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A REVIEW ON RETINAL BLOOD VESSEL SEGMENTATION USING SUPERVISED & UNSUPERVISED LEARNING METHOD

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A B S T R A C T

Image segmentation is the problem of partitioning an image in a semantically meaningful way. This vague definition implies the generality of the problem-segmentation can be found in any image-driven process, e.g. fingerprint/- text/face recognition, detection of anomalies in industrial pipelines, tracking of moving people/cars/airplanes, etc. For many applications, segmentation reduces to finding an object in an image. Retinal image vessel segmentation and their branching pattern can provide us with the information about abnormality or disease by examining its pathological variance. Retinal vascular pattern are used for automated screening and diagnosis of diabetic retinopathy to assist the ophthalmologists. To enhance the blood vessels and suppress the background information, in this paper, we are proposing smoothing operation on the retinal image using mathematical morphology. Then the enhanced image will be used for segmented using K-means clustering algorithm. We will use the proposed approach on the DRIVE dataset and it will be compared with alternative approaches.

Keywords: Gabor filter, retinal images, segmentations, k-mean clustering, drive dataset, stare dataset.

I. INTRODUCTION

In medical imaging, segmentation [1] of vascular structures form an essential part of several practical applications such as diagnosis of vessels and registration of patient images obtained at different times. Segmentation methods vary depending on the imaging modality, application domain, method being automatic or semi-automatic, and other specific factors. Image segmentation is the problem of partitioning an image into meaningful parts, often consisting of an object and background. As an important part of many imaging applications, e.g. face recognition, tracking of moving cars and people etc, it is of general interest to design

robust and fast segmentation algorithms. However, it is well accepted that there is no general method for solving all segmentation problems. Instead, the algorithms have to be highly adapted to the application in order to achieve good performance.

A. BLOOD VESSEL SEGMENTATION

Blood vessel is one of the most important features in retina for detecting retinal vein occlusion, grading the tortuosity for hypertension and early diagnosis of glaucoma. The segmentation of blood vessels is an important preprocessing step for the early detection of retinal diseases. Because of multifarious nature of the vascular network, the manual vessel segmentation is very difficult and time consuming, so the researchers have proposed several automated methods for retinal vessel segmentation which are grouped as supervised and unsupervised based on the vessel classification techniques. The supervised methods require a feature vector for each pixel and manually labeled images for training the algorithm. To classify the pixel as vessel or non-vessel the supervised method uses different classifiers such as neural networks [4], support vector machine [5], Bayesian classifier with class-conditioned probability density function [6], k-nearest neighbor classifier [7] and Ada boost classifier [8]. The existing methods include background homogenization, vessel central light reflex removal and feature extraction as preprocessing step. In the follow-up phase, the extracted features are classified as vessel or non-vessel by the use of different classifier, then the post processing steps like filling pixel gaps and removing falsely detected vessel pixels are added for enhancing the segmentation performance. The high resolution, variability in vessel width, brightness and low contrast make automated vessel segmentation as difficult task. We have a different vessel extraction techniques and algorithms. Put the various vessel extraction approaches and techniques in perspective by means of classification of the existing research. We have mainly targeted the extraction of blood vessels; neurosvascular structure in particular; we have also reviewed some of the segmentation methods for the tubular objects that show similar characteristics to vessels. Thus we have divided vessel segmentation algorithms and techniques into six main categories:

- pattern recognition techniques
- model-based approaches
- tracking-based approaches
- artificial intelligence-based approaches
- neural network-based approaches
- miscellaneous tube-like object detection approaches

II. RELATED WORK

Retinal blood vessel segmentation is achieved through assigning each pixel as either a vessel pixel or non-vessel pixel. The retinal vessel segmentation methodologies can be seen in different dimensions. In a broad sense, the vessel segmentation methodologies can be divided into two categories namely rule based techniques and pattern recognition based techniques.

Lei Zhang et al.[1] in 2015 presented a retinal vessel segmentation algorithm which uses a texton dictionary to classify vessel/non-vessel pixels. However, in contrast to previous work where filter parameters are learnt from manually labeled image pixels our filter parameters are derived from a smaller set of image features that we call key points. A Gabor filter bank, parameterized empirically by ROC analysis, is used to extract key points representing significant scale specific vessel features using an approach inspired by the SIFT algorithm. They determined key points using a validation set and then derive seeds from these points to initialize a k-means clustering algorithm which builds a texton dictionary from another training set. During testing they used a simple 1-NN classifier to identify vessel/non-vessel pixels and evaluate the system using the DRIVE database. They achieved average values of sensitivity, specificity and accuracy of78.12%, 96.68% and 95.05%, respectively. They found that clusters of filter responses from key points are more robust than those derived from hand-labeled pixels. This in turn yields textons more representatives of vessel/non-vessel classes and mitigates problems arising due to intra and inter-observer variability.

Gehad Hassan et al. [2] in 2015 presented a blood vessel segmentation approach, which can be used in computer based retinal image analysis to extract the retinal image vessels. Mathematical morphology and K-means clustering are used to segment the vessels. To enhance the blood vessels and suppress the background information, they performed smoothing operation on the retinal image using mathematical morphology. Then the enhanced image is segmented using K-means clustering algorithm. The proposed approach is tested on the DRIVE dataset and is compared with alternative approaches. Experimental results obtained by the proposed approach showed that it is effective as it achieved average accuracy of 95.10% and best accuracy of 96.25%.

Aboul Ella Hassanien et al.[3] in 2015 proposed approach makes use of the artificial bee colony optimization in conjunction with fuzzy cluster compactness fitness function with partial belongings in the first level to find coarse vessels. The dependency on the vessel reflectance is problematic as the confusion with background and

vessel distortions especially for thin vessels, so we made use of a second level of optimization. In the second level of optimization, pattern search is further used to enhance the segmentation results using shape description as a complementary feature. Thinness ratio is used as a fitness function for the pattern search optimization. The pattern search is a powerful tool for local search while artificial bee colony is a global search with high convergence speed. The proposed retinal blood vessels segmentation approach is tested on two publicly available databases DRIVE and STARE of retinal images. The results demonstrate that the performance of the proposed approach is comparable with state of the art techniques in terms of sensitivity, specificity and accuracy.

Sangmesh Biradar et al.[4] in 2015 discussed the blood vessel identification is performed on the basis of blood vessel characteristics such as blood vessel's orientation, cross-sectional area, surface shapes, and abnormal regions volumes. The quantitative analysis of retinal images is of increasing importance in the diagnosis of the blood vessel abnormalities. An automated method for identification of optic disc has two methodologies location methodology and boundary segmentation methodology. Segmentation is the process of partitioning an image into set of components. Segmentation of blood vessel and optic disc is necessary for early detection of affected area in the retina. The eye is very unique part in human body where the vascular conditions are directly observed in vivo.

D.Siva Sundhara Raja et al.[8] in 2014 presented the retinal image diagnosis is an important methodology for diabetic retinopathy detection and analysis. The morphological operations and svm classifier are used to detect and segment the blood vessels from the retinal image. the proposed system consists of three stages-first is preprocessing of retinal image to separate the green channel and second stage is retinal image enhancement and third stage is blood vessel segmentation using morphological operations and svm classifier. The performance of the proposed system is analyzed using publicly available dataset.

Rana Uday Singh et al. [11] in 2013 described the field of ophthalmology; retinal analysis is used for medical diagnosis and detection of the diseases. Various diseases such as diabetic retinopathy, age-related macular degeneration, muscular dystrophy can be easily diagnosed using automated diagnostic systems, thus providing resource savings. The present paper reviews image segmentation based techniques for retinal analysis which is used to provide retinal microvasculature non-invasively. A brief comparison is between pixel-based and tracking based techniques is also provided.

III. RESEARCH PROBLEM

Blood vessel segmentation is the basic foundation while developing retinal screening systems, since vessel serve as one of the main retinal landmark features. Previous works on blood vessel detection and segmentation can be mainly divided into 3 categories: window based, classifier based and tracking based. Important application of automatic retinal vessel segmentation is in the registration of retinal images of the same patient taken at different times. Segmentation involves dividing images into subsections such as defining areas of an image that are appropriate to be subsequently analyzed, or finding circles, lines or other shapes of interest. And segmentation can stop when such objects of interest have been isolated. In the research, we will study segmentation methods for blood vessels in medical images.

In this paper, research work will performs to implement the image preprocessing steps such as cropping, color space transformations, channel extraction, color enhancement, gabor filter. After that, preprocessed images will be used to form feature vector and then apply k-means clustering to form segments for blood vessels segmentation.

IV. RESEARCH OBJECTIVES

The research work presents a technique for automatically segmenting retinal blood vessels from the fondues image for retinal analysis and disease diagnosis. The research work comprises of three phases viz., image pre-processing, supervised and unsupervised learning and image post-processing. The objective of the research includes:

— To study and understand the blood vassals segmentation techniques.

— To preprocessing of image which comprises of image cropping, color space transformation and color channel extraction, contrast enhancement, Gabor filtering and half wave rectification.

— To use the preprocessed images for the formation of feature vector, which are the application of principal component analysis.

— To apply the k-mean clustering to differentiating vessels and non-vessels for the formation of segments for blood vessels segmentation.

— Finally, to compare the existing technique and the proposed technique using the parameters given by accuracy, sensitivity and specificity under Receiver operating characteristic (ROC) curve for true positive rate and false positive rate.

V. RESEARCH METHODOLOGY

Input: - input the required fundus image data collection for preprocessing

Output: - To receive final blood vessel segmented images

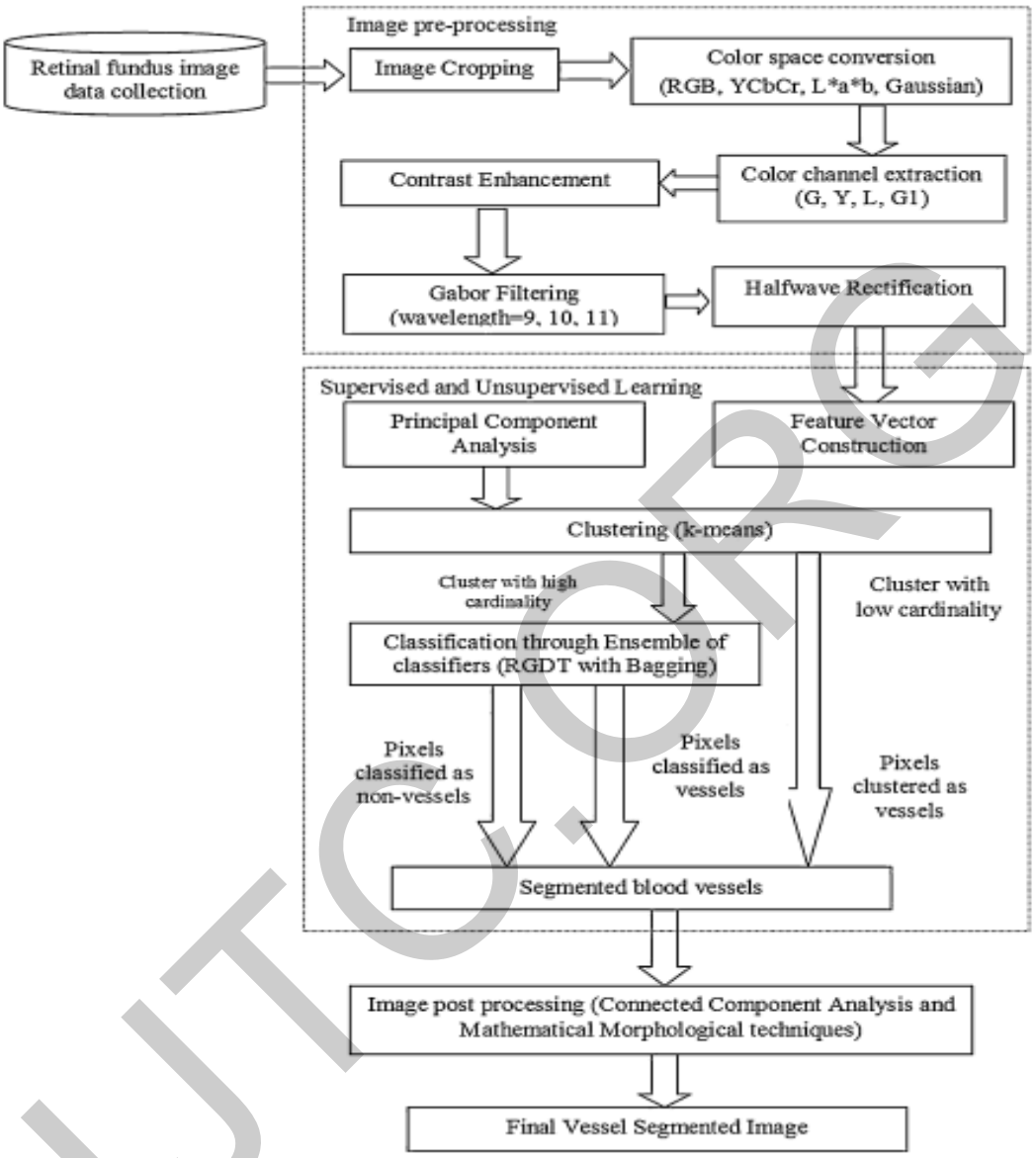

Fig.1. steps to perform blood vessel segmentation

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