Comparison of different image preprocessing methods used for retinal fundus images

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COMPARISON OF DIFFERENT IMAGE PREPROCESSING METHODS USED FOR RETINAL FUNDUS IMAGES

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***Abstract*— Retinal fundus image morphology indicates diseases like diabetic retinopathy and glaucoma like diseases. Blood vessel features of the retinal image allow ophthalmologist to perform retinal disease evaluation. Presence of lesions in the fundus image is initial sign of diabetic retinopathy. Preprocessing technique is mainly used to remove unwanted noises and it enhances some image features. Different types of pre-processing techniques are used for image processing. This paper represents the comparison of different methods used for pre-processing in retinal fundus image.**

Keywords*— *Adaptive histogram equailization; Gaussian filter;Median filter;Weiner filter;Adaptive median filter.

I INTRODUCTION

Fundus image consist of retina, optic disc, macula, fovea and it is opposite to lens. For fundus photography a microscope attached flashed camera is used. The morphology of the retinal fundus image is an important indicator of disease like diabetic retinopathy, hypertension, glaucoma, haemorrhages, vein occlusion [6].When sugar level in blood increases, then it increases the reactive oxygen species in blood . It damages the retinal vascular tree and leads to the formation of lesion in retina. Presence of lesions in retina is the initial sign of diabetic retinopathy. The basic block diagram for image processing is shown in fig.1

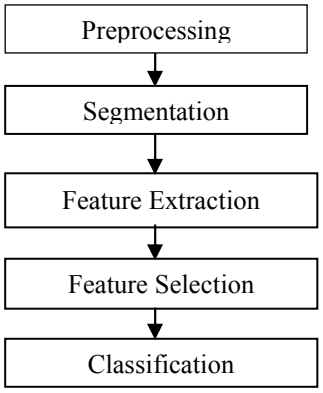

Fig.1Basic block diagram for image processing

Fig 2 Shows retinal main regions .The most common signs of Diabetic retinopathy are red lesions and bright lesions. Micro aneurysms and exudates are red lesion, and cotton wool spots are bright lesions in retina. The presence of red lesion is the early sign of DR. Micro aneurysms appear as red dots in retinal fundus images. Bright lesions occur as the results from the breakdown of blood from the retinal barrier [10].

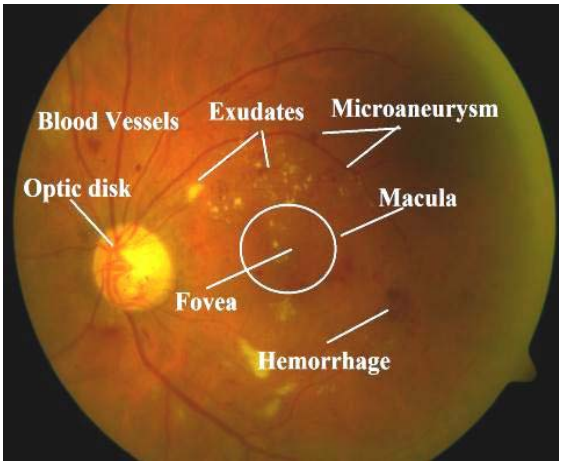

Fig 2 Retinal main regions

Diabetic Retinopathy is a disease which causes loss to the eyesight. The detection of the early stage of diabetic retinopathy can aid the people from complete vision loss. Blood vessels in the retina supply blood and oxygen to the retina. If the oxygen supplies in retina are not smooth, then this will create health problems like hypertension, cardiovascular problems. [8]

Retinal hemorrhages are a type of retinal injury, it observed as dark color patch in retina. On a retinal image, hemorrhages appear as dark or reddish color of different sizes. Hemorrhages can be classified into dot hemorrhages and blot hemorrhages . Dot hemorrhages are small isolated red spots

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and blot hemorrhages are irregular. Hemorrhages are fan-shaped lesions occur in the optic nerve head.[4]

The early stage of DR classified as NPDR (Non-Proliferative diabetic retinopathy) and proliferative diabetic retinopathy. In NPDR, main signs are micro aneurysms and exudates. Microaneurysms are small, round and dark and occur red dots with sharp margins to macula[5]. Morphological changes like diameter, branching angle, length occur in retinal blood vessels. Variation of this features changes in retinal vessels is the main symptom of the diabetic retinopathy. In the case of proliferative DR It is Advanced stage compare to NPDR where growth of new abnormal blood vessels occur in retina. These blood vessels can grow along the retina and may cause the complete vision loss.[9]
True vessels in the retinal image can be find out using vessel tracking method. [3]

The pre-processing step is the important step in medical image processing. Pre-processing remove Noises presented in the acquired image and enhance some image features. Salt and pepper noise, Gaussian noise and flicker noises are the main noise effects in image processing .Impulse noise contain random white pixels .In salt and pepper noise random occurrence of black and white pixel and in gaussion noise variation of intensity value with the gaussion normal distribution occur.

II.PREPROCESSING

Image preprocessing improve the image features and also remove unwanted noises from the fundus image.Pre-processing can enhance some image features. Its depends on computational cost, computational time, noise removal and also quality of the denoised image .Image pre-processing can be use linear method and nonlinear method. In linear method algorithm can apply linear to all pixels without defining the image corrupted or uncorrupted. In nonlinear method algorithm can only apply pixels by defining which pixel is corrupted or uncorrupted. Then corrupted image filtered by specific algorithm and uncorrupted retained. Nonlinear filter produce better result compared to linear filter

A. Adaptive histogram equalization

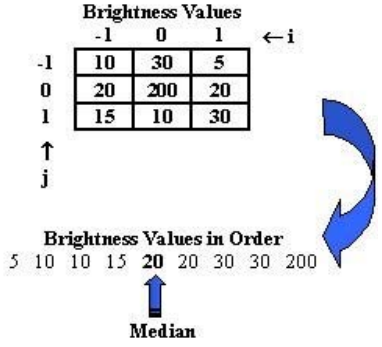
Adaptive histogram equalization is used to make better contrast of retinal images .In this method adaptive method computes number of histograms and each corresponding to a particular part of the image and also redistribute the lightness values of the image. It is mainly suitable for enhancing the definitions of edges in each region of an image. Contrast between the back ground pixels and the information lead to enhancement of the noisy pixels in adaptive histogram equalization. The noisy pixels appear as the background information. This operation improves the accuracy of the adaptive histogram equalization and this method help uniform illumination. [5][6]. using contrast limited adaptive histogram equalization (CLAHE) algorithm the contrast of the image can be enhanced .It is applied to increase the contrast of the blood vessels[11][5] .The grey levels can normalized by stretching of the image brightness using CLAHE pixels in dynamic range, its eliminates the surrounding dark border pixels and image labels.[14] CLAHE limits amplifying of noises present in the low contrast area of the image [10]. Adaptive Histogram equalization is used for constant enhancement of images. This method is mainly used for increase the contrast between the exudates and the image background

B. Weiner filter

The inverse filtering is a type of restoration technic. If the image is blurred by using a specific filter it can recover the original image using Inverse filtering . It is sensitive to noise. This method reducing degradation of image and allows the development of restoration algorithm for each type of degradation method . The Wiener filtering is a trade-off between inverse filtering and noise smoothing method. It removes the noise and blurring effects in the fundus image. When a color image is passed as an input to the wiener filter. The channel having maximum trade off taken as an input image. For the color channel selection contrast of the each channel was calculated .R, G, B channels can be measured by wiener filter using low pass filter. It can measure the contrast between the original image and low pass filter image [1].

C. Median filter

A median filter is a type of nonlinear filter. It is mainly used to removing salt and pepper noise. It is better than mean filter, median is the middle value of the neighborhood pixel. Median filter keep the sharpness of image edges while removing noise. Median filter is useful in non-linear smoothing. In image processing initially necessary to perform noise removal in an image before further processing steps, . The median filter is a type of non-linear filtering method. Disadvantages of the median filtering is its remove both noises and details. Median filter can't understand exact details from noises.[3]



D Adaptive median filters

It is a linear filter, optimization algorithm is used for adjusting the changing parameter of the image .It is advanced method compared to standard median filter and Its perform spatial processing.In the case of adaptive median filtering classify the pixel in the image by its surrounding neighbor pixel, size of the neighbor is adjustable. Main purpose of the filters is removing impulse noises and smoothing other noises.it reduce distortions and excessive thinning and thickening of boundaries. During operation adaptive median filter change the size of neighborhood. Its main advantages are impulse response is greater than .2 and preserve the details[3].

E. *Gaussian filter*

Fundus image contain three bands red, green, blue Exudates appear brighter in green layer compared with red and blue channel. Optic disc in fundus image is also brighter in green layer .The Gaussian Smoothing execute the average value of neighboring pixels based on the Gaussian function. This operator removes the effect of noise and other illuminations. Its act as Gaussian low pass filter [2]remove high frequency components in the image.

$$Is(x,y)=Ig(x,y)*g(x,y) \quad (1)$$

Where * denotes convolution and g(x,y) is a Gaussian function .Where $Ig(x,y)$ is green channel component and $Is(x,y)$ is gaussion noise.

III RESULT AND DISCUSSIONS

The fundus image contains three different bands, red, green and blue. It is observed that green bands have significant information for exudates and lesion detection

Different preprocessing method used for the retinal image denoising and enhancement. Fig 3-8 shows different filtered images. Table 1 shows the comparison of these methods. PSNR and MSE value used for measurement of the efficiency of various methods.

Fig 3. Original image

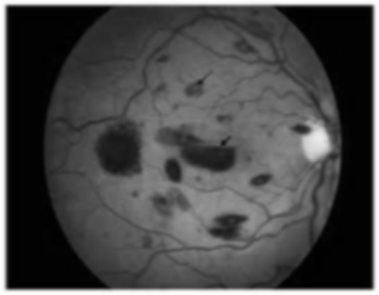


Fig 4 Gaussian filter

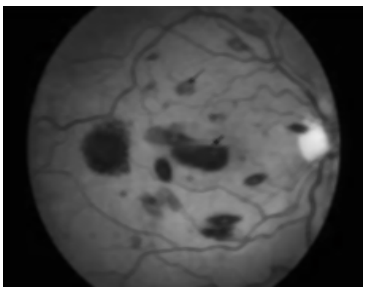


Fig 5 Median filter

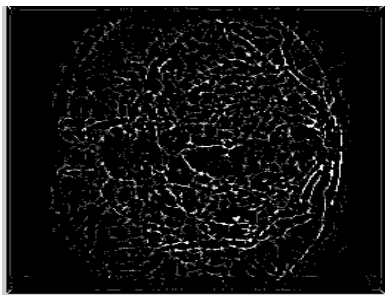


Fig 6 Adaptive histogram equalization

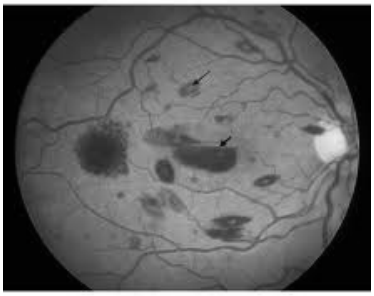


Fig 7 wiener filter

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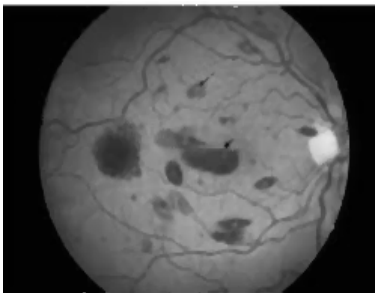

Fig 8 adaptive median filter

a) PSNR (Peak signal to noise ratio)

PSNR is a ratio between the maximum possible value and the value of the corrupting noise of an image which PSNR is uses to measure the quality of image. Here the value represents the power of image. It was usually expressed regarding logarithmic decibel scales, due to the wide dynamic range of many signals. It was proved that a filter having higher PSNR value is considered to be the best filter.

$$PSNR = \quad (2)$$

b) MSE (mean square error)

MSE of a filter is used to evaluate the difference between true value and the value implied by a filter.

$$MSE = \frac{1}{MXN}\sum_{i=1}^{n}\sum_{j=1}^{n}(\quad (3)$$

Image size given as input is in size M x N, where $m_{i,j}, m_{i,j}$ are the initial image and the reconstructed image respectively

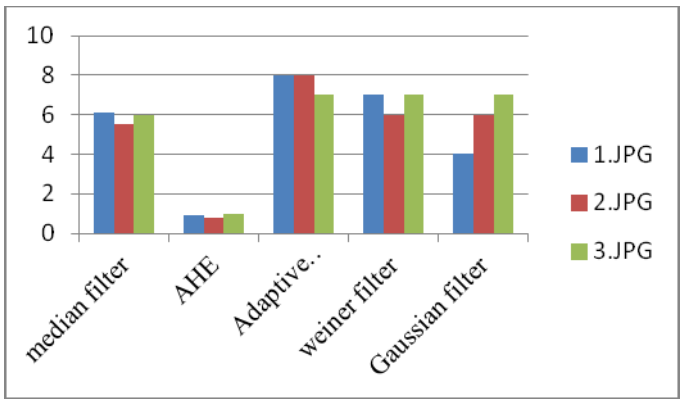

Fig 7.Comparison of different pre-processing algorithms by PSNR

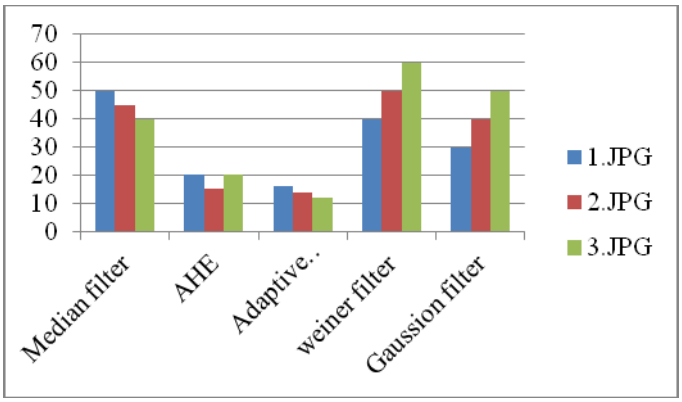

Fig 8 Comparison of different pre-processing algorithms by MSE

TABLE 1. PREPROCESSING METHODS COMPARISON

Filter	**Advantages**	**Disadvantages**
Median filter	Robust, Better preserving edges	Corrupted by gaussian noise
Adaptive median filter	1.Reduce impulse response and distortions 2.Smoothing of other noises	Less loss of data compared to median
Gaussian filter	Effective for removing Gaussian noise	Take time and reduce details
Weiner filter	Denoising better compared to median	Result is too blurred
Adaptive histogram equalization	Over amplifies the noise	Time consuming

IV. CONCLUSION

In this paper, we have considered techniques for pre-processing of retinal fundus images. Pre-processing stage enhance the data of retinal image based on removal of noises, like Gaussian and salt and paper noise. This paper makes a review on the five pre-processing methods, and discussed principles ,advantages and disadvantages, Here adaptive median filter is found to be better compared to other preprocessing methods ,because it have higher PSNR value and lower MSE value.

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