IMPROVED RESOLUTION IN 3D STRUCTURED ILLUMINATION MICROSCOPY USING 3D MODEL-BASED RESTORATION

Cong T.S. Van and Chrysanthe Preza*

Computational Imaging Research Lab., Dept. of Electrical & Computer Engineering, The University of Memphis, Memphis, TN, USA.

e-mail: *cpreza@memphis.edu

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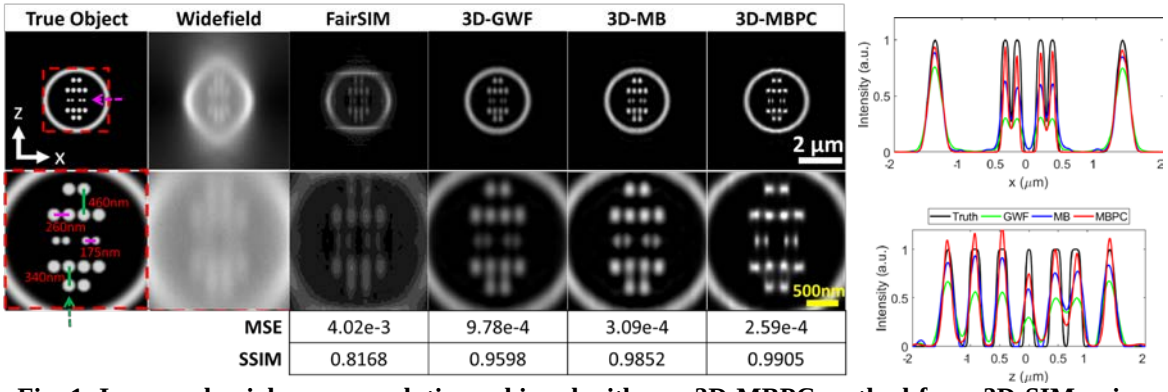
Three-dimensional structured illumination microscopy (3D-SIM) [1], in which the structured illumination (SI) pattern varies laterally and axially, has become one of the most effective optical imaging modalities used in biological investigations because of its optical sectioning and super-resolution capabilities. Computational methods are an integral part of SIM and thus, have a direct impact on its performance. In prior work [2,3], we demonstrated the first 3D model-based (3D-MB) iterative approach for 3D processing of 3D-SIM data, and showed that it provides more accurate results than the 3D generalized Wiener filter (3D-GWF), the standard deconvolution approach and the only other method besides ours that performs 3D processing [1]. Development of model-based iterative restoration methods has been restricted to 2D-SIM instead, in which the SI pattern does not vary axially, and the inverse problem can be solved easily by 2D data processing [4]. In this contribution, we extend our 3D-MB approach to include a positivity constraint (PC) through the use of an auxiliary function and a conjugate-gradient method, thereby avoiding unrealistic negative values in the restoration. Our 3D-MBPC method provides 3D processing that relies on a 3D forward imaging model, and provides more accurate results compared to 3D-GWF or other approaches, such as FairSIM [5], that rely on 2D processing of a single plane from a 3D-SIM dataset (**Fig. 1**). Results from experimental verification of the 3D-MBPC method will be presented during this presentation.



	FairSIM	3D-GWF	3D-MB	3D-MBPC
MSE	4.02e-3	9.78e-4	3.09e-4	2.59e-4
SSIM	0.8168	0.9598	0.9852	0.9905

Fig. 1. **Improved axial super resolution achieved with our 3D-MBPC method from 3D-SIM noisy simulated data** (63x1.4NA oil lens; wavelength λ = 515 nm; Poisson noise with SNR = 15 dB). Axial XZ-section images (marked region zoomed in bottom row) from the true object, and SIM restorations obtained with different methods. Intensity profiles taken along the arrows shown in the top and bottom images of the object, respectively. **MSE**: mean squared error. **SSIM**: structural similarity index metric.

References

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