Combined Autorefractor and Visual Fixation Target to Study Human Accommodative Response: Benchtop Optical Design and Calibration

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Accommodation is the process by which eye changes focus from far to near.
Accommodation decrease with age and is completely lost by age ~ 50.
Loss of accommodation → loss of near vision.
Near vision can be corrected with reading glasses.
Reading glasses cannot restore accommodation.

BACKGROUND

“Relaxed”
“Accommodated”

PURPOSE

To develop a system that can simultaneously measure the power of the eye and changes in the lens shape combining an adjustable accommodation stimulus, an autorefractor, and an Optical Coherence Tomography (OCT) system.

MATERIALS AND METHODS

Proposed Optical Layout of Accommodation Imaging System

OCT SYSTEM

VISUAL FIXATION TARGET

AUTOREFRACTOR

The accommodative stimulus was designed based on the modified Badal optometer which provides accommodative demand of -20 to 10 Diopters with constant magnification. In order to reduce the overall size of the fixation target, smaller optics and a folded optical layout were utilized.

An autorefractor system was designed using a superluminescent diode centered at 960nm with bandwidth of 40nm (InPhenix) and a Shack-Hartmann wavefront sensor with maximum measurement speed of 1200Hz (Thorlabs).

RESULTS

(Left) Using the Badal equations, the theoretical accommodative stimulus was calculated for the new selected lenses. (Right) The visual fixation target was assembled on an optical bench.

AUTOREFRACTOR

(Left) The autorefractor module was setup on the optical bench. (Right) The performance of the new wavefront sensor system was evaluated using a model eye of variable spherical refractive error ranging between -10 to +15 Diopters.

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