

PRACTICAL WORK 2

MATERIALS – LIGHTINGS – SHADOWS

Prerequisites

Cornel box

The Cornell box is a test aimed at determining the accuracy of rendering software by comparing the rendered scene with an actual photograph of the same scene which has become a commonly used 3D test model. It was created by Cindy M. Goral, Kenneth E. Torrance, Donald P. Greenberg, and Bennett Battaile at the Cornell University Program of Computer Graphics for their paper Modeling the Interaction of Light Between Diffuse Surfaces published and presented at SIGGRAPH'84.



The basic environment of the Cornell box consists of:

- One light source in the center of a white ceiling.
- A green right wall.
- A red left wall.
- A white back wall.
- A white floor.

all Lambertian.

In this practical work you will model the Telumen lighting system present in the IXR platform in 3D in order that it has the same characteristics as a Cornell Box.

Physical based rendering

- <http://www.pbr-book.org/>
- <https://marmoset.co/posts/basic-theory-of-physically-based-rendering/>

Exercise 1 – Basic Modeling

Document:

- <https://threejs.org/manual/#en/materials>

Build a 3D model of the Telumen lighting system where you will place on the table:

- At the left: a cone with a MeshLambertMaterial
- At the right: a cylinder with a MeshPhongMaterial
- At the center in front of the cone and the cylinder: a sphere with a MeshPhysicalMaterial

Exercise 2 – Graphic User Interface

Three.js includes since November 2021 a new JavaScript Framework named **lil-gui** (which replaces **dat.gui**) which work in 2D and in 3D (in VR) : <https://lil-gui.georgealways.com/>

- 2D examples in three.js:
 - https://threejs.org/examples/?q=light#webgl_lightprobe
 - https://threejs.org/examples/?q=tonema#webgl_shaders_tonemapping
 - https://threejs.org/examples/?q=curva#webgl_materials_curvature
 - Etc.
- 3D examples in VR in three.js: https://threejs.org/examples/webxr_vr_sandbox.html

Test the 2D GUI interface inside the Exercise 1 by dynamically changing the color of one face of the Cornel Box.

Exercise 3 – Lightings

Document:

- <https://threejs.org/manual/#en/lights>

Create a 3D scene with a GUI which allows to select 4 different lightings coming from the ceiling of the Cornel Box:

- A directional light.
- A point light.
- A spot light.
- A hemisphere light.

For this, use the default parameter values of the 3 materials integrated in your scene and add an ambient light.

The GUI integrated inside your scene will allow to change the available properties for each of these lighting technics (geometric properties, color, etc.).

Exercise 4 – Material properties

Fixe the lighting of your scene with a neutral white ambient light associated with a point light (also white neutral).

Add a GUI which allows to change all the properties for the 3 used materials (transparency, shininess, etc.). If these materials share identical parameters use the same values for all the 3 materials.

These properties must include textures (map, specular map, environmental map, etc.).

Exercise 5 – Surface lighting

Document:

- <https://threejs.org/docs/index.html#api/en/lights/RectAreaLight>
- https://threejs.org/examples/?q=recta#webgl_lights_rectarealight

When the walls of the Cornell box are illuminated they become secondary light sources. In order to improve the realism of the previous scene, associate to each walls a rectangular lighting consistent with its color.

Exercise 6 – Shadows

Document:

- <https://threejs.org/manual/#en/shadows>
- https://threejs.org/examples/?q=shado#webgl_shadowmap_viewer

Add shadows inside the scene created in exercise 3 and create a GUI which allows to change the properties of these shadows (shadow map size, etc.)

Exercise 7 – VR experimentation

Example:

- https://threejs.org/examples/?q=VR#webxr_vr_sandbox

Transform exercise 5 into a VR experience (with the gui like https://threejs.org/examples/?q=vr#webxr_vr_sandbox)