基于波前整形技术的多模光纤扫描内窥镜

DOI: 10.12086/oee.2025.251005.h03

基于波前整形技术的多模光纤扫描内窥镜因其具有显著减小内窥镜的探头尺寸并且增强成像性能的潜力而得到了广泛地发展。多模光纤扫描内窥镜适用于复杂的生物医学应用场景，并且能够提供良好的成像对比度。在这个发展迅速的领域，有必要对迄今为止所取得的成果进行总结。

南京大学徐飞教授和厦门大学洪明辉教授联合研究团队总结了多模光纤扫描内窥镜的基本工作原理、关键的性能参数、不同的成像模态以及当前的应用进展，并对该领域在发展中面临的挑战进行了探讨。他们首先介绍了三种基于波前整形原理的技术路径，能够克服输出光场的无序特性进而产生聚焦的光斑用于扫描成像。接着介绍了在提升多模光纤扫描内窥镜的成像性能方面的进展。最后介绍了多模光纤扫描内窥镜和多种先进的成像模态的集成。

多模光纤扫描内窥镜在进行广泛地商业化应用之前，还有一些问题亟需解决，比如如何进一步提高系统的抗外部干扰能力，如何提高扫描成像速度，以及是否能够打造一个小型化、集成化的多模光纤内窥镜系统。相信随着这些瓶颈的突破，未来多模光纤扫描内窥镜一定能够被广泛地应用于生物医学等领域。

Opto-Electronic Science, 2024, **3**(3): 230041.
https://www.oejournal.org/article/doi/10.29026/oes.2024.230041.

Optical scanning endoscope via a single multimode optical fiber

DOI: 10.12086/oee.2025.251005.h03

The scanning imaging method based on the wavefront shaping technique is highly developed and provides benefits including excellent imaging contrast, broad applicability to complex imaging scenarios, and good compatibility with various well-established scanning imaging modalities. A timely and comprehensive review of MMF scanning endoscopes can offer a valuable resource for researchers in this field and facilitate the development of this technique.

The research group of Prof. Fei Xu from Nanjing University and Prof. Minghui Hong from Xiamen University reviews the MMF scanning endoscope based on the wavefront shaping principle. This review summarizes the fundamental focusing and scanning imaging mechanisms, key performance metrics, diverse imaging modalities, and applications of MMF scanning endoscopes, while also offering insights into the prospects of this field. Firstly, they introduces the speckle output characteristics of MMF caused by intermodal dispersion and mode coupling effects. Subsequently, they analyzes several key scanning imaging performance metrics of MMF scanning endoscopes. Finally, they introduces the integration of MMF scanning endoscopes with numerous advanced imaging modalities.

Before MMF scanning endoscopes can be widely commercialized, several issues need to be addressed, such as further improving the system's resistance to external disturbances and promoting imaging speed. With the breakthrough of these bottlenecks, it is believed that MMF scanning endoscopes will find widespread applications in biomedical and other fields, thereby substantially driving the progress of these fields.

Opto-Electronic Science, 2024, **3**(3): 230041.
https://www.oejournal.org/article/doi/10.29026/oes.2024.230041.