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ARVO Annual Meeting Abstract | July 2018

Diagnostic assistance system to detect progression of diabetic retinopathy (DR) in fundus images of follow up examinations of patients with diabetes

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Investigative Ophthalmology & Visual Science July 2018, Vol.59, 1692. doi:

Abstract

Purpose : An important step in detecting and monitoring DR is regular screening by fundus images. The aim is to identify patients with sight-threatening DR timely to be able to initiate adequate treatment and thus to prevent loss of vision (blindness). We developed an algorithm to detect progression between follow up examinations in order to minimize the time consuming diagnostic of the images by an ophthalmologist.

Methods : Digital fundus images of 12 patients (4 female, 8 male) with diabetes (10 type 1, 2 type 2) were retrospectively selected from the records of the Department of Ophthalmology of the Oulu University Hospital. Red-free fundus images of each eye were clinically graded for DR, and eyes with progression were included. A 5-step classification was used: no DR, mild DR, moderate DR, severe non-proliferative DR or proliferative DR. There were at least 5 cases presenting every transition, e.g. from no DR to mild DR. A total of 158 grayscale fundus images of 24 eyes were included. The mean age at time of the first examination was 34 ± 15 years, and 43 ± 13 years at the latest examination. The number

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of examinations varied between 4 and 9 per eye.

For each eye, the progression map of all possible combinations of two individual fundus images were calculated. First, the two images were roughly registered with help of a similarity transformation. A finer registration was implemented patchwise together with the adjustment of the contrast between them as a second step. The next step consisted of the calculation of the difference map between the two images. The remaining noise from the background was filtered as a last step by considering the local noise level from the two source images.

Results : The transition between the different grades of DR was correctly detected (true positive) in 91% of the instances, and the absence of transition (true negative) in 94%. In 6% of the cases the algorithm signaled progression without clinically detectable change of DR grade (false positive), and in 9% (false negative) the algorithm was not able to detect clinically detected progression.

Conclusions : The results demonstrate that the algorithm developed for the detection of progression of DR in fundus images does reliably highlight changes between the images, and has the potential to reduce the time needed for evaluation of images by an ophthalmologist.

This is an abstract that was submitted for the 2018 ARVO Annual Meeting, held in Honolulu, Hawaii, April 29 - May 3, 2018.

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