

EXERCISE 5 – CHRISTMAS EDITION — SOLUTION

1. Illumination

When implementing Phong illumination something strange might happen, when you polish a material.

- (a) Which three components make up the Phong illumination model? How are they combined in order to compute the overall illumination?

Solution

Components:

I_a : ambient illumination

I_d : diffuse illumination

I_s : specular illumination

Overall illumination: $I = I_a + I_d + I_s$

- (b) Write down the equation for the component that is required for creating highlights. Explain the individual variables.

Solution

$$I_s = I_p \cdot k_s \cdot (\mathbf{r}^\top \mathbf{v})^n$$

I_p : incoming light intensity

k_s : material's specular reflection coefficient

\mathbf{r} : reflection vector (normalized)

\mathbf{v} : vector towards the viewer (normalized)

n : material's shininess

- (c) Which variable is changed in what way, when you polish the material?

Solution

n gets larger by polishing the material.

- (d) Compute the result for highlights using the following settings (assuming monochromatic light).

$$I_p = k_a = 1,$$

$$\mathbf{r} = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \end{bmatrix}^\top,$$

$$\mathbf{v} = \frac{1}{\sqrt{5}} \begin{bmatrix} -2 & 1 \end{bmatrix}^\top,$$

$$n = 2, 3, 4, 5.$$

Comment on how these results affect the overall illumination.

Solution

$n =$	2	4	4	5
$I_s \approx$	0.1	-0.032	0.01	-0.0032
overall	bright	dark	bright	dark

- (e) What went wrong in the implementation? How to avoid it?

Solution

- The dot product $\mathbf{r}^\top \mathbf{v}$ is negative, i.e., all light gets reflected *away* from the viewer.
- Clamp the dot product to $[0, 1]$ before evaluating the overall implementation.
- This applies also to diffuse illumination.