

CAP 6701 Advanced Computer Graphics
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Exercise #1
DUE: January 22nd, 11:59 pm

Realistic Image Synthesis

BRDFs are used to compute photorealistic images for interactive computer graphics.

1. The BRDF lighting equation is defined as:

$$\int_{\Omega} BRDF_{\Lambda}(\Theta_i, \Phi_i, \Theta_o, \Phi_o, u, v) \cos \Theta_o d\omega_o \leq 1 \quad (1)$$

- (a) Explain the components of the BRDF lighting equation.
2. Several interactions occur when light interacts with a surface material.
 - (a) Give an example of how one of these factors can change the scattering distribution of the reflected light in a BRDF model. Use diagrams to support your answer.
 3. Explain the terms *isotropic* and *anisotropic* as they relate to BRDFs.
 4. The Phong lighting model can be written as:

$$L_o = L_i(k_d(L \cdot N) + k_s(R \cdot V)^n) \quad (2)$$

Where L_o is light intensity toward the viewer, L_i is incoming light from a light source and L and V correspond to the incoming direction and outgoing direction.

- (a) Derive an expression from equation 2 that explains the relationship between the Phong Lighting Model and a general BRDF.

Radiance and Irradiance

The term Radiometry describes practical methods for measuring light.

1. Given a diffuse surface with outgoing radiance L and surface area $8m^2$
 - (a) What is the radiant exitance?
 - (b) What is the total power?
2. Given a point light source located at the origin(0,0) and radiating with a power ϕ (Assume that the light is radiating isotropically)
 - (a) What is the irradiance E of this source at the point p for a surface with normal n ?
 - (b) What is the total irradiance \bar{E} ?
 - (c) Derive a function that illustrates the relationship between scalar irradiance at a point p and irradiance on a surface facing the light source. What is the relationship?
3. Ramamoorthi & Hanrahan 2001 describe the theoretical relationship between radiance and irradiance.
 - (a) Thought Exercise: Through a series of diagrams try to explain their analysis. You may use mathematical symbols to label your diagram. Include a symbol key to define your terms.