Numerical Simulations of Iris Biomechanics: Modeling Active-Passive Muscle Behavior

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Abstract:
The iris is an adjustable diaphragm located between the cornea and the lens, which surrounds the pupil and separates the anterior segment of the eye into anterior and posterior chambers. The iris behavior is governed by the alternative action of two smooth muscles, the sphincter pupillae, which runs circumferentially around the pupil, and the dilator pupillae, which is disposed radially in the external part of the iris. The two muscles regulate the amount of light entering the pupil, to optimize image sharpness formation on the retina. The aim of this study is to capture by numerical simulations the antagonistic mechanics of the light regulation process, using a finite element model of the iris where the coupled active-passive behavior induced by photo-sensitivity is modelled explicitly. We model the iris as a soft active material, where the passive behavior is governed by the fibrous enriched model by Holzapfel-Ogden model and the active contraction is provided by an active strain a pproach. The numerical simulations are performed using the software LIFEX. The computational framework will allow for understanding the fundamental biomechanics of the iris and its role in vision regulation, as a first step to introduce a more sophisticated model where the effects of the light intensity are assumed to be directly related to active behavior. The model has potential applications in ophthalmology and may provide suggestions for the development of bio-inspired optical systems.