Holographic microscopy and tomography: present solutions and future trends in biomedical applications

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Abstract

Holography has been fascinating people for nearly 80 years (since Gabor's invention in 1947) as the True 3D imaging technology which can replicate in free space three-dimensional scenes. Holography has also brought important development in physics and technology, as it has been shown by the central ideas of such great scientists and holographers as Emmeth Lieth (off-axis holography), Yuri Denisyuk (reflection holography), Stephen Benton (rainbow holography), and Adolf Lohmann (computer generated holograms). Their ideas have continued as essential concepts and have advanced dramatically over the last fifty years. The XXI century, which is the age of digital technology and of huge progress in optoelectronics and micro/nanotechnology, has finally opened the doors for true holographic applications in such important areas as holographic 3D displays with photorealistic visualization and 3D quantitative imaging in biomedicine provided by digital holographic microscopy and tomography. In my lecture, at first I will provide a short introduction to digital holography, followed by some comments on holographic displays, and finally I will focus on the current concepts in the holographic microscopy and tomography for 2D and 3D quantitative phase imaging of cells, cell cultures and tissues. The holographic tomographs with limited angular range of projections (LAHT) developed at WUT will be presented. The processing path which provides fully quantitative 3D refractive index distribution in biological microobjects will be described. The comparison for volumetric analysis of biological samples obtained by a variety of commercial and research tomographic systems will be presented and example applications of phase analysis of cell cultures under external environmental changes will be described.

About the presenter

Malgorzata Kujawińska, PhD, DSc, SPIE Fellow, Full Professor of applied optics at Warsaw University of Technology, head of Photonics Engineering Division at the Institute of Micromechanics and Photonics. Expert in full-field optical metrology and 3D imaging with special focus on holography, development of novel photonics measurement systems, data analysis for metrology and 3D displays, 3D quantitative imaging in biomedical engineering. Author of one monograph, several book chapters, and more than 200 papers in international scientific journals. She had been the 2005 SPIE President and vice-President of the European Technology Platform Photonics21. She is the recipient of SPIE 2013 Chandra S. Vikram Award in Optical Metrology and SPIE 2020 Denis Gabor Award in Diffractive Optics.