Reflections implementation

For

D3D9Client

March 5, 2013

Fresnel reflection

Fresnel reflection will occur when a ray of light will hit into an "optical" material that has a refractive index n. Good examples of such materials are glass, water and most plastics. Fresnel reflection is highly depended from a viewing angle. In the D3D9Client we use so called Schlick's approximation of fresnel reflection.

$$R = R_0 + (1 - R_0)(1 - \cos\theta)^p \tag{1}$$

Where the "Offset" R_0 is given by

$$R_0 = \left[\frac{1-n}{1+n}\right]^2 \tag{2}$$

To gain some additional properties for our function we have replaced the term $(1 - R_0)$ with a multiplier m resulting an equation

$$R = R_0 + m(1 - \cos\theta)^p \tag{3}$$

Here are two plots of the equation using different values of p. Red curve is using value 2.0 and blue 4.0. The parameter p will only effect in the view angle dependency of the fresnel reflection. The multiplier m is most often set to a value $1 - R_0$ and in that case the maximum reflection intensity is 1.0.

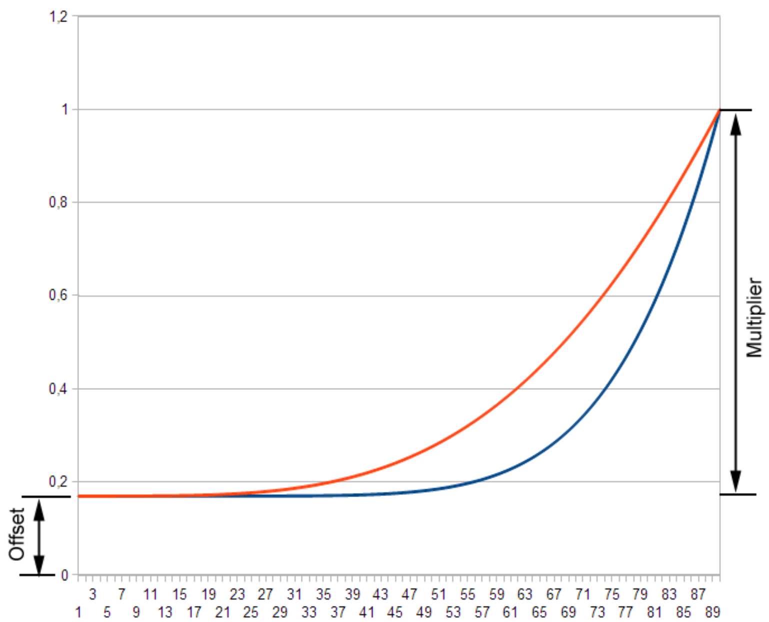

Figure 1: Reflection intensity as function of angle

Reflection Model

Here is an image about the reflection model used in D3D9Client

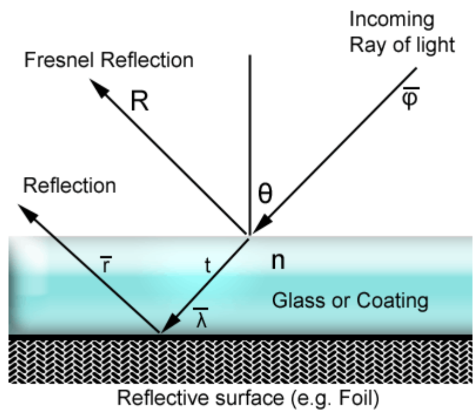

Figure 2: Reflection model

The model consists from a fresnel reflection R and a metallic reflection r. The lambda $\vec{\lambda}$ is a reflectivity color of the material. t is a fraction of the incoming ray that is not reflected away from the interface. $\vec{\varphi}$ is the color of incoming ray of light. The value of t is simply $t = 1 - R$.

The intensity of "metallic" reflection alone is independent from a viewing angle. However, when combined with a fresnel reflection it is given by

$$\vec{r} = \vec{\lambda} t \vec{\varphi} = \vec{\lambda}(1 - R)\vec{\varphi} \tag{4}$$

The total reflected light is, of course, $\vec{R_{tot}} = r + R$. I suppose the fresnel reflection could take a specular color $\vec{s}$ of the material but currently it is considered to be white $\vec{s} = [1, 1, 1]$

$$\vec{R_{tot}} = (\vec{\lambda}(1 - R) + \vec{s}R)\vec{\varphi} \tag{5}$$

The color intensity of the diffuse surface is attennuated by the reflection intensity factor $1 - |\vec{\lambda}|$. Resulting pixel color $\vec{c}$ is given by following equation where $\vec{d}$ is the color of the diffuse material or a texture.

$$\vec{c_{rgb}} = \vec{d_{rgb}}(1 - |\vec{\lambda}|) + \vec{R_{tot}} \tag{6}$$

Material/Texture alpha must be modified for alpha blending stage to make reflections visible on otherwice transparent surfaces like glass.

$$\vec{c_a} = max(\vec{d_a}, |\vec{R_{tot}}|) \tag{7}$$

In the D3D9Client we simplify the computations and we do not apply fresnel equations to incoming sunlight. A diffuse surface under a reflective coating is considered to be fully lit by the sunlight and other light sources.

If we would take the sun angle σ in to account then the equation would become

$$\vec{c_{rgb}} = \vec{d_{rgb}}(1 - |\vec{\lambda}|)[1 - R_0 - m(1 - \cos\sigma)^p] + \vec{R_{tot}} \tag{8}$$