Periodic axial motion estimation and correction using low-cost optical coherence tomography (OCT)

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PURPOSE

- Motion artifacts in OCT imaging have been an important topic in OCT data analysis.
- Periodic motion artifacts during OCT image acquisition of a patient can be caused by various sources such as muscular, peristaltic, cardiovascular, respiratory, as well as mechanical vibration in the instrument.
- Here we present a new periodic motion correction method for OCT data. We demonstrate the performance of the method by evaluating RPE (retinal pigment epithelium) elevation with and without motion correction.

METHODS

- Our method uses ILM (internal limiting membrane) and RPE segmentation in low-cost OCT volume scans. The Fourier transformation of ILM layer is used to estimate the periodic motion. The frequency bands associated with periodic pattern were removed prior to the inverse Fourier transformation.
- The estimated motion is then used to remove periodic motion artifacts from the RPE layer. A polynomial surface is fitted to the RPE layer (RPE-fit) to mimic Bruch's membrane. The RPE elevation map is created by measuring the difference between the RPE-fit and RPE surfaces. We evaluated this method using scans from 17 subjects, either left or right eye, with retinal pathology.
- Each eye was scanned twice using a prototype low-cost OCT device that had a macula scan with 128x512 A-scans over 7x5.8 mm. The RPE elevation map from the 2nd scan was registered to that of the 1st scan. The RPE elevation volumes (in cubic micrometers) were averaged over central 3-mm and 5-mm zones. Regression and Bland-Altman plots were derived to evaluate the agreement of RPE elevation map.

RESULTS

- Figure 1 shows the algorithm pipeline using ILM and RPE segmentation.
- Figure 2 shows examples of RPE elevation maps with and without periodic motion correction.
- Figures 3 & 4 illustrate the Bland-Altman plots comparing the RPE elevation volume (in cubic micrometers) of the two scans from the same eye in the central 3-mm and 5-mm zones.
- Our results show that there is a good correlation and agreement between the two scans. The method with motion correction shows smaller mean difference and within 95% limits of agreement, which indicate a more repeatable method.

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CONCLUSIONS

We presented a method to compensate for periodic motion in low-cost OCT data prior to the RPE elevation map creation. We demonstrated that the motion compensation is essential for visualization of the RPE elevation map as well as better agreement between repeat scans.

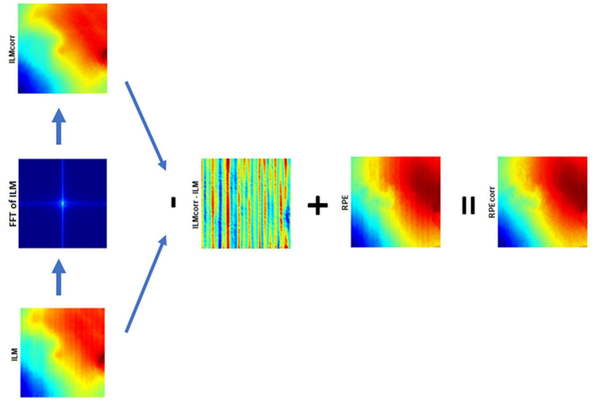

Fig. 1: Algorithm pipeline for ILM and RPE Segmentation.

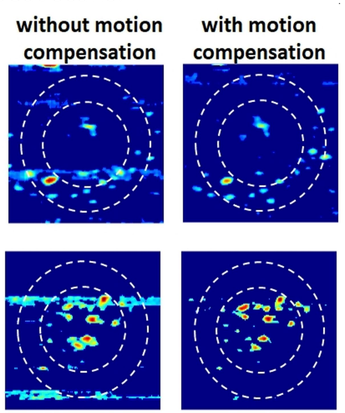

Fig. 2: Examples for RPE elevation map with and without motion correction.

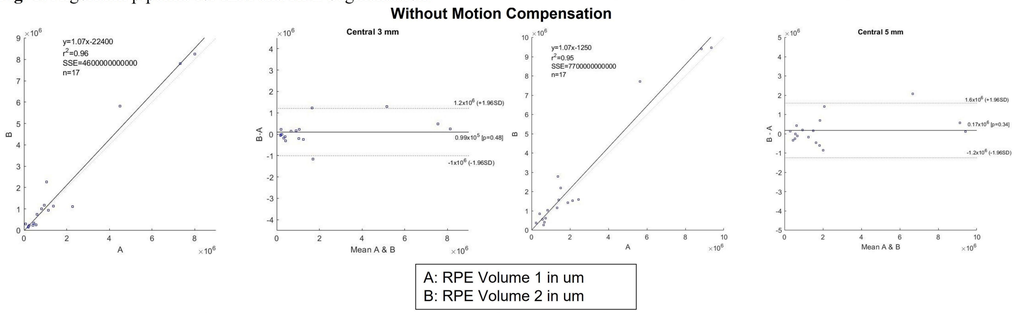

Fig.3: Regression and Bland-Altman plots comparing the RPE elevation volume in the central 3-mm and 5-mm zones.

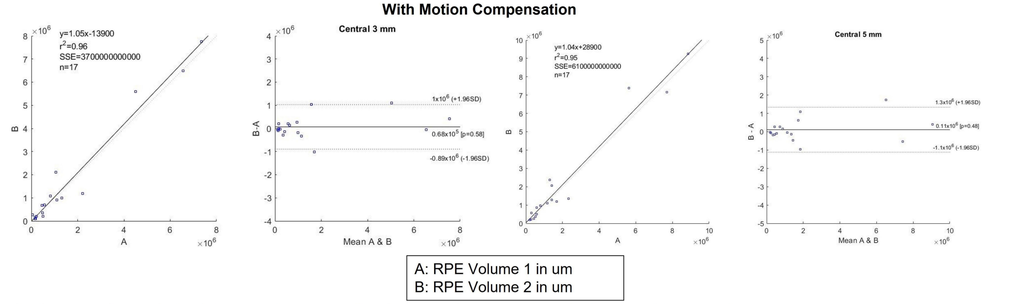

Fig.4: Regression and Bland-Altman plots comparing the RPE elevation volume in the central 3-mm and 5-mm zones.