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Measurement and Correction of the Eye's Chromatic Aberration

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Abstract

Purpose: To precisely measure the chromatic aberration of the eye using a new objective method. To design and manufacture phase plates to correct the ocular chromatic aberration using chromatic aberration data.

Methods: We developed a new instrument to measure the complete ocular wave–front aberration for a series of different wavelengths. It is based on a Hartmann–Shack (HS) wave–front sensor but uses a Xe white–light lamp together with a set of interference filters as illumination source. By using a high–sensitivity camera, it is possible to record HS images for all visible wavelengths with enough signal–to–noise ratio. From the wavefront estimated for each wavelength, the longitudinal chromatic aberration (LCA) is obtained simply as the defocus difference. Sphero–chromatism, the dependence of spherical aberration with wavelength, is also determined. Phase plates were designed and manufactured to compensate for the LCA in a particular eye.

Results: We measured the wave–front aberration for five different wavelengths (440, 488, 532, 633, 694 nm) in four subjects. The average measured values of LCA and spherochromatism follows the predicted theoretical behavior in a simple water–eye model. The same instrument was used to measure chromatic aberrations of the eye plus the correcting phase plate.

Conclusions: We demonstrated the feasibility of using a white light source for wave–front aberration measurement in the human eye within the 440–700 nm wavelength region. The instrument was also used to control the accuracy of the correction of the chromatic difference of focus by using phase plates. This device will be used in the future to further study the impact of correcting chromatic aberration in spatial vision.

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