

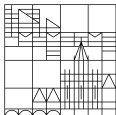
Global Illumination Methods

Practical Course

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Work Package III

Tasks

1. Reflection
2. Refraction
3. Rough surfaces (optional)
4. Shadows
5. Clouds and Fog (optional)

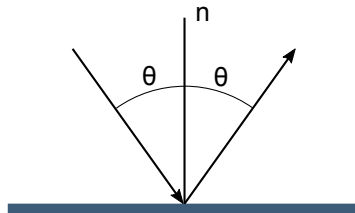
Date

This assignment is due **January, 9th**. Please bring your Laptop to class.
If you have any questions regarding the assignment, just write us an email.

Task 1

Reflection

- ▶ Extend the Material to contain the amount of reflection
- ▶ You can use an environment map to generate the illusion of a surrounding room (reflection mapping, optional)
- ▶ Emit a new ray at the hit-point
- ▶ Maximum number ray creations



Task 1: Reflection Mapping



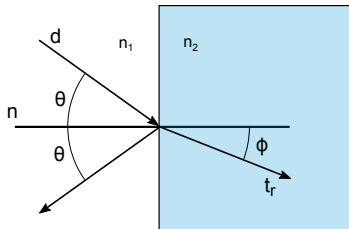
Terminator 2 (1991)

Task 2

Refraction

- ▶ Extend the Material to contain transparency and refraction information (m_i)
- ▶ Emit a new ray at the hit-point
- ▶ A ray traveling from one medium to another bends according to Snell's law
 $m_1 \sin \theta = m_2 \sin \phi$
- ▶ Total reflection:

$$\theta_{crit} = \arcsin \left(\frac{m_2}{m_1} \sin \phi \right) = \arcsin \left(\frac{m_2}{m_1} \right)$$



Task 2

Refraction

The direction of refraction t_r is [Shirley and Marschner, 2009]:

$$t_r = \frac{m_1(\mathbf{d} - \mathbf{n}(\mathbf{d} \cdot \mathbf{n}))}{m_2} - \mathbf{n} \sqrt{1 - \frac{m_1^2(1 - (\mathbf{d} \cdot \mathbf{n})^2)}{m_2^2}}$$

Typical refractive indices are:

- ▶ Air: 1.00
- ▶ Water: 1.33
- ▶ Window glass: 1.51, optical glass: 1.49 - 1.92
- ▶ Diamond: 2.42

Task 3

Rough surfaces

- ▶ Rough surfaces do not have perfect reflection or refraction
- ▶ Emit multiple rays at the hit-point
- ▶ Add a random deflection to each of the new rays
- ▶ Average the color of each of the rays

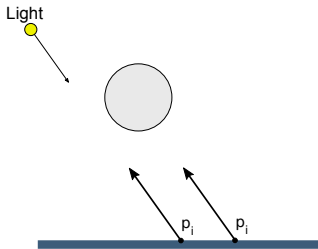
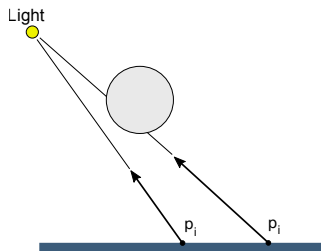
Task 4

Shadows

- ▶ Perform shadow test by implementing a visibility function $V(p \leftrightarrow L_j)$

Problems

- ▶ Self intersection because for numerical imprecision
- ▶ can be solved by adding an offset to p in direction of the surface normal



Task 5

Clouds and Fog

For clouds and fog the color and transparency has to be integrated over the volume of the object. Clouds and fog can be represented by either a volume texture or by noise functions.

- ▶ first check if the ray hits an object
- ▶ check if the ray intersects with one or more cloud object.
- ▶ integrate over the cloud object from the start point of the ray to the hit-point of the object or abort if fully opaque



Optional: Parallelization with OpenMP

CMakeLists.txt

```
find_package(OpenMP)
if (OPENMP_FOUND)
    set (CMAKE_C_FLAGS
        "${CMAKE_C_FLAGS} -fopenmp")
    set (CMAKE_CXX_FLAGS
        "${CMAKE_CXX_FLAGS} -fopenmp")
endif()
```

Optional: Parallelization with OpenMP

Rendering Loop

```
#pragma omp parallel for
for (int y = 0; y < h; ++y) {
    for (int x = 0; x < w; ++x) {
        if(!_running) {
            // ...

            #pragma omp critical
            _image->setPixel(x, y, color);
        }
    }
}
```