CS6630 Realistic Image Synthesis

Radiometry

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Radiometry overview

Light and Radiant Flux
- phase space
- solid angle
- throughput

Four elementary units
- Radiant Flux
- Irradiance; Radiant Exitance
- Intensity
- Radiance

Integrals of radiance
- Radiance to Irradiance
- Radiance to Intensity
- Radiance to Flux

Surface reflection
- Lambertian (diffuse)
- Specular
- BRDF

Illumination Integrals
Key questions of radiometry:

- Where is the light? (position)
- Which way is it going? (direction)
- Together, which ray is it traveling on?
- How concentrated is it around a position? (irradiance)
- How concentrated is it around a direction? (intensity)
- How concentrated is it around a ray? (radiance)
Phase space:

the set of \((p, \omega)\) pairs where light can be traveling

for rays all in the same direction, phase space is measured in (projected) area

for rays all through the same point, phase space is measured in solid angle

for general rays, phase space is measured in etendue or throughput
Solid angle

a measure on 3D directions
generalizes ordinary planar angle from 2D to 3D

planar angle (radians)
(subset of unit circle)
solid angle (steradians)
(subset of unit sphere)
Throughput (aka etendue)

**a “volume” for phase space**

built as product of (differential) projected area and (differential) solid angle

an important quantity because it is conserved in propagation through free space

\[
dG = dA_\perp d\omega = dA d\omega \cos \theta
\]

\[
dG = \frac{dA_1 dA_2}{r^2}
\]
Four radiometric units

Radiant Flux
- flow of light energy

Irradiance
- flux per unit area

Intensity
- flux per unit solid angle

Radiance
- flux per unit throughput
- irradiance per unit s.a.
- intensity per unit area
Irradiance integrals

\[ E(\mathbf{p}) = \int_{H^2(\mathbf{n})} L_i(\mathbf{p}, \omega) (\omega \cdot \mathbf{n}) \, d\omega \]

\[ E(\mathbf{p}) = \int_{H^2(\mathbf{n})} L_i(\mathbf{p}, \omega) \, d\omega \perp \]
Intensity integrals

\[ I(\omega) = \int_{S} L_0(p, \omega) \omega \cdot n(p) \, dA(p) \]

\[ I(\omega) = \int_{S} L_0(p, \omega) \, dA^\perp(p) \]