Advanced Computer Graphics Proseminar

Univ.-Prof. Dr. Matthias Harders

Winter semester 2015



Announcement – Inaugural Lecture

Einladung
zur Antrittsvorlesung

Interaktive Simulation in der Medizin – von „Blood and Guts" zu „Bits and Bytes"

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Mittwoch, 28. Oktober 2015, 18:00 c.t.

Großer Hörsaal der Fakultät
für Technische Wissenschaften
Technikerstraße 13b, 6020 Innsbruck

Example Renderings

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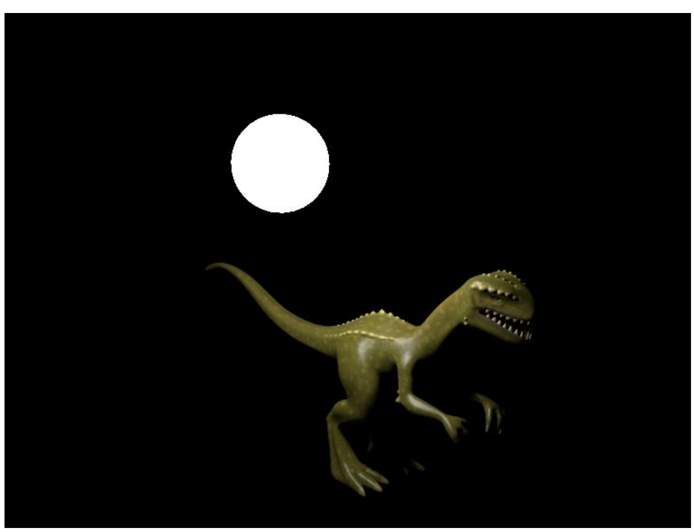

Example Renderings

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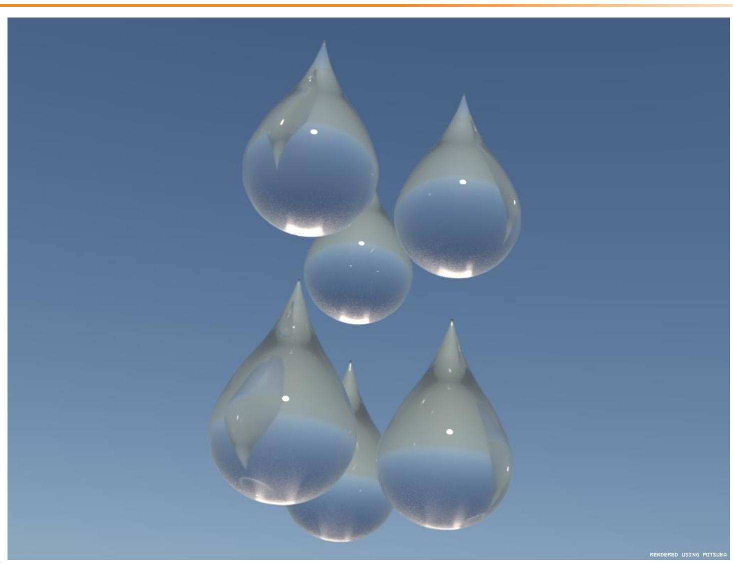
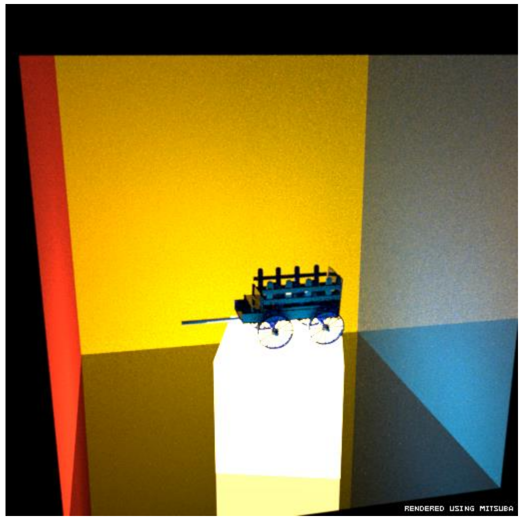


Example Renderings



Exercise 1

- How many photons does a $100\ \mathrm{W}$ light bulb emit per second (assuming 2% efficiency and single emitted wavelength $\lambda = 500\ \mathrm{nm}$)?

Exercise 1 – Solution

- Energy of a photon

$$Q = \frac{h \cdot c}{\lambda}$$

Planck´s constant

$$h \approx 6.62606957 \times 10^{-34}\ \mathrm{m^2kg/s} \approx 6.63 \times 10^{-34}\ \mathrm{m^2kg/s}$$

Speed of light propagation in air

$$c \approx 2.99702547 \times 10^{8}\ \mathrm{m/s} \approx 3 \times 10^{8}\ \mathrm{m/s}$$

Exercise 1 – Solution

- Energy of photon in example

$$Q = \frac{h \cdot c}{\lambda} \approx \frac{6.63 \times 10^{-34} \cdot 3 \times 10^{8}}{500 \times 10^{-9}} \frac{\mathrm{m^2kg \cdot m}}{\mathrm{s \cdot s \cdot m}}$$

$$= 3.978 \times 10^{-19}\ \mathrm{J}$$

- 100 W light bulb at 2% efficiency, emits 2 J/s

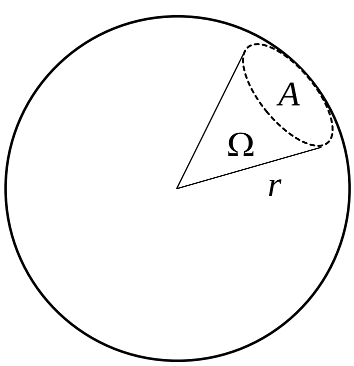
$$\frac{2}{3.978 \times 10^{-19}} \frac{\mathrm{J}}{\mathrm{s \cdot J}} \approx 5.027 \times 10^{20} \frac{1}{\mathrm{s}}$$

Exercise 2

- What is the solid angle of Austria on Earth?

Exercise 2 – Solution

- Solid angle of area on sphere



Exercise 2 – Solution

- Solid angle of Austria

Area of Austria

$$A \approx 83879\,\text{km}^2$$

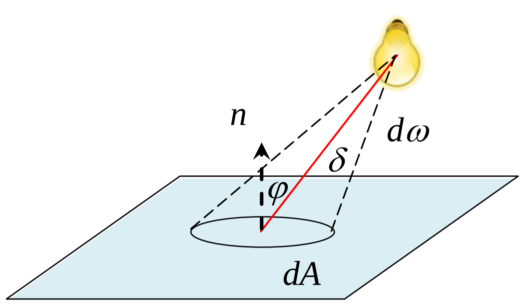
Earth´s radius

$$r \approx 6371\,\text{km}$$

$$\Omega = \frac{A}{r^2} = \frac{83879\,\text{km}^2}{(6371\,\text{km})^2} \approx 0.002\,(\text{sr})$$

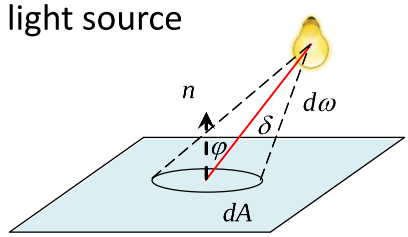
Exercise 3

- What is the irradiance due to an ideal point light source on a distant surface element?



Exercise 3 – Solution

- Irradiance due to ideal point light source



Irradiance

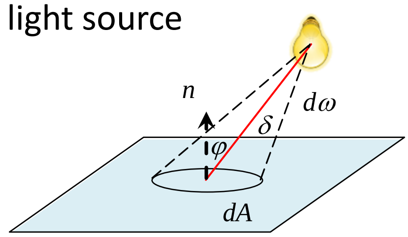
$$E = \frac{d\Phi}{dA}$$

Radiant intensity

$$I = \frac{d\Phi}{d\omega} \Rightarrow d\Phi = I \cdot d\omega$$

Exercise 3 – Solution

- Irradiance due to ideal point light source



Irradiance

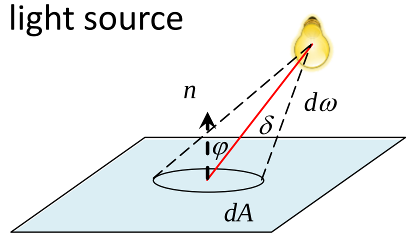
$$E = \frac{I \cdot d\omega}{dA}$$

Solid angle

$$d\omega = \frac{dA \cdot \cos\varphi}{\delta^2}$$

Exercise 3 – Solution

- Irradiance due to ideal point light source



Irradiance

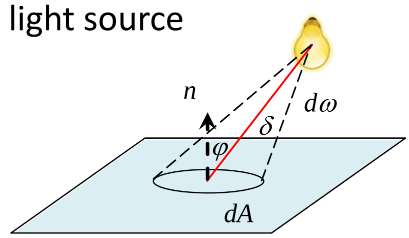
$$E = \frac{I \cdot \cos\varphi}{\delta^2}$$

For ideal point light sources

$$I = \frac{\Phi}{4\pi}$$

Exercise 3 – Solution

- Irradiance due to ideal point light source

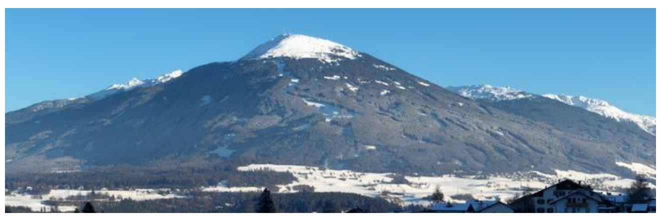


Irradiance

$$E = \frac{\Phi \cdot \cos\varphi}{4\pi \cdot \delta^2}$$

Exercise 4

- Assume a small, flat, square plate placed on top of the Patscherkofel, with the normal pointing upwards. It is during the day and there are no artificial light sources. The sky is covered in clouds, exhibiting a uniform radiance of 1000 W/(sr · m²). What is the irradiance at the center of the plate?

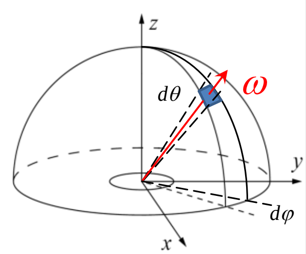


[OE7AAI, Manfred]

Exercise 4 – Solution

- Irradiance via integration of radiance

$$E = \int_{\Omega} L \cdot \cos\theta d\omega$$



Radiance constant (uniform)

$$L = 1000 \frac{\mathrm{W}}{\mathrm{sr} \cdot \mathrm{m}^2}$$

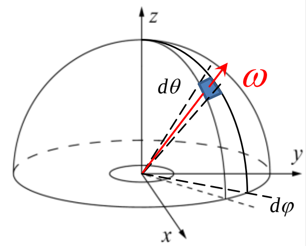
Exercise 4 – Solution

- Irradiance via integration of radiance

$$E = 1000 \int_{\Omega} \cos\theta \, d\omega$$

Expression of differential solid angle

$$d\omega = \sin\theta \cdot d\theta \cdot d\varphi$$



Exercise 4 – Solution

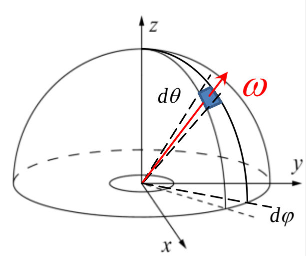
- Irradiance via integration of radiance

$$E = 1000 \int_0^{2\pi} \int_0^{\pi/2} \cos\theta \sin\theta \cdot d\theta \cdot d\varphi$$

$$= 1000 \int_0^{2\pi} d\varphi \left[-\frac{1}{2}\cos^2\theta \right]_0^{\pi/2}$$

$$= 1000 \int_0^{2\pi} \frac{1}{2} d\varphi$$

$$= 1000 \left[\frac{1}{2}\varphi \right]_0^{2\pi} = 1000\pi \frac{\mathrm{W}}{\mathrm{m}^2}$$



Tasks for Next Time

- Download radiosity example from lecture webpage
- Compile, run program, view output
- Examine source code (detailed explanations next proseminar)

Proseminar Schedule

Date	Topic	Remark
12.10.	Introduction	
19.10.	Theory – Radiometry	Radiosity example code
26.10.	*(no proseminar - Nationalfeiertag)*	
2.11.	*(no proseminar - Allerseelen)*	
9.11.	Discussion of Radiosity code	Programming assignment 1
16.11.	Programming support and advice	
23.11.	Presentation of solutions	Path Tracer example
30.11.	Discussion of Path Tracer code	Programming assignment 2, *Hand-in PA1*
7.12.	Programming support and advice	
14.12.	Presentation of solutions	*Project proposal (21.12. Hand-in PA2)*
	Christmas break	
14.1.	Geometric Modelling	
21.1.	Procedural Modelling	
28.1.	Programming support and advice	
4.2.	Project presentation	*Submission final project*