High fidelity reconstruction algorithm for two-dimensional super-resolution structured illumination microscopy

Gang Wen[1], Simin Li[1], Linbo Wang[1], Xiaohu Chen[1], Zhenglong Sun[1], Yong Liang[1], Xin Jin[1], Yuguo Tang[1] & Hui Li[*1]

[1]Jiangsu Key Lab of Medical Optics, CAS Center for Excellence in Molecular Cell Science, Suzhou Institute of Biomedical Engineering and Technology, Chinese Academy of Sciences, Suzhou, China.

Email: weng@sibet.ac.cn

Key words: Structured illumination microscopy, optical sectioning, artifacts suppression

Super-resolution structured illumination microscopy (SR-SIM) is highly dependent on complex post-processing mathematical algorithms [1-2]. For two-dimensional linear SIM, the reliability and fidelity of reconstructed results have been challenged for a long time due to out-of-focus related artifacts caused by the "missing" of axial sectioning capability. Here, we propose an effective and robust SR-SIM reconstruction algorithm, called "high-fidelity SIM (HiFi-SIM)". By optimizing SR-SIM reconstructed spectrum, it provides better performance than the conventional Wiener reconstruction algorithm in suppressing artifacts and retaining effective signals, especially in processing raw data with sub-optimal modulation or strong background, as Figs. 1(a) and 1(b). Further, the reconstruction of single-layer commercial 3D-SIM data demonstrates that HiFi-SIM has the out-of-focus sectioning capability comparable to the 3D-SIM technology [3], as Figs. 1(c) and 1(d).

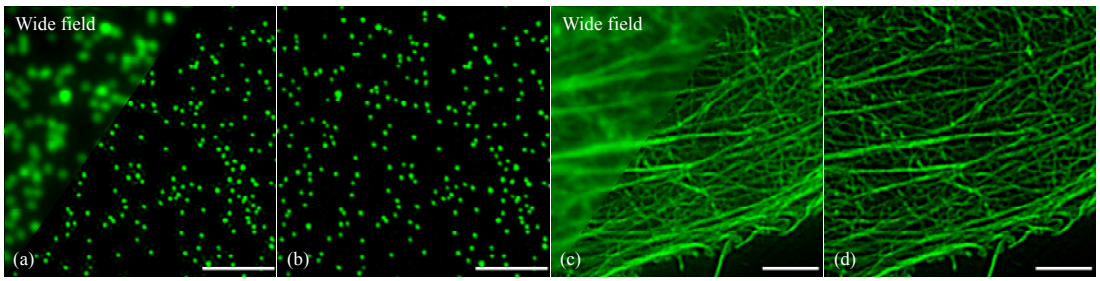

Figure 1: The SR-SIM reconstruction of 100-nm fluorescent microspheres sample by conventional Wiener algorithm (**a**) and HiFi-SIM (**b**), where 2D-SIM data was acquired on our home-built system. The SR-SIM reconstruction of actin filaments in liver sinusoidal endothelial cells sample by FairSIM (**c**) and HiFi-SIM (**d**), where 3D-SIM data was acquired on commercial SIM system (DeltaVision | OMX). The external data was downloaded from the fairSIM website [3]. Scale bar: 2 μm.

References:

[1] Gustafsson, M. G. L., *et al*. Three-dimensional resolution doubling in wide-field fluorescence microscopy by structured illumination. Biophys J **94**, 4957-4970 (2008).

[2] Wicker, K., *et al*. Phase optimisation for structured illumination microscopy. Opt Express **21**, 2032-2049 (2013).

[3] Müller, M., *et al*. Open-source image reconstruction of super-resolution structured illumination microscopy data in ImageJ. Nat. Communications, **7**, 10980 (2016).