CPSC 578: Assignment #7

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Problem 1

A glass sphere of radius 1 is sitting in clear air at the center of a coordinate system (i.e. the sphere center is at 0,0,0). A ray starting from point (5,5,4) in the direction of the origin intersects the sphere. The index of refraction for the glass is 1.5.
i. What is the direction of the ray reflected from the intersection point?
ii. Where does the refracted ray exit the sphere?

i.$\because$ the direction of the light points to the center of the sphere

$\therefore$ light direction perpendicular to the normal of the interacting point

$\therefore$ the reflected light bounces back to the light source

$\therefore$ direction of reflected light is $(\frac{5}{\sqrt{66}}, \frac{5}{\sqrt{66}}, \frac{4}{\sqrt{66}})$

ii. $\because$ the direction of the light points to the center of the sphere

$\therefore$ light direction perpendicular to the normal of the interacting point

$\therefore$ light direction does not change

$\therefore$ refracted ray exit at $(-\frac{5}{\sqrt{66}}, -\frac{5}{\sqrt{66}}, -\frac{4}{\sqrt{66}})$

Problem 2

A surface has a diffuse reflectance Kd = 0.1 and specular Ks = 0.5. Using the simple shading model described in class, find the exponent for the Phong specular reflectance such that for light incident from a direction L of 45 degrees to the surface normal, the intensity of light reflected in the direction D1 that is 55 degrees from the surface normal is twice the intensity of the light that is reflected in direction D2, also 55 degrees from the surface normal, as shown. L, the surface normal, D1 and D2 all lie in the same plane. The surface does not emit light itself, and the rest of the environment is black. For the same case, find the exponent for the Blinn-Phong variant of Phong reflectance.

Problem 2 continued on next page. . .

i. The simple formula for Phong lighting can be represented as (omit emission and ambient):

$$I = K_d(N \cdot L) + K_s(N \cdot R)^n \tag{1}$$

in which, R can be represented as:

$$R = (L \cdot N)N - L \tag{2}$$

According to the data provided, we can generate following equation:

$$\frac{\sqrt{2}}{2} * 0.1 + 0.5(\sqrt{2}\cos 55^\circ - \cos 100^\circ)^n == 2(\frac{\sqrt{2}}{2} * 0.1 + 0.5(\sqrt{2}\cos 55^\circ - \cos 10^\circ)^n) \tag{3}$$

$\because \sqrt{2}\cos 55^\circ - \cos 10^\circ < 0$, we treat it as zero.

$\therefore n = \log_{\sqrt{2}\cos(55^\circ)-\cos(100^\circ)} \sqrt{2} * 0.1$

$\therefore n = 127.77$

ii. To calculate the exponent for the Blinn-Phong, we turn R into H, which is:

$$H = \frac{L+V}{||L+V||} = \frac{L+V}{2 * \cos\frac{\theta}{2}} \tag{4}$$

in which, θ is the angle between L and V.

$\therefore$ we get the following equation:

$$\frac{\sqrt{2}}{2} * 0.1 + 0.5(\frac{\cos 45^\circ + \cos 55^\circ}{2\cos 50^\circ})^n = \sqrt{2} * 0.1 + (\frac{\cos 45^\circ + \cos 55^\circ}{2\cos 5^\circ})^n \tag{5}$$

$\therefore n = 1.933$