number	$axis$	value
1	x	40
2	y	80
3	z	50

Table 1: Example table.

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References

[1] M. Seiler, J. Spillmann, and M. Harders. Enriching coarse interactive elastic objects with high-resolution data-driven deformations. In *ACM SIGGRAPH/Eurographics Symposium on Computer Animation*, pages 9–17, 2013.

[2] Peter Shirley. *Fundamentals of Computer Graphics*. Taylor & Francis, 3rd edition, 2009.