3D Optical Human Eye Model Based on COMSOL Multiphysics® to Provide a Test Bench for Laser Surgery

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Abstract

We present here the development of an optical human eye model - based on Ray Optics module in order to reproduce the eye optical properties. Current simulations in literature do not fully cover the light propagation inside all parts of the eye by taking into account the absorption but also the scattering effect. A complete 3D modelling of the human eye will be helpful to develop new procedures for medical applications such as laser surgery or the development of new medical devices specifically designed for ophthalmology.
For that reason, we use the Ray Optics module to model a 3D eye. Optical parameters of the eyes are extracted from experimental results obtained from a study carried out on a porcine eye - which is close to the human eye. Firstly, we investigate each part of the eye separately in order to validate the simulated results. For that, we use the reflection and transmission conditions at the boundary but also the scattering transmission. We thus had to develop a scattering transmission model in order to fit the experimental results. Afterwards, we implement the parameters on the 3D model.
This work allows evaluation of light propagation inside the eye for a specific wavelength. The model is developed for wavelengths from 400 to 1400 nm. We can estimate the amount of light received by a specific part of the eye, depending on the incident light conditions. Figure 1 presents the propagation of light from the cornea to the retina. For example, if we take a laser operation performed to treat glaucoma disease, we can evaluate the amount of light absorbed by the ciliary bodies.

Figures used in the abstract

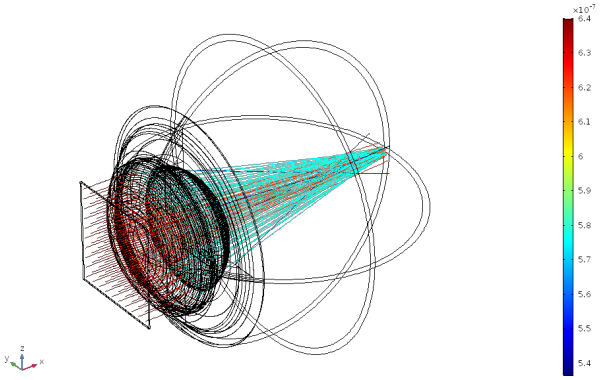

Figure 1: Light propagation inside human eye.