REDUCTION OF COHERENCE INDUCED DISTURBANCES IN QUANTITATIVE PHASE IMAGING WITH LASER-BASED MACH-ZEHNDER INTERFEROMETER DIGITAL HOLOGRAPHIC MICROSCOPY UTILIZING AN ELECTRICALLY FOCUS TUNABLE LENS

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ABSTRACT

Laser light-based digital holographic microscopy (DHM) has been demonstrated to be a versatile tool for label-free minimally invasive quantitative phase imaging (QPI) of living cells and disected tissues (see [1,2] and references therein). However, the properties of the laser light can disturb the quality of QPI images by parasitic interference fringes and other coherence induced image disturbances due to internal reflections within the optical setup or scattering, which significantly affects the resolution and sensitivity for detecting optical path length changes. We explored an approach for the reduction of coherence induced disturbances in which the sample illumination is modulated by an electrically focus tunable lens (EFTL). The concept is compatible with fiber optical Mach-Zehnder interferometer-based off-axis DHM arrangements and suitable for integration into commercial research microscopes. For reduction of coherence induced QPI image disturbances series of digital off-axis holograms are acquired while amplitude and phase of the object illumination is modulated with the EFTL. Automated reconstruction of the recorded hologram series is performed with an earlier reported evaluation procedure [3] which considers the EFTL-induced object wave phase aberrations numerically. The resulting quantitative phase images are subsequently averaged to achieve enhanced QPI. Experimental data from time-lapse observations of living cells and investigations on nanomaterial-induced alterations in dissected tissues demonstrate the performance of the proposed concept and that the method allows an effective and reliable reduction of coherence-induced image disturbances. It is further illustrated and that thin single cells, subcellular components as well as tiny tissue structures appear with improved contrast in DHM QPI images.

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