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Screening for Diabetic Retinopathy Using Computer Vision and Physiological Markers

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Abstract

Background:

Hyperglycemia and diabetes result in vascular complications, most notably diabetic retinopathy (DR). The prevalence of DR is growing and is a leading cause of blindness and/or visual impairment in developed countries. Current methods of detecting, screening, and monitoring DR are based on subjective human evaluation, which is also slow and time-consuming. As a result, initiation and progress monitoring of DR is clinically hard.

Methods:

Computer vision methods are developed to isolate and detect two of the most common DR dysfunctions—dot hemorrhages (DH) and exudates. The algorithms use specific color channels and segmentation methods to separate these DR manifestations from physiological features in digital fundus images. The algorithms are tested on the first 100 images from a published database. The diagnostic outcome and the resulting positive and negative prediction values (PPV and NPV) are reported. The first 50 images are marked with specialist determined ground truth for each individual exudate and/or DH, which are also compared to algorithm identification.

Results:

Exudate identification had 96.7% sensitivity and 94.9% specificity for diagnosis (PPV = 97%, NPV = 95%). Dot hemorrhage identification had 98.7% sensitivity and 100% specificity (PPV = 100%, NPV = 96%). Greater than 95% of ground truth identified exudates, and DHs were found by the algorithm in the marked first 50 images, with less than 0.5% false positives.

Conclusions:

A direct computer vision approach enabled high-quality identification of exudates and DHs in an independent data set of fundus images. The methods are readily generalizable to other clinical manifestations of DR. The results justify a blinded clinical trial of the system to prove its capability to detect, diagnose, and, over the long term, monitor the state of DR in individuals with diabetes.

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Abbreviations: (DHs) dot hemorrhages, (DR) diabetic retinopathy, (LCR) largest connected region, (NPV) negative prediction value, (PPV) positive prediction value

Keywords: computer vision, diabetes, diabetic retinopathy, digital images, fundus images, image processing

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