Segmentation of retinal layers and lesions by loosely coupled level sets in eyes affected by CSR and AMD

Novosel, Jelena; van Vliet, Lucas J; Wang, Ziyuan; de Jong, Jan H; Vermeer, Koenraad Arndt

Publication date
2016

Document Version
Final published version

Published in
Investigative Ophthalmology & Visual Science

Citation (APA)
Novosel, J., van Vliet, L. J., Wang, Z., de Jong, J. H., & Vermeer, K. A. (2016). Segmentation of retinal layers and lesions by loosely coupled level sets in eyes affected by CSR and AMD. *Investigative Ophthalmology & Visual Science*, *57*(12), 5946-5946.

Open Access

Segmentation of retinal layers and lesions by loosely coupled level sets in eyes affected by CSR and AMD

Investigative Ophthalmology & Visual Science
September 2016 Vol: 57, Issue 12

Author Affiliations & Notes

- Jelena Novosel
  Rotterdam Ophthalmic Institute, Rotterdam, Netherlands
  Department of Imaging Physics, Delft University of Technology, Quantitative Imaging Group, Delft, Netherlands
- Lucas J. van Vliet
  Department of Imaging Physics, Delft University of Technology, Quantitative Imaging Group, Delft, Netherlands
- Ziyuan Wang
  Department of Imaging Physics, Delft University of Technology, Quantitative Imaging Group, Delft, Netherlands
- Jan H. de Jon
  Rotterdam Ophthalmic Institute, Rotterdam, Netherlands
- Koenraad Arndt Vermeer
  Rotterdam Ophthalmic Institute, Rotterdam, Netherlands

- Footnotes
- Commercial Relationships **Jelena Novosel**, None; **Lucas J. van Vliet**, None; **Ziyuan Wang**, None; **Jan de Jong**, None; **Koenraad Vermeer**, US patent number 8.721.077 (P)
- Support The work was supported by Stichting Combined Ophthalmic Research Rotterdam, Stichting Glaucoomfonds, Stichting voor Ooglijders and ZonMw (grant number: 91212061).

Purpose : We present and evaluate an approach to segment retinal layers and lesions in eyes affected by central serous retinopathy (CSR) and age-related macular degeneration (AMD).

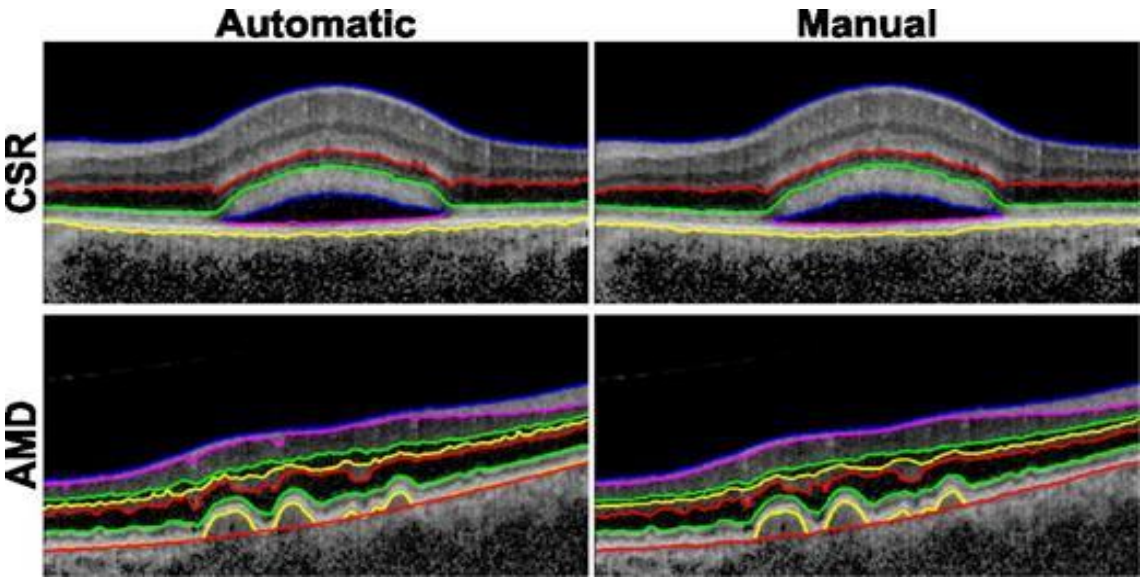
Methods : The proposed approach extends our loosely coupled level set (LCLS; Novosel et al, MedIA, 2015) method by allowing it to deal with local intensity variations and topology-disrupting pathologies, such as drusen and fluid pockets. In this extended approach, interfaces between layers are simultaneously segmented based on local difference between signals of layers surrounding an interface. Further, lesions are modelled as an additional layer by introducing auxiliary interfaces. In the absence of lesions, this additional layer will have near zero thickness.
One eye of five patients with CSR or AMD was imaged with a Spectralis OCT system (Heidelberg Engineering, Germany; AMD data from Srinivasan et al, BOE, 2014). Two B-scans from each eye were used to evaluate the method's accuracy. In CSR, the fluids and four interfaces (the vitreous-RNFL and OPL–ONL interface and the IS ellipsoid's and posterior RPE boundary) were considered. In AMD, in addition to the drusen and the aforementioned interfaces, the RNFL–GCL, IPL–INL, INL–OPL interfaces and Bruch membrane were considered. Differences between manual and automatic segmentations were expressed as the root mean square error (RMSE) and mean absolute deviation (MAD). For fluids and drusen, the Dice coefficient was used to assess the segmentation quality.

Results : Examples of the segmentation on a B-scan of a CSR and AMD eye are shown in Fig 1. Evaluation results are listed in Table 1. The MAD of the segmentation was 2.5 – 10.4 μm

and 3.8 – 9.0 µm for CSR and AMD subjects, respectively. By comparison, the MAD of the earlier LCLS segmentation in normal eyes was 2.7 – 5.9 µm (Novosel et al, MedIA, 2015). The Dice coefficient for fluid and drusen was 94 % and 77 %, respectively

Conclusions : The approach achieved a high accuracy in segmenting eyes affected by CSR and AMD. The achieved accuracy of the segmentation remains similar to that in normal retinas. As such, the proposed method shows a potential for clinical use as it can handle both normal and topology-disrupting retinas with similar accuracy. To further enhance this potential, the framework could be extended to other retinal diseases.

This is an abstract that was submitted for the 2016 ARVO Annual Meeting, held in Seattle, Wash., May 1-5, 2016.



View Original Download Slide

Fig 1. Segmentation results for a CSR and an AMD eye

Interface	CSR		AMD	
	RMSE (µm)	MAD (µm)	RMSE (µm)	MAD (µm)
Vitreous – RNFL	3.1	2.5	4.4	3.8
RNFL – GCL	n/a	n/a	6.8	4.7
IPL – INL	n/a	n/a	11.6	7.5
INL – OPL	n/a	n/a	10.2	6.5
OPL – ONL	14.8	10.4	13.8	9.0
IS ellipsoid boundary	13.1	7.7	5.8	3.7
Posterior RPE boundary	8.2	6.3	10.4	6.6
Bruch membrane	n/a	n/a	6.8	5.1
Fluid/Drusen (Dice)	93 %		77 %	