Automatic Localization of the Optic Disc Center in Retinal Images based on Angle Detection in Curvature Scale Space

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ABSTRACT

Digital images of the retina is widely used for screening of patients suffering from sight threatening diseases such as Diabetic retinopathy and Glaucoma. The localization of the Optic Disc (OD) center is the first and necessary step identification and segmentation of anatomical structures and in pathological retinal images. From the center of the optic disc spreads the major blood vessels of the retina. Therefore, by considering the high number of vessels and the high number of the angles resulted from the vessels crossing, the authors propose a new method based on the number of angles in the vicinity of optic disc for localization of the center of optic disc. The first step is pre-processing of retinal image for separate the fundus from its background and increase the contrast between contours. In the second step, the authors use the Curvature Scale Space (CSS) for angle detection. In the next step, they move a window about the size of optic disc to count the number of corners. In the final step, they use the center of windows which has the most number of corners for localizing the optic disc center. The proposed method is evaluated on DRIVE, CHASE_DB1 and STARE databases and the success rate is 100, 100 and 96.3%, respectively.

Keywords: CSS Angles Detection, Optic Disc, Retinal Image

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1. INTRODUCTION

Retinal imaging is increasingly used in large scale, to studies for detection of glaucoma, diabetic retinopathy age-related macular degeneration and cardiovascular disease. When an ophthalmologist uses an ophthalmoscope to look into the eye, he sees the view of the retina represented in (Figure 1). Retina is the innermost layer of the eye and composed of many important anatomical features. The main structures of a fundus retinal image were defined as the OD, fovea, and blood vessels. The optic nerve is one of the most important organs in the human retina. The localization of the OD is the first step of most identification, segmentation, diagnosing some diseases on retinal images such as diabetic retinopathy (A. Dehghani, 2012) and retinal recognition (M Ortega, 2009). Detection of the optic nerve is a key preprocessing component for the automatic extraction of the anatomical structures of the retina (X. Zhu, 2010).

Identification of the OD disc is an important step in the detection and analysis of the anatomical structures and pathological features in the retina. A crucial preliminary step in computer-aided analysis of retinal images is localization of the OD center, several researchers have proposed methods for these purposes (RM Rangayyan, 2010). Zhu et al. (X. Zhu, 2010) proposed a method based on edge detection using the Sobel operators and detection of circles using the Hough transform were employed to localize OD. RM Rangayyan et al. uses a method based on the detection of the vessels using Gabor filters, detection of peaks in the node map obtained via phase portrait analysis and an intensity-based condition. Tobin et al. (K.W. Tobin, 2007) proposed a method relies on the accurate segmentation of the vasculature of the retina followed by the determination of spatial features describing the density, average thickness, and average orientation of the vasculature in relation to the position of the optic nerve. H. Ying et al. (H. Ying, 2007) proposed an algorithm to differentiate the OD from other bright regions such as hard exudates and artifacts, based on the fractal dimension related of blood vessel. The OD was segmented by local histogram analysis. The scheme was tested with the DRIVE dataset and identified the OD in 39 from 40 images. Mendonça (A.M. Mendonça, 2013) proposed a method for automatic location of the OD in retinal images, based on the combination of information taken from the blood vessel network with intensity data. The distribution of vessel orientations around an image point is quantified using the new concept of entropy of vascular directions. The robustness of the method for OD localization is improved by constraining the search for maximal values of entropy in image areas with high intensities. Dehghani et al (A. Dehghani, 2012) proposed a method for localizing OD. Four retinal images in DRIVE dataset was used to extract the histograms of each color component. Then, the average of histograms was calculated for each color as template for localizing the center of OD. Foracchia et al. (M. Foracchia, 2004) presented a technique based on the preliminary detection of the main retinal vessels. All retinal vessels originate from the OD and their path follows a similar directional pattern (parabolic course) in all images. To describe the general direction of retinal vessels at any given position in the image, a geometrical parametric model was proposed, where two of the model parameters are the coordinates of the OD center. Youssif et al. (AA Youssif, 2008) used directional pattern of the retinal blood vessels. Hence, a simple matched filter is proposed to roughly match the direction of the vessels at the OD vicinity. The retinal vessels are segmented using a simple and standard 2-D Gaussian matched filter. Consequently, a vessels direction map of the segmented retinal vessels is obtained using the same segmentation algorithm. The segmented vessels are then thinned, and filtered using local intensity, to represent finally the OD center candidates. Mahfouz et al. (A.E. Mahfouz, 2010) proposed a fast technique to localize the OD. The technique is based upon obtaining two projections of certain image features that encode the x- and y- coordinates of the OD. The resulting 1-D projections are then searched to determine the location of the OD.
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