2025-1 Computer Graphics Homework Report

Modeling a Cornell Box Scene

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1. Features Overview & User Guide

1.1. Overview

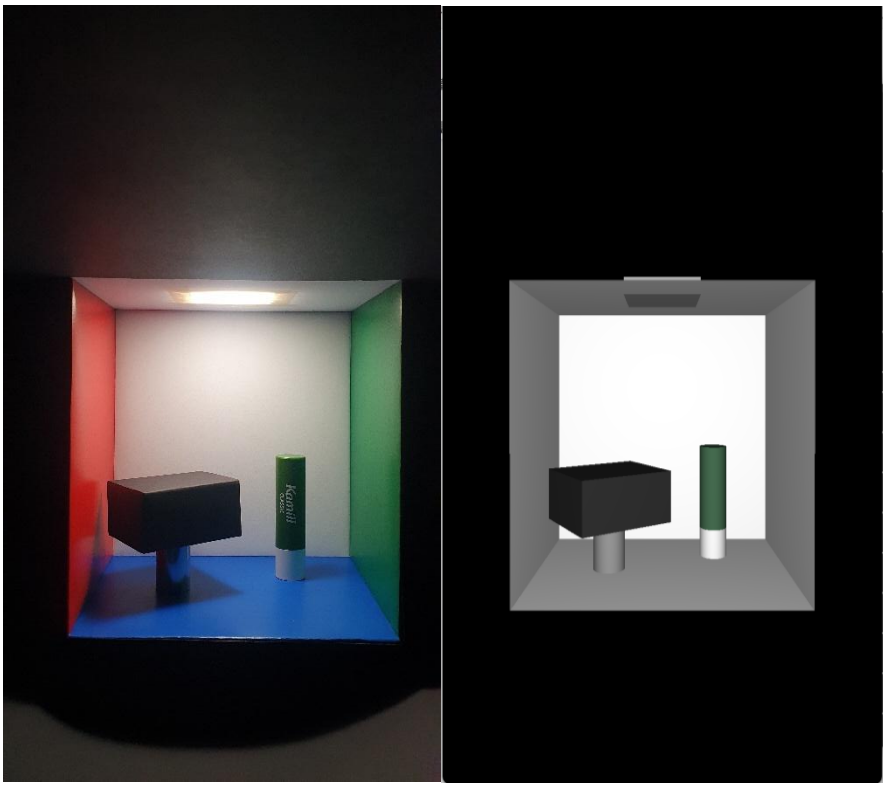

Figure 1. Cornell box image(left) and virtual model(right)

The Cornell Box was implemented in both the physical and virtual environments. The interior of the Styrofoam box was lined with thick black paper to minimize reflections, and five wooden plates were installed to form the walls. Each plate was covered with red, green, blue, or white paper to introduce a variety of colors and reflective interactions. A square hole was cut into the ceiling of the box, covered with two layers of tissue foil to diffuse light, and illuminated from above to create a soft, uniform square light source.

Inside the box, three distinct objects were placed: a black cube, a metal cylinder, and a plastic cylinder. A camera was positioned in front of the box entrance, aligned parallel to the front surface. All dimensions, orientations, and positions of the box, objects, and camera were measured precisely for accurate modeling. Using this setup, a virtual twin was created in Pyglet. All physical dimensions were replicated, and the camera specifications were incorporated to configure the virtual camera's projection matrix accurately. The final results of both the real-world and virtual renderings are shown in Figure 1.

I believe the slight difference between the two images may be due to automatic cropping functionality.

When I manually crop both images to focus solely on the box area, they appear to be very similar.

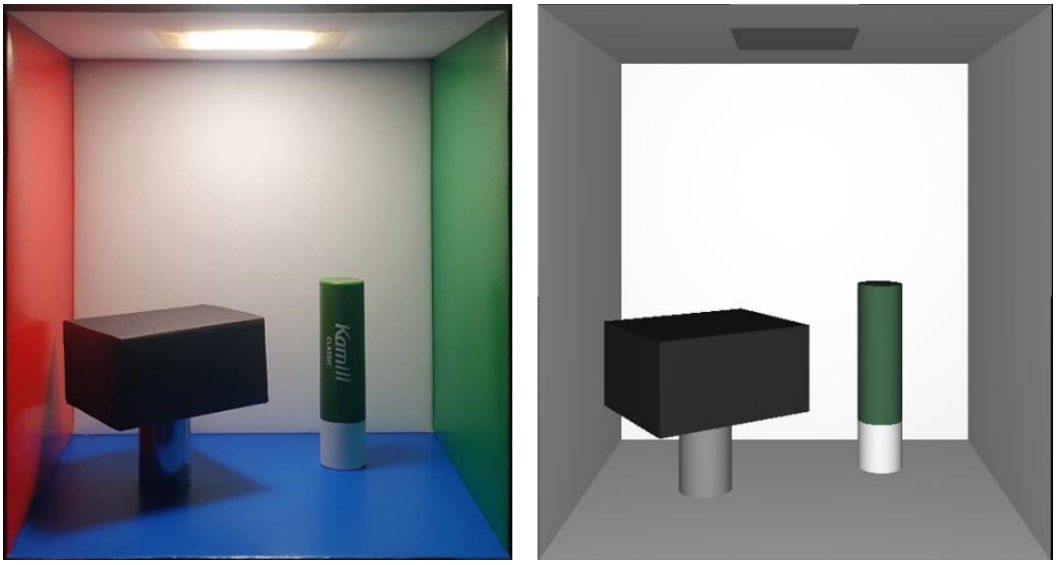

Figure 2. Cropped version of the Cornell box image comparison

1.2. Installation

Instructions on how to install and run the program are written in the README.md file. Assuming you properly cloned or downloaded the repository, you can simply activate the Conda virtual environment and see the result by running below lines.

```
cd path/to/cloned/repo/
conda env create -f environment.yml
conda activate cornell_env
python main.py
```

1.3. How to Play

The screen that appears immediately after running is a view from the real-world camera orientation. Also, the aspect ratio is set similarly to the camera (16:9). You can use trackball-viewer and mouse scroll to move around and change the view. Whenever you want to go back to see the initial camera view, press key 1.

Input	Control
key 1	Return to initial viewpoint
mouse drag	Change view angle (Trackball viewer).
mouse scroll	Zoom in/out

Table 1. Control guidelines

2. Implementation

2.1. Cornell Box Dimensions

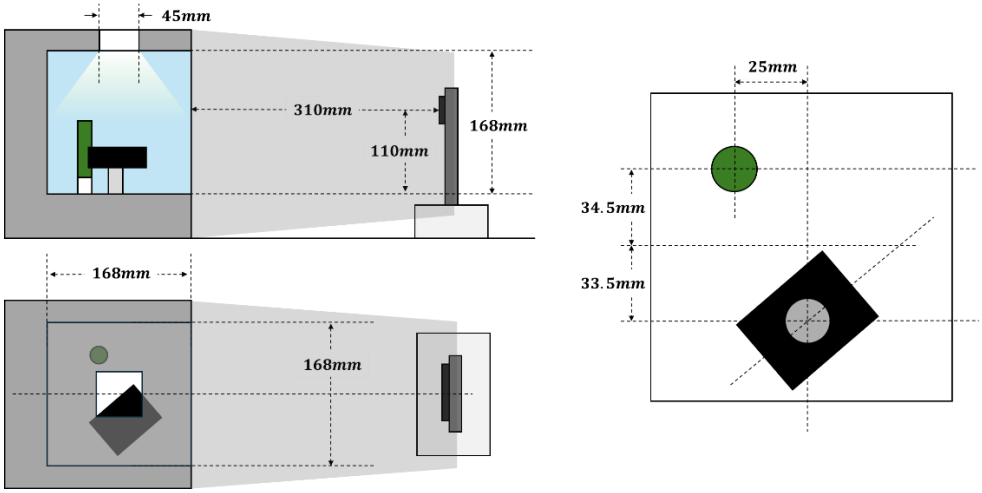

Figure 3. Dimensions of the Cornell box setup

The specific dimensions of the Cornell Box are illustrated in Figure 3. All measurements were taken using vernier calipers with a precision of 0.1 mm. One notable feature of the setup is the implementation of light-shielding walls positioned between the camera and the box. Although the experiment was conducted in a closed room with all lights turned off except for the square ceiling light, additional shielding was constructed to block any indirect light reflected from the room walls. These barriers were arranged to enclose the camera's field of view, forming a short tunnel-like structure to ensure minimal external light interference.

Figure 4. Light shield setup

Inner walls of the Cornell box is red at the left wall, green at the right wall, blue at the floor, white at the back wall and the ceiling. Color texture is created by printing out a RGB colored image with the high-quality printers and covering it around the wooden walls.

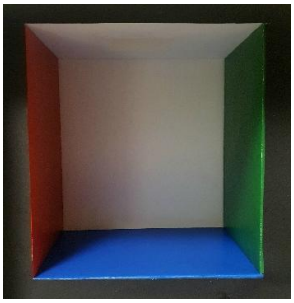

Figure 5. Cornell box inside walls

2.2. Objects

Three different objects are placed inside the Cornell Box. The first is a black cube, constructed from a cleaning sponge block covered with thick black paper. While efforts were made to make it as dark as possible, it still reflects a small amount of light. The second object is a stainless-steel cylinder, specifically a guitar accessory known as a "slide bar." Though it is naturally hollow like a short tube, it was placed vertically on the ground with the black cube positioned on top to cover the opening, allowing it to be treated simply as a solid cylinder. The third object is a white and green textured cylinder, which is a lip gloss container. It has the shape of a perfect cylinder, with the bottom portion entirely white and the upper portion green, featuring some printed text. Figure 7 displays images taken from various angles around the lip gloss, which will be used to create a texture map for the virtual model.

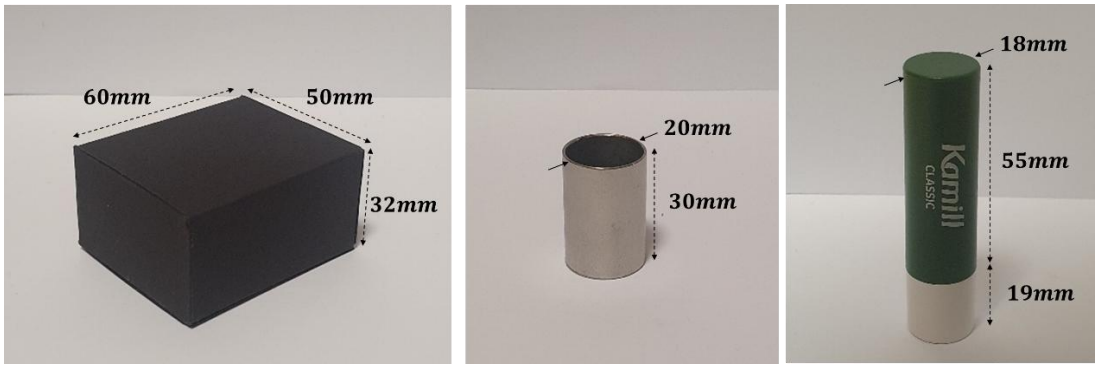

Figure 6. Dimensions of the objects

Figure 7. Texture of the lip gloss side

2.3. Camera Specification

The camera used for taking a picture of the real-world Cornell box, is Samsung Galaxy S10 cellphone camera. Field of view of this camera in normal zoom-lens mode is 77°, and other detailed specifications are unknown. This information is used for setting a camera view projection matrix in the modelling part.

Figure 8. Samsung Galaxy S10

2.4. Scene Modeling

The scene modeling process closely followed the approach used in Homework 1. In addition to the basic geometric shapes implemented previously, a hollow box structure was introduced to form the inner walls of the Cornell Box. This was achieved by modifying a cube: one face was removed, and the vertex normals of the remaining faces were flipped inward to create the appearance of an enclosed interior space.

3. References

[1] SNU MRL, Trackball Viewer, GitHub Repository. Available: https://github.com/snumrl/TrackballViewer

[2] SNU Intelligent Motion Lab, SNU Computer Graphics, GitHub Repository. Available: https://github.com/SNU-IntelligentMotionLab/SNU_ComputerGraphics