Learning from examples in optics

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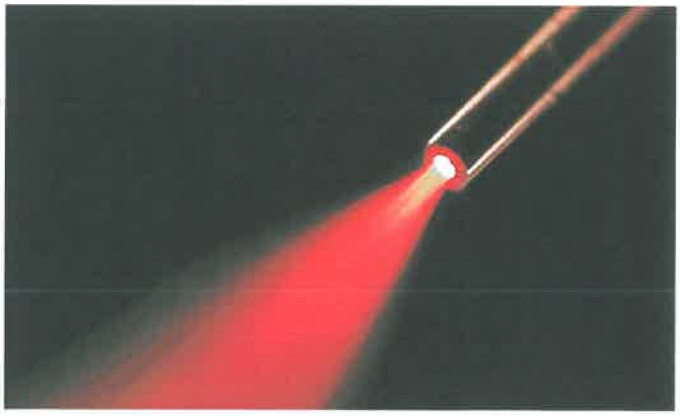
Abstract

We consider optical imaging systems in which the detected output is not directly a reproduction of the object yet it is possible to derive an image of the object by post-detection digital processing. We will focus on learning methods to assist in the image formation process. Specifically the optical system is illuminated with various input patterns and the corresponding optical response is recorded. The set of input-output pairs can be thought of as examples with which we can train the system. We consider two cases: Imaging through multimode fibers [1,2] and optical tomography [3]. For multi-mode fibers the learning procedure can be thought of as a calibration step that converts the fiber into a device with imaging capabilities similar to a lens. This can lead to interesting applications in endoscopy. In the case of tomography, we construct a multi-layer neural network that simulates light propagation. The adaptable parameters of the network correspond to the voxel values of the 3D object. Training the network to reproduce the experimentally recorded input-output pairs yields the 3D image of the object. Our results suggest that the learning method yields an image quality better than other tomographic reconstruction methods .

1. Focusing and scanning light through a multimode optical fiber using digital phase conjugation, Papadopoulos et. al. , *Optics Express*, Vol. 20, pp. 10583-10590, April 201
2. Imaging with Multimode fibers, Psaltis D. and Moser C. , *Optics and Photonics News,* page 26, January 2016.
3. Learning Approach to Optical Tomography, Kamilov et.al., *Optica,* volume 2, Issue 6, pp. 517-522 (2015)



Multimode fiber