Earmarking Retinal Changes on a Color Fundus Photograph Time-Sequence

#2644

R. Bernardes[1], P. Baptista[1], J. Ferreira[1], L. Duarte[1], J. Cunha-Vaz[1,2]

[1]AIBILI – Association for Innovation and Biomedical Research on Light and Image, Center of New Technologies for Medicine, Coimbra, Portugal
[2]IBILI – Institute of Biomedical Research on Light and Image, Faculty of Medicine University Coimbra, University Hospital, Coimbra, Portugal

Purpose

To automatically earmark changes on a time sequence of color fundus photographs and to allow the follow-on of individual retinal changes selected manually.

Methods

Image acquisition and pre-processing

Sequences of 5 digital color fundus photographs taken every 6 months, during a 2-year follow-up period, were collected using a Zeiss FF450 fundus camera, with a 3 CCD detector to produce 50° field-of-view, 768×576 pixel RGB color images centered on the macula.

All images were pre-processed through normalization to correct differences in intensity and non-uniform illumination conditions, and the retinal vascular tree segmented using contourlets.

Registration

Vessel bifurcations, intersections and cross-overs, were used as landmarks for a two-step image registration: a rigid transformation followed by a perspective image transformation.

Image sequence follow-up

The differences between each image visit and the baseline image were computed for their overlapping region, thus providing a means of detecting changes for a particular instant in time during the follow-up. These differences were thresholded so that only significant alterations were taken into account. Finally, each of the difference-images was non-linearly scaled (by logarithmic function) to amplify the effect of small retinal changes.

Mapping differences

Each difference-image is considered as a band of a hyperspectral image. The first component of the principal components analysis (PCA) is then scaled into a gray-scale image for each instant in time, and assigned a specific color-code. Each of these images represents the evolution history of retinal changes (Fig. 1).

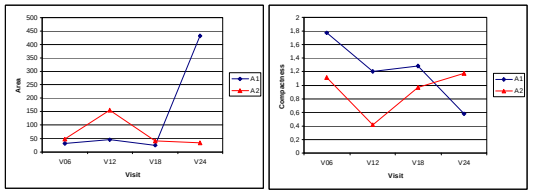

Fig. 2: Area (left) and compactness (right) parameters plotted over time.

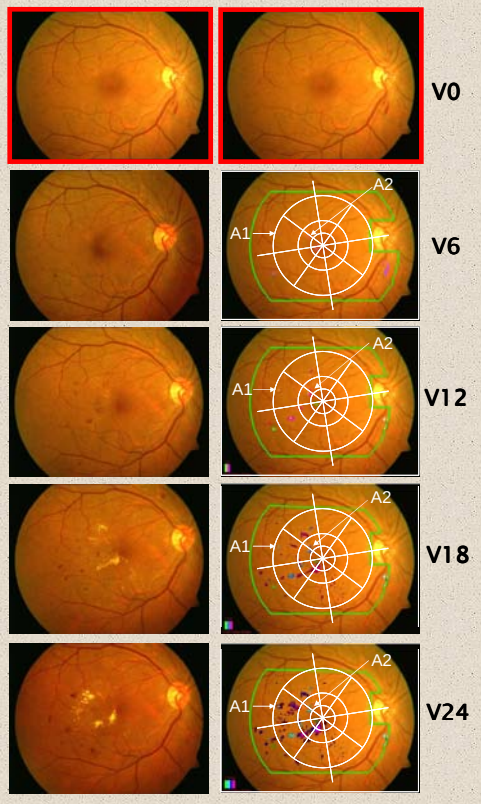

Fig. 1: Original retinal images (left) of a subject presenting a clinically significant macular edema resulting from diabetic retinopathy. The right column shows the detected changes for the set of images on the left to the baseline image (top image, V0).

Results

We were able to automatically earmark retinal changes in a sequence of color fundus images from patients followed-up every 6 months over a 2-year time period. Fig. 1 shows a diabetic patient eye with clinically significant macular edema. On the left column are shown the images as taken over the consecutive visits, from top (baseline image, V0) to bottom (2-year time visit, V24). On the right column are shown the cumulative detected changes, projected over the baseline image, using a color scheme allowing to identify in which visit each change was initially detected.

Individual detected changes can be followed along the sequence in terms of their area and/or shape and their parameters graphically displayed (Fig.2).

Conclusions

Changes automatically detected in color fundus images were successfully earmarked, despite different image conditions. The developed color scheme allows earmarking of the location, on the time-sequence, of the detected changes, as well as the areas where previous changes return to baseline status. Individual areas of detected changes can be followed in terms of their area and/or shape and these parameters are automatically plotted for graphical display.

Funding: None **CR:** None