OCTA flow signal enhancement by reducing residual structural signal

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PURPOSE

The image quality of OCT angiography (OCTA) strongly depends on the contrast between static tissue and moving scatterers, i.e. blood cells travelling through capillaries. Simply calculating variance between multiple acquisitions at the same location attenuates signal from static tissue and highlights perfused capillaries [1]. However, the high contrast OCTA images clinicians are used to, undergo significant image processing before they are displayed. We present a fast, practical approach for further suppressing signal from static tissue and hence enhancing the contrast of OCTA images.

METHODS

- Acquired OCTA volumes using a CIRRUS™ HD-OCT 5000 with AngioPlex® OCT Angiography (ZEISS, Dublin, CA)
- Generated OCTA B-scans using the Optical Micro Angiography (OMAG) algorithm [1], using complex OCT signal as input. It corresponds to the additive mix (Fig. 1b):
  - $I_l = x + \omega I_u$
    - ωI_u: a fraction of the structural intensity signal
    - x: pure flow signal
- The desired pure flow signal (x) (Fig. 1c), with all structure removed, should look fundamentally different from the pure structure image (I_u) (Fig. 1a).
- A solution for ω can be found by minimizing the square of the normalized cross-correlation between I_u and I_l:

$$argmin_{\omega}\gamma^2(I_u, I_l - \omega I_u),$$

with its simple explicit solution:

$$\omega = \frac{cov(I_u, I_l)}{var(I_u)}$$

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RESULTS

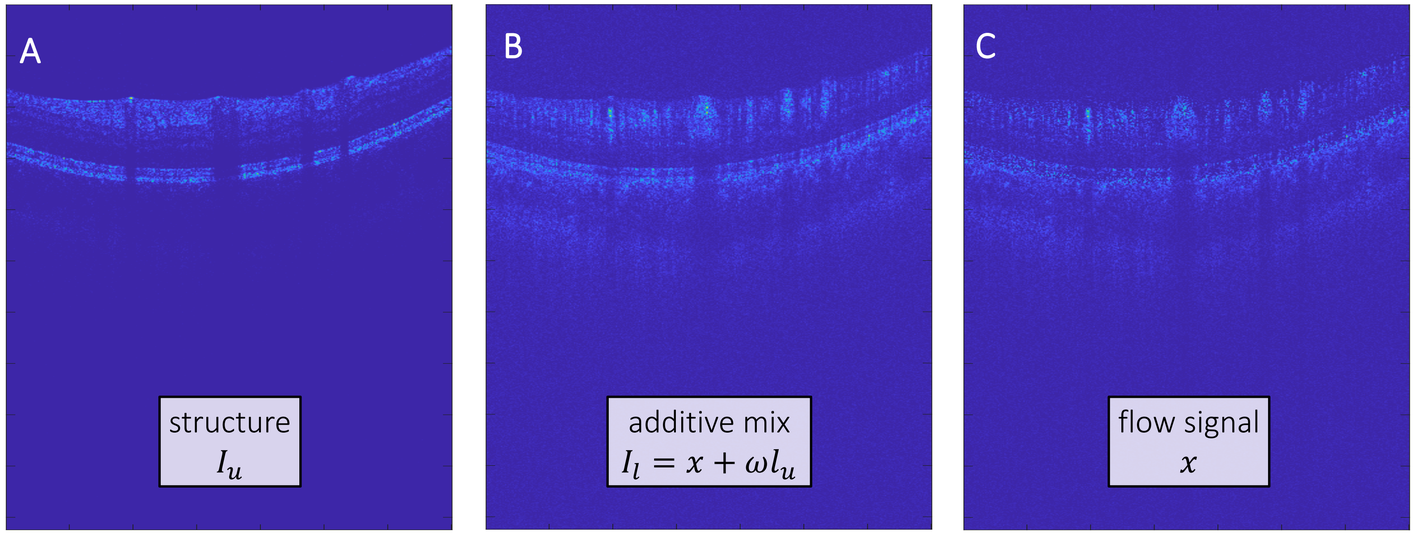

Figure 1. Example B-scans. a) structural intensity, b) flow B-scan with residual structural signal, c) flow B-scan with residual structural further attenuated

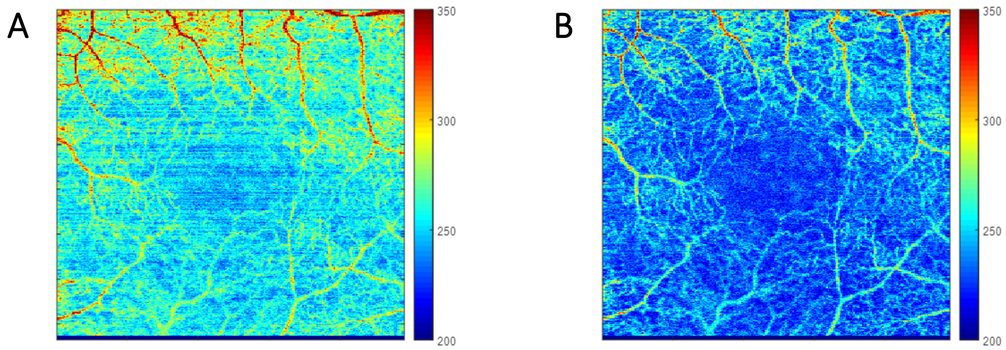

Figure 2. OCTA enface projections. a) direct output from OMAG algorithm, b) after processing with the presented method

CONCLUSIONS

- The presented method significantly improves the contrast of retinal OCTA images.
- Compared to traditional OCTA post-processing methods for attenuating remaining signal from static tissue, which are often applied iteratively or use spatial filtering over sliding 2D kernels, this method is computationally efficient.

References

1. Zhang, A., et al. (2015). "Methods and algorithms for optical coherence tomography-based angiography: a review and comparison." J Biomed Opt 20, 2015.