DENSITY SEGMENTATION IN DETECTION OF DIABETIC RETINOPATHY

C. Travassos[2], R. Monteiro[2], S. Oliveira[2], C. Baptista[1], D. Martins[1], F. Carrilho[1], P. Furtado[2]

[1] Endocrinology Diabetes and Metabolism Department. Coimbra University Hospital Centre. Portugal

[2] Faculty of Science and Technology, DEI/CISUC, University of Coimbra. Portugal

Introduction

Diabetic Retinopathy (DR) is an eye condition related to microvascular changes in the retina that affects people with diabetes. As illustrated in Figure 1, DR is partly characterized by the leakage of extra fluid and small amounts of blood in the eye (microaneurysms and hemorrhages) and deposits of cholesterol and other fats (exudates) [1].

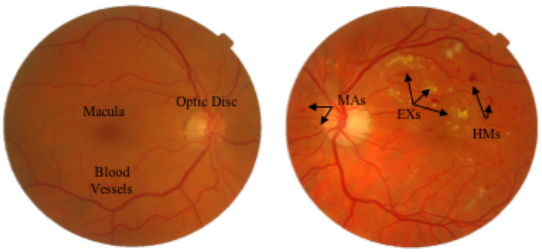

Figure 1 - Schematic representation of constituents of the retina (a) some structures; (b) three main lesions that can be detected by automatic means (MAs-microaneurysms; EXs-exudates; HMs-hemorrhages) [Messidor dataset].

Since DR is initially a silent disease, early diagnosis is critical for prevention of further complications. Analysis of the fundus images is one of the simplest ways of diagnosis, as it is a non-invasive technique, easy to perform and that allows the visualization of lesions [1], [2].

The main goal is to define an approach for automated segmentation of DR lesions and vascular tree, using super-pixelation and density clustering.

Materials and Methods

Retinal Image Pre-processing (Figure 2)

Application of Coye Filter [3] to extract the vascular region and RD lesions out of the background

Automatic Segmentation by Density Clustering (Figure 3)

Application of SLIC [4] to determine small homogeneous sets of neighboring pixels (superpixels) and DBscan [4] to group superpixels that are closest in color and spatial properties (clusters)

Cluster Features Extraction

Number of pixels, eccentricity, color, texture

Segmentation of Candidate RD Lesions (Figure 4)

Tuning of DBscan threshold, and cluster features to separate candidate RD lesions from vascular tree

Results

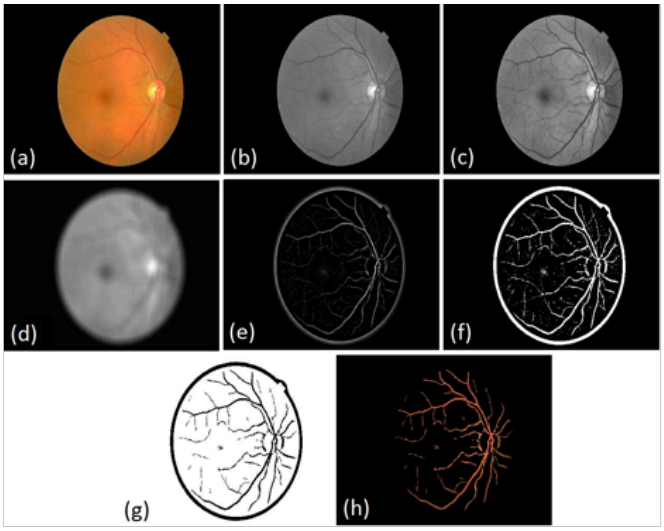

Figure 2 - Retinal Image Pre-processing (Coye Filter): (a) original image, (b) green-channel, (c) adaptive histogram equalization, (d) average filter, (e) difference between (c) and (d), (f) binary mask, (g) binary mask complement, (h) final result.

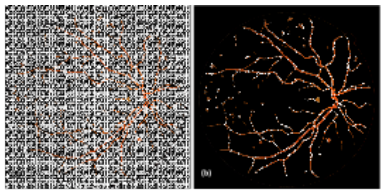

Figure 3 - Eye Vascular Tree Image after SLIC and DBscan: (a) Image after SLIC, (b) Image after DBscan.

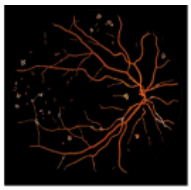

Figure 4 - Clusters candidate RD lesions after vascular tree removal.

Conclusions and Future Work

This work focused on the detection of bleeding in the retina. Despite it being an exploratory work, the results are encouraging, as we were able to detect individual lesions.

The most relevant challenges in automatic detection of lesions in the retina were:

- Segmentation of small lesions in low-contrast regions;
- Similarity and proximity between some lesions and the vascular tree;
- Discrimination of small dimension lesions from noise;
- Disparity in form, size and color of lesions (inter and intra images).

Future Work:

- Improve the quality of the pre-processing steps;
- Parallelization-based speedup of density clustering tasks;
- Classification of segments into non-lesions, microaneurysms, hemorrhages and exhudates.

References:

[1] Figueira, J; Nascimento J., et al., 2009. Retinopatia Diabética Guidelines ed. 1. Lisboa, Portugal: Sociedade Portuguesa de Oftalmologia.

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[4] P. Kovesi, "Image Segmentation using SLIC SuperPixels and DBSCAN Clustering," 2013. Accessed online in http://www.peterkovesi.com/projects/segmentation/ on 20-Jan-2016.

Acknowledgments:

Messidor dataset kindly provided by the Messidor program partners (see http://www.adcis.net/en/DownloadThirdParty/Messidor.html).