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A Review on Segmentation Techniques for Extracting Blood Vessels from Retina Images

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Abstract—

Image Segmentation partitions the image into various regions thus by making image more easy to read and understand. This segmentation process can be applied on different types of images. Though segmentation has proved to be useful in almost every field but it plays a major role when it is applied to retina images where it helps in the early diagnosis of certain diseases related to eye. So this segmentation needs to be done accurately. This paper describes different segmentation techniques with their benefits and limitations. The newest approach is also proposed which will handle all the issues found in the existing literature and will improve the accuracy of segmentation results.

Keywords— Digital Image Processing, Image Segmentation, Edge Based Segmentation, Diabetic Retinopathy, Blood Vessels, Retinal Vessel Segmentation.

I. INTRODUCTION

An image may be described as a two dimensional picture which records a visible perception. An image is mainly of two types- analog image and digital image. An analog image is the one that we as individuals search at and they are usually continous and are not divided into small specific pieces. They are mostly employed for human viewing. On the other hand, digital images are those which consist of finite quantity of elements, each of that includes a specific value and location. These elements are termed as pixels or picture elements. The value of pixel relates to the lighting which is observed when digital image is changed into analog image for presenting and viewing. The area of digital image processing describes running digital images through an electronic computer. The main focus of digital image processing is to create such a computer system that has the capacity to conduct processing on the images. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output.

II. IMAGE SEGMENTATION

In the vision of computer, image segmentation is the procedure of dividing a digital image into multiple sections i.e. units of pixels. The main purpose of segmentation is always to simplify and modify the illustration of an image into something which will be more meaningful and better to understand. Image segmentation is usually applied to discover the items and boundaries within an image.

Segmentation can also be considered as an activity of grouping together those pixels which have related attributes. As segmentation subdivides the image into their constituent regions and the point to which that subdivision must be performed is entirely dependent upon the problem which is to be solved. It states that segmentation must certainly be ended when the object of interest in the application has been achieved. In simple words we can say that image segmentation is the process of assigning a name to every pixel in the image in a way that pixels with exactly the same name share specific visible characteristics.

III. APPLICATION AREAS OF SEGMENTATION

The segmentation process is being used nowadays in almost every field. But some of the practical applications where segmentation of images is proved to be very useful are:-

a) In medical science to locate tumours, for the examination of various disorders in the eye by automatic segmentation of retina images, for the diagnosis of diabetic retinopathy etc.
b) In recognition tasks such as face detection, iris detection and fingerprint detection.
c) To locate objects in various satellite images like roads, crops, forests etc.

This segmentation process can be applied on different types of images but when it is applied on the retina image, it is referred to as retinal vessel segmentation. The segmentation of blood vessels present in the retina can be used by different clinical experts to diagnose the disorders that a person might be suffering from such as diabetic retinopathy, age related macular degeneration, hypertension etc. As we know that the blood vessels present in the retina play a major role in the medical diagnosis of many diseases. So it becomes very necessary that this segmentation should be done properly and very accurately. This is one of the main use of segmentation in the field of medical science.

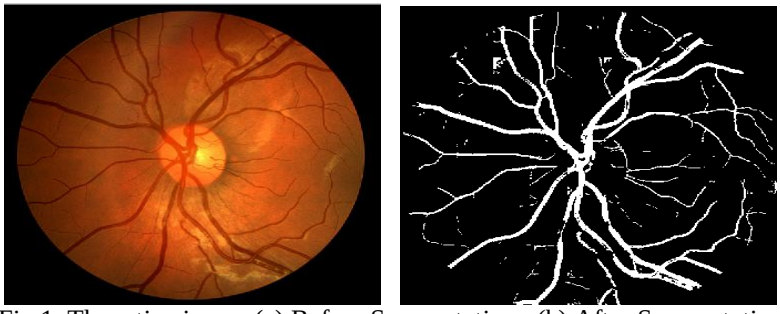

Fig 1 The retina image (a) Before Segmentation (b) After Segmentation

A large number of various methods for segmentation can be found because there is not just a single technique which can be regarded as beneficial for various images. On the basis of the qualities of an image, the techniques of image segmentation can be categorized as:-

a) Finding Discontinuities: It aims to divide an image on the basis of immediate improvements in intensity. It particularly involves edge detection method.
b) Finding Similarities: It aims to divide an image into parts which can be related in accordance with a couple of pre-stated criteria. It involves region based segmentation.

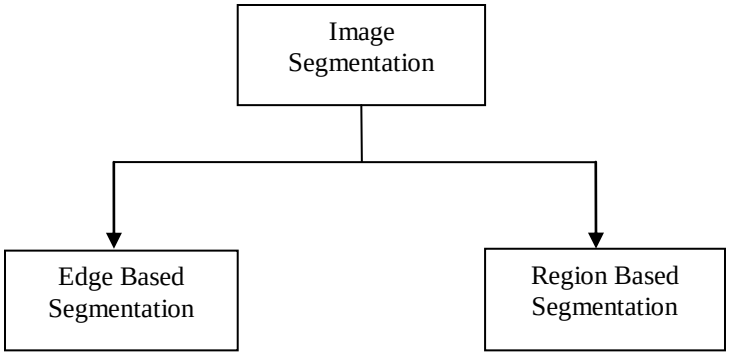

Fig 2 Classification of Segmentation

IV. IMAGE SEGMENTATION TECHNIQUES

A. Edge Based Segmentation

An edge can be defined as a set of attached pixels that rest on the border between any two regions. The edge based segmentation is mainly the process of determining the ends in an image. This method mainly reduces the unwanted information from the image without changing the original structure of the image. In other words we can say that it extracts some essential characteristics like corners, lines, curves from an image. So the resultant image obtained after applying this method cannot be used as the final segmentation output.

The edge detection techniques need a balance between finding accuracy and noise immunity used. If the amount of finding accuracy is too much then noise might generate artificial edges thus making the outline of images uncommon and if the amount of noise immunity is too excessive then some areas of image outline could get undetected and also the positioning of various objects might be mistaken. Therefore edge detection methods are more suited for those images which are simple and noise free otherwise in case of complex and noisy image these edge detection techniques might produce some missing edges or extra details might get added to image due to the presence of noise.

B. Region Based Segmentation

This type of segmentation is based on dividing an image into regions. It is a simple method to implement as compared to edge based segmentation. It further can be categorized as:

I. Region Growing: It is a technique that joins together sub-regions into bigger regions on the basis of some conditions which are defined before for the purpose of growth.
The fundamental strategy which is adopted here is to start with a seed pixel and start adding to it the neighbouring pixels which seems to be similar to it thus making the region to grow larger. In this method, when all the pixels belong to some region only then the procedure is stopped.
II. Region Splitting & Merging: It is a top down technique which generally starts by considering the whole image to be homogeneous. This method partitions an image into a couple of disjoint regions and then merges the regions in order to satisfy the conditions of segmentation.

C. Thresholding Based Segmentation

It is considered to be a very strong method to segment those images which are having light objects on a dark background. This method is based on the features of an image. It picks up an appropriate value for T called threshold to change a multilevel image to a digital image and thereby split the pixels of an image into various regions. Any pixel (x, y) is

recognized as an integral part of that item if their intensity is more than or equal to threshold value i.e. $f(x, y) \geq T$, otherwise the pixel belongs to the background. On the basis of choice of thresholding value, there are two forms of thresholding method and they are local thresholding and global thresholding. Global thresholding techniques may not perform when the background light is not even. But in case of local thresholding, a number of thresholds are accustomed to compensate for the irregular lightning. The selection of this threshold value is done very interactively but there are several automated methods of generating this value which can be used efficiently. The main disadvantage of using this method is that it includes only two classes which are generated and can not be put on multichannel images. Moreover it does not considers the spatial characteristics of an image due to which it is more sensitive to noise.

V. LITERATURE SURVEY

Zhang et al. (2015) [1] has proposed a retinal vessel segmentation algorithm which works on a texton dictionary to identify whether the pixels are vessel/ non-vessel. They have extracted the filter parameters using a small group of image characteristics that are called as keypoints. A gabor filter bank which was empirically parameterized by ROC evaluation was used to discover these keypoints. Then by firstly utilizing a validation collection those keypoints were identified from which seeds were discovered to start a k-means clustering algorithm to make a texton dictionary. Then finally during the testing stage, 1-NN classifier was used to discover the pixels as vessel/ non-vessel pixels.

Kuri et al. (2015) [2] has presented a new automated solution in order to acquire the blood vessels with large accuracy. The new method presented was composed of an improved gabor filter with regional entropy thresholding under certain normal or abnormal situations. The volume and alignment of gabor filter was updated to fit an integral part of blood vessels so that it could be increased in the green component of the image.

Hassan et al. (2015) [3] discussed that by analyzing and identifying the vessel structures in the images of retina we could be able to diagnose the condition of an eye and the presence of diabetes on which stage. They have proposed mathematical morphology and K-means clustering methodology to discover the blood vessels. In order to improve the blood vessels and restrain the background information, a smoothing function is conducted on the retina image by applying mathematical morphology. And then K-means clustering algorithm is applied to segment the improved image.

Zhang et al. (2014) [4] proposed a technique for retinal vessel segmentation which was influenced by individual visible process and runs on a gabor filter bank. In order to enhance the various filter parameters machine learning was employed. The filter reactions were displayed as textons and this enables the equivalent membership features to be utilized as a platform for understanding vessel and non-vessel classes. Then at the end to produce segmentation results these vessel textons were utilized.

Rahebi et al. (2013) [5] discussed a technique to fine-tune the efficiency of co-ordinated filter by employing a gabor filter to enhance the entire accuracy of vessel segmentation. In this, the proposed gabor filter determines each pixel as vessel or non-vessel pixels on the basis of the co-ordinated filter and many other characteristics produced on the pixel level. The vessels were recognized by thresholding the retinal image's reaction to the matched filter, as the threshold is modified by image's reaction to the gabor filter. The result of the ground truth can be obtained by manually labelled images. Various tests were done to attain greater efficiency for this matched filter.

Sharma et al. (2013) [6] presented in order to examine any eye disorder the recognition of blood vessels is very essential. The current examination was mainly directed at building a computerized system for the removal of typical and abnormal characteristics in retina images. The RGB component was employed for determining the records of blood vessels. And this proposed technique has also used such stages such as pre-processing, segmentation and extracting various features. This method has been found to be successful as it is easy to implement.

James et al. (2013) [7] has presented that various details about the blood vessels of retina are very essential for analyzing, testing, verification and medical examination of certain diseases like diabetes, hypertension etc. Automatic segmentation and recognition of several retina structures are among the key study topics in today's time. For the ophthalmologists who are specialists in performing medical and surgical operations on eye, the automatic segmentation of retina blood vessels is the very first task to perform. With the growth in computational performance, various structure classification methods are utilized in areas of medical science. In this paper the author has provided an overview of the known supervised methods available for retinal vessel segmentation and the also the basic concepts on which these methods are based.

Wang et al. (2013) [8] presented an unsupervised method for retinal vessel segmentation that does not require any pre-processing and training stage. The vessels were enhanced using matched filtering with a multi-wavelet kernel. The multi-scale hierarchical decomposition of the enhanced image was used for noise removal and vessel localization. The final binary segmentation was obtained by adopting an adaptive threshold which generates a threshold surface based on the vessel edge information extracted by the previous processes.

Xiao et al. (2013) [9] proposed a Bayesian method with spatial constraint for segmenting vessels in retina images. This method was based on the assumption that the possibility of each pixel was influenced by the likelihood of its neighbouring pixels. The blood vessels were extracted by making use of a revised stage in order to decrease the energy function. This method was tested on two publicly available databases DRIVE and STARE. The results proved that this method was better than other available methods in terms of its accuracy.

Joshi et al. (2012) [10] has discussed that the advancement of diabetic retinopathy is assessed by their seriousness, which often decides the volume of tests to be done. But a lack of qualified individuals for this purpose has encouraged the use of computer aided monitoring. Analysis of blood vessels plays a very significant role in diagnosing various medical problems. They have employed the green component of the RGB images for detection of blood vessels. The proposed was based on morphological functions and has been proved suitable for identifying various blood vessels.

Dass et al. (2012) [11] has presented that image segmentation is a method in which an image is broken down into numerous sections in order to modify the illustration of an image into anything which is more simple and significant to understand. Many different methods have already been proposed and in this paper they have discussed the techniques utilized in ultrasound and SAR processing of images. Overall it can be said that a general review of all the existing segmentation methods have been discussed here.

Priya R et al. (2011) [12] has presented in this paper an automated diagnosis of age related macular degeneration (ARMD) from color retinal images. In this ARMD has been classified into two types: Dry macular degeneration and Wet macular degeneration. The extent of the disease spread in the retina can be identified by extracting the features of the retina. The detection of ARMD disease is done using probabilistic Neural Network (PNN) method. ARMD is gradual loss of vision by oxidation of macula and is the most common cause of irreversible vision loss.

Fraz et al. (2011) [13] has presented a supervised methodology for retinal vessel segmentation. In this a 7-D feature vector is constructed by obtaining the outputs of linear operators, line strengths and oriented Gabor filters at multiple scales. The Gaussian Mixture Model is used for classifying retinal images into vessels and non vessels.

Ricci et al. (2007) [14] has presented a method in which it groups features in three categories prior to generating feature vectors. A line detector based on the evaluation of the average grey level along lines of fixed length passing through the target pixel at different orientations. A line of three pixels in length, orthogonal to the linear features, is used in identifying pixels inside vessels, and its grey level provides the third feature. A classification for vessel/non vessel labels is done using a linear support vector machine.

VI. CONCLUSION

Several segmentation methods has been proposed so far which have proved to be very efficient in segmenting the blood vessels present in retina which can help in detecting certain diseases of eye such as diabetic retinopathy, age related macular degeneration etc. The recent techniques of segmentation have been considered for review purpose. But the existing literature has found that most of the available techniques have not considered the issue of noise. And the method which has provided good results is not so efficient for multiple kinds of high density noises at the same time. So in order to handle this issue of noise a new hybrid approach will be proposed in which a pre-processing stage will be applied before applying a segmentation method. This new approach will consist of a switching median filter before segmenting the image which will help to improve the accuracy rate further.

REFERENCES

[1] Zhang Lei, Fisher Mark and Wang Wenjia, "Retinal Vessel Segmentation using multi scale textons derived from keypoints", Computerized Medical Imaging and graphics, vol. 45, 2015, pp no. 47-56.

[2] Kuri SK and Kulkarni JV, "Automated Segmentation of Retinal Blood Vessels using Optimized gabor filter with local entropy thresholding", in International Journal of Computer Applications, vol. 114 no. 11,2015.

[3] Hassan Gehad et al., "Retinal Blood Vessel Segmentation approach based on mathematical morphology" ,in International Conference on Communication, Management and Information technology (ICCMIT), 2015, pp no. 612-622.

[4] Zhang L, Fisher M, Wang WJ, "Retinal vessel segmentation using Gabor filter and textons" , in 18th Conference on Medical image understanding and analysis,2014, pp no. 155–60.

[5] Rahebi Javad and Hardalac Firat," Combination of Matched Filter and Gabor Filter for Retinal Vessel Extraction", in Life Science Journal, vol. 10(6s), 2013, pp no. 483-486.

[6] Sharma Archana and Hempriya," Detection of Blood Vessels and Diseases in Human Retinal Images", in International Journal of Computer Science and Communication Engineering(IJCSCE), 2013.

[7] James Edward and Francisco Antonio, " On Supervised Methods for Segmentation of Blood Vessels in Ocular Fundus Images", in Advances in Image and Video Processing, Vol. 1, 2013, pp no. 21-37.

[8] Wang YF, Ji GR, Lin P, "Retinal vessel segmentation using multi-wavelet kernels and multi-scale hierarchical decomposition. Pattern Recogn2013; 46(8):2117–33.

[9] Xiao Zhiyong, Adel Mouloud, and Bourennane Salah, "Bayesian Method with Spatial Constraint for Retinal Vessel Segmentation" in Hindawi Publishing Corporation, Volume 2013.

[10] Joshi Shilpa and Dr karule P.T. , " Retinal Blood Vessel Segmentation", in International Journal of Engineering and Innovative Technology(IJEIT), Vol. 1, 2012.

[11] Dass et al., "Image Segmentation Techniques" in International Journal of Electronics and Communication Technology (IJECT), Vol No. 3, 2012.

[12] Priya R, Aruna P, "Automated diagnosis of age-related macular degeneration from color retinal fundus images", in Proc. 3rd international conference on electronics computer technology (ICECT), 2011, pp no. 227–30, 2.

[13] Fraz MM, et al. , "A supervised method for retinal blood vessel segmentation using line strength, multiscale Gabor and morphological features", in 2011 IEEE International Conference on Signal and Image Processing Applications (ICSIPA), Kuala Lumpur, Malaysia: IEEE; 2011, pp no. 410–5, Nov.16–18, 2011.

[14] Ricci E , Perfetti R," Retinal Blood Vessel Segmentation using line operators and support vector classification", in IEEE Trans Med Image 2007, 26(10), 1357-65.

