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A computational model to optimize vision correction via contact lens design

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A contact lens typically assumes different positions with respect to the pupil after each blink and saccade, and lens motion may cause a loss in visual acuity. An exact understanding of the loss of visual acuity is lacking in current literature. By estimating the precise three-dimensional lens motion on the cornea, combined with an accurate lens model, we compute the loss of visual acuity as a consequence of lens motion for myopic patients, using a ray tracing approach. Using markers on the lens, we calculate a three-dimensional rotation matrix that corresponds to the apparent two-dimensional rotation and decentration. To determine the wavefront for a different lens position, we use reverse ray tracing to propagate the measured wavefront back through the lens and tear, and forward ray tracing to propagate it forward to the new lens position in such a way that the optical path length is preserved. The lens' motion leads to a coma component in the new wavefront. As the lens' motion alters the visual acuity, rotational stability of contact lenses is necessary for consistent visual acuity after correction. We propose a contact lens model to mitigate the loss of visual acuity caused by lens motion through a numerical simulation.

Keywords: Contact lens, decentration, ray tracing, visual acuity, wavefront