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Shack-Hartmann wavefront sensor applications in holographic imaging systems

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Abstract. Nowadays, the Shack-Hartmann (SH) wavefront sensor is one of the most versatile instruments in the field of optics and photonics. Its main applications are in astronomy and vision sciences, but it can be used in any device requiring image quality control and enhancement. In this work, the SH wavefront sensor has been used to characterize, optimize, and study the quality of different holographic lens (HL) types. HLs are one of the most widely used holographic optical elements (HOEs) in use today. They are often used as imaging systems in devices such as head-mounted displays for virtual and augmented reality, or as non-imaging systems in deflectors and light concentrators. In this work, the optical quality, image quality, and object-image similarity of negative holographic lenses recorded in a low-toxicity photopolymer (Biophotopol) have been studied theoretically and experimentally, using a laser emitting at 488 nm and in 200 μm thick layers. In the reconstruction stage with the SH wavefront sensor, two different lasers have been used, one closer to the recording wavelength, 473 nm, and the other further away, 633 nm. In addition, the impulse response of the optical system has also been studied theoretically, which in this case, when working with coherent light, is the amplitude spread function (ASF). Using the SH wavefront sensor, the Zernike coefficients have been obtained for each of the HLs; the aberrations (spherical aberration, coma, and astigmatism) have been studied, comparing them with the theoretical values predicted by Seidel's aberration theory; and the similarity between object and image has been studied using the Convolution Theorem. Finally, the resolution of the HLs has been obtained using the simulated images obtained by convolution.

Keywords: Shack-Hartmann wavefront sensor, holographic lenses, volume holography, resolution, convolution theorem.

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References:

[1] Lloret, T.; Morales-Vidal, M.; Navarro-Fuster, V.; G. Ramírez, M.; Beléndez, A.; Pascual, I. Holographic Lens Resolution Using the Convolution Theorem. *Polymers* **2022**, 14, 5426.

[2] Lloret, T.; Navarro-Fuster, V.; Ramírez, M.G.; Morales-Vidal, M.; Beléndez, A.; Pascual, I. Aberration-Based Quality Metrics in Holographic Lenses. *Polymers* **2020**, 12, 993.