Nuages de Points et Modélisation 3D
Rendus de points et maillages

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1. Introduction

In this report, we are going to discuss the different methods of shaders that have been implemented, and the experiments that have been made.

2. Diffuse Shading : Lambert BRDF

To apply a shade to our normal image, I started by implementing a Lambert BRDF:

$$f^d(w_i, w_o) = \frac{k^d.albedo}{\pi}$$

where albedo corresponding to the shade color, and k^d the diffuse coefficient. Each pixel of the final image is replaced by the folloing rendering "equation":

$$L_o(w_o) = L * f(w_i, w_o) * (n.w_i)$$

where L is the light intensity, the function f is our Lambert BRDF function in this case, w_i the incoming light direction, w_o the outgoing light direction, n the normalized normal vector at the corresponding pixel, w_i the normalized light direction.

In this practical lab, I decided to use a **directional "white"light** with an intensity of 1.413 corresponding to the maximum solar radiation on earth.
In the majority of the experiments (not all of them), I use the diffuse coefficient of gold under certain conditions : 4.5 .

Figura 1. Diffuse Shading : diffuse coef. = 4.5

In this first experiment, I just emphasize the effect of the diffuse coefficient with a very simple material.

I tried different diffuse coefficients in order to see how the material appears regarding its diffuse coefficient. We observe that the higher the diffuse coefficient, the brighter the color. The diffuse coefficient represents how much the object diffuse back the light it receives, in all the direction (a blue object very exposed to a white light will look blue, but a very bright blue).

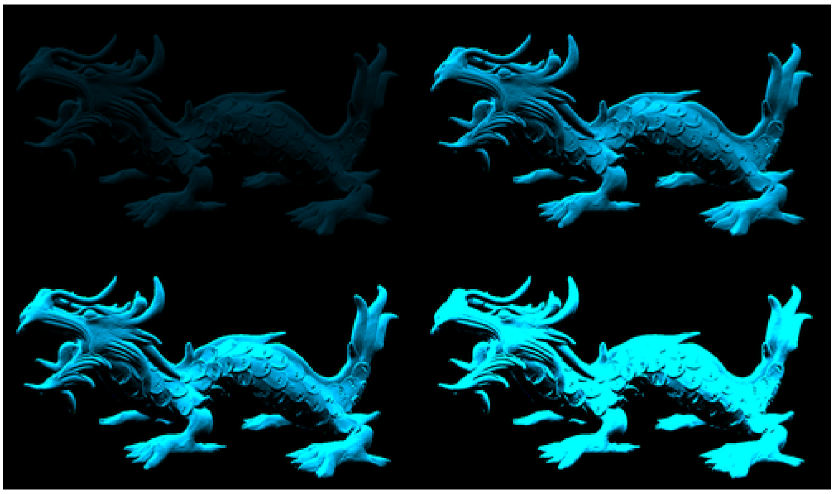

Figura 2. Diffuse coefs. = [1, 5, 7, 15] from left to right, top to bottom

3. Specular Shading : Blinn-Phong BRDF

In this experiment, we are studying a more complex BRDF : Blinn-Phong BRDF.

$$f^s(w_i, w_o) = k^s * (n.w_h)^s$$

where k^s is the specular coefficient, w_h the normalized sum of the incoming and outgoing light directions, s the shininess coefficient that controls the size of the specular refections areas.

This function emphasizes another parameter : the specular reflections of the materials. In the specular reflection, also called mirror-like reflecion, the incident light is reflected into a single outgoing direction resulting into very bright or ”white”parts in the material. In our implementation, we use both diffuse shade and Blinn-Phong shade that we add up.

Figura 3. Diffuse + Blinn-Phong Shading, specular coef. = 255, shininess=0.7

I was also interested in the experiments in the look of the materials when the shininess and the specular coefficients vary. In the image below, the rightmost materials correspond to a high shininess coefficient and the bottom-most materials to a high specular coefficient.

Figura 4. Diffuse + Blinn-Phong Shading, specular coef. = [100, 255, 600] from top to bottom, shininess=[0, 0.5, 1] from let to right.

4. Physically-Based Microfacet Shading : Cook-Torrance BRDF

Finally, I experimented a more complex BRDF:

$$f^s(w_i, w_o) = \frac{D(w_h)F(w_i, w_h)G(w_i, w_h, w_o)}{4(n.w_i)(n.w_o)}$$

where D is the GGX normal Distribution function, G the Schlik approximation for he Smith model and F the spherical Gaussian variant of the Schlik Fresnel approximation.

I replaced the previous Blinn-Phong BRDF by this one. It is controlled by a roughness (how far away is the material away from a perfect mirror) coefficient and a specular coefficient. I implemented this method paper as described in [1].

Figura 5. Diffuse+Microfacet Shading, Cyan color, roughness=2.965, specular coef.=70

Figura 6. Diffuse+Microfacet Shading, Purple color, roughness=2.965, specular coef.=70

Once again, I tried to vary the coefficients and observe the result in the materials. The rightmost images correspond to the highest specular coefficient and the bottom-most images correspond to the highest roughness coefficient.

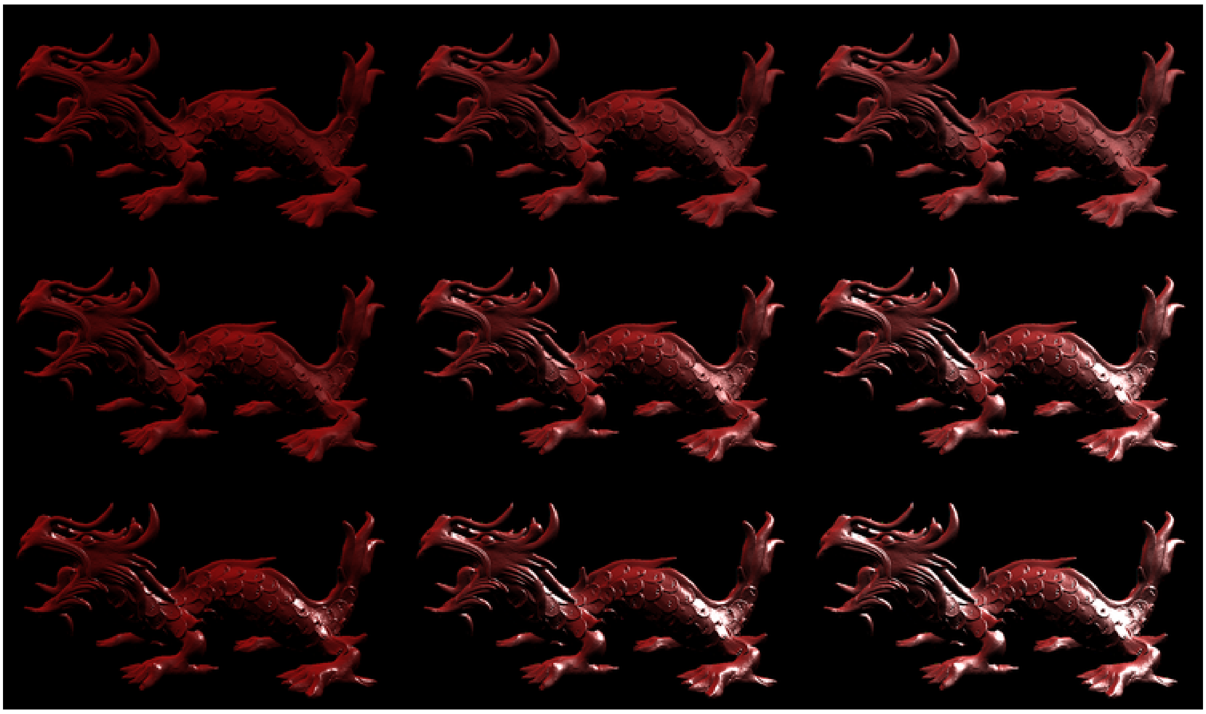

Figura 7. Diffuse + microfacet shadin, roughness=[2.9, 2.95, 2.965] from top to bottom, specular coef. = [100, 500, 1000] from left to right.

Referências

[1] BK - *Real Shading in Unreal Engine 4* , Brian Karis, Epic Games