

$$\lambda := 523 \cdot 10^{-9} \text{ m} \quad \text{Wavelength of Light}$$

$$k := \frac{2 \cdot \pi}{\lambda}$$

$$r0 := 0.6 \text{ m} \quad \text{Distance from subject to aperture}$$

$$z := 50 \cdot 10^{-3} \text{ m} \quad \text{Distance from aperture to sensor / image plane}$$

$$a := \frac{100 \cdot 10^{-6}}{2} \text{ m} \quad \text{Radius of aperture}$$

$$x_{\max} := 600 \cdot 10^{-6} \text{ m} \quad \text{maximum distance from the optic axis at which the diffraction pattern will be calculated}$$

$$r(x) := \sqrt{x^2 + z^2}$$

$$i := 0, 1, \dots, 1000$$

$$x_i := i \cdot \frac{x_{\max}}{1000} \quad \text{Locations at which the intensity will be calculated}$$

$$u(x) := \frac{k \cdot a^2 \cdot (r0 + r(x))}{r0 \cdot r(x)}$$

Note:  $v < u$  for all values of  $a$ , evaluate using V0 and V1. For  $v > u$  use U1 and U2

$$v(x) := \frac{k \cdot a \cdot x}{r(x)}$$

$$u1_i := u(x_i)$$

$$v1_i := v(x_i)$$

$$m := 25$$

$$V0(u, v) := \sum_{s=0}^m (-1)^s \cdot \left(\frac{v}{u}\right)^{2 \cdot s} \cdot J_n(2 \cdot s, v)$$

$$V01_i := V0(u1_i, v1_i)$$

$$V1(u, v) := \sum_{s=0}^m (-1)^s \cdot \left(\frac{v}{u}\right)^{1+2 \cdot s} \cdot J_n(1+2 \cdot s, v)$$

$$V11_i := V1(u1_i, v1_i)$$

$$U1(u, v) := \sum_{s=0}^m (-1)^s \cdot \left(\frac{u}{v}\right)^{1+2 \cdot s} \cdot J_n(1+2 \cdot s, v)$$

$$U2(u, v) := \sum_{s=0}^m (-1)^s \cdot \left(\frac{u}{v}\right)^{2 \cdot s+2} \cdot J_n(2 \cdot s+2, v)$$

$$Mv(u, v) := \frac{2}{u} \cdot \left( \cos\left(\frac{v^2}{2 \cdot u}\right) + V0(u, v) \cdot \cos\left(\frac{u}{2}\right) - V1(u, v) \cdot \sin\left(\frac{u}{2}\right) \right)$$

$$Lv(u, v) := \frac{2}{u} \cdot \left( \sin\left(\frac{v^2}{2 \cdot u}\right) + V0(u, v) \cdot \sin\left(\frac{u}{2}\right) - V1(u, v) \cdot \cos\left(\frac{u}{2}\right) \right)$$

$$Mu(u, v) := \frac{2}{u} \cdot \left( U1(u, v) \cdot \sin\left(\frac{u}{2}\right) - U2(u, v) \cdot \cos\left(\frac{u}{2}\right) \right)$$

$$Lu(u, v) := \frac{2}{u} \cdot \left( U1(u, v) \cdot \cos\left(\frac{u}{2}\right) + U2(u, v) \cdot \sin\left(\frac{u}{2}\right) \right)$$

$$M(u, v) := \text{if}(v < u, Mv(u, v), Mu(u, v)) \quad \text{choosing whether to use U or V based of value of } v \text{ compared to } u$$

$$L(u, v) := \text{if}(v < u, Lv(u, v), Lu(u, v))$$

$$I00(u) := 2 \cdot \left( 1 - \cos\left(\frac{u}{2}\right) \right) \quad \text{Closed form solution when } v=0$$

$$Iuu(u) := \frac{1}{4} \cdot \left( 1 - 2 \cdot J0(u) \cos(u) + J0(u)^2 \right) \quad \text{closed form solution when } v=u$$

$$I(u, v) := \frac{u^2}{2} \cdot \left( M(u, v)^2 + L(u, v)^2 \right) \quad \text{calculation of light intensity for all other values of } u \text{ and } v$$

$$I00(u1_0) = 0.105$$

$$Iuu(u1_0) = 0.094$$

$$I1_i := I(u1_i, v1_i)$$



