CS 523 – Fall 2003

Homework 1

Due Monday, September 29, noon

(email me a solution, or drop it off at my office—CoRE 310)

Question 1:

On page 23 of Hanrahan's book chapter *Rendering Concepts*, a simple exposure meter is described, along with why the radiance at the sensor is proportional to the radiance of the surface. This derivation applies only for a point on the sensor centered in the exposure meter (on its "optical axis").

- **(a)** Derive an expression for the radiance on the sensor at locations not centered in the exposure meter (i.e. off the optical axis.) The resulting expression turns out to be quite simple, when formulated in terms of the right quantities.
- **(b)** Can you see this effect in images? Explain.

Question 2: The following is a phenomenological BRDF that models diffuse and glossy reflection:

$$f_r(\omega_i, \omega_o) = \frac{k_d}{\pi} + \frac{k_s}{\pi} \cos^n \alpha$$

Here, k_d is the diffuse reflection coefficient, k_s is the specular reflection coefficient, n is the specular exponent, and α is the angle between the mirror reflection direction and the outgoing direction (values larger than 90 degrees are clamped at 90 degrees; i.e. use $\max(0, \cos\alpha)$ in place of $\cos\alpha$). See section 2.3.3 of Watt & Watt.

- **(a)** Does this BRDF satisfy energy conservation?
- **(b)** Does it satisfy Helmholtz reciprocity?
- **(c)** If not (for either **(a)** or **(b)**), can you manage to "fix" it with a relatively small change?

Question 3:

The following are three different versions of the rendering equation:

$$L(x' \to x'') = L_e(x' \to x'') + \int_S f_r(x', x \to x', x' \to x'') V(x, x') G(x, x') L(x \to x') dA \quad (1)$$

$$I(x' \to x'') = I_e(x' \to x'') + G(x', x'') \int_S f_r(x \to x' \to x'') V(x, x') I(x \to x') dA \quad (2)$$

$$L_o(x', \omega') = L_e(x', \omega') + \int_\Omega f_r(x', \omega \to \omega') L_i(x', \omega) \cos\theta \, d\omega \quad (3)$$

- **(a)** For each one, provide a picture and short phrase or equation describing each term (e.g., $I(x \to x')$ is the intensity of light traveling from point x to point x').
- **(b)** Show that the equations are equivalent by deriving two of them from one of the others.

Work policy: You may discuss this assignment with others, but everything handed in must be your own work (and not copied or derived from any other source—paper or electronic).