

C2.0 THE MODULATION TRANSFER FUNCTION

The Rayleigh criterion is specialized for resolution of stars against a dark background. It is less useful for image problems in which the sensor must distinguish a range of radiances and a variety of shapes.

A more useful parameter is the Modulation Transfer Function (MTF). MTF is useful in describing the overall performance of an optical imaging system because the MTF's of different system elements can be combined linearly into a single overall MTF. The MTF essentially describes the optical system as an angular filter, with an angular cut-off frequency. It provides a measure of the contrast in the final image relative to the objects and is usually given as a function of the angular spatial frequency of the object.

The MTF for a perfect optical system having a uniformly transmitting circular aperture is

$$MTF(\nu) = \frac{2}{\pi} (\phi - \cos\phi \sin\phi)$$

where

$$\phi = \cos^{-1} \left(\frac{\lambda \nu}{2NA} \right)$$

The cut-off frequency

$$\nu_0 = \frac{2(NA)}{\lambda} = \frac{(fno.)}{\lambda}$$

where

- NA = n sin U
- the numerical aperture of the system
- λ = wavelength of the light
- (fno.) = effective speed or relative aperture of the system