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Tunable sphero-cylindrical lens for automated refractors

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Traditional manual and automated refractors for subjective and objective measurements of the ocular refractive errors are based on working principles and designs which often limit their practicality and are currently hindering the possibility of combining subjective and objective measurements in a single instrument. We present the preliminary work towards the development of an optical system consisting of a tunable-focus spherical lens for myopia/hyperopia correction coupled to a tunable-focus cylindrical lens with variable axis for correcting astigmatism.
The tunable sphero-cylindrical module can be divided into two optical subsystems that can be independently controlled to generate different levels of defocus and astigmatisms. They are both based on similar liquid lens technologies, where an optically transparent liquid or polymer is sandwiched between two thin (<1 mm) glass membranes. Mechanical or electro-actuators are used for locally bending one of the glass membranes in a controllable and programmable fashion.
This novel sphero-cylindrical module is designed to be capable of simultaneously and continuously varying the refractive power of both lenses in the ranges of about ±10 D and about ±5 D for the spherical and cylindrical subsystems, respectively. In addition, the cylindrical lens is designed to deliver a <0.4° precision on the selection of the cylinder axis, over a range of ±90°.
Optical simulations and theoretical performance analysis of the tunable-focus spherical and cylindrical lenses will be followed by an exhaustive experimental characterization of the sphero-cylindrical module based on wavefront sensing analysis for assessing its dynamic range, dioptric resolution and repeatability.

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