Comparison of two retinal tracking methods using infrared-reflectance (IR) fundus images

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Poster # PB0056

PURPOSE

- OCT acquisition systems rely on robust and real-time retinal tracking methods to capture reliable OCT images for visualization and further analysis.
- The retinal tracking parameters (xy-translation and rotation) are determined by a real-time registration between a reference and a moving IR fundus image.
- We compared two different real-time tracking methods using a fixed reference image and a method based on dynamic reference image update.

METHODS

- Retinal tracking methods use fixed (Bagherinia et al, *IOVS* 2020, Vol.61, PB0060) or dynamic reference image during OCT acquisition.
- The tracking problem primarily consists of aligning the corresponding key points (KPs) as detected in a pair of images (reference and moving).
- The number and well-distributed KPs matches as well as the RMSE of matched KPs determine the robustness of the tracking.
- 500 IR images per scan (11.52x9.36 mm with a pixel size of 15 µm, a frame rate of 50Hz) of 12 subjects (a total of 68 scans) were captured using a prototype slit-scanning ophthalmoscope with normal and small pupil acquisition mode.
- 9 different patient fixations including central and peripheral fixations with different levels of eye motion and image quality were considered.

Dynamic reference image update improves robustness of retinal tracking

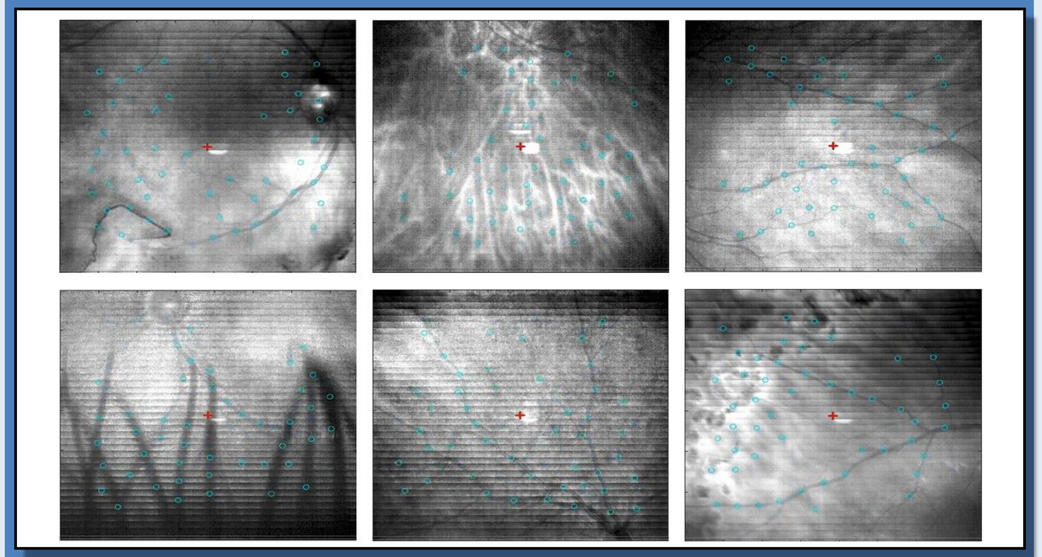

Figure 1. Examples of different patient fixations including central and peripheral fixations with various artifacts (stripe artifacts, central reflex, or eyelashes) and image quality (blurriness, uneven illumination, contrast). Detected KPs are shown in the images.

Method	RMSE Mean (SD) [µm]	Proportion of the image covered by the KPs Mean (SD)	Number of KPs Mean (SD)	Number of frames tracked per acquisition Mean (SD)
Fixed reference image	15.1 (±2.8)	0.36 (±0.1)	30.6 (±12.4)	402.3 (±100.0)
Dynamic reference image	8.4 (±3.5)	0.46 (±0.1)	46.0 (±9.4)	437.1 (±70.4)

Figure 2. Statistics for the RMSE of matched KPs, proportion of the image covered by the KPs, number of KPs, and number of frames tracked per acquisition.

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Disclosures: HB (E), QZ (E), XZ (N), RW (C): Carl Zeiss Meditec, Inc., RW (F): Carl Zeiss Meditec, Inc., Colgate Palmolive Company, Estee Lauder Inc; RW (P): US8,750,586, US8,180,134, US9,282,905, US9,759,544, US 10,354,378, US10,529,061

- The images contain artifacts such as stripe artifacts, central reflex, and possibly eyelid and eyelashes (Fig 1).
- The RMSE of the matched KPs, the proportion of the image covered by the KPs, the number of KPs, and the number of frames successfully tracked per acquisition were calculated.
- Statistics were reported for both tracking methods.

RESULTS

- Figure 2 shows the reported statistics for both tracking methods using a fixed and dynamic reference image.
- The mean values of the RMSE, the proportion of the image covered by the KPs, the number of KPs, and the number of frames tracked per acquisition were improved by 44%, 22%, 33%, and 8% respectively using the method based on the dynamic reference image update.
- The average execution time of both tracking methods were measured 15 ms using Intel i7-8850H CPU, 2.6 GHz, 32 GB RAM.

CONCLUSIONS

- We compared two real-time retinal tracking methods based on fixed and dynamic reference image update.
- We showed significant performance improvement of the retinal tracking using dynamic reference image update.
- Retinal tracking based on dynamic reference image update may improve the OCT acquisition workflow and robustness of the retinal tracking.