Analysis and Detection of Diabetic Retinopathy using Features Extraction Techniques

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ABSTRACT
Diabetic Retinopathy is a damage of eye caused by changes in the blood vessels of the retina. Diabetic retinopathy is one of the major problems that lead to blindness in adults around the world today. Early detection of the disease is absolutely essential in preventing unnecessary blindness. So in this paper firstly, we performed preprocessing operations on fundus Images to enhance the images, such as gray scale conversion, Median filter and lastly adaptive histogram equalization. To perform the above functions we have used database from MESSIDOR, this proposed method achieves the rate of specificity and sensitivity. So, we have proposed an automated system to detect diabetic retinopathy from retinal images and classify normal images and abnormal images as Hemorrhages and Exudates. In this approach after pre-processing, texture features are extracted from retinal images and used K-means cluster to classify and detect normal and abnormal images.

Keywords
Diabetic Retinopathy, Fundus Images

1. INTRODUCTION
In early days many people facing the Diabetic retinopathy problem. Diabetic retinopathy damage to the retina caused by complications of diabetes, which can eventually lead to blindness [1]. There are three main type of retinopathy. Fist is Background Retinopathy, second is Pre-proliferative Retinopathy and third one is Proliferative Retinopathy.

1.1 Background retinopathy
Small red dots will appear on retina due to tiny swellings in the blood vessel walls. If you have been diabetic 30 years, even with the best control, these may develop. But most people who have background retinopathy have not been diabetic that long, and need better control as per these targets. BDR consists of:-

• Microaneurisms: these are usually the earliest visible change in retinopathy seen on exam with an ophthalmoscope as scattered red spots in the retina where tiny, weakened blood vessels have ballooned out.

• Hemorrhages: bleeding occurs from damaged blood vessels into the retinal layers. This will not affect vision unless the bleeding occurs in or near the Macula [2].

• Hard Exudates: caused by proteins and lipids from the blood leaking into the retina through damaged blood vessels. They appear on the ophthalmoscope as hard white or yellow areas, sometimes in a ring like structure around leaking capillaries. Again vision is not affected unless the macula is involved [3].

1.2 Pre-proliferative retinopathy
Retina swells and leaks blood reading small print may become particularly difficult. In this condition the retina has been damaged by the higher than normal sugar levels over several years. The condition is called 'pre-proliferative' as it usually progresses to develop proliferative retinopathy, when 'new vessels' develop. It is now generally termed 'non-proliferative'. In severe forms of pre-proliferative retinopathy there are lots of hemorrhages, as the retina is very ischemic. This needs laser treatment to prevent new vessel growth. Proliferative retinopathy in one eye is especially likely if the other eye has already developed new vessels.

1.3 Proliferative retinopathy
It is third stage of retinopathy usually causing a sudden loss of vision. In this condition very small blood vessels grow from the surface of the retina. The retina is the film at the back of your eye, and the tiny blood vessels are capillaries. Diabetic Retinopathy is a major disease which may occur to a patient who having diabetic mellitus [4].

DR is shown in Figure 1 and in Figure 2.

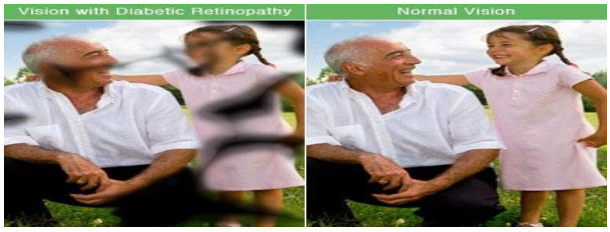


Figure 1: Infected Vision **Figure 2: Normal Vision**

Diabetes may occur when the body does not have enough "insulin" [2]. This is mainly to regulate the body based on the food that had been taken.

2. PROPOSED SYSYTEM
We have proposed an automated system for classifying the type of retinal diseases by using K-means cluster technique. The main goal of the proposed system is to automatically classify the retinal images as normal or abnormal. The input retinal images are taken from MESSIDOR database which is given as input to the pre-processing. After pre-processing, the features are extracted. K-means cluster is used to classify the retinal images are normal or abnormal. SOM (Self-organizing map) is also used in this proposed work as a neural network. Abnormal images are identified through the extracted features such as the images contain microaneurysms, hemorrhages or exudates problem. Block diagram of the proposed system is shown in Figure 3. The proposed system consists of three

main parts: Preprocessing, Feature Extraction and Classification.

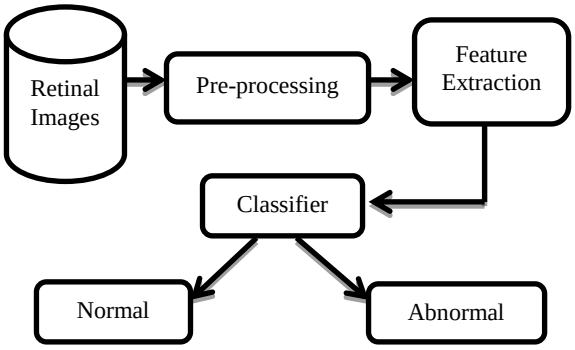


Figure 3: Block Diagram of the Proposed System

3. METHODOLOGY

3.1 Pre-processing:

The input of the automated system is color fundus retinal images which is taken from MESSIDOR database. This stage corrects the problem of illumination variation during the pictures are taken [6] [7]. The following pre-processing steps in my automated system consist of are:

3.1.1 Color to gray scale conversion

To convert RGB colour fundus images into gray conversion.

Grayscale color = (red + green + blue) / 03 …… (1)

3.1.2 Median Filter

The median filter is a nonlinear filter, which can reduce impulsive distortions in an image and without too much distortion to the edges of such an image. It is an effective method that of suppressing isolated noise without blurring sharp edges. Median filtering operation replaces a pixel by the median of all pixels in the neighborhood of small sliding window. The advantage of a median filter is that it is very robust and has the capability to filter only outliers. Noisy pixels are appeared with the background information. Hence we need to remove noisy pixels before contrast enhancement by using a median filter.

3.1.3 Adaptive histogram technique

After gray-level conversion, we applied adaptive histogram to enhance the "contrast" and to improve the quality of retinal image. Some areas of the fundus images are appear as brighter than the other. At the centre of the image are always well illuminated. Hence, it appears very bright while they far away from the poorly illuminated region and also appear as very dark. If the illumination decreases then the distance from the centre of the images are also increases. Many methods were tried to resolving this problem of un-even illumination, among which is the use of Adaptive Histogram Equalization Method (AHEM). AHEM gives better performance, higher processing speed and work well for all images are of different sizes, hence the reason for it being used as method of correcting un-even illumination. A variant of adaptive histogram equalization called Contrast Limited Adaptive Histogram Equalization (CLAHE). Images processed with CLAHE are of more natural appearance and facilitate the comparison of different areas of an image to enhance the contrast of the grey scale images by transforming the values using contrast-limited adaptive histogram equalization (CLAHE). The main objective of this method is to define a point transformation within a local fairly large window. By assuming the assumption of intensity value within it is a stoical representation of local distribution of intensity value of the whole image. The local window is assumed to be unaffected by the gradual variation of intensity between the image centers and edges.

3.2 Feature Extraction

In feature extraction, Texture analysis used to extract feature values from the input images. These features are used to attempts quantify intuitive qualities that are described in terms of rough, smooth and silky as a function of spatial variation are shown in pixel intensities [8]. Texture analysis can be helpful when objects in an image are more characterized by texture than by intensity. It consists of entropy, entropy filter, gray level co-occurrence matrix, range filter and standard deviation filter. The sample features values are shown in table 1.

3.2.1 Entropy

Entropy is a statistical one which measures the randomness. It is used to characterize the texture of the input image. Syntax and formula for the entropy is shown below, the entropy formula is shown in equation 2.

$$H=\sum_{k=0}^{M-1} P_k \log_2(P_k) \quad \ldots (2)$$

Where M is the number of grey levels and pk is the probability associated with grey level k.

3.2.2 Entropy Filter

Entropy filter specifies the local entropy of the gray scale images. It performs entropy filtering function for all the input images. This filter is used to create a texture for an image. The entropy filter returns an array where each output pixel contains the entropy value of the 9-by-9 neighborhood around the corresponding pixel in the input image.

3.2.3 Range Filter

Range Filter is found out the local range of the gray scale images. Mat lab function of range filter is used to generate ranges for the input images. It returns each output pixel that contains the range value which is greater value – smaller value find for every 3-by-3 neighborhood around the corresponding pixel in the input image.

3.2.4 Standard Deviation Filter

Standard Deviation Filter calculates the local standard deviation for the input images. Standard Deviation Filter function is used from mat lab which returns each output pixel contains the standard deviation of the 3-by-3 neighborhood around the corresponding pixel in the input image.

$$stddev = \sqrt{\frac{\sum(x_i - \bar{x})^2}{r * c - 1}} \quad .. (3)$$

Table: 1 Feature Extracted

Sr. No.	Entropy	Entropy Filter	Range Filter	Standard Deviation Filter
1	4.7803	2.0627	6.0217	2.2692
2	4.5246	1.8953	4.8537	1.8695
3	4.6939	1.9294	5.1087	1.9575
4	4.7575	2.0811	6.7432	2.5713
5	4.6096	1.8844	5.3823	2.0611

3.3 Classification

3.3.1 K-Means Cluster:

K-means clustering is a partitioning method. The function k-means partitions data into k mutually exclusive clusters, and returns the index of the cluster to which it has assigned each observation. Unlike hierarchical clustering, k-means clustering operates on actual observations, and creates a single level of clusters. The distinctions mean that k-means clustering is often more suitable than hierarchical clustering for large amounts of data. Clustering problems arise in various areas like pattern recognition and pattern classification, image processing, bioinformatics etc. It is considered that the k-means algorithm is the best-known squared error based clustering algorithm. It is very simple and can be easily implemented in solving many practical problems [9].

Clustering is used to classify items into identical groups in the process of data mining. It also exploits segmentation which is used for quick bird view for any kind of problem. K-Means is a well-known partitioning method. Objects are classified as belonging to one of k group.

In this work after applying k-means Cluster algorithm on the extracted texture features data, we got the result as shown in the figure 4. The blue colour dots are used to show the abnormal images and red dots are used to show the normal images from the Messidor database.

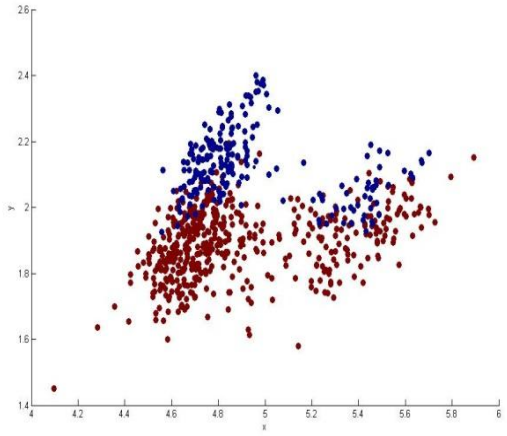


Figure 4: K-means cluster

3.3.2 SOM Neural Network (Self Organizing map)

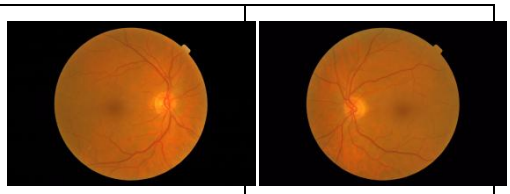
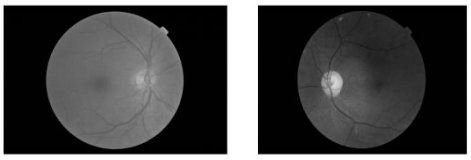
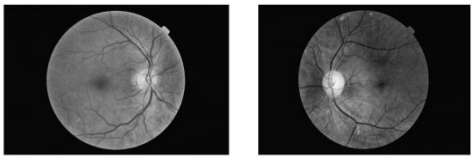
After K-means cluster, we applied SOM (Self-organizing map) as neural network part on the features extracted data form Messidor database (900 retinal images). The Self-Organizing Maps method is a special type of neural network used in clustering, visualization and abstraction [8]. Self-organizing maps learn to cluster data based on similarity, topology, with a preference (but no guarantee) of assigning the same number of instances to each class.

The self-organizing map (SOM) is an excellent tool in exploratory phase of data mining. It projects input space on prototypes of a low-dimensional regular grid that can be effectively utilized to visualize and explore properties of the data. When the number of SOM units is large, to facilitate quantitative analysis of the map and the data, similar units need to be grouped, i.e., clustered [10]. We got the resultant neural network like as shown in the figure 5.

4. RESULT AND ANALYSIS

The grey colour fundus images were used in this experiment to detect the retinal images having Diabetic Retinopathy problem or not. We have taken 900 retinal images from MESSIDOR database for evaluating the proposed approach. We have trained K-means cluster classifier to classify the images as normal or abnormal. We also have the SOM Neural Network to do the proposed work more effectively. The sample experimental result of preprocessing is shown in Table 2.

Table: 2 preprocessing output

Original Image	
Gray Scale Image	
Median Filter	
Adaptive Histogram Technique	

4.1 Specificity

Specificity measures the proportion of negatives which are correctly identified as such the percentage of normal healthy people who are correctly identified as not having the condition, sometimes called the true negative rate. Specificity formula is shown in given equation 4.

Formula: Specificity = TN/ (TN+FP) …… (4)

TN – True negative and

FP – False Positive

4.2 Sensitivity

Sensitivity also called the true positive rate or the recall rate in some fields. It measures the proportion of actual positives which are correctly identified as such the percentage of DR people who are correctly identified as having the condition. Sensitivity is shown in the given equation 5.

Formula:Sensitivity = TP/ (TP+FN) …… (5)

TP – True Positive and

FN –False Negative

5. CONCLUSION

We have proposed an automated system to identify patients having diabetic retinopathy using fundus images from MESSIDOR database. After pre-processing we have extracted texture features and used K-means cluster to classify normal and abnormal fundus images. Then we used SOM neural network and detect diabetic retinopathy diseases such as hemorrhages (red patches) or exudates (yellowish dots) which falls between Back ground Diabetic Retinopathy (BDR) and Proliferative Diabetic Retinopathy (PDR) stages of the disease. In performance comparison, we have achieved specificity as 91%, sensitivity as 55%.

6. REFERENCES

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