

# DEEP LEARNING FOR WIDE-FIELD MICROSCOPY WITH ENHANCED OPTICAL SECTIONING

Chen Bai, Jia Qian, Shipei Dang, Tong Peng, Junwei Min, Xianghua Yu, Dan Dan\*, and Baoli Yao\*

State Key Laboratory of Transient Optics and Photonics, Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, Xi'an, China

E-mail: yaobl@opt.ac.cn; dandan@opt.ac.cn

**KEY WORDS:** Image reconstruction technique, wide-field microscopy, structured illumination microscopy, deep learning, convolutional neural network.

Wide-field microscopy (WFM) is broadly used for investigation of biological specimens. However, the out-of-focus signals merging in the in-focus plane reduce the signal-to-noise ratio (SNR) and axial resolution of the image. Therefore, structured illumination microscopy (SIM) has been used to obtain 3D images, which can capture high SNR optically-sectioned images with improved axial resolution. Nevertheless, the full-color SIM (FC-SIM) has a burden of large data acquisition for 3D-image, especially for thick samples such as insects and large-scale 3D imaging using stitching techniques. Here, we propose a deep-learning-based method for full-color WFM (FC-WFM), *i.e.* FC-WFM-Deep, which can reconstruct high-quality full-color 3D images with an extended optical sectioning capability directly from the FC-WFM  $z$ -stack data. As shown in Fig. 1, the image quality achievable with this FC-WFM-Deep method is comparable to the FC-SIM method in terms of 3D information and spatial resolution, while the reconstruction data size is 21 times smaller and the in-focus depth is doubled. This technique significantly reduces the 3D data acquisition requirement without losing details and improves the 3D imaging speed of biological samples.

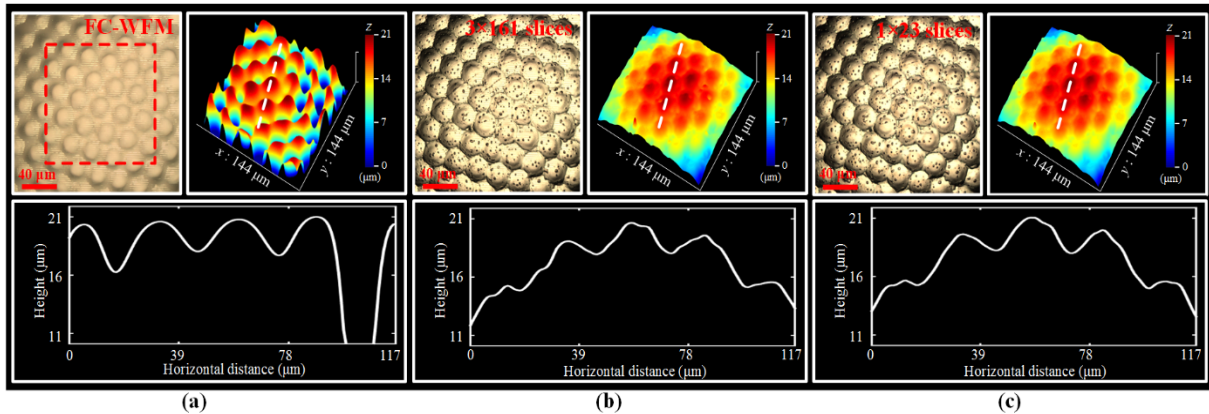


Fig. 1 Imaging results of the compound eye using three methods: (a) original FC-WFM, (b) FC-SIM, and (c) the proposed FC-WFM-Deep, including the corresponding maximum intensity projection (MIP) image, the 3D height map in the region of interest selected within the red dashed box, and the profile along the white dashed lines.