Part 3: Equation summary

Direct illumination

$$I_{\text{direct}} = k_e + k_a I_{La} + \sum_j A_j^{shadow} A_j^{dist} I_{Lj} \left[k_d (\mathbf{N} \cdot \mathbf{L}_j)_+ + k_s B_j (\mathbf{V} \cdot \mathbf{R}_j)_+^{n_s} \right]$$

$$A_j^{dist} = \min\left\{1, \frac{1}{a_j + b_j r_j + c_j r_j^{\,2}}\right\}$$

Note that $\mathbf{R}_j$ is the reflection of $\mathbf{L}_j$ across the normal. The reflection equation that appears below below is for reflecting $\mathbf{V}$ to get a reflection ray. The same equation can be used for reflecting $\mathbf{L}_j$ in order to get $\mathbf{R}_j$, after substituting $\mathbf{L}_j$ for $\mathbf{V}$ in that equation.

Direct plus indirect illumination

$$I_{\text{total}} = I_{\text{direct}} + k_r I_{\text{reflectedRay}} + k_t I_{\text{transmittedRay}}$$

Reflection direction

$$\mathbf{R} = 2(\mathbf{V} \cdot \mathbf{N})\mathbf{N} - \mathbf{V}$$

Refraction direction

$$\eta = \frac{\eta_i}{\eta_t}$$
$$\cos\theta_i = \mathbf{N} \cdot \mathbf{V}$$
$$\cos\theta_t = \sqrt{1 - \eta^2 \left(1 - \cos^2\theta_i\right)}$$
$$\mathbf{T} = (\eta \cos\theta_i - \cos\theta_t)\mathbf{N} - \eta\mathbf{V}$$

Note that total internal reflection (TIR) occurs when the square root term above is imaginary.