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Modulation Transfer Function (MTF)

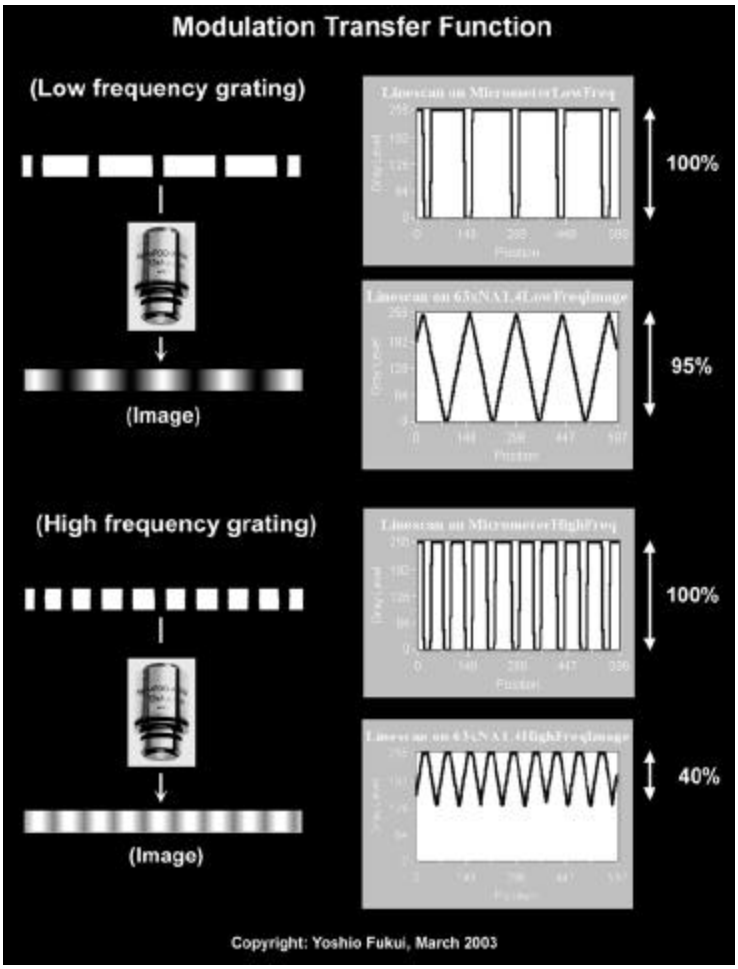
Modulation transfer function (MTF) is a quantity representing a relationship between the sample and result image. The properties include spatial frequency and contrast. The graph below illustrates an example how the MTF was tested. More specifically, optical transfer function (OTF), phase transfer function (PTF), and contrast transfer function (CTF) represent certain characteristics of MTF. In "perfect" optical system where there is no significant phase shift, the PTF is identical to the CTF, and for most specimens having sinusoidally varying intensities at different spatial frequencies, the CTF is identical to the MTF. Therefore in the example below, MTF can be represented by CTF. Those parameters are used by optical system manufacturers for designing or determining the optical characteristics of the product. The mathematical calculations are made assuming a diffraction-limited optical system.

In this example, periodic grating at two different spatial frequencies were imaged with 63x, N.A. 1.4 plan panchromatic objective. The image was acquired with a high-performance cooled CCD camera installed with Kodak KAF-1400 image sensor. The sensor is made of an array of 1,317 x 1,035 chips, each 6.7 μm in size. The imaging system has been proven to be "diffraction-limited". Therefore, this test provides the accurate evidence that the system was properly integrated satisfying Rayleigh criterion providing the "matching resolution".

Although there is a significant loss in contrast in acquired image of high frequency grating, our eye appears to resolve each line. To assure that each line is resolved, the output intensity was measured and illustrated as sinusoidal curve. The intensity measurement shows that 95% contrast was achieved for low frequency grating, thus both spatial and intensity resolution can be transferred nearly perfectly from specimen to the image using this optical system. In contrast, only 40% contrast was achieved for high frequency grating. This decrease in contrast was due to overlap of the sinusoidal intensity curves. Although contrast resolution is low, this value exceeds the Rayleigh criterion of 34%, thus guarantees that the grating was resolved.

For more detail about "Rayleigh criterion", "matching resolution" and other factors, see "Technical Notes" in link:

http://faculty-web.at.nwu.edu/med/fukui/fukuifacweb.html


Modulation Transfer Function
(Low frequency grating)
(Image)
100%
95%
(High frequency grating)
(Image)
100%
40%
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