

Transfer Function Analysis for Holographic Tomography

Shan Shan Kou^{1,2} and Colin J. R. Sheppard^{1,2}

¹Optical Bioimaging Laboratory, Division of Bioengineering,
National University of Singapore, 7 Engineering Drive 1, 117576
²NUS Graduate School for Integrative Sciences and Engineering (NGS),
10 Medical Drive, 117597

<http://www.bioeng.nus.edu.sg/optbioimaging>, s.kou@nus.edu.sg,

KEY WORDS: optical diffraction tomographic imaging, three-dimensional microscopy, holographic microscopy

Single-shot holographic imaging is rather restricted in 3D performance as only spatial frequencies on the cap of Ewald Sphere are captured. Holographic tomography improves this [1] by mapping the complex refractive indices within an object to its 3D spatial frequency support, but diffraction effects in the regime of optics must be accounted. There are two ways to achieve tomography in holographic system, either by rotating the sample or by scanning the illumination beam. The case of rotating the object has been recently investigated by Vertu et al [2] and they showed that in this case a diablo can be formed in Fourier domain and a region of missing spatial frequencies resembles the shape of an apple core. In this paper, we consider the case of scanning the illumination in one direction. The 3D coherent transfer function (CTF) was derived firstly under paraxial approximations. The shape of the

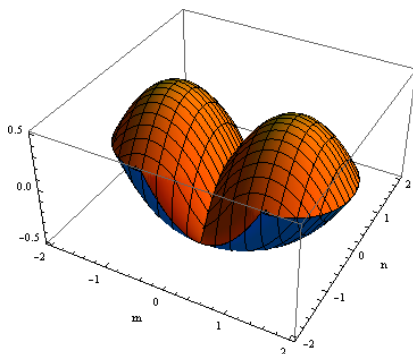


Fig.1. Spatial cutoff of the 3D CTF for paraxial peanut

calculated 3D CTF takes on a form of what we might call a “peanut” [3]. Compared with the shape of an apple core, the peanut is non-isotropic, and it extends to non-symmetry in s direction generally. Interestingly, when considered at high-aperture imaging conditions, the “peanut” takes on a slightly different shape and the spatial frequency singularity is no longer observed. The analytically derived 3D CTFs and their spatial cutoffs from both the apple core and the peanut can be used to give an insight into the behaviors of the imaging systems. Resolution as well as the capacity for 3D object information reconstruction can be compared.

REFERENCE:

- [1]. S. S. Kou and C. J. R. Sheppard, *Imaging in digital holographic microscopy*. Opt. Express **15**, 13640-13648 (2007).
- [2]. S. Vertu, J.-J. Delaunay, O. Haeberlé, *Diablo-shaped optical transfer function for microtomography with sample rotation*, Focus on Microscopy 2008, Awaji, Japan, 13-16 April 2008, p. 16.
- [3]. S. S. Kou and C. J. R. Sheppard, *Image formation in holographic tomography*. Opt. Lett. **33**(20): p. 2362-2364. (2008).