AUTOMATED BLOOD VESSEL SEGMENTATION IN RETINAL IMAGE

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Abstract — **The First step in development of automated system for ophthalmic diagnosis is Automatic segmentation of blood vessels from retinal images. Automated blood vessel segmentation in retinal image is used to provide the information about diseases like diabetes, stroke, hypertension and Arteriosclerosis. The abnormal image, cottonwoolspots and hard exudates makes the vessel extraction process as difficult task. A Support Vector Machine (SVM) based supervised method is proposed for extracting blood vessel in retinal fundus image. In this work, the green channel image is enhanced by Gabor filter, and then various features are extracted by Thresholding method for SVM classifier. The method will be implemented on publicly available digital retinal images for vessel extraction (DRIVE) database.**

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Index Terms — **Gabor filter, thresholding, SVM classifier, blood vessel segmentation.**

I. INTRODUCTION

The World Health Organization estimates that a 250 million people have diabetes mellitus worldwide and that the number of people with diabetes will increase to 400 million by the year 2030[1].Lack of Oxygen causes stroke which leads to sudden death of brain cells . Then the most common eye disease is diabetic retinopathy which is caused due to retina changes in the blood vessel[2]. The major complication of diabetes is diabetic retinopathy (DR).The retinal image is the only location where the blood vessels can be directly visualised non-invasively in vivo. Automated blood vessel segmentation in the retinal image provides the information about diabetes, hypertension and stroke. A fundamental component of automatic retinal disease screening system is retinal vessel segmentation. An important role in the computerised detection of different ophthalmic pathology is blood vessel segmentation which leads towards vascular anomalies. The blood vessels appear as elongated features in retinal images that are of different intensity than the background, and their thickness is always smaller than a certain value. They enter into the retina by the optic disc and form branches of vessels that are connected. Fig.1 shows the anatomy of eye with retinal image.
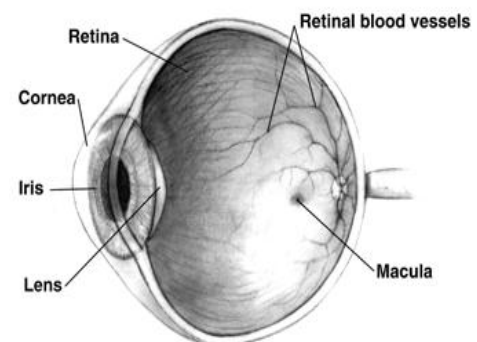

Fig.1.ANATOMY OF EYE

The rest of the paper is structured as follow: In Section 2 is Related Work. In Section 3 we describe Proposed method. In Section 4 we give an experimental result finally in Section 5 we give Conclusion to paper.

II.RELATED WORK

In the existing work, based on CLAHE [1], vessels are enhanced and double sided thresholding is used for segmentation. It proves to be useful in enhancing the contrast without causing an increasing in the number of false positives. A new supervised method [2] is presented for blood vessel detection in digital retinal images which uses a neural network (NN) for pixel classification and uses gray-level and moment invariants-based features for pixel representation. For different image conditions it provides effectiveness and robustness together with simplicity and fast implementation. Blood vessel morphology [3] is related to the risk of cardiovascular diseases. A new method is designed to solve optimisation problem and evaluated it in 2446 retinal images. The proposed approach provides 98.9% pixel precision and 98.7% recall of the true vessels for clean segmented retinal images. A simple thresholding method [4]

is used along with connected components analysis (CCA) indicates the remained ridges belonging to vessels. Feature of the multistructure elements method makes it an effective tool in edge detection. It achieves more than 94% accuracy in about 50s for blood vessel detection. The intensity or grey-level [5] are used for image segmentation and enhancement. When compared with other conventional filters it provides more effective in detecting adjacent structures. An ensemble system [6] of bagged and boosted decision trees and utilizes a Gabor filter responses with line strength and morphological transformations.. Two retinal vessel segmentation [7] approaches based on combination of multi scale morphological reconstruction and morphological bit plane slicing with the vessel centrelines is presented. A new tracking-based segmentation [8] method is used to detect blood vessels in retinal images. True positive rate and false positive rate can be evaluated by this segmentation. A robust method [9] is used to perform retinal vascular fractal analysis from digital retina images. Complexity with aging is reduced in the vasculature due to Fourier Fractal dimension. A novel active contour model is proposed [10] for vessel tree segmentation. Gaussian mixture is used to find thick vessels.

The above techniques provide effectiveness, robustness, fast implementation, speed, specificity, accuracy, sensitivity, computational time. Still it is suffering with some limitations.

Our proposed work focuses on Gabor filter for enhancement process and features of the image are extracted using Thresholding method. Finally supervised classification provides automated segmentation in retinal image.

III. PPOPOSED MODEL

3.1 Material for DRIVE Database

The large databases of fundus images are classified automatically and managed more than labour-intensive observer-driven techniques in the research or screening setting. Automated diagnosis may also aid decision-making for optometrists. The retinal images are downloaded from publicly available digital retinal images for vessel extraction (DRIVE) database. Diabetic Retinopathy screening programs were used to obtain retinal photographs. The images were acquired using a Canon CR5 non-mydriatic 3CCD camera with a 45° field of view (FOV). Image was captured using 8 bits per colour plane at 768×584pixels.
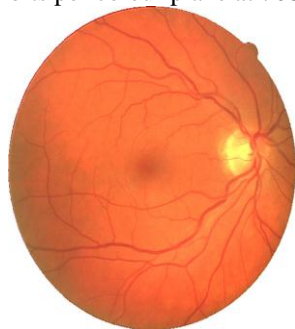
Fig.2.Original Image

3.2 Green channel construction

The green channel exhibits the best contrast between the vessels and background while the red and blue ones tend to be more noise. The green channel image contains the most amount of information since there is a higher contrast between the vessel pixels and the non-vessel pixels. Then the green channel is converted into gray scale image.Fig3.shows system design for proposed method.
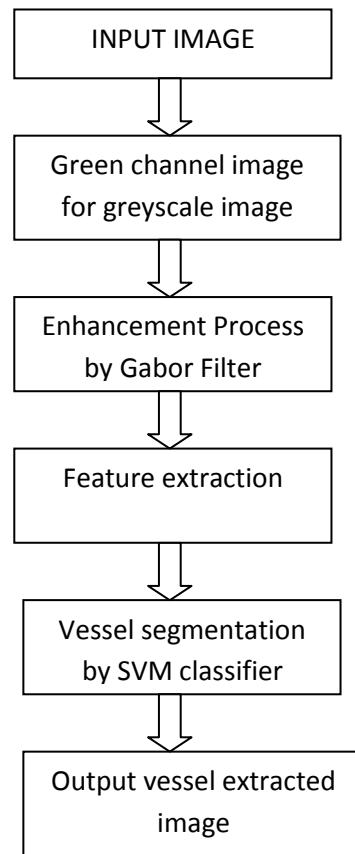
INPUT IMAGE

Green channel image for greyscale image

Enhancement Process by Gabor Filter

Feature extraction

Vessel segmentation by SVM classifier

Output vessel extracted image

Fig.3 system design

3.3 Enhancement process

Enhancement process is useful for image display and analysis. Sharpening, noise reduction can be done by enhancement process. Here enhancement process is implemented Gabor filter. Fig.4 shows the Gabor filtered image.

Gabor Filtered image

Fig.4 enhanced image

The major properties of the Gabor filter includes: Ability to be tuned to specific orientations. This allows the extraction of the features of line segment at any possible orientation. Second, the bandwidth of the filter is adjustable.

Gaussian envelope, orientation, phase offset, wavelength, spatial aspect ratio are used to create the Gabor filters. It can be implemented by,

$$g(x,y) = \exp\left\{-\pi\left[\left(\frac{x_p^2}{\sigma_x}\right)+\left(\frac{y_p^2}{\sigma_y}\right)\right]\right\}+\cos\left(2\pi f\, x_p\right)$$

$$x_p = x\cos\theta + y\sin\theta$$

$$y_p = -x\sin\theta + y\cos\theta$$

Where,

$\lambda - wavelength$

$\theta - orientation$

$\sigma - gaussian\, envelope$

3.4 Feature extraction

When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant. Then the input data will be transformed into a reduced representation set of features. In order to classify the given input images different classes must be represented using relevant and significant features. Data with sufficient accuracy can be described by feature extraction. Mean, standard deviation , RMS value of the image, entropy are the list of features in the retinal image and it can be extracted .

3.5 Segmentation process

Image segmentation is the process of partitioning a digital image into multiple segments (i.e.) set of pixels. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. It is typically used to locate objects and boundaries. Then, assign a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

Partitioning the digital image into multiple images is the process of the image segmentation. Visual characters of the image can be assigned by segmentation process. Supervised classification is better for vessel Segmentation and it is implemented by SVM classifier. The SVM have high performance in higher dimensional spaces. SVM Classifier is a binary linear classification used to classify training examples. SVM classifier demonstrates good generalisation ability when compared to other classifiers. Data can be easily analysed by SVM classifier. It can also perform the non-linear classification. In the retinal image, SVM classifier is used to find blood vessel and non-blood vessel. Fig 5. Shows the segmented image.
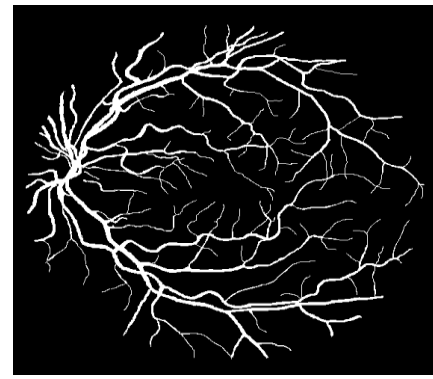

Fig 5.segmented image

IV. Experimental Result

1)The mean of the retinal image can be calculated by,

$$mean = \frac{1}{N}\sum_{i,j\in ROI} g(i,j) \longrightarrow (1)$$

where g(i,j) is the gray level at pixel (i,j), and N is the total number of pixel inside the ROI.

2)The entropy value can be calculated by following equation

$$En = -\sum_{i=0}^{G-1} p(i)\times\log p(i) \longrightarrow (2)$$

where G is the maximum gray level of the region.

3)The Accuracy with classification and without classification can be calculated due to segmentation in the retinal image. Table.1 shows performance analysis of segmentation. Accuracy can be measured by.

$$Accuracy = \frac{\sum(correctly\, classifed\, pixel)}{total\, no.\, of.\, pixels}$$

Performance analysis	Accuracy
Segmentation with classification	95%
Segmentation without classification	90%

Table.1 performance analysis for segmentation

4) Classifications

The classifications are

i)True Positive (TP) ; when a pixel is correctly segmented as a vessel pixel i.e. the pixel is classified as a vessel pixel .

ii)True Negative (TN); when a pixel is correctly segmented as a non-vessel, the pixel is classified as a non-vessel pixel .

V. Conclusion

Retinal vessel segmentation algorithms are a fundamental component of automatic retinal disease

screening systems. Blood vessel segmentation in retinal digital images plays an important role in the computerized detection of different pathologies leading to vascular anomalies. Retinal vessel segmentation is greatly required to extract certain features that may help in diagnosis and treatment .The accurate extraction of the retinal vascular tree forms the backbone of many automated comport aided systems for screening and diagnosis of cardiovascular and ophthalmologic diseases .The experiment was performed for the set of 20 test images of the DRIVE database. It can be concluded that Gabor filter provides better results when compared with other filter based methods. Binary kernel classification is used to SVM classifier to classify the blood vessel. In Future work the SVM classifier will be compared other classifier like neural network (NN) classifier and Bayesian classifier.

Acknowledgement

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