Detecting Early Choroidal Thickness Changes using Piecewise Rigid Image Registration and Eye-Shape Adherent Regularization

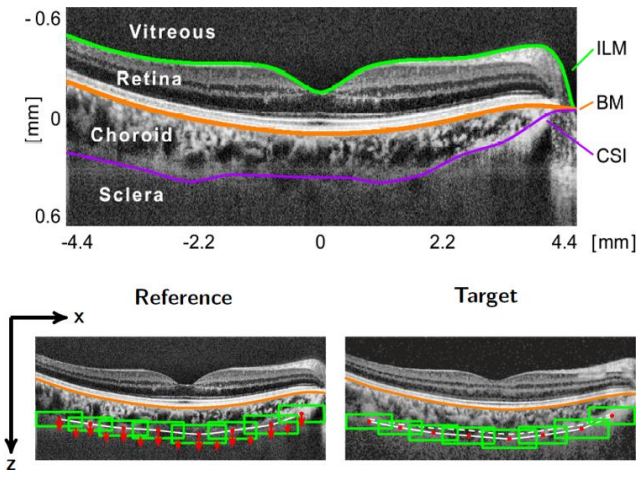

Figure 1: Above: OCT B-scan with segmented layers: inner limiting membrane (ILM), Bruch's membrane (BM) and choroid-sclera interface (CSI). Below: Simulation of choroidal growth. Left: The white continuous line serves as reference for the deformation. Right: After blockwise transformation the reference line is shifted (white dotted line). As the images are aligned to BM, the displacement corresponds to shifts of the CSI (Picture: T. Ronchetti).

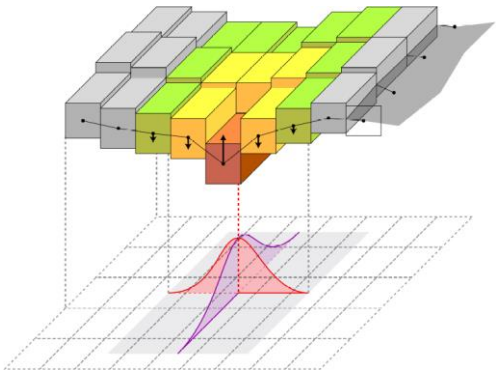

Figure 2: The eye-shape adherent regularization used in the developed method CRAR (Picture: T. Ronchetti).

PhD Thesis of Tiziano Ronchetti at CIAN.

This research work focuses on developing an automatic algorithm to detect subtle changes in the area of the human choroid. This is relevant because choroidal thickness changes could be among the first signs of, for example, myopia or glaucoma and must therefore be monitored.

Image acquisition with optical coherence tomography (OCT), allows 2- and 3-dimensional images with micrometer resolution. However, segmenting the choroid is often challenging because of low contrast, loss of signal and the presence of artifacts. In particular, in vivo imaging of the choroid-sclera interface (CSI, see Fig. 1), the border separating the choroid from the sclera, is problematic.

CRAR [1] is a novel method for the early detection of **C**horoidal changes based on piecewise rigid image **R**egistration using eye-shape **A**dherent **R**egularization. It focuses on the changes of the entire choroid-sclera border, for which an exact recognition of the CSI is not required (see Fig. 1 and 2).

Since a ground truth for comparison with the in-vivo situation is lacking, we combined a self-developed statistical validation framework with an exhaustive power analysis [2]. We then applied CRAR to macular telangiectasia type 2 (MacTel2). Follow up images of this disease suggest a correlation between changes in the choroidal thickness and the further development of MacTel2 [3].

We see great potential in expanding CRAR in other medical imaging fields, especially with low SNR, reproducible environments and potentially disease-related minute changes in tissues.

Funding:

FNSNF
Swiss National Science Foundation

FH
Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences

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References:

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(2) Ronchetti et al. Statistical framework for validation without ground truth of choroidal thickness changes detection. PloS one, 2019.

(3) Ronchetti et al. Feasibility study of subfoveal choroidal thickness changes in SD-OCT measurements of macular telangiectasia type 2. MICCAI OMIA, Springer, 2018.