

Optimizing the point spread function of a volume holographic imaging system

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**SMART Enterprise Wing Level 5,
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Volume holographic imaging system (VHIS) has recently been demonstrated for imaging in vivo three-dimensional biopsy without mechanical or optical axial scanning. Compared to confocal microscopes, VHIS has the advantage of taking wide field images at multiple depths with optical sectioning ability in a single exposure. Thus, it can enable fast wide field imaging with good axial resolution. Due to the volume grating nature of the hologram, VHIS has shift-variant and wavelength-dependent point spread function. This has led to a challenging task to analyze and predict the performance of the VHIS.

Based on a weak diffraction assumption, we can model the point spread function of the VHIS using Fourier optics method. Here we present a simulation model based on this method to investigate the point spread function and image formation of VHIS. We are able to simulate the whole field intensity image on the detector plane given any random field input. We can also simulate the effect of light source spectrum to the image. With this proposed simulation model, we can well characterize the performance of a VHIS. We will also show an application using this model: with a good knowledge about the system's point spread function, we can use optimization method such as TwIST to compressively sense sparse signals in noisy background, such as imaging in deep tissue where scattering of light cause strong noise.



Chen Zhi, received his B. Eng. (Engineering Science) Degree in 2011 from Engineering Science Program (ESP) at National University of Singapore (NUS). In his undergraduate study, he specialized in optics and photonics direction. He then joined SMART as research engineer in Prof. George Barbastathis group.

Since then, he works in various optical imaging systems such as volume holographic imaging system, digital holography system, optical tweezer system, underwater imaging system, light sheet microscopy, biomedical microscopy system, etc. His research interest covers holography, imaging through turbid media and microscopy. Currently, he is also pursuing his PhD under the Department of Biomedical Engineering, NUS.