

PURPOSE

- Robust registration of longitudinal data is required to measure the changes of OCT/OCTA slabs and retinal thicknesses over time.
- The pathological changes in the retina from one visit to another makes the registration of two OCT/OCTA slabs a challenging task.
- A robust registration method based on using multiple OCT/OCTA slabs was proposed.

METHODS

- The OCT registration consists of aligning the corresponding keypoints in a pair of images.
- To ensure a robust registration, well distributed keypoints were extracted from OCT/OCTA slabs at different depth.
- OCT images were generated from
 - 1) superficial and deep retinal layer slab
 - 2) retinal pigment epithelium (RPE) slab
 - 3) choroidal slab
- OCTA images were generated from
 - 1) superficial (SRL) slab
 - 2) deep capillary plexus slab
 - 3) RPE and choriocapillaris slab
- An exhaustive search method was used to fit best rigid transformation to a subset of matched keypoints.
- 15, 25, and 5 pairs of OCT volumes over 6x6 mm with eye diseases such as diabetic retinopathy and age-related macular degeneration using 1) CIRRUS™ HD-OCT 5000 (ZEISS, Dublin, CA), 2) PLEX® Elite 9000 SS-OCT (ZEISS, Dublin, CA), 3) CIRRUS HD-OCT 5000 with AngioPlex® OCT Angiography (ZEISS, Dublin, CA).

A novel registration approach provides robust image registration in advanced disease cases

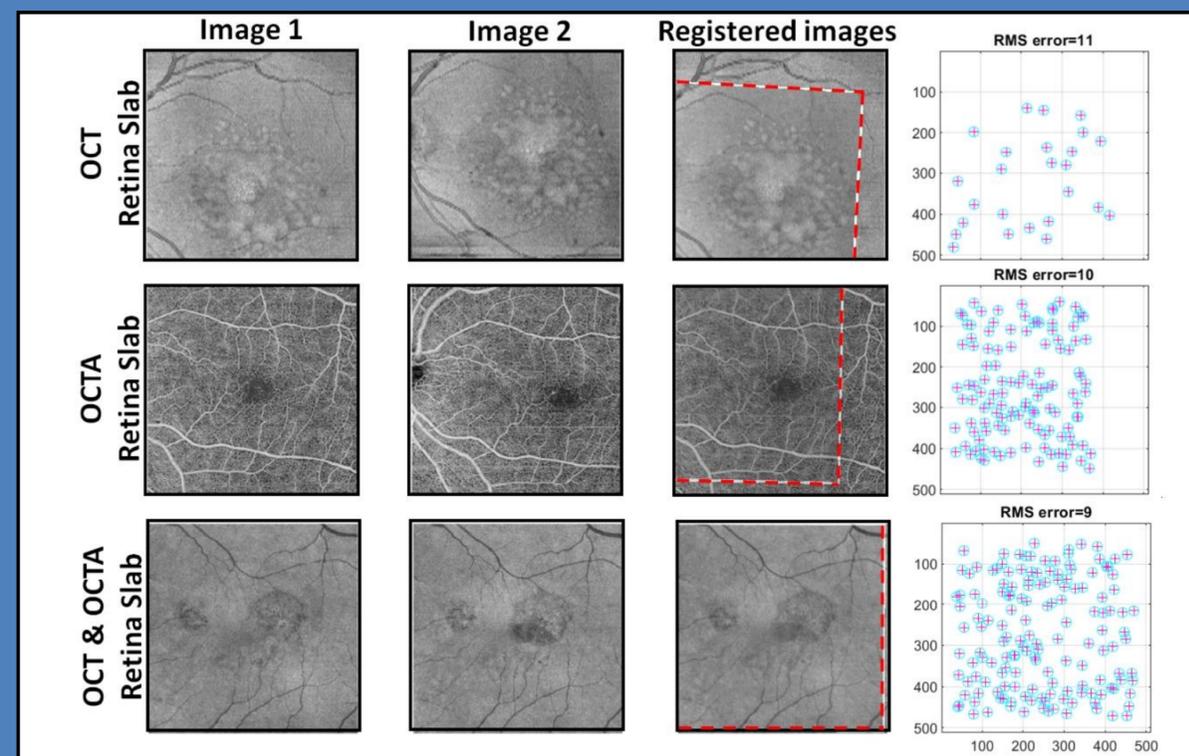


Figure 1. Three registration examples of longitudinal data: all three OCT images (top), all three OCTA images (middle), and all OCT and OCTA images (bottom) were used for registration.

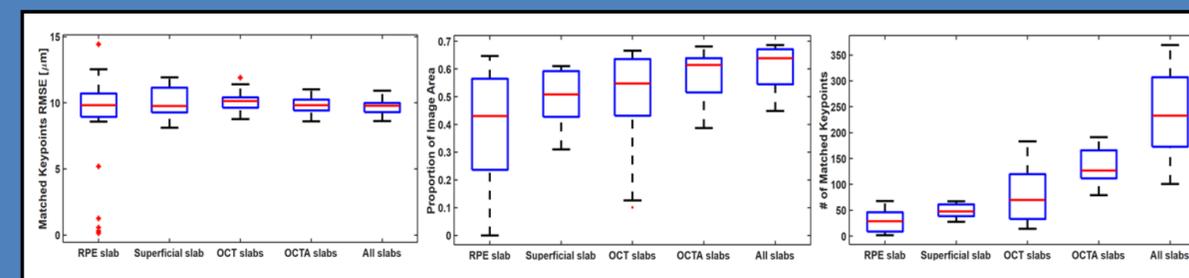


Figure 2. Box plots for RMSE of the matched keypoints (left), the keypoints area coverage (middle), the number of keypoints (right) for all 5 keypoints extraction methods.

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- The performance of 5 registration methods were measured using keypoints extracted from 1) RPE, 2) all 3 OCT, 3) SRL, 4) all 3 OCTA and 5) all OCT and OCTA images.
- The nonparametric statistics of the RMSE of the matched keypoints along with the number and keypoints image area coverage for each pair of OCT volumes were reported for all 5 methods.

RESULTS

- Figure 1 shows examples using multiple slabs for registration.
- Figure 2 shows the box plots for RMSE of the matched keypoints, the number and keypoints image area coverage for 5 registration methods.
- The number and the keypoints area coverage increase significantly when multiple OCT/OCTA slabs were used.
- The RMSE using multiple slabs shows tighter distribution with a median value around 10 µm.
- The accuracy requirement of OCT registration with A-scan spacing greater than 10µm may be achieved.

CONCLUSIONS

- A novel registration approach based on matched keypoints extraction from multiple OCT/OCTA slabs was introduced.
- This study suggests that using multiple OCT/OCTA slabs outperforms using a single slab for registration, which is essential for measuring changes in longitudinal data.