ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 3, March 2017

Increased Learning In Retinal Blood Vessel Segmentation Approach Based on Fuzzy-C Means Clustering and Mathematical Morphology

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Abstract: **-- One of the major diseases that cause severe threat to the eye is named as Diabetic retinopathy. It creates thereby blindness among the people in the small age itself. The retinal image processing is used for analyzing and detecting the disease with the retinal blood vessels. By analysing and detecting of vasculature structures in retinal images, The most widely recognized manifestations of diabetic retinopathy incorporate cotton fleece spots, hemorrhages, hard exudates and enlarged retinal veins. A patient with diabetic retinopathy malady needs to experience intermittent screening of retina.we can early detect the diabetes in advanced stages by comparison of its states of retinal blood vessels. In this paper, we present blood vessel segmentation approach, which can be used in computer based retinal image analysis to extract the retinal image vessels. Mathematical morphology and FCM clustering are used to segment the vessels. To enhance the blood vessels and suppress the background information, we perform smoothing and sharpning operation on the retinal image using mathematical morphology. Then the enhanced image is segmented using FCM-means clustering algorithm.The main focus of this proposed work is to design the algorithm based on segmentation with clustering,for detection of Retinal blood vessel with the help of MATLAB with maximum accuracy.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 best accuracy of 98.23%**

Index Terms **— Blood vessel Extraction, FCM Clustering, Mathematical morphology, Vessel segmentation**

I. INTRODUCTION

Retinal image processing is required in diagnosing and treatment of many diseases affecting the retina and the choroid behind it. The retina is a nerve tissues layer that lies inside of our eye. The retina is very thin and a tear in the retina is very serious and potentially blinding problem. The former identification and analysis of DR is vital to prevent the vision of diabetes patients. An automatic retinal image is rising as a significant testing tool for early recognition of eye diseases. Diabetic retinopathy(DR) is the leading Ophthalmic pathological cause of blindness among people of working age in developed countries.The estimated prevalence of diabetes for all age groups worldwide was 2.8 % in 2000 and 4.4 % in 2030, meaning that the total number of diabetes patients is forecasted to rise from 171 million in 2000 to 366 million in 2030. The main cause of DR is abnormal blood glucose level elevation, which damages vessel endothelium, thus increasing vessel permeability.The first manifestations of DR are tiny capillary dilations known as micro aneurysms. DR progression also causes neo vascularization, hemorrhages, macularedema..By using this proposed frame work, the better accuracy of retinal vessels were identified.

This paper presents an automated segmentation approach for retinal blood vessel. It based on some morphological operation and FCM-means algorithm. The rest of this paper is organized as follows: Section II presents the Literature survey about our approach, and Section III presents the proposed methodologies. Section IV describes the core concepts of morphological processing and FCM-means algorithm. Section V discusses the tested image dataset and presented the obtained experimental results. Finally, Section VI presents conclusions and future work.

II. LITERATURE SURVEY

In [21] an approach is presented which is combined unique vessel centrelines detection with morphological bit plane slicing. The first order derivative of a Gaussian filter is used in four directions to extract the centrelines, and then performing an average derivative and derivative signs with the extracted centrelines. Mathematical morphology has proven their worth as a brilliant technique for the blood

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vessels segmentation in the retina. Morphological multidirectional top-hat operation is applied on blood vessels gray-scale image with linear structure element to obtain the orientation map and shape, and then the enhanced vessels are subject to bit plane slicing. For obtaining the vessel tree, these maps are combined with the centrelines. This method has average accuracy, sensitivity and specificity on the DRIVE database 0.943, 0.715, 0.977, respectively.

Many different algorithms were deployed for vessels segmentation, which achieved various results and performances. Fraz, Rudnicka and Barman [19] introduced supervised method. Dual Gaussian is used; a collection of second derivative of Gaussian and Gabor filters, feature vector is generated using some morphological transformation. This feature vector gives information which helping on handling the normal vessels and the vessels with the central reflex. The proposed system achieved accuracy, sensitivity and specificity of 0.96, 0.74 and 0.98, respectively. A supervised method, Yin and Bourennane [20] introduced, they used this method for vessel segmentation taking into account vessel edge detection on the retinal image. To detect vessel edge points in this method, they with maximum a posteriori (MAP) as criterion. This method achieves sensitivity and specificity 0.7248 and 0.9666, respectively on DRIVE.

S. Shen et al., (2003) described a method for improving the segmentation of brain (MR) magnetic resonance images which involves two stages they are preprocessing and segmentation .The image intensities are first identical using the pixel histograms during preprocessing, again morphological processing is used to remove the non-brain regions. During the second process that is segmentation process, the normal and abnormal brain tissues are segmented using both the fuzzy c-means (FCM) that are clustering, and a new improved FCM algorithm. Some effects are considered in the latter method to avoid noise [4]. The Segmentation results showed this method is more robust to noise and improved the integrity of the segmentation performance. Segmentation results improved FCM is much closer to the original image, and the cluster boundaries are smoother and clearer than those using the traditional FCM.

Mohamad Awad et al., (2007) described an essential process for image analysis by image segmentation. Here the Image segmentation method is established using a nonparametric unsupervised ANN called hybrid genetic algorithm (HGA) and Kohonen's selforganizing map (SOM). SOM detect the main features that are present in the image; then, HGA is used to cluster the image into homogeneous regions without any knowledge. Experiments performed on various satellite images confirm the efficiency and robustness of the SOM–HGA method is called Iterative Self-Organizing DATA analysis technique [16] .Here the implementation is in c language. The output contains the information about capturing an image and other related information.

Proposed Methodology

The main objective of the proposed method is to precisely identify the presence of retinal disease. Retinal dieseas and its identification at an early stage is very essential for saving patient's eye vision. The algorithm so far developed was still unable to identify the features of retinal disease .The proposed algorithm shows the clear image of the Retinal blood vessels. The proposed framework is sub divided into three stages they are Preprocessing, Mathematical morphology and FCM Clustering

System Architecture diagram of the proposed system.
Orginal

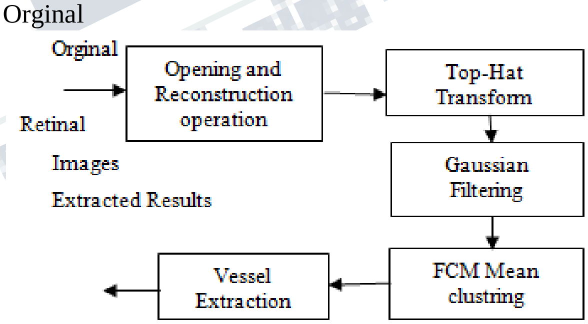

Fig 1: System Architecture diagram of the proposed system

Thus the proposed frame work used to enhance the accuracy in detection of retinal vessels.

Retinal Database

The Retinal images are collected from the stored database. One of the images is taken from the database and is subjected to retinal vessel detection.

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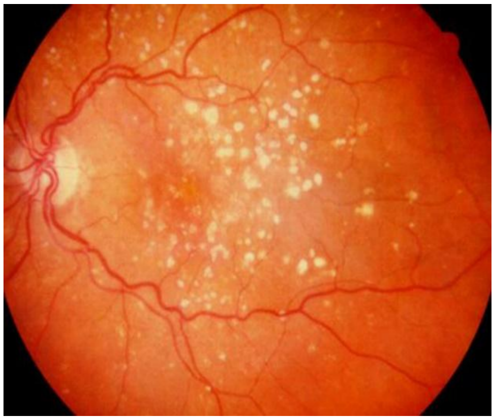

Fig 2 (a): Input Retinal Image

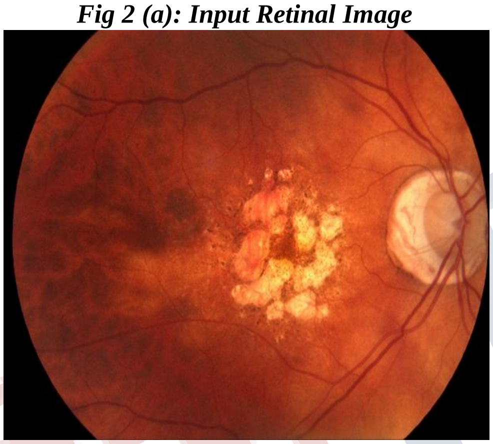

Fig 2 (b): Input Retinal Image

Pre-Processing

Initially the image is allowed to pre-processed using following techniques like restoration, smoothening, sharpening and finally contrast enhancement. The obtained image consists of noise and is of low contrast which makes difficult for analyzing.

To overcome this, Pre-processing is done which consists of following steps.

1. Image Restoration
2. Smoothening and Sharp
3. Contrast Enhancement

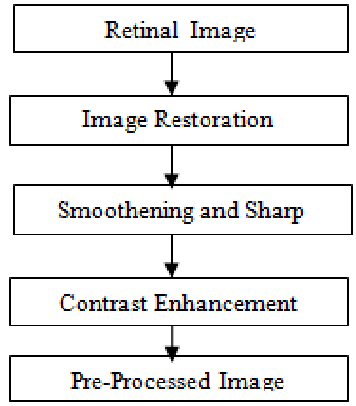

Fig 3: Pre-processing of Retinal image

Image Restoration

Reducing degradation level is caused during image scanning is the main purpose of image restoration. To avoid this we must make use of level set functions for proper orientations. The shrinks can be eliminated using plan curve motion.

Smoothening and Sharpening

The band pass filter is employed to get optimal resolution in both spatial and frequency domains. By varying the standard deviation of Gaussian function, the degree of smoothening can be adjusted.

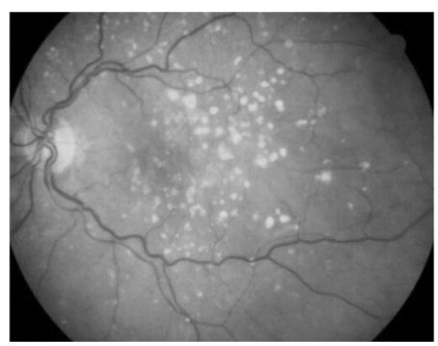

Fig 4(a): Grayscale of the Fist input Retinal Image

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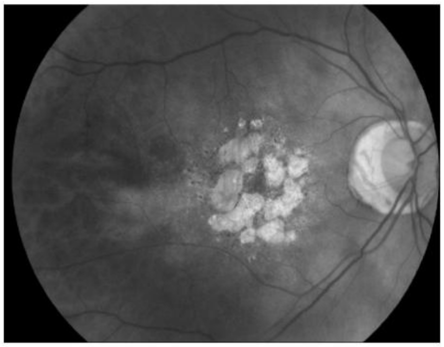

Fig 4 (a): Grayscale of the second input Retinal Image

Contrast Enhancement

The contrast is improved by Histogram equalization and to obtain the uniform intensity of the image. The image contrast can be improved by transforming the values in an intensity image so that its output image matches the specified histogram image.

Image Segmentation

The purpose of segmentation is *Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters.*. Image segmentation is done using a novel algorithm that is about to be proposed.

The segmented Images

Image clustering is a process of combining same image information into one cluster, multiple images of the same scene into an image, so that the resultant image contains a more accurate description of the scene than any of the individual source images. Here Image clustering is used to segmented image which is based on the Euclidean distance and the clustering centers. The clustering center matrix v is acquired by an improved FCM clustering algorithm and its size is Cluster_n_3. According to the clustering center matrix v, the Euclidean distance Dist FH between the segmented images F and H are used to express the closeness between them and it is defined as

$$\text{Dist}_{FH}=\sqrt{\sum}(V_F-V_H)^2 \quad (1)$$

where vF and vH are the clustering centers of F and H, and their sizes are1 X 3. Two closest segmented images are fused by mutual fusion, then their clustering centers are combined as a new one, that leads to a new clustering center matrix v^1, and finally the number of the images is Cluster_n^1 after the first level.

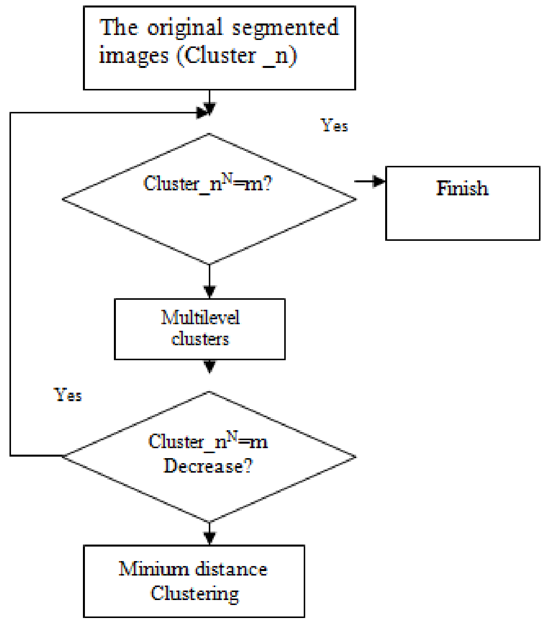

Fig 5: The framework of multilevel image clustering

The Nth level clustering

Mutual fusion is used to fuse the two very closest images. Final results accuracy can be improved by this method. But it is possible that not all the clustering centers meet the mutual fusion rule in fusion levels of the certain image. So it is essential to control the process of the mutual fusion by introducing minimum distance fusion. The mutual fusion rules fail for the two segmented images, but if the distance between them is smallest in the distance matrix, then the two images are fused.

Morphological Processing

To extract larger vessels, we select structuring elements with length near to the diameter value of the largest vessels. In our experiments, in order to save the time spent on the segmentation, each structuring element is 7 pixels long and 1 pixel in width.The Accuracy of a diagnostic test can be determined by sensitivity and specificity. There are some terms that are normally used with the description of sensitivity, specificity and accuracy. They are (TP) true positive ,(TN), true negative , (FN) false negative and (FP).false positive. If a disease like a retina tear is proven present in a patient, the given diagnostic test which also shows the presence of disease, then the result of the diagnostic test is considered TP. Likewise, if a disease is proven but absent in a patient, the diagnostic test suggests the disease is absent and then the test result is true negative (TN). However, no medical test is perfect. If the diagnostic test shows the presence of disease in a patient who actually has no such disease, then the test result is false positive (FP). Also, if the result of the diagnosis test suggests that the disease is absent for a patient with the disease for sure, then test result is false negative (FN). Both FP and FN indicated that the test results are opposite to the actual condition.The proposed system performance is evaluated by using this parameter such as sensitivity, specificity and accuracy.

Thus the sensitivity, specificity and accuracy formula are mentioned below:

Sensitivity, specificity and accuracy are described in terms of TP, TN, FN and FP.

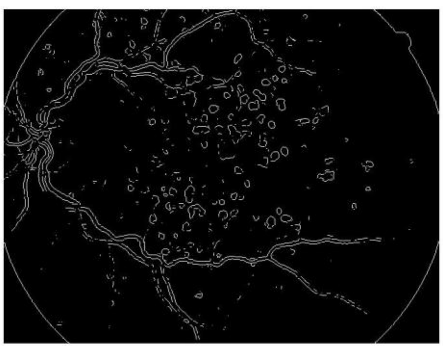

Fig 6 (a): Segmented output of first Retinal Image

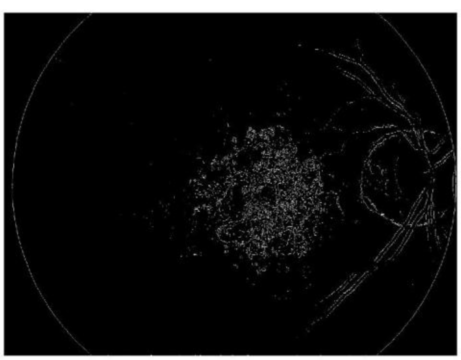

Fig 6(b): Segmented output of second Retinal tear Image

Tabulations of the Proposed System

The Accuracy of a diagnostic test can be determined by sensitivity and specificity. There are some terms that are normally used with the description of sensitivity, specificity and accuracy. They are (TP) true positive ,(TN), true negative , (FN) false negative and (FP).false positive. If a disease like a retina tear is proven present in a patient, the given diagnostic test which also shows the presence of disease, then the result of the diagnostic test is considered TP. Likewise, if a disease is proven but absent in a patient, the diagnostic test suggests the disease is absent and then the test result is true negative (TN). However, no medical test is perfect. If the diagnostic test shows the presence of disease in a patient who actually has no such disease, then the test result is false positive (FP). Also, if the result of the diagnosis test suggests that the disease is absent for a patient with the disease for sure, then test result is false negative (FN). Both FP and FN indicated that the test results are opposite to the actual condition [19].The proposed system performance is evaluated by using this parameter such as sensitivity, specificity and accuracy.

Thus the sensitivity, specificity and accuracy formula are mentioned below:

Sensitivity, specificity and accuracy are described in terms of TP, TN, FN and FP.

$$\text{Sensitivity} = \frac{TP}{(TP+FN)} \quad (3)$$

$$\text{Specificity} = \frac{TN}{(TN+FP)} \quad (4)$$

$$\text{Accuracy} = \frac{TP+TN}{(TP+TN+FP+FN)} \quad (5)$$

Comparison of the proposed system with existing system

Methods	Sensitivity	specificity	Accuracy
AliFahmy et al	87.99	97.99	96.25
Proposed method	97.30	97.55	98.23

When compared to the existing method, we get the better accuracy Retinal image. Since in reference paper which is AliFahmy et al provides sensitivity level of 96.33 whereas proposed approach provides sensitivity level of 87.99. Similarly while comparative analysis of proposed approach with the reference our proposed approach accuracy level is higher which have 98.23% where reference paper achieves accuracy at the rate of 96.25%.

VI. CONCLUSIONS AND FUTURE WORK.

In this proposed system automatic approach of vessel segmentation is presented. Mathematical morphology is applied as pre-processing phase with K-means clustering. Mathematical morphology firstly employed to enhance and smooth the digital retinal images and to suppress the background information. Then, the FCM-means clustering is applied to segment the vessels. And finally the blood vessels are extracted. Our results which obtained from the proposed method are compared with the standard segmentation methods. It achieves quantitative and qualitative results on normal and abnormal retinal images. Our results shows that the proposed system produce identical results as the ground truth and have a high accuracy ratio and low misclassification ratio comparing with the manual extraction, we aim to perform more efficient methodologies and improve in time complexity.Thus, the stimulation results had displayed that the proposed system results are an average accuracy of 98.23%, the sensitivity of 97.30% and Specificity of 97.99 % respectively.

Thus the proposed model had enhanced the overall performance and increases the efficiency of the image. Hence the proposed methods are significant than the existing methods and it can be utilized as an efficient diagnostic tool for detecting the retina disease.

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