Synchronous phase demodulation algorithm for conic carrier Hartmann topographer

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Abstract

In this paper, a theoretical analysis of a new algorithm for measuring phase objects (PO) is presented. The algorithm analyses images captured with a modified Hartmann plate. The proposed method demodulates a signal with a conic-wavefront carrier by using synchronous interferometric techniques. Typically a Hartmann plate is a mask with an array of holes, the proposal is to replace those holes with a series of circular concentric rings created by a conic carrier, named Conic Hartmann plate mask (CHM). The proposed algorithm computes a dense correspondence between the pattern source and its interferogram on the PO. This dense correspondence is computed as the phase change of the refracted waveform with respect to the reference one. This approach is more robust than standard techniques that computes the center of each spot in order to estimate its position; which involves pattern recognition and segmentation tasks, something normal in a typical Hartmann test. We show in this work that the new method overcomes different problems such as irregular background illumination, spots overlapping with pupil border and spots matching due to rapid changes on the surface slopes. This work shows a general procedure for radial derivatives integration based on base functions. As far as the authors know, the here presented demonstration has not been reported before. In particular, we show that Zernike polynomials are suitable for PO. Numerical experiments with real and simulated data demonstrate the algorithm performance.