Level Sets for Retinal Vasculature Segmentation
Using Seeds from Ridges and Edges from Phase Maps

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INTRODUCTION

• Level set methods could be considered to generally fall into two groups: edge-based approaches and region-based approaches.
• For level set based smooth region growing methods, major challenges posed by the very thin and elongated structure of retinal vessels are compounded further by the poor contrast of the regions of interest.
• We present an improved method for automatic level set based vessel segmentation specifically employed in the context of retinal vasculature segmentation in fundus images.

METHOD

Image segmentation based on level set methods typically consists of three additively combined energy terms: regularization, length and area.

\[
\frac{\partial \Phi}{\partial t} = \mu \left( \nabla^2 \Phi - \text{div} \left( \frac{\nabla \Phi}{||\nabla \Phi||} \right) \right) + \lambda \delta_\varepsilon(\Phi) \text{div} \left( g \frac{\nabla \Phi}{||\nabla \Phi||} \right) - \alpha g \delta_\varepsilon(\Phi).
\]

Existing phase map, Our phase map, Binary image, Skeletonized image, Segmented image and Level set function after 70 iterations.

Skeleton image that produces projection-based seed points, Distance regularized level set evolution method (DRLSE), Phase-based approach and Proposed method after 70 iterations.

Our segmented image: Skeleton-based seed points, Projection-based seed points after 70 iterations.

Statistical average results for test images 1 to 20 from the datasets (SK: skeleton-based seed points; PCP: principal curve projection based seed points).

CONCLUSION

• We presented a phase-based level set method with ridge sampling seed selection for the problem of segmenting retinal vasculature in fundus images.
• Future work will involve quantitative feature extraction from segmented retinal vessels, followed by implementation of these image analysis algorithms for image-based diagnostic assistance.
• Our goal is to extend the study to improve the results especially for pathological regions: macula, optic disk, and drusen.

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