Motion Artefacts Correction in Optical Coherence Tomography Volumes based on Scan Patterns

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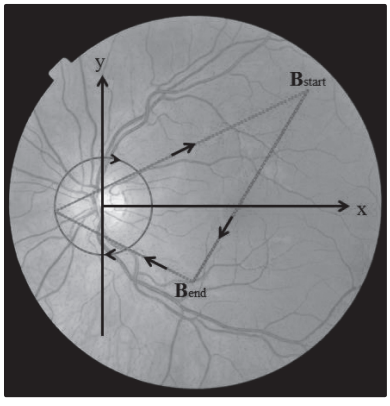
Optical coherence tomography is an imaging technology providing cross sectional images of the retina, however, one of the major problems are motion artifacts. Several hardware and software based motion trackers were developed to overcome this problem, whereby hardware based trackers require additional imaging modalities resulting in higher costs. Therefore, a software based method was developed. Tests on artificial data showed a possible tracking accuracy of approx. 35mum.

Introduction

Optical coherence tomography (OCT) is an imaging technology providing high resolution, cross sectional images of the human retina, however, one of the major problems in retinal OCT imaging are motion artifacts caused by heart beating, breathing and eye motion. In recent years, several hardware and software based motion trackers were developed to overcome this problem. Hardware based trackers require additional imaging modalities resulting in higher costs whereas software based methods use the acquired image to correct for motion. Recently published software based methods require multiple volume scans for motion detection «M. F. Kraus et. al., **Biomedical optics express,** vol. 3, no. 6, pp. 1182-1199, 2012». The aim of this thesis is to develop a simple software based method which detects motion on a B-scan basis.

Materials and Methods

The idea of the proposed method is to scan a retinal region containing strong features like the vessels around the optical nerve head (ONH) followed by scanning the region of interest. The absolute position of the acquired scans can then be estimated by segmenting the vessels from the reference scan and matching them to a previously acquired map of the ONH. The whole vessel matching process can be divided into an image acquisition, a vessel segmenting and a vessel matching task.



The red circle denotes the reference scan around the ONH and the green line the region of interest.

In order to generate the desired reference scans and a map of the ONH, a simple retinal scanner was developed and an existing OCT processing LabView software was extended to create the desired scan pattern and save the acquired scans. The vessels of the reference scans were segmented and had to be matched to the corresponding fundus vessels in the map. Aligning the OCT vessels to the fundus vessels and minimizing the distance between them was achieved with an expectation maximization algorithm «H. Zhu et al., **Medical Imaging, IEEE Transactions on,** vol. 30, no. 6, pp. 1228–1238, 2011». The algorithm estimates the probabilities if an OCT vessel belongs to a fundus vessel and minimizes the distances between corresponding vessels according to the previously calculated probabilities.

Results

The algorithm was implemented in Matlab and tested on artificial data and OCT scans from healthy subjects. Simulations with artificial data demonstrated a theoretical B-scan aligning accuracy of +/–15µm in x and y direction if the OCT vessels are segmented with an accuracy of +/– 7µm and no axial movement occurs. The patient data was assessed by measuring the normalized cross correlation of B-scans that were assumed to originate from the same position. Adjacent B-scans showed correlation values of >0.7.

Discussion

Results show that with the proposed algorithm tracking of OCT scans can be achieved without the need for additional complex and expensive hardware. However, results demonstrate an accuracy which is approximately three times lower then state of the art hardware based motion tracker. The results from living subjects only showed sufficient correlation when acquired consecutively. The reason for this can be inaccurate vessel segmentation but also axial movement of the eye during acquisition.

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