Accurate Detection of Retinal Tears Based on Neural Network Using Fourier series Power Spectrum Segmentation Technique

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Abstract. Stride towards developing an automated technique for diabetic damage detection through blood vessel segmentation in retinal images. Medical image plays very important role in identification and classification of diseases. In human eye, retina is attached to the inner surface which plays the major role for visualization. Image processing technique is used to improve the visualization of retina and become better quality of the retinal images. The retina is a layered tissue, covering the inner of the eye that allows the transformation of incoming light into a neural signal which is acceptable for the processing in the visual cortex of the brain. A retinal tear will occurs when a portion of the retina separates from the outer layers of the eye. Serious condition of the retinal tears is called as retinal detachment. The former identification and analysis of Retinal tears is vital to prevent the vision of the patients. In this paper, high accurate detection of retinal tears is presented. The proposed methods made are up of three major stages such as preprocessing, Fourier Series Power spectrum segmentation and improved ANN classification. The main focus of this proposed work is plan to design the algorithm based on segmentation with clustering, and the artificial neural network (ANN) for identification of Retinal tears with the help of MATLAB with maximum accuracy.

Keywords: Retinal tear, Fourier Series Power spectrum segmentation, artificial neural network (ANN).

1 Introduction

Retinal image processing is involve in determine and analysis of many diseases infect the retina and the choroid beyond it [22]. 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. Retinal tears are one of the main reason of blindness and vision defects in developed countries. Retinal tears may occur when the gel like vitreous pulls loose and separates from its attachment to the retina, commonly in the peripheral parts of the retina. The serious condition of Retinal tears is called Retinal detachment. The Retinal detachment caused by tears or holes is called Rhegmatogenous [2]. It only occurs in about 1 in 10,000 people each year. If new holes developed with further detachment, a successful encircling scleral buckling procedure was performed [5] Retinal detachment can happen to someone at any age but it is very rare under the age of sixteen and mostly happens to people aged between 60 and 70 years. It only occurs in about 1 in 10,000 people each year. Most retinal detachments occur only because of a tear in the retina. Greater than 25 percent of eyes with retinal tears obtained. Atrophic retinal holes patients must have annually eye examinations, but those with nearby localized (<1 DD) retinal detachments should be seen every 6 to 12 months [1] Image segmentation is an important procedure for image evaluation [16].

After segmentation process, the usage of Otsu edge detection implemented on Artificial neural network nodes increase the accuracy in detection of retinal tears. By using this proposed frame work, the better accuracy of retinal tears is identified.

The rest of the paper is systematic as: section II that deals with literature survey of existing methods, section III gives the detailed explanation about the proposed methods, preprocessing, and Fourier series power spectrum segmentation of the disease. It also assign with the artificial neural network (ANN). Section IV elaborates the interpretation of the stimulation outcome and lastly section V discussed about the conclusion of the paper.
2 Literature Survey

Adi, K. G et al., (2015) calculate the position of the Cholesterols and also predict any abnormalities present in the same Cholesterol. The abnormalities detection of Cholesterol inside the body can be detected. Due to some abnormalities (speckle noise) in ultrasound or MRI images or US or CT and artifacts, the wrong diagnosis may happen by analyzing the scanned image. The ANN algorithms MLP-BP are trained and classified the images in the database with the accuracy about 89.6% [3]. The images in the database with the maximum accuracy of 97.6% using MLP-BP ANN algorithm. Better accuracy is developed by the proposed method. This system is cost effective The main focus of the proposed framework is to design the algorithm based on level set segmentation, wavelets filters and the artificial neural network (ANN) architecture for finding of Cholesterol in real time using biomedical images with a maximum accuracy of 98.8%.

Rale, A. P et al., (2009) developed pre-processing and analyzed NDT images. The developed Software allows the user to train neural networks only for fault detection. Once trained reasonably, the developed software scans the new input image and the trained ANN used for fault detection. This system could be used to obtain the faulty areas in a given input image. This performance of MLP and RBF for detection of fault is presented in this paper. The result of different types and performance of ANN is discussed [6]. Artificial Intelligence techniques with both Expert Systems and ANN’s can be successfully applied to provide the fault classification and final product quality conclusion. Back propagation Neural Networks are being applied for radiographic image investigation. The experiment performed is found that RBF network with 7 moments gives more precise results as compared to MLP. But for fast detection MLP is better compared to RBF.

S. Shen et al., (2003) described a method for upgrade the segmentation of brain (MR) magnetic resonance images which involves two phases they are preprocessing and segmentation. The image intensities are first identical using the pixel histograms during preprocessing, again morphological action is used to remove the non-brain regions. Throughout 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 results are examine in the final method to avoid noise [4]. The Segmentation results showed this method is additional robust to noise and improved the fairness of the segmentation performance. Segmentation results improved FCM is much closer to the original image, and the cluster borderlines are smoother and apparent than those using the traditional FCM.

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

The main objective of the proposed method is precisely identify the presence of retinal tears. Retinal tears are a dynamic disease 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 tears. The proposed algorithm shows the clear image of the Retinal tears as well as retinal detachment. The proposed framework is sub divided into three stages they are Preprocessing, Fourier series power spectrum Segmentation and Improved ANN classification.

![System Architecture diagram of the proposed system](image)

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

3.1 Retinal Tear database

The Retinal images are collected from the stored database. One of the images is taken from the database and is subjected to retinal tear detection.
Fig 2: (a) Input Retina with Tear Image (b) Input Retina with Tear Image

3.2 Pre-processing

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

To overcome this, we use Pre-processing which consists of following steps.

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

Fig 3: Pre-processing of Retinal Tear image

3.2.1 Image Restoration

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

3.2.2 Smoothening and Sharpening

The band pass filter is used 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.
3.2.3 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.

3.3 Image Segmentation

The purpose of segmentation is to overcome the energy function difficulties. This energy function depends on image properties such as curvatures, intensities, gradients and regularization terms. Image segmentation is done using a novel algorithm that is about to be proposed. Fourier series power spectrum is used to find the different energy levels of the retinal tear image such that it could reveal the teared region in the image.

3.3.1 The fusion of segmented images

Image fusion is a process of combining complementary information from 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 fusion is used to fuse the segmented image which is based on the Euclidean distance and clustering centers. Clustering center matrix \( v \) is obtained by an improved Fuzzy C-Mean clustering algorithm and its size is Cluster_n_x3. According to the clustering center matrix \( v \), the Euclidean distance \( FH \) between the segmented images \( F \) and \( H \) are used to express the closeness between them and it is defined as

\[
\text{Distance}_{FH} = \sqrt{\sum (V_F - V_H)^2}
\]  

(1)

Where \( V_F \) and \( V_H \) are the clustering centers of \( F \) and \( H \), and their sizes are \( 1 \times 3 \). Two closest segmented images are fused by mutual fusion, then their clustering centers are combined with new one that tends to a new clustering center matrix \( v^1 \) and finally the number of the images are Cluster_n^1 after the first level fusion.

3.3.2 The Nth level fusion

Mutual fusion is used to fuse the two very closest images. Final results accuracy could be improved by this method. But this 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.

3.4 Improved ANN Classification

An artificial neural network or generally just neural network (NN) is an interconnected group of artificial neurons that uses a computational model or mathematical model for information processing based on a connection list approach to computation. In some cases artificial neural network adaptive system that will change its structure based on external or internal information that flows through the network.

Here a technique is going to be proposed based on active learning concept in the neural network. The usage of Otsu edge detection is going to be implemented on neural network nodes to increase the accuracy in detection of
retinal tears causing eye lattice. Using Otsu thresholding, the intensity or the amount of weight that is been given to neurons increases and this in turn increases the active learning concept. This approach could be implemented on unsupervised learning approach using a neural network.

![Diagram of ANN System](image)

**Fig 5**: ANN System

Weights for thresholding are defined as:

$$\sum_i (w_i + w_0)x_i + \text{bias}$$  \hspace{1cm} (2)

Furthermore weights are increased and this could enhance the decision making process. Also further decision making could be improved using function **EXNOR** for calculating the weights function.

![EXNOR gate](image)

The input of EXNOR is 3 and -1, thus implementing this gate in decision making, the bitwise output will increase the efficiency of the output.

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

**4 Tabulations of the Proposed System**

The accuracy of a diagnostic test can be calculated by using parameters such as 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 malady 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 true positive (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) [19]. 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 shows 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.

\[
\text{Sensitivity} = \frac{TP}{(TP + FN)} 
\]

\[
\text{Specificity} = \frac{TN}{(TN + FP)} 
\]

\[
\text{Accuracy} = \frac{TP + TN}{(TP + TN + FP + FN)} 
\]

Comparison of the proposed system with existing system

<table>
<thead>
<tr>
<th>Methods</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adi, K.G et al</td>
<td>96.33</td>
<td>96.58</td>
<td>97.6</td>
</tr>
<tr>
<td>Proposed method</td>
<td>97.30</td>
<td>97.55</td>
<td>98.24</td>
</tr>
</tbody>
</table>

When compared to the existing method, we get the better accuracy Retinal tear. Since in reference paper which is Adj, K.G et al provides sensitivity level of 96.33 whereas proposed approach provides sensitivity level of 97.30. Similarly while comparative analysis of proposed approach with the reference our proposed approach accuracy level is higher which have 98.24% where reference paper achieves accuracy at the rate of 97.6%.

5 Conclusion

In this proposed system, three stages of Retinal tears detection were subjected by preprocessing, Fourier series power spectrum segmentation and Improved ANN classification. The preprocessing stage extracts background pixels to empower the working on further stages on the foreground pixels only. During segmentation different energy levels of the retinal tear image can revile. The usage of Otsu edge detection implemented on neural network nodes to increase the accuracy in detection of retinal tears. Thus, the stimulation results had displayed that the proposed system results are an average Accuracy of 98.24%, the Sensitivity of 97.55% and Specificity of 97.30% 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.
Reference

10. HARRABI, R., & BRAIEK, E. B. Color Image Segmentation by Multilevel Thresholding using a Two Stage Optimization Approach and Fusion.