Spatial Light Modulator based wavefront sensor with structured light

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The term structured light refers to all the necessary efforts to shape light's amplitude, phase and/or polarization. This is important as it often leads to equipping the light with some unique features. In this work, we explore the Laguerre-Gaussian (LG) modes of light and their possibility to retrieve the wavefront in the optical setups utilizing Spatial Light Modulators.

Any SLM based wavefront sensor instantly offers the additional dynamics, due to the possibility of almost instant modification of the sensor's parameters. These requires no physical interference to the optical system. For these reasons, we implemented the Shack-Hartmann wavefront sensor as a digital hologram with embedded LG modes. LG modes carry phase singularity and possess circular symmetry. Due to their unconventional nature, they are well-known to be an excellent beam's quality marker [1, 2].

In this research we compare the performance of the dynamic Shack-Hartmann wavefront sensor based on LG modes with its conventional counterpart utilizing Gaussian modes [3]. Especially, we delve into the impact on shot noise on the residual error of the retrieved wavefront under various controlled static aberrations. This has been possible due to the new possibilities of center detection, offered through the existence of LG modes. We examine beams center detection algorithm for each case, testing the weighted centroid method applied so far, and our own which implements the localization based on Laguerre-Gaussian transform. The latter has been possible due to a priori information about the LG modes existence.

Based on the numerical simulations we performed, we will demonstrate that LG beams can get beyond the drawbacks of a standard Gaussian beam and overcome wavefront sensing difficulties in the experimentally demanding regime.

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