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Editorial

Introduction to the special issue on high-resolution optical focusing and imaging within or through thick scattering media

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Optical technologies have been increasingly utilized in biomedicine, including diagnosis, therapy, and surgery. In almost all of these applications, photons need to propagate some distance in tissue. Therefore, the capability of focusing or demodulating light information plays an essential role, largely determining the sensitivity and spatial resolution of these techniques. This has always been desired yet considered challenging within or through thick biological tissues due to the strong scattering of light. However, research has shown that the seemingly random scattering and the resultant speckle patterns are indeed deterministic within a certain temporal window. This finding has inspired quite a few exciting approaches, such as iterative wavefront shaping, optical phase conjugation, transmission matrix measurement, and adaptive optics to reverse or compensate for the scattering-induced phase distortions, or to reconstruct high-resolution images through or within scattering media. Although it is still in its infancy, development in this field has already shown its potentials to reshape biomedical optics from imaging, sensing, therapy, treatment, and manipulation. Nevertheless, the endeavor is still on. There are still many challenges ahead to make this field beneficial for real applications. A deeper understanding of scattering, novel technologies, and creative applications are indeed in need.

In this Special Issue, four review and seven original research articles are selected. For example, some have reviewed the recent progress for deep-tissue high-resolution focusing and imaging based on adaptive optics and wavefront shaping,[1] point spread function deconvolution,[2] and artificial intelligence.[3] Implementations for fast wavefront shaping[4] have also been summarized towards the goal of applications in dynamic scattering media and living biological tissues. Original studies presented in this issue span from the development of technology[5] and optimization algorithm[6,7] to applications for high-resolution imaging[8–10] and fiber sensing.[11] Overall, they represent a diverse set of works reflecting a broad range, albeit not the full picture, of the state of the art and direction of the field. We, thereby, strongly recommend you these articles to have a glimpse or close eye into this challenging yet exciting dream of seeing deep and seeing clearly into biological tissue.

References

1. C. Ahn, B. Hwang, K. Nam, H. Jin, T. Woo, J.-H. Park, "Overcoming the penetration depth limit in optical microscopy: Adaptive optics and wavefront shaping," *J. Innov. Opt. Health Sci.* **12**(4), 1930002 (2019).
2. H. He, X. Xie, Y. Liu, H. Liang, J. Zhou, "Exploiting the point spread function for optical imaging through a scattering medium based on deconvolution method," *J. Innov. Opt. Health Sci.* **12**(4), 1930005 (2019).
3. S. Cheng, H. Li, Y. Luo, Y. Zheng, P. Lai, "Artificial intelligence-assisted light control and computational imaging through scattering media," *J. Innov. Opt. Health Sci.* **12**(4), 1930006 (2019).
4. M. Xia, D. Li, L. Wang, D. Wang, "Fast optical wavefront engineering for controlling light propagation in dynamic turbid media," *J. Innov. Opt. Health Sci.* **12**(4), 1930007 (2019).
5. H. Liu, X. Wang, J. Gao, T. Yu, S. Han, "Seeing through dynamics scattering media: Suppressing diffused reflection based on decorrelation time difference," *J. Innov. Opt. Health Sci.* **12**(4), 1942001 (2019).
6. Z. Fayyaz, N. Mohammadian, M. R. R. Tabar, R. Manwar, K. (M.) Avanaki, "A comparative study of optimization algorithms for wavefront shaping," *J. Innov. Opt. Health Sci.* **12**(4), 1942002 (2019).
7. D. Wu, J. Luo, Z. Li, Y. Shen, "A thorough study on genetic algorithms in feedback-based wavefront shaping," *J. Innov. Opt. Health Sci.* **12**(4), 1942004 (2019).
8. B. Zhang, W. Gong, C. Wu, L. Hu, X. Zhu, K. Si, "Multidither coherent optical adaptive technique for deep tissue two-photon microscopy," *J. Innov. Opt. Health Sci.* **12**(4), 1942003 (2019).
9. J. Liu, J. Fan, Q. Wang, W. He, C. Dong, M. Sun, G. Shi, "Observation of the early blood vessels of cutaneous malignant melanoma using Swept Source Optical Coherence Tomography Angiography (SS-OCTA)," *J. Innov. Opt. Health Sci.* **12**(4), 1942005 (2019).
10. T. V. Tien, N. N. Quynh, L. H. Duc, P. N. K. Cat, H. Q. Linh, "Detection and localization of the hemoglobin and collagen distribution of the uterine cervix," *J. Innov. Opt. Health Sci.* **12**(4), 1942006 (2019).
11. T. Zhong, Z. Yu, H. Li, Z. Li, H. Li, P. Lai, "Active wavefront shaping for controlling and improving multimode fiber sensor," *J. Innov. Opt. Health Sci.* **12**(4), 1942007 (2019).