Advanced Topics in Computer Graphics I - Sheet R03

Ninian Kaspers, Robin Landsgesell, Julian Stamm

May 5, 2025

Assignment 2

Reflection Equation

Radiance of Sun: $L_s = 20.045 \frac{MW}{m^2 \cdot sr}$

Irradiance of table:

Solid Angle Sun:

$$\begin{aligned} \Omega &= \pi \cdot \frac{r_s^2}{d_s^2} \\ &= 6.81 \cdot 10^{-5} sr \end{aligned}$$

Where r_s is the radius of the sun and d_s is the distance to the sun.

$$\begin{aligned} E_T &= \int_\Omega L_\theta \cdot \cos(\theta) \cdot d\omega \\ &= L_s \cdot \cos(45°) \cdot \int_\Omega d\omega \\ &= 20.045 \cdot 10^6 \frac{W}{m^2 \cdot sr} \cdot \cos(45°) \cdot 6.81 \cdot 10^{-5} sr \\ &= 965.246 \frac{W}{m^2} \end{aligned}$$

Radiance of table:

$$\begin{aligned} L_T &= L_e + f_{BRDF} \cdot E_T \\ &= 0 + \frac{0.5}{\pi} \cdot E_T \\ &= \frac{0.5}{\pi} \cdot 965.246 \frac{W}{m^2} \\ &= 153.624 \frac{W}{m^2 \cdot sr} \end{aligned}$$

Irradiance of Lens:

Solid Angle Table:

$$\begin{aligned} \Omega &= 4 \cdot \arctan\left(\frac{l^2}{2d \cdot \sqrt{4d^2 + 2l^2}}\right) \\ &= 4 \cdot \arctan\left(\frac{(0.8m)^2}{2 \cdot 1.2m \cdot \sqrt{4 \cdot (1.2m)^2 + 2 \cdot (0.8m)^2}}\right)) \\ &= 0.401sr \end{aligned}$$

$$\begin{aligned} E_L &= \int_\Omega L_\theta \cdot \cos(\theta) \cdot d\omega \\ &= L_T \cdot \cos(0°) \cdot \int_\Omega d\omega \\ &= 153.624 \frac{W}{m^2 \cdot sr} \cdot \cos(0°) \cdot 0.401sr \\ &= 61.552 \frac{W}{m^2} \end{aligned}$$

Radiant Power of Lens:

$$\begin{aligned} A &= \pi \cdot r^2 \\ &= \pi \cdot (0.025m)^2 \\ &= 0.0019635m^2 \end{aligned}$$

$$
\begin{aligned}
P_L &= E_L \cdot A \\
&= 61.552 \frac{W}{m^2} \cdot 0.0019635 m^2 \\
&= 0.121 W
\end{aligned}
$$