Hybrid OCT-OCTA Vessel Visualization for Projection-Free Display of the Intermediate and Deep Retinal Plexuses

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Program #638
Session #138
Board #B0385

Purpose

- In optical coherence tomography angiography (OCTA), projection artifacts (i.e., "shadowing artifacts" or "decorrelation tails") cause superficial retinal vasculature to appear in the intermediate and deep retinal plexuses.
- The projections of these larger superficial vessels obfuscate the unique vascular patterning of the deeper layers.
- Several algorithms have been proposed to remove these shadows (e.g. [1-3]).
- However, by removing the projected vessels it is sometimes the case that intermediate/deep vessels are also removed in that region (we term these "vessel discontinuity artifacts").
- The purpose of this study is to develop a projection artifact removal scheme that overcomes these limitations, preserving the intermediate and deep retinal vasculature.

Methods

- Amplitude decorrelation based OCTA data was collected using a prototype 1050nm swept source OCT system developed at MIT.

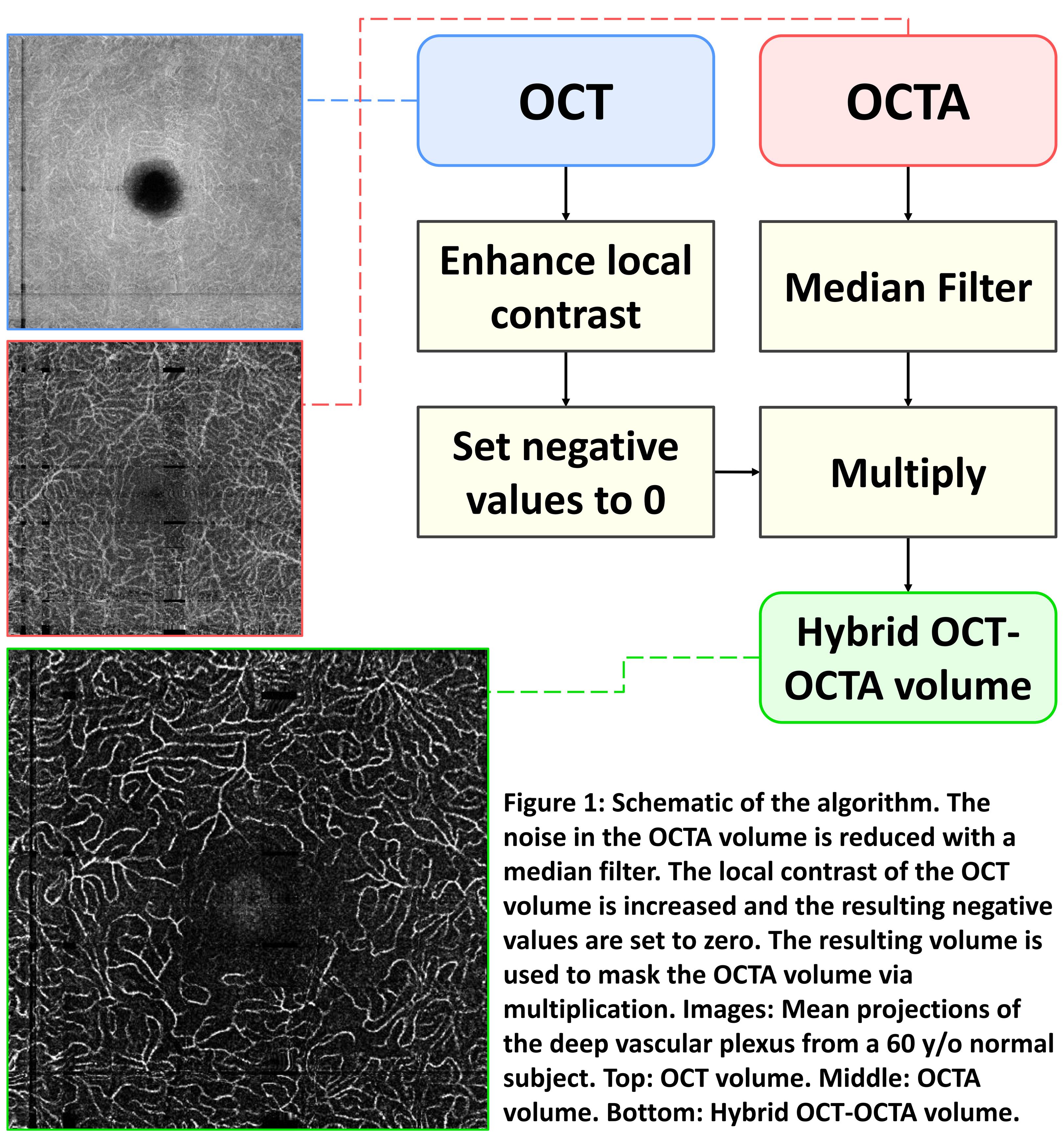

Figure 1: Schematic of the algorithm. The noise in the OCTA volume is reduced with a median filter. The local contrast of the OCT volume is increased and the resulting negative values are set to zero. The resulting volume is used to mask the OCTA volume via multiplication. Images: Mean projections of the deep vascular plexus from a 60 y/o normal subject. Top: OCT volume. Middle: OCTA volume. Bottom: Hybrid OCT-OCTA volume.

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Results and Discussion

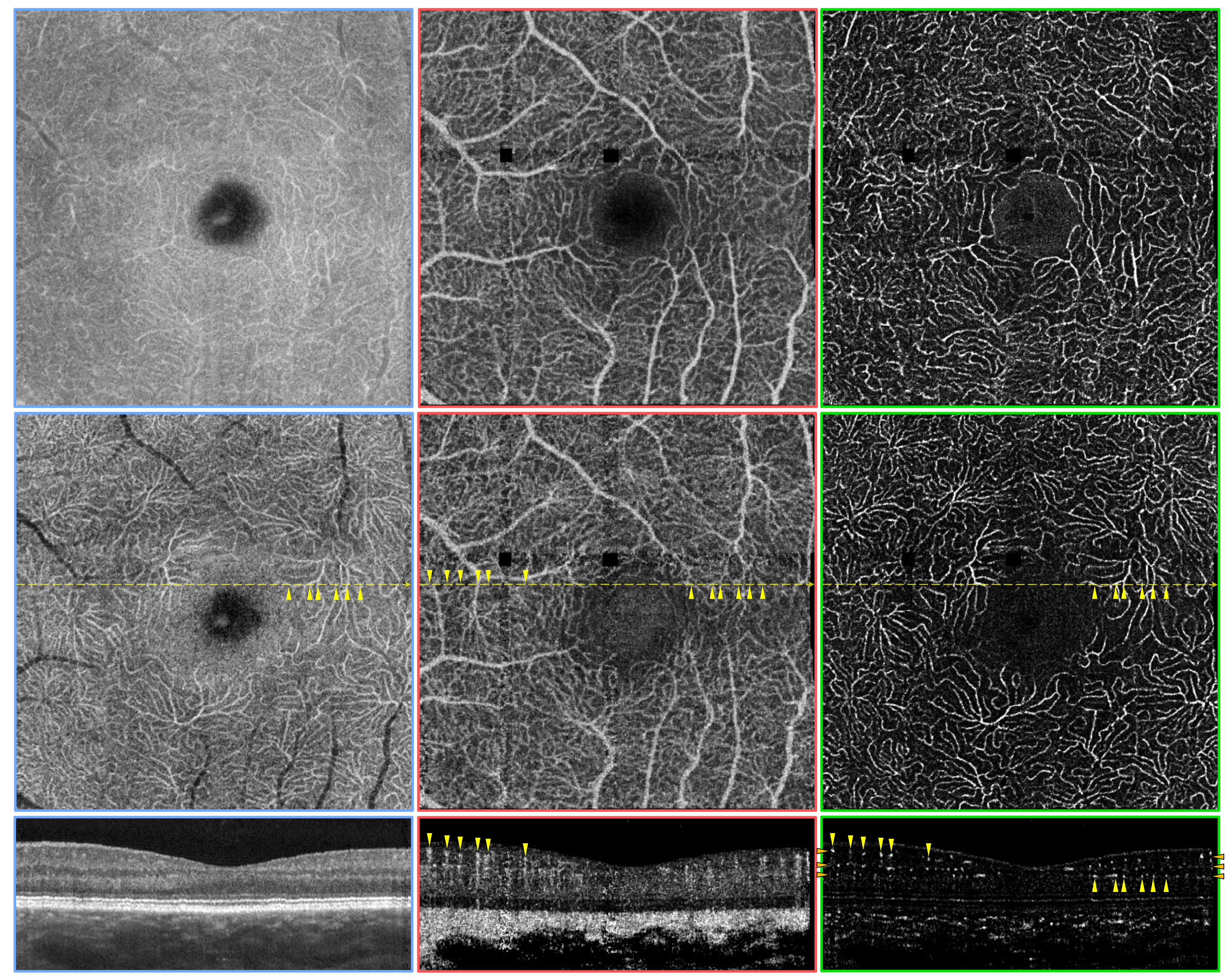

Figure 2: Images of a 43 y/o normal subject. Left column: OCT volume. Central column: OCTA volume. Right column: Hybrid OCT-OCTA visualization. Top row: en-face projections of the intermediate vascular plexus. Middle row: en-face projections of the deep vascular plexus. Bottom row: B-scans at the position of the dashed yellow line. Downward / upward facing yellow triangles point at vessels in the superficial / deep vascular plexus. Orange triangles from top to bottom: Superficial, intermediate and deep vascular plexus.

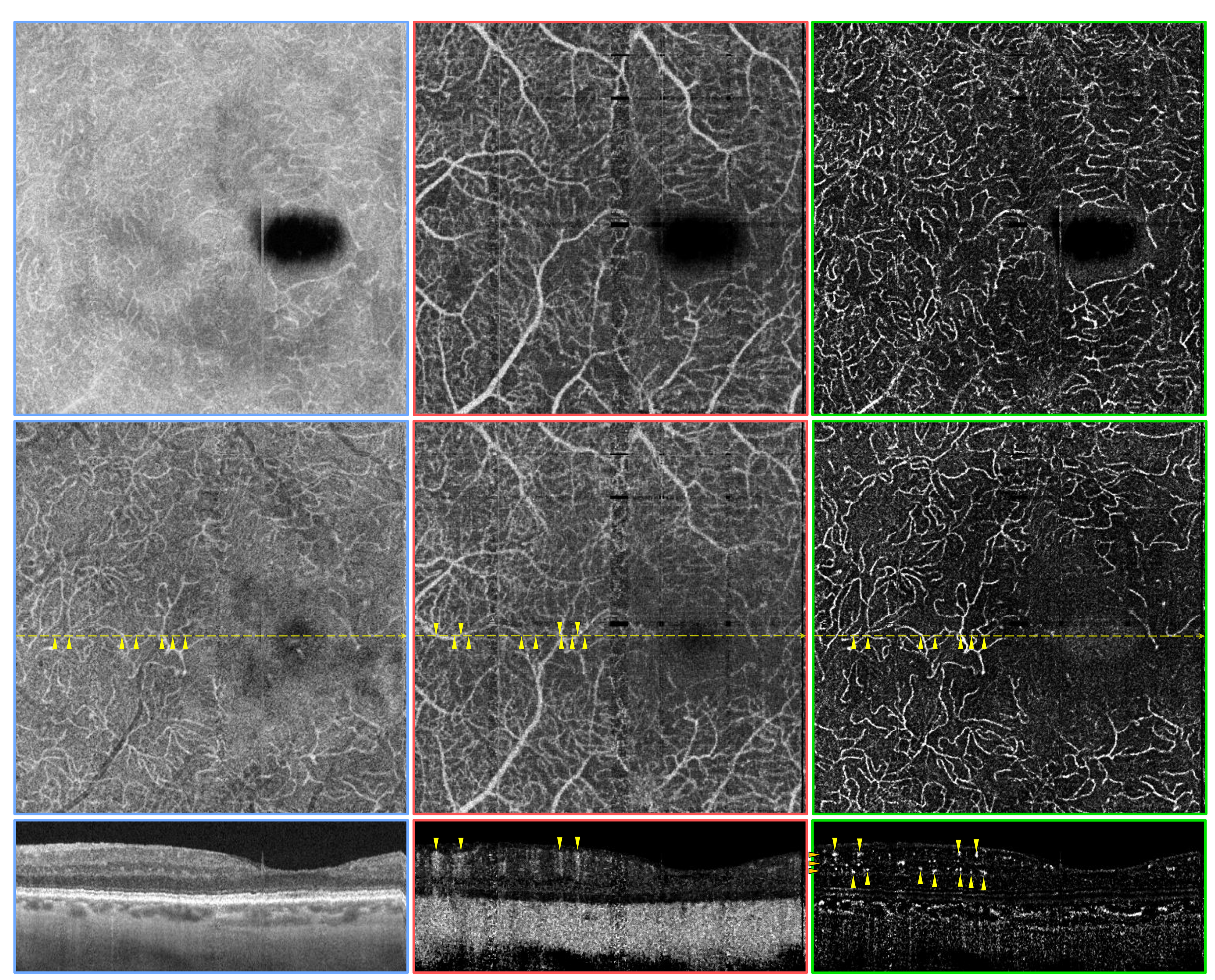

Figure 3: Images of a 65 y/o PDR patient. Left column: OCT volume. Central column: OCTA volume. Right column: Hybrid OCT-OCTA visualization. Top row: en-face projections of the intermediate vascular plexus. Middle row: en-face projections of the deep vascular plexus. Bottom row: B-scans at the position of the dashed yellow line. Downward / upward facing yellow triangles point at vessels in the superficial / deep vascular plexus. Orange triangles from top to bottom: Superficial, intermediate and deep vascular plexus.

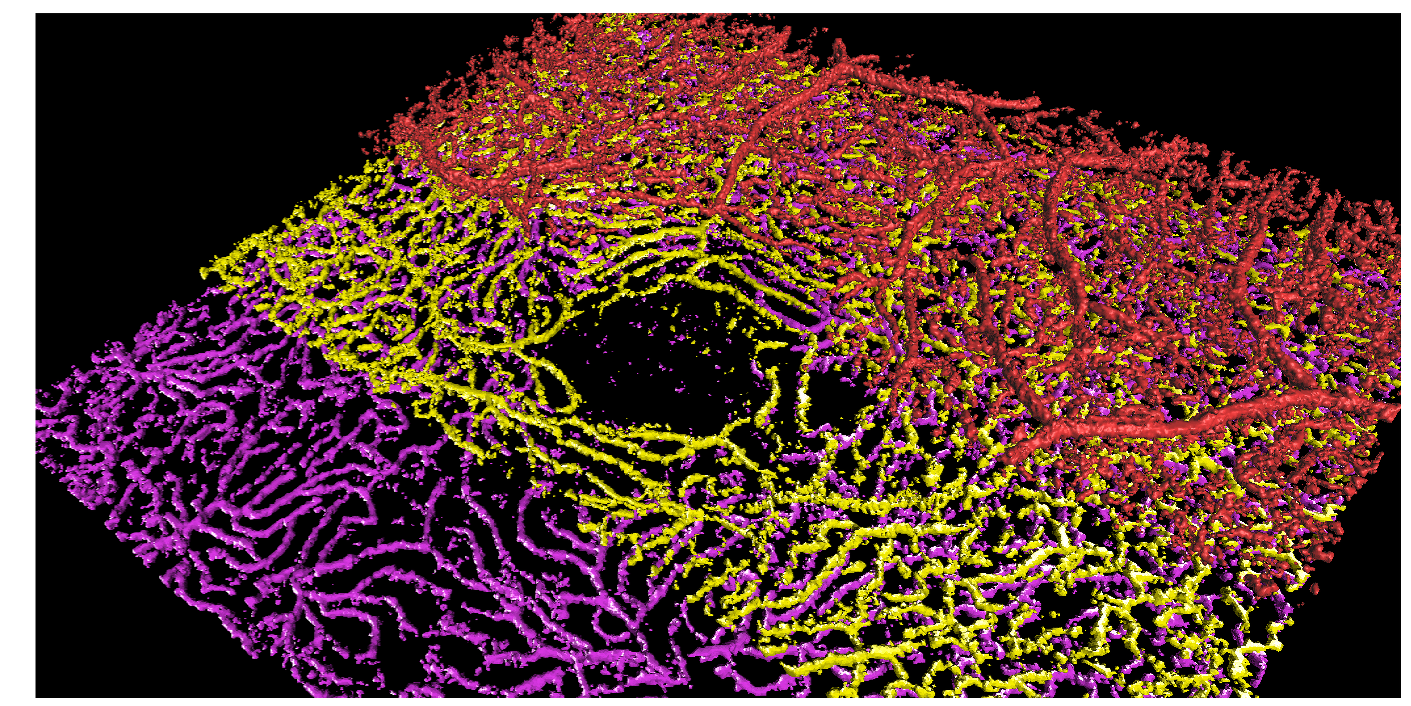

Figure 4: Volumetric rendering of a 43 y/o normal subject. Red: superficial vascular plexus. Yellow: intermediate vascular plexus. Purple: deep vascular plexus.

Conclusions

- The hybrid OCT-OCTA approach reduces projection artifacts to a negligible level in the intermediate and deep plexuses while minimizing vessel discontinuity artifacts (Fig. 2, Fig. 3).
- Hybrid OCT-OCTA improves 3-D visualization of vascular plexuses (Fig. 4).
- Further work is needed to evaluate the algorithm in different pathologies.
- Hybrid OCT-OCTA may be useful for quantitative analysis of vascular patterns (e.g., [4]), particularly in diseases such as diabetic retinopathy where the deep plexus is known to be altered (Fig. 3) (e.g., [5]).

References

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Commercial Relationships Disclosure: SBP: Code P (Patent) ● EMM: Code P (Patent) ● JJS: None ● LH: None ● CDL: None ● CBR: None ● AYA: None ● JSD: Optovue, Inc.: Code C (Consultant), Code F (Financial Support); Topcon Medical Systems, Inc.: Code C (Consultant), Code F (Financial Support); Carl Zeiss Meditec, Inc.: Code C (Consultant), Code F (Financial Support); ● NKW: Janssen: Code C (Consultant); Ocudyne: Code C (Consultant); Optovue, Inc.: Code R (Recipient); Regeneron: Code C (Consultant); Genentech: Code C (Consultant); Nidek: Code R (Recipient); Carl Zeiss Meditec, Inc.: Code R (Recipient); MVRF: Code F (Financial Support) ● AKM: None ● JGF: Optovue, Inc.: Code I (Personal Financial Interest), Code P (Patent); Carl Zeiss Meditec, Inc.: Code P (Patent)

The authors gratefully acknowledge support from National Institutes of Health (NIH) contract 5-R01-EY011289-28 and Air Force Office of Scientific Research (AFOSR) contracts FA9550-15-1-0473 and FA9550-12- 1-0499.