Segmentation of Optic Disc in Fundus Images Using an Active Contour

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ABSTRACT

A successful optic disc (OD) segmentation is an important task for automated detection white lesions related to diabetic retinopathy. Therefore, exudate detection is the authors’ major purpose, but they must extract the OD prior to the process because it appears with similar color, intensity and contrast to other characteristics of the retinal image. The retinal image consists of blood vessels that emerge from the OD. The presence of these blood vessels may act as a disturbance for the detection of OD. This article presents a novel method for segmentation of the OD in retinal images. The methodology includes localization of the OD center, followed by elimination of vascular structure using an inpainting method. Finally, an active contour model was applied to boundary OD segmentation. The results are compared with a ground truth image from the ophthalmologist. The source retinal image for performing this work was obtained from the publicly available DRIVE and MESSIDOR databases. This method offers a successful segmentation of OD which may help in diagnosis of various retinal abnormalities.

KEYWORDS

Active Contour, Fundus Image, Level Set Formulation, Optic Disc Segmentation

1. INTRODUCTION

Disc optic removal is an essential step in analysis systems for automated detection of various serious ophthalmic pathologies, such as diabetic retinopathy and glaucoma (Youssif, 2008). Moreover, it is usually taken as a base for detecting other anatomical structures (macula, blood vessels) and retinal abnormalities (microaneurysms, hard exudates, etc.). It is indispensable for the detection of exudates because the OD has similar attributes in terms of brightness, color and contrast for exudates (Elbalaoui, 2014). The size of OD varies from patient to patient and its diameter lies between 40 and 60 pixels in 640x480 color photographs (Walter, 2002). The OD appears toward the left-hand or right-hand side of a fundus image as an approximately circular area, roughly one-sixth the width of the image in diameter, brighter than the surrounding area, and as the convergent area of the network of blood vessels (Zhu, 2009). Figure 1 shows the major structures of the disc.

Many methods can be found in the literature for detection of OD in retinal images, which could mainly be divided into four categories, namely morphological based methods, template based methods, deformable model based methods, and pixel classification methods. Within the first category, Walter et al. (Walter, 2002) used modified variance image method to detect the OD region and OD cup. The contour of the OD was found using the watershed transform. Liu and Chen (Liu, 2001) proposed a method based on mathematical morphology and gradient vector flow snake model to detect the OD in fluorescing retinal images. Park et Chen (Park, 2006) used a method to find the OD using threading, circle detection by Hough transformation and morphological operations. Principal Component Analysis

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(PCA) and mathematical morphology based method are used to extract OD contour (Morales, 2013). Before removing the vessels, a variant of watershed and stochastic watershed are applied. Welfer et al. (Welfer, 2013) proposed an adaptive morphological method for the automatic detection of the OD. This method has been designed to detect the OD center and the OD cup.

In the group of template based methods for OD segmentation, Youssif et al. (Youssif, 2008) proposed a method based on directional filters matched with the outgoing vessels. This OD detection algorithm is focused on matching the expected directional pattern of the retinal blood vessels. 2-D Gaussian matched filter is used for segmentation of retinal vessels. The segmented vessels are then thinned, and filtered using local intensity, to represent finally the OD-center candidates. Zhu and Rangayyan (Zhu, 2009) used Sobel operators for edge detection and Hough transform to model the disc boundary. Wong et al. (Wong, 2008) proposed a method using a variational level-set approach to segment the OD, an ellipse-fitting post-processing step is also introduced. Aquino et al. (Aquino, 2010) utilized a locate methodology based on a voting-type algorithm in order to find the location of OD as initial information to define a starting sub-image. Then morphological and edge detection methods followed by Circular Hough Transform can be applied to get a circular OD boundary estimation. Sarathi et al. (Sarathi, 2016) adopted a method which starts with center localization followed by removal of vascular structure by accurate inpainting of blood vessels in the optic disc region. An adaptive threshold based region growing technique is then practiced for reliable segmentation of fundus images.

In the group of deformable model, Lowell et al. (Lowell, 2004) proposed a concept based on a correlation filter to locate the OD center. After that, the OD is segmented by means of a deformable contour based on a global elliptical model and on a local deformation. Xu et al. (Xu, 2007) tackled the problem of vessel occlusion that interferes with the OD segmentation. Thus, the classification result is used to refine the OD boundary before repeating the contour deformation. Yin et al. (Yin, 2011) proposed a method that combines edge detection, the Circular Hough Transform and a statistical deformable model to detect the OD from retinal fundus images. The method proposed in (Yu, 2012) uses template matching and a directional matched filter to localize the OD. Then, the blood vessels and bright regions are removed using alternating sequential filtering and morphological operations. Finally, a fast and hybrid level set segmentation method with optimized parameters is used for extracting the OD boundary.

In the pixel classification methods, Abràmoff et al. (Abràmoff, 2007) used a feature selection based on simulation of photoreceptor color opponency and visual cortex simple and complex cells, and a k-nearest neighbor classifier. The final step is the classification of each pixel into the rim, cup, or background. Cheng et al. (Cheng, 2013) proposed an OD segmentation using superpixel classification. In OD segmentation, histograms and center surround statistics are used to classify
Factors Associated with the use of Personal Internet Banking in Thailand
www.igi-global.com/article/factors-associated-use-personal-internet/53196?camid=4v1a