Skew-Axis Cylinder Lens Optical System: Physical Properties, Application for Novel Method of Clinical Optometry of Astigmatism, and Engineering Implementation

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Astigmatism is a cylindrical imperfection of the optical system of the eye that normally should be spherical. The optometry of astigmatism, so-called subjective refraction, involves multiple iterative trials of discrete interchangeable lenses usually combined into a phoropter apparatus. The method relies on verbal interaction between a practitioner and a patient and is often impeded by language barriers and communication issues. As a result, optometric measurements of astigmatism are often done suboptimally. In this work, a rotatable skew-axis cylinder lens optical apparatus has been designed and created with a goal to provide a novel, improved alternative to the existing subjective refraction methods. A prototype of the aforementioned apparatus has been built, and physical properties of the employed optical system have been studied. Modulation transfer function (MTF) values of the resulting optical system have been obtained and mapped over the two-dimensional parametric space of the cylindrical optical power and angle of orientation. It has been shown that the apparatus is capable of both compensating an arbitrary astigmatic defect and measuring its optical characteristics. The accuracy of the optometric measurements has been demonstrated. The proposed apparatus enables a novel method of optometry of astigmatism, which relies on a patient's feedback obtained through intuitive actions rather than verbal interaction. Thus, the developed device paves a way for quick, inexpensive, and accurate optometry of astigmatism, free from communication issues – an improvement over existing solutions.

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