Blood Vessel Segmentation in Fundus Images

Priya C, Ramya C, Deepika R, Rosshini V, Sowmiya A, Vasuky M

Abstract: ***In this paper, image segmentation model based on hierarchical pixel is proffered to obtain blood vessels from fundus images of the eye. A hierarchical designadopting the durability and flexibility of retinal blood vessels is articulated into the image segmentation designs for blood vessel segmentation. Retinal blood vessels show a mesh-likestructure, so itsfundamental features viz., thickness, dimension plays a vital role in interpretation, early detection and healing of various systematic disease's viz., veinocclusions, diabetes, hypertension. Morphological features which is required for image segmentation which was found as inappropriate.***

Keywords: ***Image Segmentation, hierarchical design, fundus, threshold value, domain characteristics, segmentation, vessel.***

I. INTRODUCTION

The retinal blood vessels exhibits rough to eleganteccentric distribution and seems likeweb patch. Its fundamental characteristics viz., thickness, width, branching of vessels plays a significant role in diagnosis, monitoring, encountering at early stage and treatment of various coronary diseases and diseases such as eye strain, red eyes, nightblindness. The scrutiny of structural features of fovea centralis blood vessels can process encountering and medicationof diseasewhen it is in its prompt stage. The analysis of centralis blood vessels can assist in interpretation of central is image registration, relationship between vessel tortuosity and hypertensive retinopathy [3], arteriolar narrowing, mosaic synthesis, biometric identification [7], foveal a vascular zone identification and computer-facilitated laser surgery[1]. Cardiovascular and coronary disorderspossess a consequential collision on anindividual, the examination of retinal blood vessels becomes more and more important. It is important in medical applications to discloserepport of comprehensive ailment and facilitate interpretation and healing of disease. And hence, necessity of analysing the retinal vessel increases quickly in which the segmentation of retinal blood vessels is the first and one of the most crucial step. In recent year the segmentation of retinal blood vessels is becoming a massively analyse done.

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The existing algorithms can be divided into supervised and unsupervised methods. In supervised method,a number of idealcharacteristics are extricated for the purpose of removing retinal blood vessels from fundus images which extracts and performs feature selection by using sequential forward selection process to pick those pel which result in enhanced implementation by a K-Nearest Neighbor (KNN).In [11] it utilizes an AdaBoost classifier feature vector which includes data on local intensity structure, geographical features and dimensions at multiple scales.[13] contrive a 7-D vector tranquil of gray-scale and moment invariants dependentcharacteristics, and then trains a semantic structure for the grouping of pixel, extracts the vessels from the image and uses a Gaussian Mixture Model classifier for vessel segmentation including a group of properties, which are extricated on the basis of pixel neighborhood and first and second-order gradient images engage a semantic structure to extricate blood vessel pixels from fundus images of the eye. In unsupervised methods, inherent properties of retinal area is applied to extract pixels from the vessel in fundus image. The unsupervised methods are classified as matched filtering, multi scale approaches ,mathematical morphology, model based approach and vessel tracking. Vessel segmentation is the first move for examining the cluster of fundus images. The segmented vascular tree has beenemployed to extricate the essential features of blood vessels viz.,thickness, breadth, sectoring and divergence. Standard segmentation of the vascular tree in centralis images is a dreary process which needs more practice and knowledge. The advancement of a system-based interpretation for neurological diseases, automated segmentation of retinal vessels was agreed as essential and formidablemove. The immensity, structure and potency level of retinal vessels varies in various regions.

II. PROPOSED METHODS

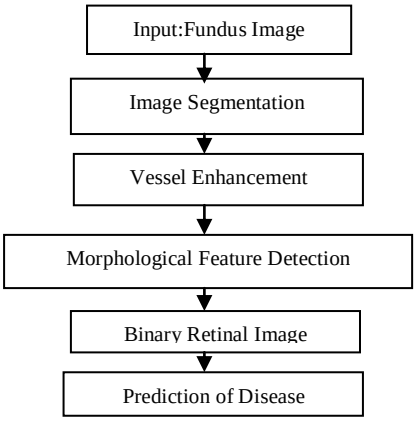

Fig. 2.1 Flowchart

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(A). Image Segmentation

Image segmentation is the process of splitting image into various parts and also used to identify objects. The goal of the segmentation is to facilitate the illustration of an image into meaningful and easier to work on it. It is usually adopted to detect items and barriers like edges, curves etc., Segmentation hastwo steps, the first step is to decompose the image for the further analysis and the second step is to perform the change of representation.Theoutcome of image segmentation is a group of pixelswhichtotally wraps the whole image, or a group of shapes extricated from the image.Each segments in the image are same with respect to the color, intensity, etc,. And the adjacent segments are different in characteristics compared to the other segments. When the image segmentation is applied to a collection of images for example, in medical imaging the result can be used to create 3D reconstructions using the interpolation algorithm like Marching cubes.

(B). Vessel Enhancement Filter

Vessel enhancement filters plays an important role in retinal blood vessel segmentation. The main abstract of this filter is to treat various diseases. There are different types of approaches regarding blood vessel network preprocessing, enhancement procedure, hard and soft cluster using KNN and post processing step. These methods can be tested and obtained from DRIVE and STARE. The combination of nonlinear finite operators is applied to the set of orientations by the basis of median filter. Since these method perform over a fixed scale analysis it shows problem to detect the vessels over large size images. The median filter is used to digitalize the image. It is a preprocessing step to improve the results of later processing. For example, edge detection in images. It is widely used in image processing to preserve edges from images while removing the noise.

(C). Morphologically Reconstructed Filter

Morphological reconstruction is a method used for extracting meaningful information about shape and size in an image and also the concepts like convexity, connectivity where also introduced with the help of both continuous and discrete spaces. By applying this filter, the input image and resultant output image will not differ according to size and shape. Morphology is a basic foundation of image processing. In morphological features there are some important operations are used such as erosion, dilation, opening and closing. Erosion is a method which removes the pixels from the edge of the image while dilation is a method where we add pixels to the edge of the image. Morphologically reconstructed filter is an effective tool for blood vessel enhancement. For each input fundus image I, the green channel image Ig is extracted firstly since Ig has the best vessel-background contrast..The diseases which are detected by using this method are microaneurysm, exudates, retinopathy, retinal detachment, astigmation, etc by seting the threshold values as high and low.

Algorithm 1: Implementing the K Nearest Neighbour Algorithm

Let($X_{i,}$,C_i) where i=1,2……..,n be data points.X_i denotes feature values & C_i denotes labels for X_i for each i.

Step 1: Assuming no of classes as 'c'.

$C_i \in \{1,2,3,…….,c\}$ for all values of i.

Step 2: Let x be a point for which label is not known,and we would like to find the label class using k-nearest neighbor algorithm.

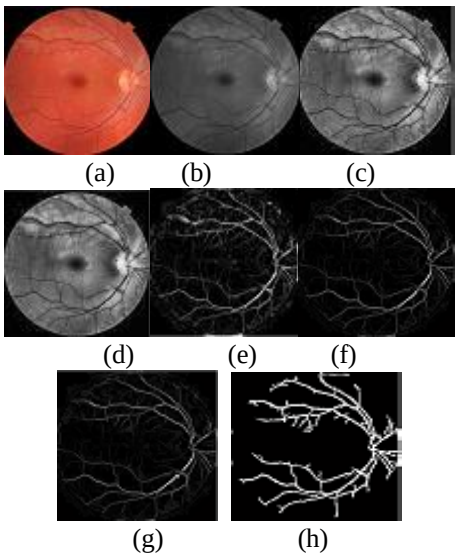

Fig. 2.2 (a) Fundus image. (b) Green channel image. (c) Enhanced image. (d) Filtered image.(e) Opening image (f) Reconstructed by dilation. (g) Reconstructed by erosion. (h) Binary retinal image

a) Fundus image involves capturing a photograph of back of the eye. b)The green channel have the most light in it mean that it will have less noise compare to red and blue.c)Various enhancement methods are available but in this process morphological operators are using and it states the process of improving the quality of the image and to make an image lighter or darker. d)The Filtered image are used to suppress either high frequencies i.e smoothing or low frequencies i.e enhancing or detecting edges. e) Opening image is simply as dilation followed by erosion using same structuring elements. f) The output pixel is maximum of all pixels and in binary image it is set to be 1then output is also be set to 1.g) The output pixel is minimum of all pixels and in binary image it is set to be 0 then output is also be set to 0.h)Binary retinal images have been predicted by using these above steps.

III. PERFORMANCE METRICS

In the process of retinal vessel segmentation, accuracy, sensitivity, specificity and time required which are defined in Table.

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Table. 3.1Performance of different segmentation models

Accuracy	Sensitivity	Specificity	Time
95.87	91	96	7.20
94.92	92	95	7.25
94.83	91	95	8.08
96.45	93	94	7.56
95.43	94.2	91	8.28
93.25	92.3	93	7.67
95.70	91.6	92	6.56
95.44	89	90	7.45
92.50	88.9	88.5	7.36

For the purpose of knowing the efficiency of this algorithm, three metrics are enforced as follow,

$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

$$\text{Specificity} = \frac{TN}{TN+FP}$$

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$

Table. 3.2 Four events of vessel classification

Vessel present	Vessel absent
TruePositive(TP)	FalsePositive(FP)
FalseNegative(FN)	TrueNegative(TN)

Sensitivity (Se) reflects the detecting vessel pixels, Specificity (Sp) is a measure of the identifying background pixels and Accuracy (Acc) is the combination of Se and Sp. So this model is compared with image segmentation model by selecting an operationg point from the above mentioned performance metrics. Also blood vessel segmentation is an unbalanced data organization issue because the vessel pixel is fewer compared to the background pixels. The segmentation time needed per image in seconds for applying the proffered segmentation algorithm in MATLAB. The efficient values is recorded and shown in the Fig 4.1. The effectiveness of the proposed model has been proved and further it can be verified by comparing it with other image mating models [4].

IV. RESULTS AND DISCUSSION

In this paper, set of examinations are undertaken with the purpose of evaluating the KNN algorithm.KNN algorithm has been executed in the MATLABr2013r are verified and tested using various jpeg images of size 245X243 in the figure 2.2.More than 15 images have been tested by using this algorithm. The different images have been taken by using KNN algorithm and it is compared to hierarchical image matting model and the output has been showed in efficient way.

V. CONCLUSION

Image matting model refers to the problem of accurately extracting a foreground object from an input image, which is very useful in many important applications. It has never been employed before the extrication of blood vessels from the fundus image. In order to enhance the process of blood vessel segmentation, the normal image has to be carefully designed by using matting model. Image segmentation model is efficient while comparing to image matting model. The continuity and extendibility of hierarchical model in retinal blood vessels. Compare to image matting image segmentation model is more efficient for extracting the blood vessels from the fundus image. The proposed model is efficient, which achieves accuracy of 96.01%,95.75% and 95.15% with an appropriate time of 10.72s,7.74s,7.207s.But the results shows competitive model in comparison with many other approaches, and it has a low computational time. Further enhancement methods are using by two types of algorithm Gray Level Co-occurrence Matrix(GLCM) and Statistical Properties. By using these two types of algorithm any type of fundus images have been tested and diseases will be detected.

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