Sheet 3 - Raytracing

Jan Scheffczyk - 3242317
Leif van Holland - 2563657
Oliver Leuschner - 3205025

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1 Practical part

Please find the solution in the accompanying .py file.

2 The rendering complexity

2.1 a)

$640 \cdot 480 \cdot 4 \cdot 0.0001s = 122.88s$

2.2 b)

$640 \cdot 480 \cdot 100^3 \cdot 0.0001s = 30720000s \approx 355.5days \approx 1year$

2.3 c)

$640 \cdot 480 \cdot 100^{(n-1)} \cdot 0.0001s$

2.4 d)

- Using a proper acceleration structure will allow us to reject most reflection rays early thus drastically reducing the average time for an intersection test.
- Instead of choosing a random direction for our rays, we can sample the reflection in a directional cone around the perfect perfection direction. This will reduce total number of rays needed to get a similar result.

3 Plane reflection

3.1 a)

Law if reflection is given in the lecture:

$$\mathbf{R} = \mathbf{d} - 2\,(\mathbf{N} \cdot \mathbf{d})\,\mathbf{N}$$

In our example $\mathbf{d} = \mathbf{L} - \mathbf{C} = \begin{pmatrix} x \\ -8 \end{pmatrix}$, $\mathbf{N} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ thus:

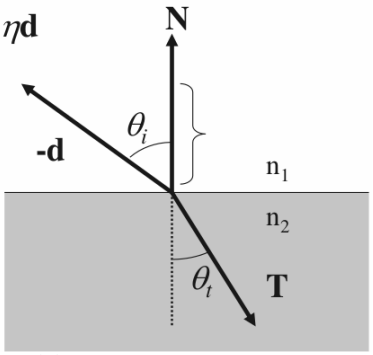
$$\mathbf{R} = \begin{pmatrix} x \\ -8 \end{pmatrix} + 2\left(\begin{pmatrix} 0 \\ 1 \end{pmatrix} \cdot \begin{pmatrix} x \\ -8 \end{pmatrix}\right) \cdot \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} x \\ 8 \end{pmatrix}$$

By solving $\begin{pmatrix} x \\ 8 \end{pmatrix} k = \begin{pmatrix} 375 \\ 194 \end{pmatrix}$ we know that the reflection of the plan will be seen at $\begin{pmatrix} 15.30 \\ 8 \end{pmatrix}$

3.2 b)

Using snells's law as given in the lecture

$$\mathbf{T} = \left(-\eta(\mathbf{N}\cdot\mathbf{d}) - \sqrt{1-\eta^2(1-(\mathbf{N}\cdot\mathbf{d})^2)}\right)\mathbf{N} + \eta\mathbf{d}$$



using $\eta = \frac{n_2}{n_1} = 1.32963169202131$, $\mathbf{d} = \begin{pmatrix} 10 \\ -8 \end{pmatrix}$, $\mathbf{N} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ we get

$$\mathbf{T} = \begin{pmatrix} \end{pmatrix}$$