Trans-scleral OCT

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Optics and photonics
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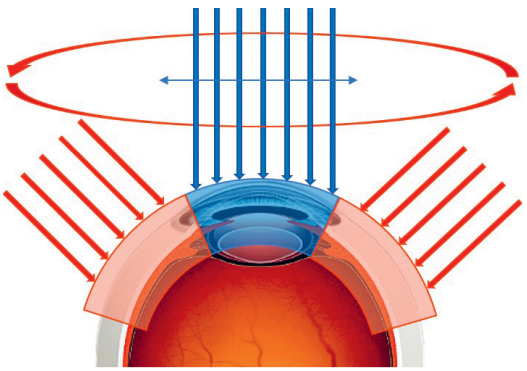
Optical coherence tomography (OCT) is a core imaging technique in ophthalmology. However, devices on the market for anterior segment imaging are not optimized for scanning beyond the iris periphery. The goal of this thesis is therefore to extend the capabilities of an OCT scanner to facilitate 3D image acquisition in the region of the sclera (the white part of the eye) and of the corneal limbus (the junction between the cornea and the sclera).

Introduction

Many eye diseases can be diagnosed using anterior segment images of the eye. In the case of glaucoma, the angle formed by the cornea and the iris provides useful information to the ophthalmologists. The treatment of this disease consists in the application of eye drops and laser surgery. In other diseases like age related macular degeneration (AMD), drug injections through the sclera are performed. However, it remains difficult to evaluate the healing process of the holes left by the injection syringe. Ophthalmologists would therefore welcome a device both capable of diagnosis making and of following up the impacts of a treatment.

Approach

The intensity of an OCT image depends strongly on the incidence angle of the light beam onto the surface of the sample. Medical OCT devices traditionally have a light beam that is parallel to the sight axis of the patient. Since the eye is a spherical object, perpendicular incidence can only be achieved in one location approximately at the center of the eye. A solution had to be found to redirect the beam in order to achieve perpendicular incidence beyond the iris periphery. To this end, an opto-mechanical design was developed and along the way, questions about the ideal wavelength and the optimal power for such measurements were also tackled.



Sectional image of an eye showing both the traditional (blue) and the new (red) scanning patterns

Results

The implemented opto-mechanical concept consists in a focusing lens, a series of flat mirrors to redirect the beam and a stepper motor with a timing belt to move the mirrors around the sight axis. This setup successfully redirects the beam perpendicularly onto the iris periphery and sectional images of pork eyes were acquired to assess the validity of the concept. The integration of the stepper motor into the Labview framework of the OCT scanner allows for sectorial scanning of ±10° around a reference position. Theoretical calculations suggest that a central wavelength of 1310nm would be appropriate for this application due to a potentially deeper penetration depth. The power of the incident beam at the sample level was of 6mW but calculations based on ophthalmological norms show that it could potentially be increased.

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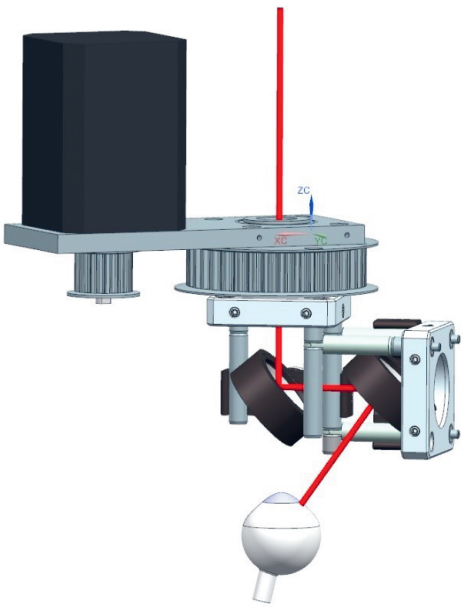

Opto-mechanical design