Chapter 9
A Review of Vessel Segmentation Methodologies and Algorithms: Comprehensive Review

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ABSTRACT

"Prevention is better than cure", true statement which all of us neglect. One of the most reasons which cause speedy recovery from any diseases is to discover it in advanced stages. From here come the importance of computer systems which preserve time and achieve accurate results in knowing the diseases and its first symptoms.One of these systems is retinal image analysis system which considered as a key role and the first step of Computer Aided Diagnosis Systems (CAD). In addition to monitor the patient health status under different treatment methods to ensure How it effects on the disease.. In this chapter the authors examine most of approaches that are used for vessel segmentation for retinal images, and a review of techniques is presented comparing between their quality and accessibility, analyzing and catgrizing them. This chapter gives a description and highlights the key points and the performance measures of each one.

INTRODUCTION

Retinal image analysis is one of systems which help on diagnosing almost of diseases in advanced stages like (hypertension, diabetic retinopathy, hemorrhages, macular degeneration, glaucoma, neo-vascularization and vein occlusion), in addition to achieving accurate result and saving time (Bernardes, Serranho, & Lobo, 2011). It is the main first step of Computer Aided Diagnosis (CAD) systems and registration of patient images. This diagnosis done by detection of some morphological features and attributes of the

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retinal vasculature like width, length, branching pattern or tortuosity and angles. And on another level, manually detection of retinal vasculature is very difficult because of the complexity and the low contrast of blood vessels in retinal image (Asad, Azar, & Hassanien, 2014). Here come the importance of vessel segmentation as a pre-step in most of medical applications.

No specific method is existed which segments the vasculature from each retinal image modality. So on classifying the segmentation methods, we should put in our mind some important factors such as application domain, method being automated or semi-automated, imagining modality, and other factors (Miri & Mahloojifar, 2011; Fraz, Remagnino, Hoppe, & Barman, 2013). And also not lose sight of the amount of effort and time which taken in the manual manner of the retinal blood vessel segmentation, in addition to our need for training and skill.

Sometimes we may need a preprocessing step before the actual algorithm of segmentation method is executed; this is due to other factors such as noise or bad acquisition that effect on the quality of image. In the opposite some methods perform post-processing in order to treat some problems which happened after segmentation method. And there are methods which not to do neither this nor that.

In this chapter, the authors present a review about the most methodologies of blood vessel segmentation; to provide the algorithms which employed for vessel segmentation to researchers to be considered as ready reference; to discuss the advantages and limitations of these approaches; to discuss the current trends and future challenges to be opened for solving, then it discusses the proposed approach for vessel segmentation which will be completely explained in the next sections.

BACKGROUND

Retinal Image Processing

Retinal Photography

Creating photograph of the interior surface of the eye containing the retina, macula, optic disc, and posterior pole is called fundus photography (also called fundography) (Lee, et al., 2000). A fundus camera is used in performing this fundus photograph; it consists of a specialized low power microscope with an attaching camera (Cassin & Solomon, 1990b; Saine, 2011).

Three modes the fundus camera basically operates in:

1. **Color Photography:** Examining the retina with full color under white light illumination.
2. **Red Free Photography:** Improving contrast of the vessels and other structures where the imaging light is filtered to remove red colors.
3. **Angiography Photography:** Where the vessels are brought into high contrast by intravenous injection of a fluorescent dye. The retina is illuminated with an excitation color which fluoresces light of another color where the dye is present. By filtering to exclude the excitation color and pass the fluorescent color, a very high-contrast image of the vessels is produced. Shooting a timed sequence of photographs of the progression of the dye into the vessels reveals the flow dynamics and related pathologies. Specific methods include sodiumfluorescein angiography (abbreviated FA or FAG) and indocyanine green (abbreviated ICG) angiography (Cassin & Solomon, 1990a).