Extraction of Blood Vessels from Retinal Phase-variance Optical Coherence Tomography Images

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Problem

Objective Develop a **robust method** to extract the **blood vessel structure** from a **3D image** of the human retina

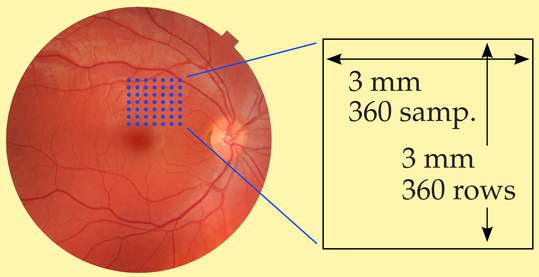
Motivation Investigate causes, progress and treatment of blinding disease such as macular degeneration

Challenge Image noise, vessel shadowing of tissue, misleading image structure

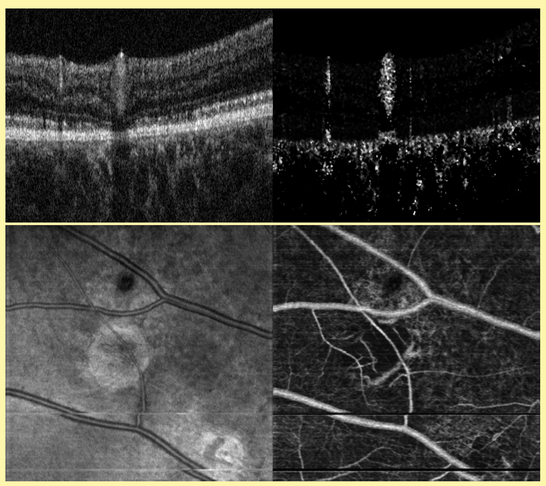
Innovation Ray casting to find radial density profile and rapidly track vessels

Data

OCT (optical coherence tomography) scans a grid on the retina. Each sample gives an axial brightness profile (an **A-scan**).



Each row (fast scan) is called a **B-scan**.

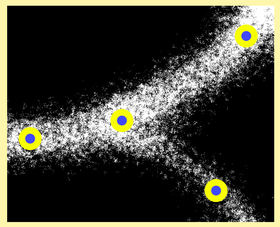


OCT (left) shows ***structure***. With oversampling and postprocessing, pvOCT (right) shows ***flow***. **Top:** one B-scan slice; **bottom:** orthographic projection.

Tracking Algorithm

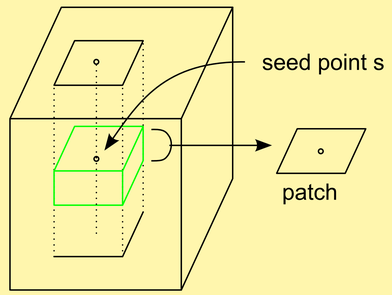
1. Pre-process: Remove B-scans damaged by motion

2. Initialize seed queue with local maxima of projected image. Scan axially to find first sharp rise in intensity (top of vessel).

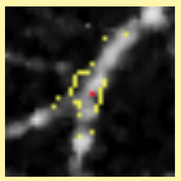


3. Step seed: repeat until queue is empty.
   Input: seed queue, volume image
   Output: list of center points and radius; list of links between center points

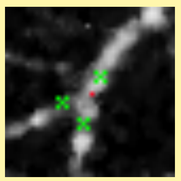
   - Dequeue s from seed queue and project local patch



   - Drop s if it overlaps existing track
   - Otherwise, cast rays from s within the patch, accumulating image value as score

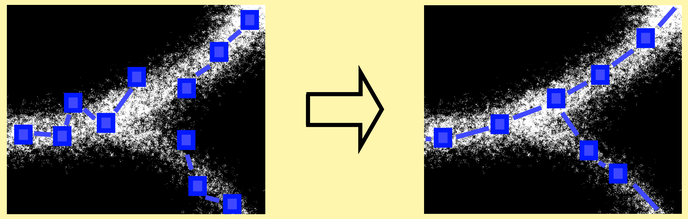


   - Estimate radius at s; recenter s within vessel; record center point s and link to parent center point
   - Enqueue new seeds along the highest-scoring rays



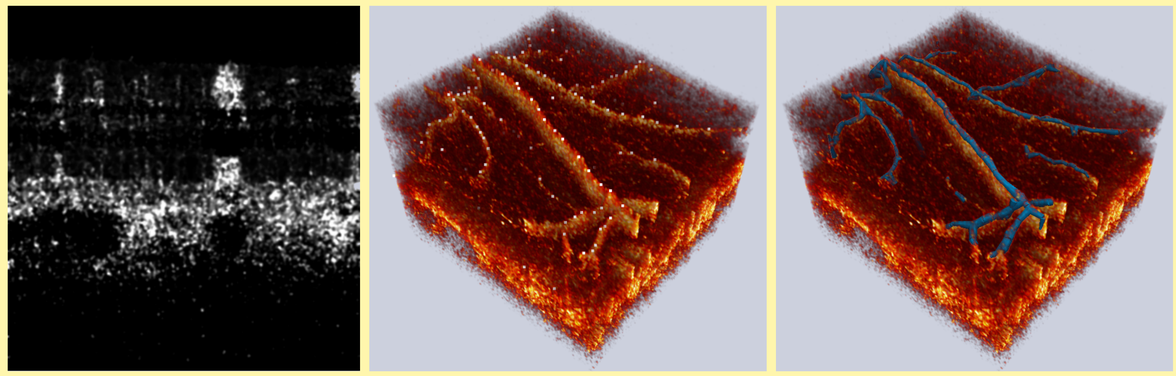
Post-processing

- Connect disjoint vessel-track segments
- Smooth and decimate track

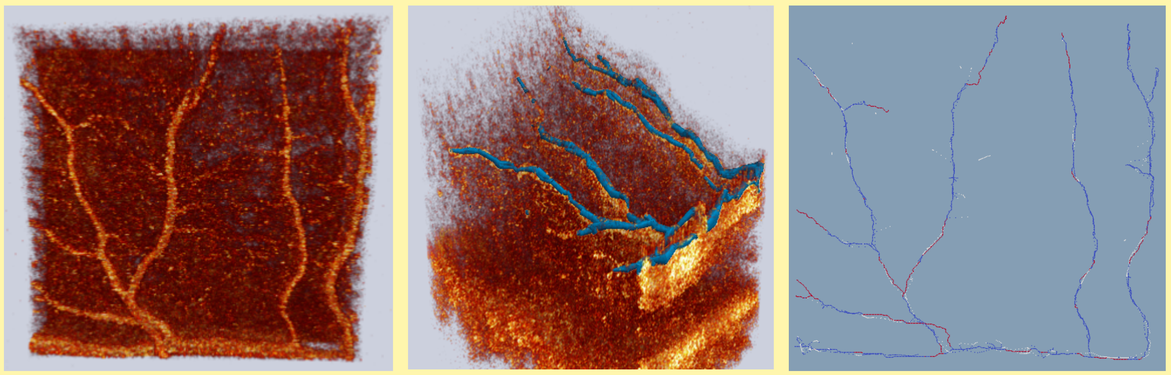


Results

Data set 1: left eye of 34-year-old normal male subject.
Right to left: representative B-scan, rendering with seeds, rendering with tracked vessels.



Data set 2: right eye of 53-year-old male subject with central serous retinopathy.
Right to left: face-on volume rendering, oblique volume rendering with tracked vessels, comparison to hand-traced "gold standard."



Comparison Legend: White: false positive, track is more than one radius from gold standard
Red: false negative, gold standard farther than one radius from track
Blue: true positive, track and gold standard are closer than one radius

Acknowledgements

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