Technology Offer

Reliable and Independent: New Automated Glaucoma Detection Method

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The invention relates to a newly developed image processing method for optical coherence tomography (OCT) to be used in particular on the (human) eye's anterior chamber. Said OCT images are used to diagnose glaucoma, but the required assessing methods are not yet available as automated and fully unsupervised.

Glaucoma is the main reason for irreversible blindness. Early-stage diagnosis is typically based on images of the anterior chamber. Various automated techniques for image analysis exist and are developing, but they are typically comparably unreliable and limited by low image quality.

In an entirely automated and unsupervised manner, the here-presented algorithm is able to analyze and characterize OCT images. By identifying and considering geometrical properties like chamber depth and iris-corneal angle, the method serves as a reliable detection system for glaucoma.

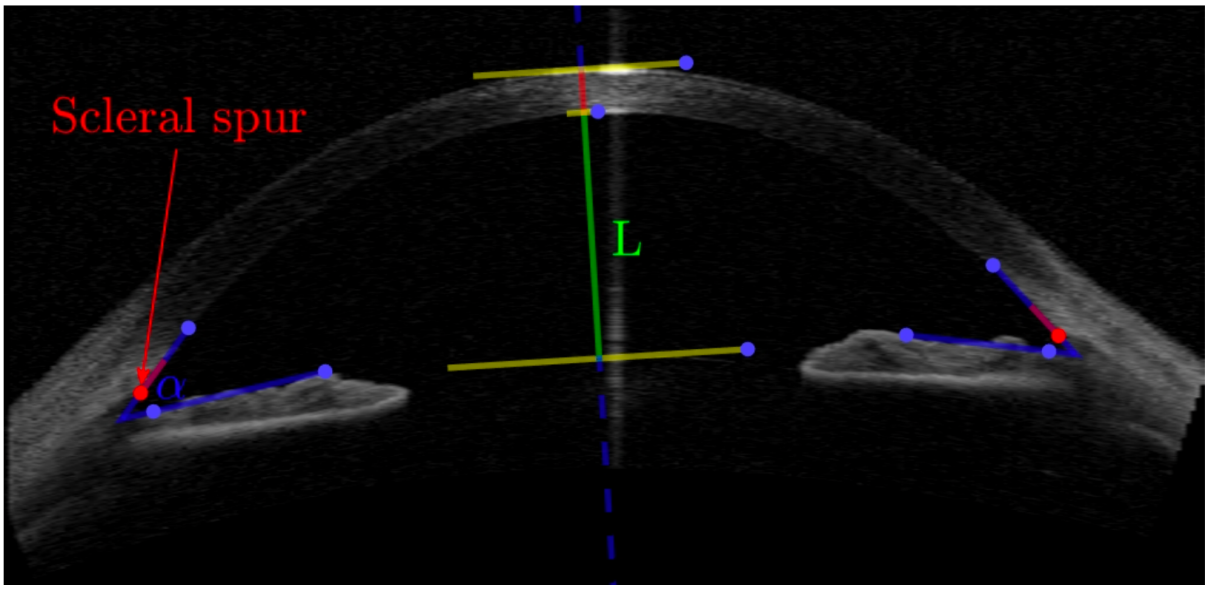

Fig. 1: Example OCT image with annotations for geometrical properties. The novel algorithm automatically calculates the chamber depth (L, green) and the iris-corneal angle (α, blue) and by that sorts the images according to categories: closed, narrow, open, and wide open.

Advantages

- Direct classification of images
- Reliable
- Highly automated
- Fully unsupervised operation possible
- Does not rely on specific landmarks
- Direct integration in OCT imaging devices possible
- Allows a patient to know the level of progress of the disease

Applications

- OCT imaging
- Ophthalmic clinics
- Glaucoma diagnosis

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Background

The world population is aging, which carries a high risk of eye diseases that significantly affect the quality of life. Thus, many efforts are currently focused on the development of reliable, cost-effective analysis tools that can improve the early diagnosis of eye diseases. Many automated methods have been proposed, but their reliability varies significantly with the image modality, image quality, and the number of images available in the dataset. For example, noise in the image and other artifacts typically cause significant difficulties in the process. Many methods also rely on manual landmark determination, thus making automated operation impossible.

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The novel algorithm for sorting and categorizing OCT images has been developed to overcome the aforementioned shortcomings. The system, thereby, uses the three steps of preprocessing the images, pair-wise distance measurement between images, and nonlinear dimensionality reduction.

The algorithm provides novel tools for assessing OCT images of the anterior chamber. They can be used for direct classification of the images defined by the ophthalmologists (e.g., closed, narrow, open, wide open) and furthermore, they can be linked to established quantities used for characterizing diseased eyes (i.e., chamber depth, iris-corneal angle) resulting in an automatic detection system. As the algorithm is fully unsupervised, it can be easily automated and set up in OCT imaging systems to aid technicians and doctors with their early diagnosis. Compared to state-of-the-art methods two main advantages of the novel algorithm reveal. Firstly, it does not need any ground truth or gold standard for training and, secondly, it is not based on specific landmarks. Hence, it can even analyze images in which relevant landmarks are invisible or difficult to locate.

Figure 1 shows an example image with the most important geometrical measurements performed by the method and Fig. 2 shows examples for images of eyes categorized as closed, narrow and wide open.

The above-described algorithm has been tested with a set of images classified by two expert ophthalmologists and with a larger set of annotated images. Most substantial is that the method is fully autonomous and can be used for analyzing images within a wide quality range, i.e., even those with vast interference through noise and artifacts.

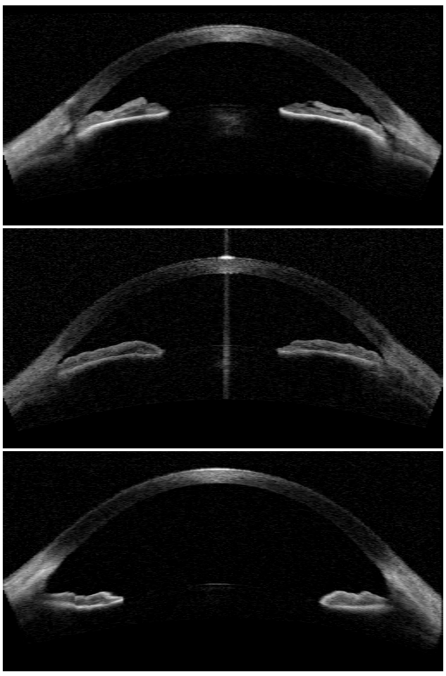

Fig. 2: Example images of the categories classified by the doctors. Closed (top), narrow (middle), and wide open (bottom).

Patent Information

PCT *(WO2019116074A1)*, EP, ES, US

Publications

P. Amil *et al*., *"Unsupervised feature extraction of anterior chamber OCT images for ordering and classification"*, Sci Rep 9 (2019)

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