AbstractID: 8464 Title: Modulation Transfer Function above Nyquist frequency: a robust algorithm for the edge image method

Purpose: We present a simple and robust numerical algorithm for the MTF calculation from an edge image, accurate up to frequencies (much) higher than the Nyquist frequency, even in the presence of noise.

Method and Materials: The oversampling of the edge image is obtained, as usual, by positioning the edge at a small angle with respect to the detector grid. The angle does not have to be adjusted manually; its value is very accurately calculated using a numeric algorithm, which does not involve recording the Edge Spread Function (ESF) on a sub-sampling grid, and the Fourier coefficients are subsequently calculated numerically. The quality of the MTF calculation is investigated on a simulated ESF, in the presence of the noise due to the quantum nature of the radiation.

Results: The numerical algorithm proposed is able to recover the angle between the edge and the detector grid with a relative error of the order of 10^{-5}, even for noise-affected data. The center of the Line Spread Function is also detected with an accuracy of the order of 10^{-3} pixels. For low levels of noise, the MTF was accurately calculated up to about 10 Nyquist frequencies; for high noise levels, an algorithm that avoids the numerical differentiation, by employing integration by parts, has been suggested. The latter algorithm was shown to provide a good estimation of the MTF up to frequencies much higher than Nyquist frequency.

Conclusions: The MTF can be accurately calculated from an edge image, when the edge is slanted with respect to the detector grid. The choice of the best algorithm for calculating the MTF depends on the level of noise; even for relatively large levels of noise the MTF can be accurately calculated up to and above the Nyquist frequency.