ENHANCEMENT OF IMAGE QUALITY FOR LIGHT-SHEET FLUORESCENCE MICROSCOPY BY COMPRESSED DECONVOLUTION AND DENOISING ALGORITHM

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Light-sheet fluorescence microscopy (LSFM), only illuminating the sample in the focal plane of the detection lens and obtaining optical sectioning images with a camera oriented orthogonally to the light-sheet, facilitates rapid, high contrast, low photo-damage, long-term volumetric imaging [1, 2]. A scanned Gaussian beam can form a light-sheet, but has to make a trade-off between the field-of-view (FOV) and the light-sheet thickness. Non-diffracting Bessel beam (BB) can create a uniform light-sheet to largely increase the FOV, whereas the side lobes produce out-of-focus background which reduces the axial resolution and the signal-to-noise ratio (SNR). To address this issue, a complementary beam (CB) of the BB was introduced to remove the out-of-focus background by subtracting the two images obtained by scanning the BB and CB beams in our previous work [3]. Nevertheless, the blurring and noise caused by the system instability during the double scanning and the subtraction operation degrade the image quality significantly. Here, we propose a compressed blind deconvolution and denoising (CBDD) algorithm to solve this problem. We use a unified formulation that comprehensively takes advantage of multiple compressed sensing reconstructions and blind sparse representation. Compared with the complementary beam subtraction (CBS) method, the CBS-CBDD algorithm achieved the gain improvement in the axial and lateral resolution of about 1.81 and 2.22 times, respectively, while the average signal-to-noise ratio was increased by about 2 folds. The obtained results demonstrate the CBDD algorithm is suited to improve the imaging performance of the CBS light-sheet fluorescence microscopy.

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