APPLICATION OF DIFFRACTION GRATINGS FOR PHASE IMAGING ENHANCEMENT IN DIGITAL HOLOGRAPHIC MICROSCOPY

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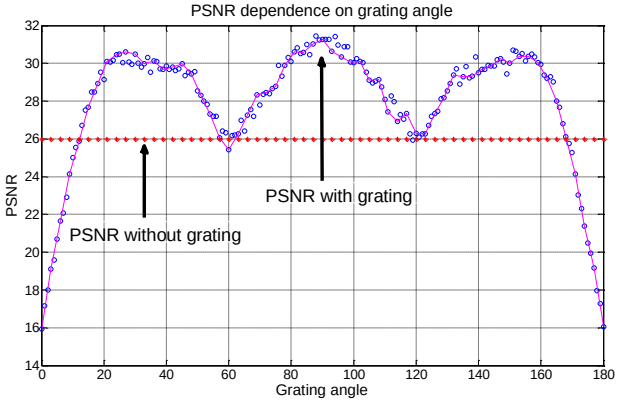
Phase imaging of transparent or translucent samples is of fundamental importance for technical and biomedical investigations, since the phase map contains information about the 3D shape and the inner structure of investigated samples. Digital holographic microscopy (DHM) is successfully applied for phase imaging in a large area of application, especially in bio-medical applications due to non-invasively visualizing and quantifying of biological tissue.

In this work we simulated the application of phase diffraction grating for phase imaging enhancement of a phase object reconstruction. At first, the phase retrieval of object was modeled without the use of mask and then it was compared with process where the mask was applied. The process of digital holographic recording of wavefront information originating from the object with subsequent computer reconstruction of object image was modeled using Matlab software. Here, we modeled digital holograms that result from the interference between the wave transmitted by the object to be imaged and a plane reference wave in off-axis optical geometry. Local Least Square (LLS) method was used to reconstruct the phase of wavefronts from a designed digital hologram.

In this experiment, the angle of the phase grating fringes were rotated from 0° to 180° (0° - vertical lines, 90° - horizontal lines). 0°, i.e. vertical fringes of grating mean that they are parallel to the interference fringes formed by the interference of the object and reference beams. The obtained modeled hologram was numerical reconstructed by LLS method using Matlab software.



These reconstructed phase images with the application of phase grating and without were compared with the original object phase image. To compare the reconstructed images the parameter Peak signal-to-noise ratio (PSNR) was introduced: $PSNR = 20\log_{10}\frac{\max_j(y_j)}{RMSE}$, $RMSE = \sqrt{\frac{1}{n}\sum_{j=1}^{n}(y_j - \hat{y}_j)^2}$, where y_j are the pixels of the original image and $\hat{y}_j$ are pixels of the reconstructed image. In fig. the dependence of PSNR for reconstructed images with and without application of phase grating is presented.

It was shown that application of phase grating during the hologram recording by DHM led to considerable phase imaging enhancement (up to 20% of PSNR) by spatial noise reduction for the given holographic configuration.

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