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Analyzing and Feature Extraction of Diabetic Retinopathy in Retinal Images

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***Abstract*-- Retina is a thin layer of tissue that lines the back of the eye on the inside and located near the optic nerve. The purpose of the retina is to receive light that the lens has focused, convert the light into neural signals, and send these signals to the brain for visual recognition. Retinopathy causes vision impairment due to the damage to the retina of the eyes. Retinopathy is an Ocular manifestation of systemic disease in diabetes or hypertension. In this paper, an innovative method is to detect blood vessels in the fundus retinal images. The given retinal image is preprocessed to enhance the region of interest to extract the feature with the help of filters. The process is repeated several times in order to have the mean values of the region of interest. This average value is compared with the specified algorithm and analyzed with the help of publicly available database of the retinal images.**

Keywords--Retinopathy, diabetes, retinal images, visual recognition, peak signal to noise ratio

I. INTRODUCTION

When the pancreas does not secrete enough insulin or the body is unable to process it properly resulting in Diabetes. As diabetes progresses, the disease slowly affects the circulatory system including the retina and damage the blood vessels. Retinopathy affects all diabetics and increases the risk of blindness, if it is left untreated. The risk factors of diabetic retinopathy are blood sugar level and blood pressure level. The morphology of the retinal blood vessel and the optic disk is an important structural indicator for assessing the presence and severity of retinal diseases such as diabetic retinopathy, hypertension, glaucoma, hemorrhages, vein occlusion, and neovascularization [1]. Diabetic Retinopathy, vision loss, double vision is the most common cause of diabetes, which is found in working age population of developed countries [9].

Non-proliferative diabetic retinopathy (NPDR) is the early stage of the disease in which symptoms will be mild or non-existent. The blood vessels in the retina are weakened in non-proliferative diabetic retinopathy. Tiny bulges in the blood vessels, called micro-aneurysms, may leak fluid into the retina and leads to swelling of the macula.

The advanced form of the disease is Proliferative diabetic retinopathy (PDR). At this stage, the oxygen to the retina is reduced which causes circulation problems. Due to this, the fragile blood vessels begin to grow in the retina and into the vitreous, the gel-like fluid that fills the back of the eye. As a result of this, clouding vision occurs and the blood may leak from the vessels.

Other complications are the detachment of the retina due to scar tissue formation and the development of glaucoma. The eye disease called glaucoma damages the optic nerve and raises the blood pressure. If left untreated, PDR cause severe vision loss and even blindness. Diabetic retinopathy is diagnosed through a comprehensive eye examination. Visual acuity measurements are taken to determine how much central vision has been affected.

II. PROPOSED METHODOLOGY

The existing method of automatic detection of diabetic retinopathy in the retinal images does not give precise values to distinguish the retinal images as normal or abnormal image. The proposed paper focuses on the detection of retinal images acquired from the databases – STARE, CHASE, DRIVE and indicates the severity condition of the retinal images by using various parameters such as mean, standard deviation, variance, mean squared error (MSE) and peak signal to noise ratio (PSNR) which gives precise value for classification.

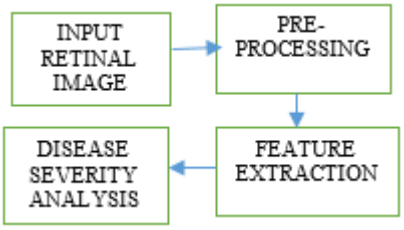

Fig 1.Flow diagram of proposed methodology

A.Input Retinal images

DRIVE (Digital Retinal Images for Vessel Extraction) database consists of 40 color images, 33 do not show any sign of diabetic retinopathy and signs of mild early diabetic retinopathy are seen in 7 images. STARE database (Structured Analysis of the Retina) database consists of 81 fundus images, 31 images of healthy retinas and 50 images of retinas with disease. In CHASE database, there exist 28 colour images of retinal fundus. The STARE database is used to analyze the performance of the retinal blood vessel segmentation with respect to ground truth images.

B.Pre-processing

The lowest level of abstraction of features from the raw image is obtained with the help of preprocessing. The aim of the preprocessing is an improvement of the

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image data that suppresses unwanted distortions or enhances some image features important for further processing.

Pre-processing methods use the considerable redundancy in images. The neighboring pixels corresponding to one object in real images have essentially the same or similar brightness value. Thus, distorted pixel is restored as an average value of neighboring pixels. In this paper, the green channel of the RGB model exhibits the best contrast between the vessels and background while the red and blue ones tend to be noisier. The grey image from the green channel is processed and the retinal blood vessels appear darker in the grey image and then invert it to appear brighter than non-vessel background. Salt and pepper noise is added in order to represent the presence of noise.

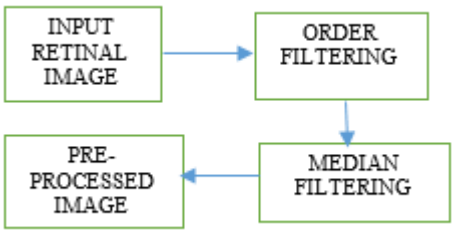

Fig 2.Flow of Pre-Processing

In order to remove the salt and pepper noise, order and median filters are used. The output of the order filter gives better contrast between the vessels and the background, thereby removing the noise more accurately than the other filters. So, order filter is used along with median filter. Median filter is used in order to reduce the noise which were leftover by the order filter.

C. *Feature Extraction*

Feature selection is a process where the features are automatically selected from the data that contribute most to the prediction variable or output of interested. MATLAB is used to extract the features like Mean, Standard Deviation, Variance, Entropy, Peak Signal to Noise Ratio and Mean Squared Error.

III RESULTS AND DISCUSSIONS

The input retinal images are obtained from CHASE database for the preprocessing technique. In this technique, the RGB image is converted into grayscale image by using green channel, because it exhibits better contrast between vessels and background.

Fig 3(a) Input Image

Fig 3(b) Gray scale image

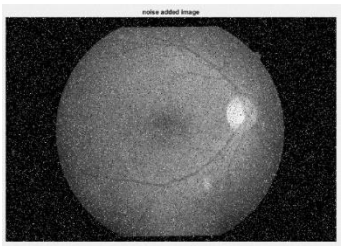

Fig 4 Salt and pepper noise image

The Salt and pepper noise is added to the grayscale image and various filters such as order filter, range filter, wiener filter, standard deviation filter and entropy filter are used and its performance were compared.

Order filter gives the better contrast between vessels and background thereby removing the noise more accurately than the other filters. The Median filter is used along with the Order filter in order to remove the noise which was left over by the Order filter.

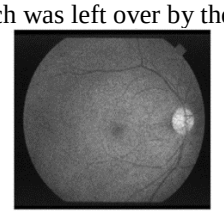

Fig 5(a)Order filter image

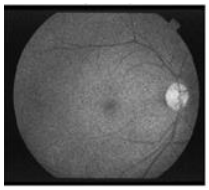

Fig 5(b) Range filter image

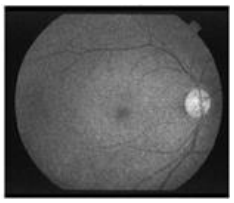

Fig 6(a) Wiener filter image

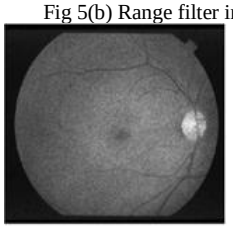

Fig 6(b) Standard deviation filter image

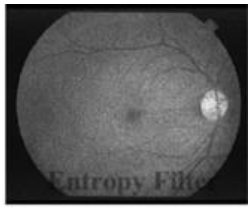

Fig 7 Entropy filter image

The feature extraction parameters such as mean, variance, standard deviation, PSNR, MSE and entropy are calculated for both normal and abnormal retinal images and compared.

Table 1 Feature extraction of normal images

Variance	Standard deviation	PSNR	MSE	Mean	Entropy
101.2459	10.0621	47.39	0.82	56.9908	4.9750
99.3169	9.9658	48.77	0.84	59.5578	4.9798
99.4194	9.9709	48.81	0.86	49.3167	5.1458
95.7568	9.7855	48.91	0.87	46.3762	5.1682
92.6496	9.6255	49.00	1.20	49.8563	5.2224

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Table 2 Feature extraction of abnormal images

Variance	Standard deviation	PSNR	MSE	Mean	Entropy
87.6723	9.3633	48.54	0.77	55.3788	4.5487
86.6777	9.3101	48.86	0.85	50.4193	4.9308
85.8169	9.2637	49.05	0.89	45.2092	5.0180
78.9530	8.8855	49.37	0.90	56.6087	5.1169
78.9155	8.8834	49.55	0.92	44.0252	5.3899

With reference to the above calculated values, the range for determining the status of a retinal image is tabulated.

Table 3 Consolidated feature extraction values

Image type	Variance	Standard deviation	PSNR	MSE	Mean	Entropy
Normal image	92-105	9.5-10.5	46-50	0.8-1.2	45-60	4.9-5.3
Abnormal image	70-88	8-9.3	48-50	0.75-0.95	40-60	4.5-5.4

Depending on the values of variance and standard deviation, the retinal images are classified into normal and abnormal images and PSNR and MSE are calculated.

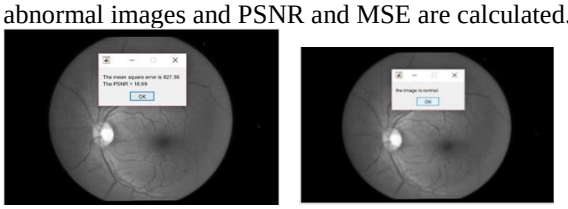

Fig 8 Output image based on PSNR and MSE

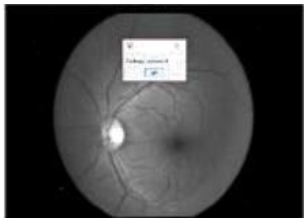

Fig 9 Abnormal Retinal Image

IV CONCLUSION

In this paper, pre-processing and feature extraction of the diabetic retinal fundus image is done for the detection of diabetic retinopathy. The extracted features are used for identifying a normal and a diabetic fundus images. By using the feature parameters such as variance and standard deviation, the normal and abnormal images are well classified. The work can be extended by extracting parameters like accuracy, sensitivity, and precision and by classifying the severity of the disease like early, mild, severe.

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