Fast Specular Highlights by modifying the Phong-Blinn Model

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1 Introduction

Specular highlights are usually modeled with the Phong-Blinn illumination model, as:

$$I_s = (\mathbf{n} \cdot \mathbf{h})^s, \tag{1}$$

where **n** is the normal, **h** is the halfway vector and s is the shininess coefficient. The evaluation of the power function is computationally expensive and therefore some alternatives have been proposed. Schlick [Schlick 1994] tries to produce the very same result as the power function. However, neither the power function nor the dot product are based on physical behavior of highlights. Therefore, we could as well try some other physically plausible function. We propose such a function which is faster, than the power function, to compute.

2 A new Approach

Let $\rho = (\mathbf{n} \cdot \mathbf{h})$ and $s = 75$. The result of varying ρ from 0.92 to 1.0 is shown in figure 1. It is quite clear that there will be no highlight if ρ is less than 0.92. We could utilize this fact and produce a similar curve with a polynomial of order d, with all roots at $\tau = 0.92$. Let $\kappa = 1/(1-\tau)^d$, then our function is:

$$f(\rho) = \kappa(\rho - \tau)^d, \tag{2}$$

where κ assures that $f(1) = 1$.

Figure 2 shows four different functions where d varies from 2 to 5. A second order curve will of course be faster than higher order curves. However, a higher order curve will give a highlight with other properties, that might be desirable for certain kind of lighting conditions and materials.

The function $f(\rho)$ will be negative for values of $\rho < \tau$. However, this is no problem because we can simply skip the whole specular computation if $\rho < \tau$, since this means that we do not have any highlight at all!

3 Conclusions

The new approach is faster than using a power function. However, it means that we have to define the specular light with τ or as an alternative with both τ and d. Figure 3 shows an ordinary highlight at the left. In the middle image $d = 2$ and $\tau = 0.92$. The highlighted area is larger with this method. The area could be decreased by using a larger d as in the image to the right. An alternative way of decreasing the highlighted area would be to increase τ. The purpose is not really to mimic the ordinary specular computation. Instead we propose a new way of computing highlights.

References

SCHLICK, C. 1994. A fast alternative to phong's specular model. *Graphics Gems 4*, 385–387.

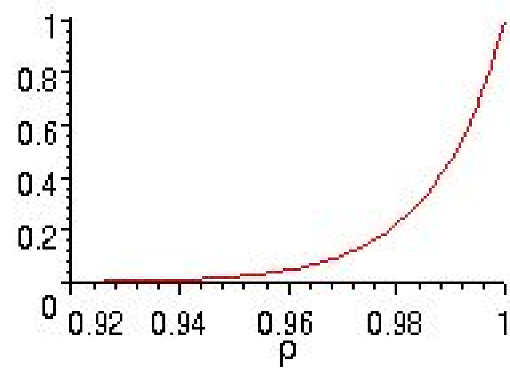

Figure 1: Specular intensity for s=75

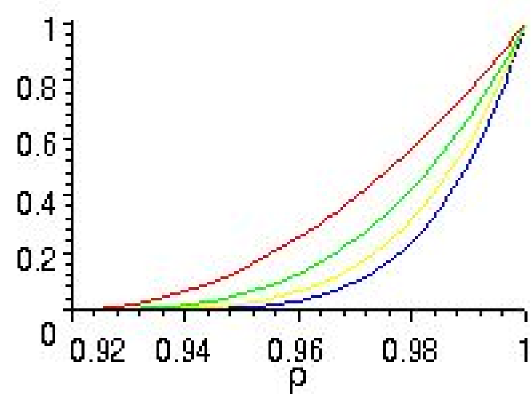

Figure 2: The proposed function with d={2,3,4,5}

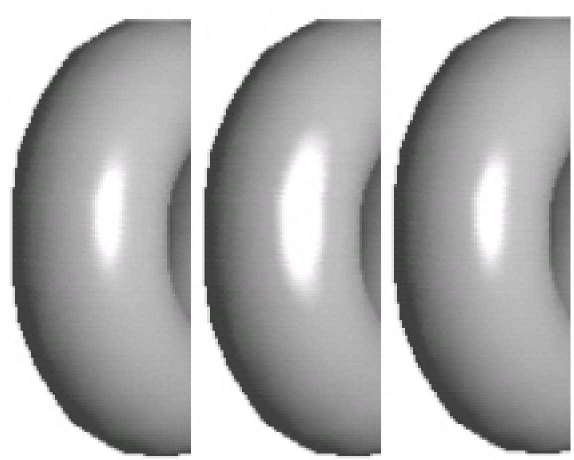

Figure 3: To the left: ordinary specular light. Middle: d=2. Right d=5.