Quantitative Measurement of the Cornea by OCT

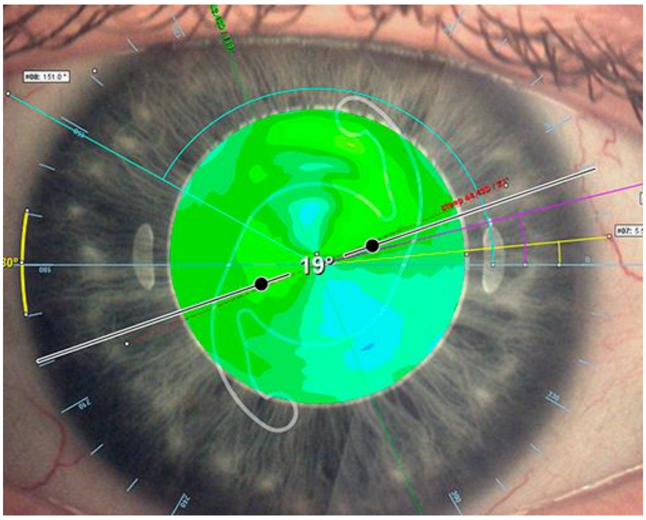

Figure 1: Topography map in a surgical planning tool shown as overlay on the cornea. The colour encodes the refractive power of the cornea at this point (Picture: J. Wagner).

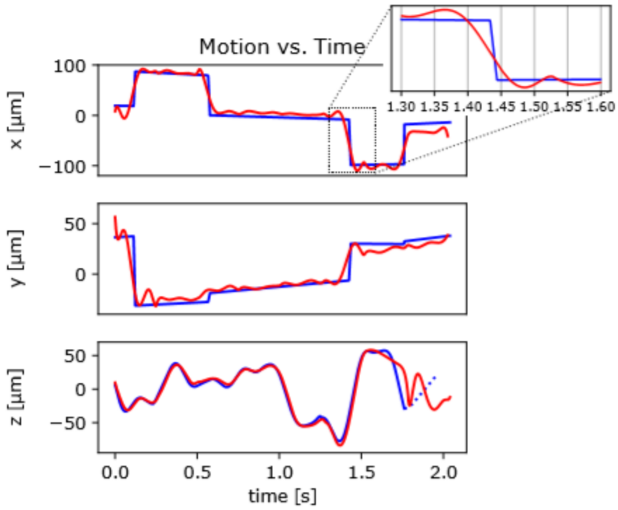

Figure 2: Comparison of the motion detected by our motion compensation (red) and the ground truth (blue) (Picture: J. Wagner).

PhD Thesis of Jörg Wagner at CIAN.

The accurate measurement of the corneal shape and refractive power is essential for diagnostics and the planning of surgeries. Keratometry and corneal topography are clinically established measures for the quantitative description of the corneal shape and refractive power. In our work (1), we present solutions to enable keratometry and topography based on optical coherence tomography (OCT).

One major application of keratometry and topography is the planning of cataract surgeries, where the natural lens gets replaced by an intraocular lens (IOL). OCT potentially enables the three-dimensional measurement of all optically relevant structures of the eye at once. However, the use of OCT for corneal topography and keratometry is still limited. One limitation is the sensitivity of beam-scanning OCT to eye motion. This sensitivity can be decreased by increasing the scan speed. Nevertheless, there is a trade-off between axial resolution, scan range, scan speed, signal-to-noise ratio (SNR) and the cost of the system. To take full advantage of OCT – measuring the full depth of the eye at once – one has to make compromises regarding the resolution and speed of the system. In our work, we present solutions for OCT-based keratometry and topography, using a system with limited axial resolution and speed which is, in return, able to measure the full depth of the eye. We propose new scanning techniques with two-dimensional scan trajectories, enabling robust reconstruction and accurate motion compensation with high temporal resolution. The motion compensation features model-based motion compensation in three dimensions. Because current segmentation methods do not apply to these new scanning techniques, we further present a novel method for model-based segmentation.

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References:

(1) Jörg Wagner. *Quantitative Meas-ure-ment of the Cornea by OCT*. Doctoral Thesis, University of Basel, 2020.