Impact of Wavefront Propagation on Ablation Shape Design

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Advanced Medical Optics, Inc.
Correction vs. measurement

Spectacles

Contact lenses

Refractive surgery

Intraocular lenses
Solution of any aberrations

Propagate the wavefront from the measurement plane to the correction plane
Huygens-Fresnel principle
Two important properties

- The magnitude of the wavefront (Zernike coefficients) changes after propagation
- The boundary of the wavefront changes after propagation (shape and size). The approximation is valid when the cylinder is moderate

Old Zernikes → New Zernikes
Approximations used

- Geometrical optics: rays propagate individually without interferences

- The boundary of the propagated wavefront (which in general is irregular) is approximated as circular

Low order aberrations

Residual error without vertex correction

Residual error (%)

PreOp refraction (D)
High order aberrations

Induced HOAS without vertex correction

@6mm pupil

5.7% ± 5.5%

Residual error (%)

PreOp HOA (um)
Conclusions

• Propagation of ocular wavefront should be accounted for in vision correction

• When an ocular wavefront propagates, both the magnitude and the boundary change

• Simulation from clinical data shows moderate induction of HOAs without the consideration of wavefront propagation
Wavefront Optics for Vision Correction

Guang-ming Dai

Written for vision-research scientists, ophthalmic device engineers, and clinicians working to correct their patients' vision, this book provides practical solutions to the problems encountered in wavefront-driven vision correction—in particular, wavefront-driven refractive surgery—and summarizes the exciting technological developments that have emerged over the last decade.

Inside you will find:
- The fundamental concepts and principles of ocular correction
- Detailed analysis of the various wavefront sensing and reconstruction methods, along with their pros and cons
- Complete coverage of ocular wavefront manipulation and analysis, including conversion, transformation (pupil dilation, cycloversion, and decentration), propagation, and evaluation
- Numerous examples, graphs, and tables as well as Matlab codes

Additionally, the author provides an analytical foundation by introducing orthonormal polynomials for the representation of ocular aberrations, along with ocular aberration statistics and the clinical results of wavefront-driven refractive surgery.

Researchers and scientists in astronomy and nonexcimer lasers may also find the book useful, because many of the problems discussed in this book may apply to their research.
Thank You!