A real-time retinal tracking method for off-centered fixation using infrared-reflectance (IR) images

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PURPOSE

- OCT acquisition systems rely on robust and real-time retinal tracking methods to capture reliable OCT images for visualization and further analysis.
- Tracking the retina with off-centered fixation can be a challenge due to lack of adequate rich anatomical features in the images.
- We demonstrated a robust and real-time retinal tracking algorithm that finds at least one anatomical feature with high contrast as a reference point (RP) to improve the tracking performance[1].

METHODS

- A real-time keypoint (KP) based registration between a reference and a moving image calculates the xy-translation and rotation as the tracking parameters.
- A unique RP and a set of reference image KPs were extracted from the reference image.
- The location of the RP in the reference image is robustly detected using a fast image saliency method.
- The RP location in moving images is detected by template-matching using RP template extracted from the reference image.
- Each reference KP template and its relative distance to the RP are used to search for the corresponding moving KP with the same distance from the moving image RP location (Figure 1).
- The tracking parameters were calculated from a subset of KP correspondences with high confidence.

Robust real-time retinal tracking provides reliable OCT image acquisition

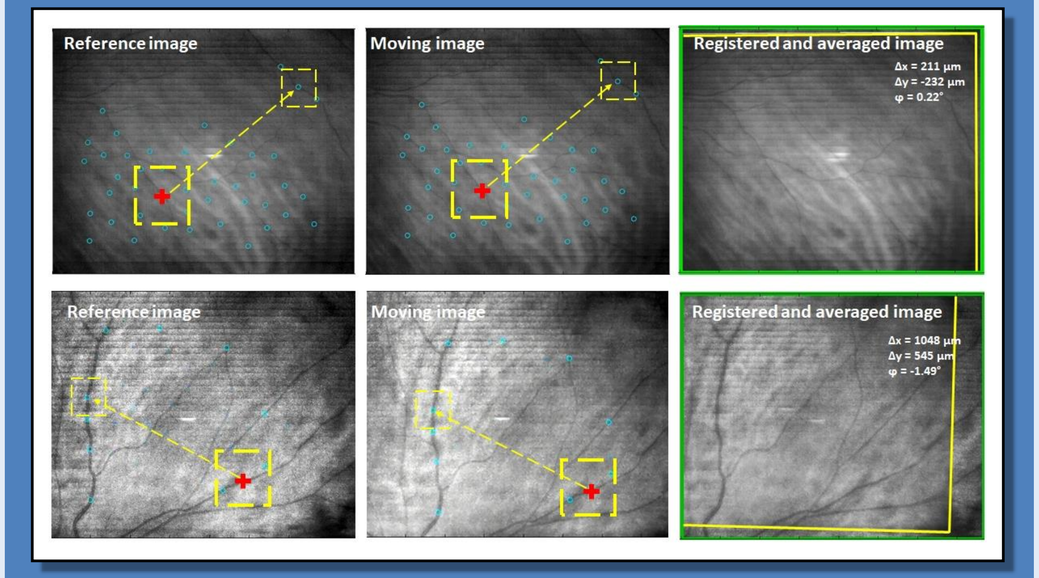

Figure 1. Two examples for small (top) and normal (bottom) pupil acquisition modes. RP (+) is detected by the fast image saliency algorithm. Keypoints are detected relative to the RP location.

Registration Error Mean,Std,(min,max) [microns]	Eye motion Mean,Std,(min,max) [microns]	Eye rotation Mean,Std,(min,max) [degrees]	Number of KPs Mean,Std,(min,max)
15.3 , 2.7 , (0.13 , 23.9)	427.8 , 433.3 , (0.0 , 2929.0)	-0.01 , 0.66 , (-4.3 , 3.7)	30.0, 11.5 , (9.0, 50.0)

Figure 2. Statistics for the registration error, eye motion and number of keypoints for a total number of 29,529 images from 45 sequences of images.

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- Prototype software was used to collect sequences of IR images (11.52x9.36 mm with a pixel size of 15 µm/pixel and 50 Hz frame rate) from a CLARUS™ 500 (ZEISS, Dublin, CA).
- The mean distance error between the registered moving and reference KPs for each moving image were calculated as the registration error.
- The statistics of registration error, number of KPs and eye motion were reported.

RESULTS

- 45 sequences with an average of 650 images each were collected from one or both eyes of 10 subjects.
- The patients' fixation were off-centered.
- The average registration error of 15.3±2.7 µm (Figure 2) indicates that accurate tracking in OCT domain with A-scan spacing greater than 15 µm is possible.
- The mean execution time of the tracking was measured as 15 ms using Intel i7-8850H CPU, 2.6 GHz, 32 GB RAM.

CONCLUSIONS

- A real-time retinal tracking method using IR fundus images was developed.
- We demonstrated the robustness of the tracking algorithm which is an important part of any OCT image acquisition system.

References

[1] *Bagherinia et al. IOVS 2020; 61(9): Abstract PB0060.*