

# Automated segmentation of geographic atrophy using U-Net on custom-generated SD-OCT *en face* images

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## PURPOSE

Geographic atrophy (GA) is a condition associated with loss of the retinal pigment epithelium (RPE) and represents the late stage of non-exudative age-related macular degeneration (AMD). This research aims to develop a fully-automated segmentation and quantification algorithm of geographic atrophy for spectral domain optical coherence tomography (SD-OCT) *en face* images.

## METHODS

- Retrospective study using 250 macular cubes (512x128x1024: 58, 200x200x1024: 192) obtained from 155 patients using CIRRUS™ HD-OCT 4000 and 5000 (ZEISS, Dublin, CA).
- Experts manually drew the GA ground truth (GT) segmentations in the *en face* images.
- For each macular cube, a 3-channel *en face* GA projection image was generated by combining: 1) sub-volume section of choroid; 2) slab projection surrounding RPE and retinal thickness between the RPE and inner limiting membrane (ILM) layer.
- The training and testing sets of custom-generated *en face* images were comprised of 225 eyes (GA: 187, drusen with no GA: 19 and healthy: 19) and 25 eyes (GA: 11, drusen with no GA: 5 and healthy: 9)
- The contracting, bottleneck and expansive path of the U-Net consisted of 4 convolutional neural networks (CNN) blocks, 2 CNN blocks with 0.5 dropout and 5 CNN blocks (Figure 1). Binary cross entropy and dice coefficient loss were used for training. 'Icing on the Cake' was used to fine-tune the model.
- Segmentations by the algorithm in the test set were compared with the GT using quantitative measurements (Bland-Altman, area and Pearson's correlation).

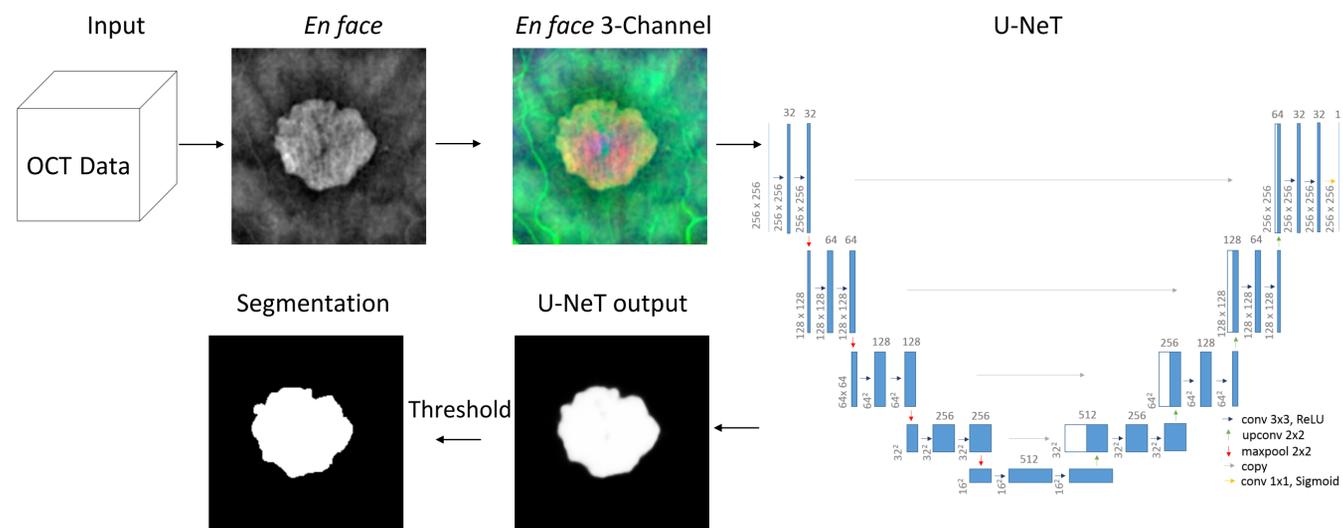


Figure 1: Flowchart of the proposed segmentation algorithm

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Disclosures: NM (E); LS (E); GG (F) (P); PR (F) (C), MD (E): Carl Zeiss Meditec, Inc.

## RESULTS

- Figure 2 shows the results of the algorithm, Advanced RPE Analysis and the GT.
- The **absolute and fractional area differences between GA regions** generated by the **proposed algorithm** and the GT were **0.11 ± 0.17 mm** and **5.51 ± 4.7%** as opposed to 0.54±0.82mm and 25.61±42.3% for Advanced RPE Analysis.
- The inference time was 1183 ms per *en face* image using an Intel® i7CPU.
- Correlations of GA areas generated by the **proposed algorithm** and Advanced RPE Analysis with the GT were **0.9996** (p-value<0.001) and 0.9259 (p-value<0.001).
- The Bland-Altman plot between the GT and the segments generated using proposed algorithm showed stronger agreement than Advanced RPE analysis.

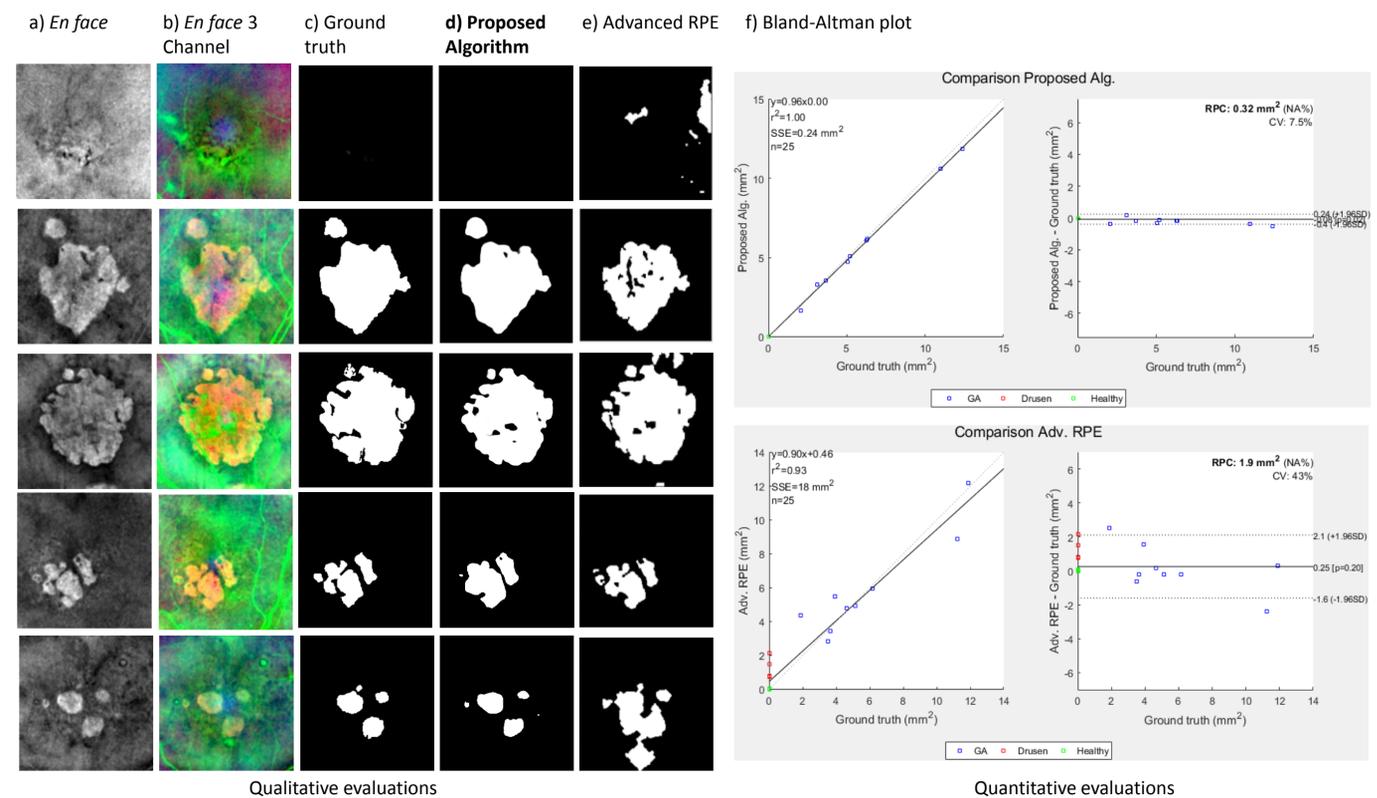


Figure 2: Qualitative and quantitative evaluations of the proposed algorithm segmentation results

## CONCLUSIONS

Qualitative and quantitative comparisons to the ground truth from manual segmentations suggest that the proposed algorithm can effectively segment GA in SD-OCT *en face* images