OPTICAL VORTEX SENSORS OF LINEAR AND ANGULAR DISPLACEMENTS

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Light beams with optical vortices (OV) can be generated and transformed by means of holograms with embedded phase singularity whose characteristic feature is existence of the fringe bifurcation ("fork" structure, see the bottom row of Fig. 1) [1]. If the incident (input) beam possesses no OV (e.g., a Gaussian beam), the output (diffracted) beam acquires the phase singularity; if the incident beam already carries an OV (e.g., a Laguerre-Gaussian beam), its order algebraically adds to the order of the phase singularity imparted by the hologram. In all cases, spatial configuration of the resulting output beam is determined by geometrical conditions of the transformation. In particular (see Fig. 1), it strongly depends on the spatial disagreement between the incident beam axis and the nominal optical axis of the hologram (normal to the hologram plane intersecting it exactly in the bifurcation point). This effect can be used for measurement of the hologram displacements and its positioning with respect to the incident beam axis [2]. Similar transformations of the output beam structure can be caused by the hologram deformations.

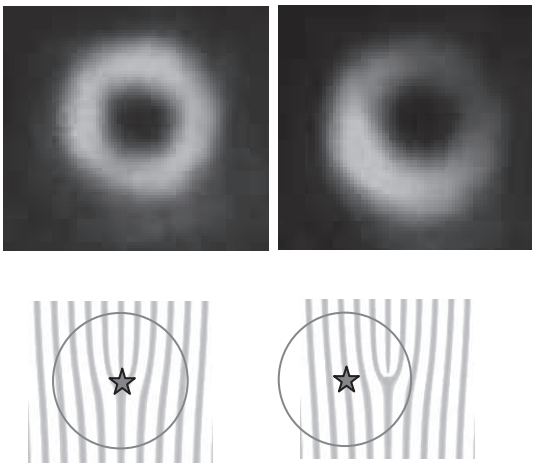

Fig. 1. View of the diffracted beam cross section (top) for the centered (left) and misaligned (right) incidence of a Gaussian beam (contours are shown in the bottom row).

In this work, we apply the mathematical model for the beam transformation in a "fork" hologram [3] for studying the sensitivity of the output beam profile to the incident beam displacements and the hologram deformations. In addition to the usual approach where the incident beam profile is Gaussian, the case of arbitrary circular Laguerre-Gaussian incident beam is considered. Both theoretically and experimentally we analyze conditions for the optimal beam size, hologram fringe spatial frequency as well as desired "strengths" of the incident and embedded phase singularity. Available accuracy and potential sensitivity of the envisaged sensor of linear and angular displacements and/or deformations are discussed.

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