Deep Learnt Random Forests for Segmentation of Retinal Layers in Optical Coherence Tomography Images

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Abstract—Retina is a crucial segment of the eye and is composed of photoreceptors comprising the retinal pigment epithelium (RPE). Age-related macular degeneration (AMD) is a condition in which deposition of drusen material between the RPE and Bruch’s membrane triggers an irreversible visual loss and ophthalmologists rely on optical coherence tomography (OCT) for examining the variation in width of anterior coat and the RPE located below it. Since a high degree of stratified contrast is not observed between these layers, automated segmentation methods are deployed to reduce reporting variability. Here we propose a deep learning technique for retinal layer segmentation in OCT image sequences. This approach uniquely facilitates learning to extract features characteristic of different layers. It is experimentally validated using images of 20 AMD + 20 healthy subjects, and 100 image per subject. Anterior coat is segmented with 0.97, RPE with 0.92, posterior coat with 0.99 accuracy.

I. INTRODUCTION

Vision loss in the elderly on account of age related macula degeneration (AMD) is caused by deposition of drusen material between the retinal pigment epithelium (RPE) and the posterior coat starting at Bruch’s membrane. Optical coherence tomography (OCT) is used for clinically examining the differential change in thickness of the anterior coat and the RPE for early diagnosis of AMD [1]. Most retinal layers have characteristic cellular composition and offer distinct stratified contrast, that is not strongly observed between RPE and at anterior coat originating at Bruch’s membrane [1]. Retinal later segmentation approaches have been proposed [2] to overcome this limitation and their performance varies based on (a) nature of feature descriptors used as well as (b) the learning methodology. In order to reduce segmentation variability we propose a deep learning approach [3] for retinal layer segmentation.

II. MATERIALS AND METHODS

Retinal OCT images of 20 AMD + 20 healthy subjects, and 100 image per subject from [1] are used for experiments.

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Fig. 1. The anterior coat, RPE and posterior coat segmented in retinal OCT with deep learnt random forest. The abrupt nature of RPE thickness characteristic of AMD is clearly visible in segmented results despite the low contrast between these layers in grayscale OCT images.

Fixed width overlapping patches from the grayscale OCT images are used initially for training a stack of two auto-encoders (AE) in a greedy manner. The AE parameters are fine tuned using labelled training data through logistic regression (LR) and error back-propagation. We consider four classes, viz., anterior coat, RPE and posterior coat; and the non-tissue region. Details of this architecture can be found in [3]. Since, LR is characteristic to learn patterns efficiently when they are separable in a logarithmic transformed space. In absence of this property in the data, we can learn patterns from the AEs using a random forest [4] when patterns are embedded in a higher order manifold.

III. RESULTS AND CONCLUSION

Experimental evaluation as presented in Fig. 1 shows accuracy of 0.97 in segmenting anterior coat, 0.92 in RPE and 0.99 in posterior coat, and substantiates efficacy of retinal layer segmentation in OCT images using deep learnt random forests.

REFERENCES