$$\rho = 0.9 \tag{1}$$

$$\sigma = 30 * \pi / 180 \tag{2}$$

$$\theta_r = \arccos((V \cdot N)) \tag{3}$$

$$\phi_{\text{diff}} = (\text{normalize}(V - N * ((V \cdot N))) \cdot \text{normalize}(L - N * ((L \cdot N)))) \tag{4}$$

$$N = \vec{n} \tag{5}$$

$$L = \vec{\omega}_i \tag{6}$$

$$V = \vec{\omega}_o \tag{7}$$

$$\theta_i = \arccos((L \cdot N)) \tag{8}$$

$$\alpha = \max(\theta_i, \theta_r) \tag{9}$$

$$\beta = \min(\theta_i, \theta_r) \tag{10}$$

$$C_1 = 1 - 0.5 * (\sigma^2)/((\sigma^2) + 0.33) \tag{11}$$

$$C_2 = \frac{0.45 * (\sigma^2)}{((\sigma^2) + 0.09)} * (\text{step}(\phi_{\text{diff}}) * (\sin(\alpha)) + (1 - \text{step}(\phi_{\text{diff}})) * (\sin(\alpha) - \frac{2 * \beta}{\pi}^3)) \tag{12}$$

$$C_3 = 0.125 * (\sigma^2)/((\sigma^2) + 0.09) * ((4 * \alpha * \beta)/(\pi * \pi))^2 \tag{13}$$

$$L_1 = \rho/\pi * (C_1 + \phi_{\text{diff}} * C_2 * \tan(\beta) + (1 - \text{abs}(\phi_{\text{diff}})) * C_3 * \tan((\alpha + \beta)/2)) \tag{14}$$

$$L_2 = 0.17 * \rho * \rho/\pi * (\sigma^2)/((\sigma^2) + 0.13) * (1 - \phi_{\text{diff}} * (4 * \beta * \beta)/(\pi * \pi)) \tag{15}$$

$$f = L_1 + L_2 \tag{16}$$

$$\text{normalize}(\vec{u}) = \frac{\vec{u}}{\sqrt{\vec{u} \cdot \vec{u}}} \tag{17}$$

$$\text{abs}(v) = \max(v, -v) \tag{18}$$

Step function that returns 1 when x ¿= 0 and 0 when x ¡ 0

$$\text{step}(x) = \min(1, \max(0, x/(\text{abs}(x) + \epsilon))) \tag{19}$$