CS 348B
Winter '95
Pat Hanrahan

Febraury 23, 1995
Handout #5

Written Assignment 2

Due Date: 9:30 am, March 7

1. First a few questions about cameras:

A. Does the depth of field increase or decrease with the size of the aperture?

B. Does the exposure increase or decrease with the size of the aperture?

C. What prevents cameras from having very large apertures?

2. The highlights on shiny surfaces can be explained by assuming the surface is rough, that is, consists of many small reflectors, or microfacets, oriented at different angles. The distribution of microfacets is called the microfacet distribution function and is a function of direction. For an isotropic surface, this function depends only of the cosine of the angle between the normal to the surface and the orientation of the microfacet.

One popular microfacet distribution function is the Trowbridge-Reitz distribution

$$D(\alpha) = b\frac{c^2}{(c^2-1)\cos^2\alpha + 1^2}$$

Here α is the angle of the microfacet relative to the zenith. The constants b and c are free parameters but may be be given a more intuitive meaning by the following criteria.

A. Define the half-angle β as the angle at which D reaches $\frac{1}{2}$ of its maximum value. Derive an expression for c in terms of β.

B. The constant b may be computed by normalizing D. Compute b by using the condition that the average projected area perpendicular to the surface (over all microfacet orientations) should equal 1.

3. One simple model for an anisotropic surface is to etch the surface along a single direction. The reflection from such a surface may be modeled by treating the scratches as a collection of small cylinders.

A. Assume that the cylinders are all aligned in the direction $\vec{T}$, the light is incident from the direction $\vec{L}$, and the eye is located in the direction $\vec{E}$. Suppose that the highlight is proportional to $(\vec{E}\cdot\vec{E}')^s$. Here s is the specular exponent, and $\vec{E}'$ is reflected direction of the light source, in the plane given by the point on the cylinder being shaded, the light source, and the eye. Derive an expression for the reflected direction and from that a formula for the reflected radiance in terms of the dot products of $\vec{L}$ and $\vec{E}$ with $\vec{T}$.

B. Suppose the moon is rising over a pond where all the waves are moving from left to right (i.e. think of the surface as being made of cylinders whose axis is in the direction from you to the moon). What does the reflection of the moon on the surface look like? How is it different than the the reflection off a surface with randomly oriented waves?