25-PLANE MULTIFOCUS MICROSCOPY WITH CAMERA ARRAY

Eduardo Hirata-Miyasaki[1], Gustav M. Pettersson[1], Khant Zaw[1], Demis D. John[2], Brian Thibeault[2], Brandon Lynch[1], Juliana Hernandez[1], Sara Abrahamsson[1]

[1] Department of Electrical and Computer Engineering
University of California Santa Cruz
1156 High Street Santa Cruz, CA 95064
E-mail: sara.abrahamsson@gmail.com
[2] UCSB Nanofabrication Facility, University of California, Santa Barbara

KEY WORDS: 3D imaging, multifocus microscopy, biomicroscopy, fluorescence microscopy

ABSTRACT

We here report an optical system for live 3D microscopy that we call the Multifocus 25-camera microscope (M25). M25 can capture 25 simultaneous focal planes at >100 Hz. This design takes advantage of the latest generation of small, fast and sensitive CMOS cameras to simultaneously but separately capture 25 focal planes on individual camera sensors, arranged in a 5×5 array (Fig. 1). Aberration-corrected multifocus microscopy (MFM) is a simultaneous 3D imaging technique based on diffractive Fourier optics that allows fast live imaging of biological samples [1]. Classically, MFM has been applied in an optical layout where the entire stack of focal planes is recorded on a single camera. Our new design—that we here demonstrate for the first time—simplifies the multifocus optical layout so that it can be built from affordable off-the-shelf components and a set of custom manufactured diffractive gratings. (We made the M25 diffractive optics in the UCSB NanoFab, an open access facility). We are currently launching M25 in biological research projects to study neural circuit function in model organisms such as drosophila and fish.

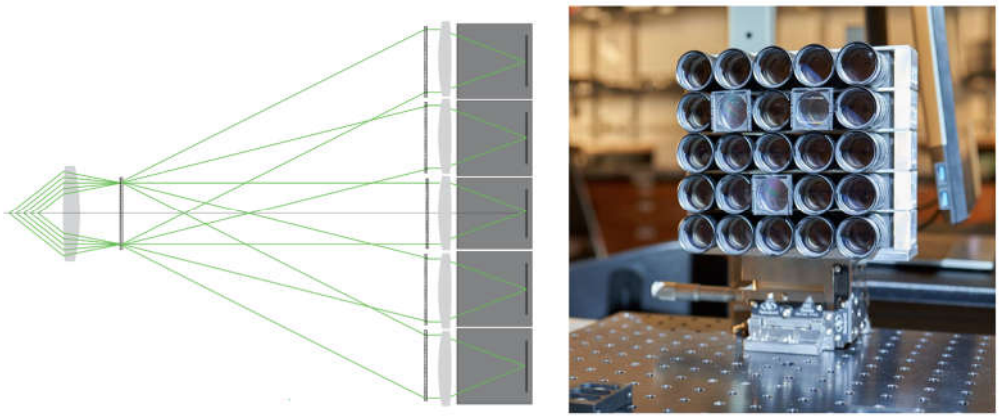

Figure 1: Ray tracing diagram of M25 system (left) and photo of the camera array (right)

[1] Abrahamsson *et al.* "Fast multicolor 3D imaging using aberration-corrected multifocus microscopy" Nat. Methods vol. 10 (2013).