NPM3D – TP4: Rendering

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I. Image loading and display

Normal.png is a 4-channel png file, of which the first 3 channels represent the normal vector for each point. To obtain *render.png*, I simply discard the last channel. I also normalize its values to [0,1].

II. Diffuse Shading

Task a:

I define *LambertMaterial* as an object with a base (albedo) color and a diffusion coefficient k_d, with a method that computes the Lambert BRDF $f^d = \frac{color \times k_d}{\pi}$.

Task b:

I define *LightSource* as an object with coordinates of the source x_s, a color and an intensity, with a method computing incoming light direction $w_i = \frac{x - x_s}{|| x - x_s||}$ given a point cloud of coordinates x, received light $L_i = \ color \times intensity$.

Task c:

Based on the previous objects, I compute the returned intensity $L_o = \ L_i(w_i) \times f(w_i, w_o)(n.w_i)$. I arbitrarily set the specular color equal to 0 (ie $f(w_i, w_o) = \ f^d$, w_o is not used here), choose $k_d = 1$, light source color as [0.5,0.5,0.5] and albedo color [0.4,0.7,0.4].

Rendering with Lambert BRDF

III. Specular Material

Task a:

To reproduce specular light reflections, I define an object *BPMaterial* with a speculary coefficient $k_s = 1$ and shininess $s = 1$ (values arbitrarily chosen), with a method computing the Blinn-Phong BRDF $f_s = k_s\,(n.w_h)^s$. Here $f(w_i, w_o) = f^d + f_s(w_i, w_o)$. I choose as arbitrary positions for the camera [1,300,1] and computes the direction of emission $w_o = \frac{x_c - x_s}{||\,x_c - x_s\,||}$ given a camera of coordinates x_c, and then deduces the half vector $w_h = \frac{w_o + w_i}{||w_o + w_i||}$. I observe (cf figure below) a realistic lightning compared to previously, the parts far from the camera (the tail here) being darker. Changing k_s changes the rendered color, while changing s changes the reflection effects.

Rendering with Blinn-Phong BRDF

Task b:

I define an object *CTMaterial* with a roughness coefficient $\alpha = 0.7$, a metallic property $\beta =$ True (conductor material), a specular color $[0.98, 0.82, 0.76]$ (used when the material is conductor) and a Fresnel index $\mathrm{n} = 5$ (values arbitrarily chosen, n being used for dielectric materials only), with a method computing the GGX distribution for the micro-facet term $D(w_i, w_o) = \frac{\alpha^2}{\pi(1+(\alpha^2-1)(n.w_h)^2)^2}$, a method computing the spherical gaussian variant of the Schlick Fresnel approximation for the Fresnel term $F(w_i, w_o) = F_0 + (1 - F_0)(1 - max(0, w_i.w_h))^5$ with $F_0 = (\frac{\mathrm{n-1}}{\mathrm{n+1}})^2$ if the material is dielectric else it is set as the specular color, a method computing the Schlick approximation to the Smith model for the geometric term $G(w_i, w_o) = G(w_i)G(w_o)$ where $G(w) = \frac{n.w}{(n.w)(1-k)+k}$ where $k = \alpha\sqrt{\frac{2}{\pi}}$ and a method to compute the Cook-Torrance BRDF $f_s(w_i, w_o) = \frac{D(w_i,w_o)F(w_i,w_o)G(w_i,w_o)}{4(n.w_i)(n.w_o)}$ (All the formulae are taken from the lecture). I observe (cf figure below) an image with realistic dark shades with these parameters (cf below). Changing α changes the lightning effect, changing the specular color (or equivalently n in the case of a dielectric material) changes the tint of the reflection.

Rendering with Cook-Torrance BRDF