A color fusion model based on Markowitz portfolio optimization for optic disc segmentation in retinal images

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Abstract

Retinal disorders are a severe health threat for older adults because they may lead to vision loss and blindness. Diabetic patients are particularly prone to suffer from Diabetic Retinopathy. Identifying relevant structural components in color fundus images like the optic disc (OD) is crucial to diagnose retinal diseases. Automatic OD detection is complex because of its location in an area where blood vessels converge, and color distribution is uneven. Several image processing techniques have been developed for OD detection so far, but vessel segmentation is sometimes required, increasing computational complexity and time. Moreover, precise OD segmentation methods utilize complex algorithms that need special hardware or extensive labeled datasets. We propose an OD detection approach based on the Modern Portfolio Theory of Markowitz to generate an innovative color fusion model. Specifically, the training phase calculates the optimal weights for each color channel. A fusion of weighted color channels is then applied in the testing phase. This approach acts as a powerful and real-time preprocessing stage. We use four heterogeneous datasets to validate the presented methodology. Three out of four datasets are publicly available (i.e., DRIVE, Messidor, and HRF), and the last corresponds to an in–house dataset acquired from Hospital Universitari Sant Joan de Reus (Spain). Two different segmentation methods are presented and compared with state-of-the-art computer vision techniques to analyze the model performance. An outstanding accuracy and overlap above 0.9 and 80%, respectively, and a minimal execution time of 0.05 s are reached. Therefore, our model could be integrated into daily clinical practice to accelerate the diagnosis of Diabetic Retinopathy due to its simplicity, performance, and speed.

Keywords
Diabetic retinopathy, Optic disc, Color fusión, Markowitz portfolio, Segmentation