DD2258
BONUS
PROJECT

PHYSICALLY BASED RENDERING (PBR)

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WHAT IS PBR?



To be considered "physically based", an illumination model must:

- 1) Be based on microfacet surface model
- 2) Be energy conserving
- 3) Use a physically-based bidirectional reflectance distribution function (BRDF)

THE COOK-TORRANCE BRDF

$$f_r = k_d f_{lambert} + k_s f_{cook-torrance}$$

$$L_o(p,\omega_o) = \int_{\Omega} (k_d \frac{c}{\pi} + \frac{DFG}{4(\omega_o \cdot n)(\omega_i \cdot n)}) L_i(p,\omega_i) n \cdot \omega_i d\omega_i$$

D is the Normal Distribution function

F is the Fresnel equation

G is the Geometry function

NORMAL DISTRIBUTION FUNCTION

- Any surface can be described on a very small scale by a series of miniscule reflective mirrors known as "microfacets"
- Rougher surface = more light scattering
- Approximate microfacets with roughness parameter that varies from 0 to 1.
- Calculate the ratio of microfacets aligned with the halfway vector of light and the viewer vectors.
- Larger roughness value = Larger specular reflection is.
- Trowbridge-Reitz GGX.

$$NDF_{GGXTR}(n, h, \alpha) = \frac{\alpha^2}{\pi((n \cdot h)^2(\alpha^2 - 1) + 1)^2}$$

$$\overrightarrow{H} = rac{\overrightarrow{L} + \overrightarrow{V}}{\left\lVert \overrightarrow{L} + \overrightarrow{V}
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V}$$

GEOMETRY FUNCTION

- Approximates relative surface area where microsurface details overshadow each other (occlusion)
- Schlick-GGX function:

$$G_{SchlickGGX}(n, v, k) = \frac{n \cdot v}{(n \cdot v)(1 - k) + k}$$

 Use Smith's Method to take both the geometry obstruction and geometry shadowing into account:

$$G(n, v, l, k) = G_{sub}(n, v, k)G_{sub}(n, l, k)$$

FRESNEL EQUATION

- Describes the ratio of reflected light to refracted light
- Approximated using Fresnel-Schlick equation:

$$F_{Schlick}(h, v, F_0) = F_0 + (1 - F_0)(1 - (h \cdot v))^5$$

 Pre-compute F₀ to use the same approximation for both metals and dielectrics

TEXTURES NEEDED FOR PHYSICALLY BASED RENDERING

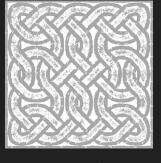


ALBEDO/DIFFUSE





AO MAP



METALLIC MAP



ROUGHNESS MAP

PUTTING ALL THE TEXTURES TOGETHER



PHONG

- Takes in ambient, diffuse and specular components of light and of the material.
- Does not use PBR
- Does not typically use roughness, AO or metallic maps

COOK-TORRANCE

- Closely approximates real-world physics
- Uses physically-based rendering (PBR)
- Takes five texture maps (albedo, normal, metallic, roughness and AO)

DEMONSTRATION TIME!