Preprocessing of Fundus Image using Enhanced Hybrid Median Filter (ENHYME)

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ABSTRACT

Detection of Optic disc (OD) in a fundus image is a foremost important step in the process of screening the diabetic retinopathy[1,2,3]. Hard Exudates detection algorithms usually find lot of false positives since the intensity and color distribution of OD will much resemble that of a Hard Exudates region[4,5]. So, most of the Exudates detection algorithms will miss classify the pixels at the OD region as Hard Exudates[6].

In our previous works, we used Genetic Algorithm(GA)[7,8] to find the OD location and size and reduced overall time, even doing the search on the entire problem space and also removed false hard exudates. In this work we are improving Hard Exudates detection accuracy using gradient index mapping technique applied on two similar planes of the RGB. An appropriate preprocessing will yield an accurate result in the furher research stage.The new preprocessing algorithm is termed as Enhanced Hybrid Median Filter shortly named as ENHYME. The database used for this preprocessing is DIARETDB1[9] for evaluation and comparision with the existing methods.

Index Terms- Diabetic Retinopathy, Hard Exudates , Optic Disc Detection.

1. INTRODUCTION

Detection of true hard exudates is a continuous challenging process[13] and hence there is research gap in fine tuning the process by introducing hybrid algorithms[2,3]. Finding the real exudates is a significant milestone to identify the diabetic retinopathy. The primary goal to achieve is a proper preprocessing and then detection of Optic Disc which got similar pixel intensity and gradient like hard exudates[12]. In the previous work based on the threshold value we have considered either the green plane or blue plane to detect the Optic Disc based on the color intensity[2.3]. In these work we are using a new preprocessing termed ENHANCED HYBRID MEDIAN FILTER (ENHYME) algorithm for denoising the image and to detect the OD and HE.

2. FUTURE METHOD

The proposed method consists of a strong preprocessed base work which uses more than one plane for feature analysis. Two similar planes of Red, Green or Blue fundus images are used for analysis. The fundus image is sliced into three planes Red, Green and Blue (RGB)[5]. The contrast of the Red, Green and blue is increased using histogram equalization. From these three separated images two similar planes are considered for the further process. Then gradient projection and windowing technique is applied to find the region of the optic disc and index mapping is used to detect the hard exudates. Boundary is analyzed using binaryzation and optic

disc masking is done to identify the hard exudates. The following is the algorithm of evaluation.

3. PROPOSED PREPROCESSING

Enhanced Hybrid median filter (ENHYME) is applied for the purpose of preprocessing. The image may contain noise while processing which has to be removed for getting desired output in the image. This filter gives the best result in the denoising method compared to other filter. It's also having high PSNR[6] value and quick processing time.

3.1 Enhanced Hybrid Median Filter (ENHYME)

The Enhanced Hybrid Median Filter (ENHYME) is the new proposed preprocessing algorithm used in this research. The ENHYME filter prepares the image to the optimal level for further stages of the research which by removing the not removed noises left by the existing filters. TheEnhanced Hybrid Median Filtering has been enhanced from the hybrid median filtering method[10,11].

In general, median filtering, the neighboring pixels are ranked according to brightness (intensity) and the median value becomes the new value for the central pixel. Median filters can do an excellent job of rejecting certain types of noise, in particular, "shot" or impulse noise in which some individual pixels have extreme values. In the median filtering operation, the pixel values in the neighbourhood window are ranked according to intensity, and the middle value (the median) becomes the output value for the pixel under evaluation.[10,11].

3.2 Hybrid Median Filter

Hybrid median filter derived from median filter which preserves edges better than a square kernel median filter because it is a three-step ranking operation: data from different spatial directions are ranked separately. Three median values are calculated: MR is the median of horizontal and vertical R pixels, and MD is the median of diagonal D Pixels. The filtered value is the median of the two median values and the central pixel C: median [MR, MD,C]. As an example, for n = 5:
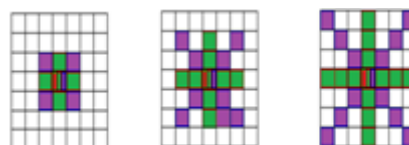

Figure.1 standard hybrid median filter

$$\begin{bmatrix} D & * & R & * & D \\ * & D & R & D & * \\ R & R & DCR & R & R \\ * & D & R & D & * \\ D & * & R & * & D \end{bmatrix}$$

B = hmf uses a 5 x 5 box (default value).

This plugin consists of 3 versions of the standard hybrid median filter: a 3x3, 5x5, and 7x7 kernel fig .1. In these implementations, the median of 1) the median of the

NxN PLUS kernel, 2) the median of the NxN X kernel, and 3) the pixel in question replaces the original pixel value. Multiple repetitions can automatically be run by specifying a repeat value greater than 1. The top and bottom edge pixels are reflected outward, and the side edge pixels are wrapped

around to complete the edge bound kernels[10].This plugins works both with the stacks an d individual slices.

The plug-in operates on a previously opened image or stack of images, and produces a new image or stack of filtered images. The output image or stack is generated upon completion of processing for all of the input data. Be sure to save the output if desired. The image which can be obtained from the hybrid median filter also be contains some amount of noise that has to be removed for further processing of the image. So that noise in the filtered image can be removed by enhancing the hybrid filter. The process is to be carried out with the help of hybrid median filter. Here the pixel value of filtered image to be inspected and noisy pixel are to be analysed for remove the noise which can be done by analyse pixel value in that image[10,11]. For example, Consider the 3x3 matrix from the image for identify the noisy pixel present in the image fig .2.
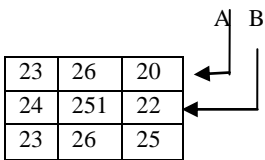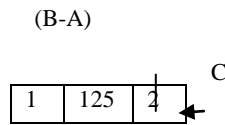

Figure.2

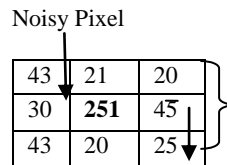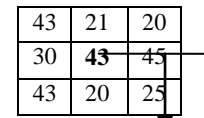**Figure.3**

Figure.4 Median value

Figure 5 Noisy pixel replaced by Median value

In this we take difference between row A and row B which will give C for to get denoised image fig.3.The same process to be carried out for each and every row vector of matrix that to be assigned to same variable C which form the one matrix. From the matrix C we have to inspect the pixel value for getting the noise level present in the image. If there is any presence of noise means pixel value is greater in the matrix C.

From the analization of pixel value, we have to fix the threshold value for the image of matrix C for the reduction of noise. If value of pixel exceeds the threshold value, there is need to calculate the median for the corresponding 3x3 window in the image that are to be done for the noise reduction which should be assigned to another variable D.

Consider the 3x3 window in the C matrix, if pixel value of C matrix > threshold value Median for C(3x3)For this matrix, median is to be calculated by arranging the matrix as vector in ascending order fig .4. The obtained median is replaced with noisy pixel. Suppose 251 is the noisy pixel then it will be replaced by median of the matrix 43 that can be done for all 3x3 matrixes in the image. The above process also be done in vertical direction (i.e.) column vector

From the above process the noisy pixel present in the image are removed well compared to hybrid median filtering and all other filtering fig.5.

While doing this it will remove the noise better than the hybrid median filter with high PSNR value. This can be done by neighborhood pixel value of reference pixel.

3.3 Enhanced Hybrid Median Filter (ENHYME)

The Enhanced Hybrid Median Filter calculates the difference of reference and its neighborhood pixel value in both horizontal and vertical direction. This is done to find out the noisy pixel present in that image. The exceeded value was noted as noisy pixel, and reduced in both horizontal and vertical direction of image[11].

To remove such type of noisy pixel, there is necessity to fix the threshold value. If value of pixel in that image greater than threshold level we have to take the median for the corresponding 3X3 window in that image from which noise level is to be reduced. The efficiency can be proved by taking Peak Signal to Noise Ratio (PSNR) for denoised image and the original image that gives high performance.

The enhanced hybrid median filter is derived from the hybrid median filter. Pixel value is inspected and noisy pixel is identified in the hybrid median filter and that noisy pixel is averaged with the existing pixel value.

The algorithm used for the proposed denoising method termed Enhanced Hybrid Median Filter (ENHYME) is illustrated below:

Step1:Generate a rank using the spatial value

Step2: Calculate three median values for the image

Step3: Let MR be the Median value for the horizontal and vertical.

Step4: Let MD be the Median value for the diagonal pixel.

Step5: Calculate the filter value using the mean of the MR and MD and find central pixel value c

Step6: Derive the filter value by calculating the median of MR, MD, C that is Median (Median of Horizontal, Median of vertical, central value)

Filter value = Median (MR, MD, C)

Step7: Take one reference pixel and its neighborhood pixel in horizontal direction of the image.

Step8: Determine the difference of those pixel to get noisy pixel value

Step9: Repeat the same process for the vertical direction

Step10: Identify the noisy pixel

Step11:Fix the threshold value and find the median value for the pixel exceeds the threshold value.

Step12: Replace those threshold value exceeding noisy pixel with the median value

3.4 Screen Shorts

Noisy Image

Figure .6 Noisy Image
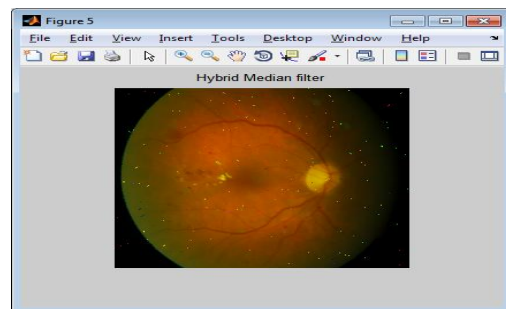
Hybrid Median Filter With Noise

Figure .7 output using hybrid median filter

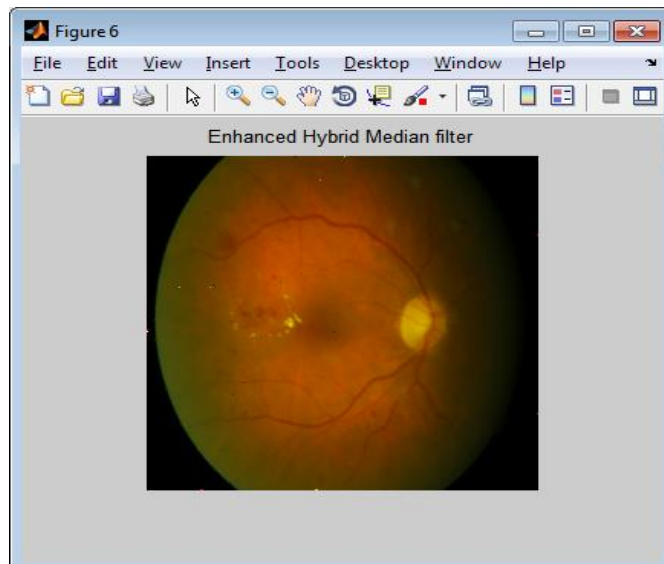**New Proposed Enhyme Filterenhyme) Without Noise**

Figure .8 output of the fundus image using ENHYME Filter

4. RESULTS

The proposed method is compared with the existing techniques and the performance is measured in terms of Peak Signal Noise Ratio.(PSNR). The below mentioned table.1 and graph.1 gives the comparitive study of the differnt filters with the proposed ENHYME filter.

Table 1   PSNR Comparision of existing filter technique with proposed filter

IMAGE	HMF	PSMF	ENHYME(PROPOSED)	MDBUTMF
image003	35.47	15.47	**42.46**	33.63
image007	33.15	11.55	**38.24**	35.51
image009	35.34	13.28	**40.06**	32.8
image010	35.3	12.73	**38.59**	36.82
image012	34.88	14.98	**39.66**	32.74
image013	35.42	11.67	**40.02**	31.19
image015	34.27	13.21	**38.32**	33.21
image016	35.59	13.71	**40.76**	31.66
image017	35.27	13.75	**40.27**	31.94
image021	33.9	12.48	**38.88**	32.8

HMF   – Hybrid Median Filter
PSMF–ProgressiveSwitching
Median Filter
ENHYME – Enhanced Hybrid Median
Filter (Proposed Method)
MDBUTMF–Unsymmetrical Trimmed
Median Filter

Graph 1. Analysis Graph

COMPARISON OF VARIOUS DENOISING METHOD(PSNR)
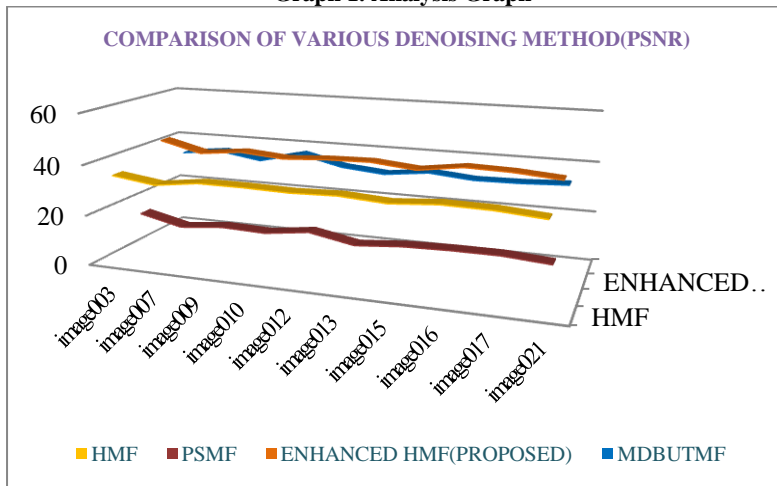
5. CONCLUSION

The enhanced hybrid median filter is simple and efficient method to denoise the fundus image. A proper denoising is a good base work for the further research. This ENHYME preserves the pathological symptoms and at the same time remove the unwanted noises in the image. This has got the high PSNR value when compare with the other existing filters. Feature denoised medthods may be developed to improve the quality of the different medical images based on the nature of the diagnosis.

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