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Quantification of Retinal Nerve Fiber Layer Atrophy in Digital Fundus Photograph
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Purpose: To measure the retinal nerve fiber layer (RNFL) loss is important in the early detection and management of glaucoma. For quantitative analysis of the RNFL atrophy, several methods were suggested. However they are not completely quantitative and automatic. To quantify the RNFL atrophy and its progression, the novel method based on image processing and learning technique will be presented.

Material and method: In digital fundus photograph, the region with RNFL atrophy shows low intensity compared to normal nerve fiber layer. So we analyzed the intensity profile of the pixels on the cirlce around the optic nerve head (ONH). Digital RNFL photograph was gray-scaled using green channel information and denoised by median filter. Optic disk was localized and fitted as a circle. And the intensity profile on the circumference having the radius equal to N- times the disk diameter (e.g. 1.5D.D.) was acquired. To determine the regions of normal RNFL, RNFL atrophy and blood vessel on the intensity profile plot, supervised learning based scheme was used. An Intensity, max-min difference, first and second derivative, standard deviation, entropy and other high order statistics were selected as features. Principal component analysis (PCA) was applied in order to reduce the inherent redundancy in feature sets. Three-layered artificial neural network (ANN) was used to segment the above three classes. To monitor the progression of RNFL atrophy quantitatively, the registration of retinal images of the same patient taken at different times (e.g. six months of follow-up) is needed. The locations of ONH and blood vessels were utilized to align these images.

Results: The segmentation and registration procedures were successful. The fraction of RNFL atrophy relative to normal layer can be visualized and quantified for further analysis.

Conclusion: The degree and the progression of RNFL defect were successfully calculated by image segmentation and registration method.