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Identification of Hidden Abnormalities in Retinal Fundus for Diabetic Retinopathy

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Abstract – *Nowadays diabetes became a common disease in world. Almost 70% of people are suffering from diabetes. Sometimes it may cause damage to retina. Early detection may prevent from complete blindness or vision loss.*

This paper mainly focuses on automatic detection of diabetic retinopathy abnormality such as hard exudates using image processing techniques. Retinal fundus disease detection in an early stage helps the ophthalmologists to provide proper treatments that might reduce the severity of it. Matlab software platform is utilized for implementing the algorithm. Low execution time is the main advantage as compared to other approaches and also it provides accurate results.

1. INTRODUCTION

Image processing has already become an important part of clinical routine. Diabetic Retinopathy (DR) occurs due to high glucose levels in body and this leads to damage of retina. It affects most of the patients who have had diabetes for 10 years or more, leads to complete damage of retina. Detection of diabetic retinopathy in advance, protects patients from vision loss. The major symptoms of diabetic retinopathy are hard exudates. Hard exudates are the lipid break down products leakage from capillaries that are seen in retina.

In this algorithm comprised of Gabor filter with local entropy thresholding for hard exudates detection under various normal or abnormal conditions. The frequency and orientation of Gabor filter are altered to match that of a part of blood vessels which is to be enhanced in a green channel image. In this method local entropy thresholding technique is used to enhance the blood vessel pixels. The performance of the proposed algorithm is analyzed by MATLAB software with DRIVE database. Proposed method for hard exudates detection

The proposed method uses following stages shown in fig1:

(1) Preprocessing (2) feature extraction (3) removal of optic disc (4) elimination of blood vessels (5) highlighting the hard exudates

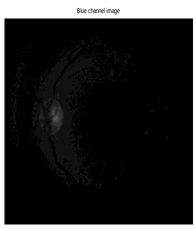
1. Preprocessing

In this paper preprocessing includes channel extraction and adaptive histogram equalization.

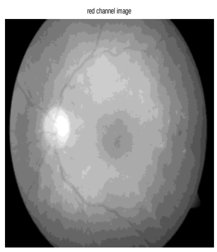
1.1Channel extraction

Any color image consists of primary colors such as red, green and blue. The grayscale image of the same size as a color image, derived from one of these primary colors. For instance, an image from a standard digital camera will have all these three channels. In this project green channel is extracted. In this paper green channel of image is preferred since it provides better results than remaining channels. The three different types of channels are shown below.

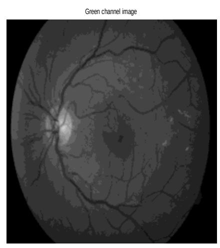
Color retinal image



blue channel



Red channel



green channel

Fig 1 different channels of the color image

1.2 Adaptive histogram equalization

In order to enhance the contrast of green channel image we prefer for adaptive histogram equalization. Adaptive histogram equalization can over amplify noise in homogeneous regions of an image. In addition to contrast limited adaptive histogram equalization prevents this by limiting the amplification.

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2. Feature extraction

In this work to extract the features we prefer for Gabor filter. Gabor filter is a linear filter and it is used for edge detection. Frequency and orientation representations of these filters are similar to those of the human visual system. These filters are appropriate for texture representation and discrimination in an image. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function that modulated by a sinusoidal plane wave The convolution of the Fourier transform of the harmonic function and the Gaussian function provides us the Fourier transform of Gabor filter's impulse response. Gabor filter has both real and an imaginary component which are representing orthogonal directions.

$$
\begin{aligned}
F(u_1,u_2) &= \exp\left(-\frac{(\hat{u_1}^2+\gamma^2\hat{u_2}^2)}{2\sigma^2}\right)\times\cos\left(\frac{2\pi}{\lambda}\hat{u_1}\right),\\
\hat{u_1} &= u_1\cos\theta+u_2\sin\theta \quad \text{and}\\
\hat{u_2} &= -u_1\sin\theta+u_2\cos\theta,
\end{aligned}
$$

Bandwidth of the Gabor filter σ =19

Wavelength of this filter λ =9

Spatial aspect ratio ϒ =6

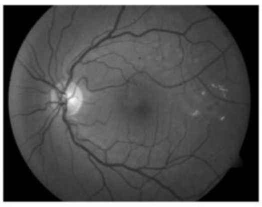

Fig 2.Gabor filtered image

3. Removal of optic disk

In order to visualize only hard exudates in retinal fundus it is necessary to remove the optic disk from the image. So mask is prepared based on region of interest.

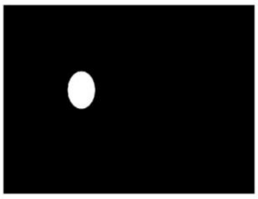

Fig 3. mask used for optic disc

4. Elimination of blood vessels

The grey-level co-occurrence matrix contains about the information of grey- level transitions in an image. A Gabor filter response image has a size of M * N with L grey levels that converted co-occurrence matrix of this image is an L * L square matrix, denoted by T =| tij $|_{L*L}$.

The probability of co-occurrence tij of gray levels i and j is normalizing the probability within individual quadrants. A, B, C and D are four quadrants of Co-occurrence matrix. Let t is a threshold value of this retinal image. Quadrants of A and C consist to local transitions within object and background. In some respects, B and D are joint quadrants which show transitions across boundaries between background and object. The sum of probabilities of each quadrant equals to one, get the cell probability.

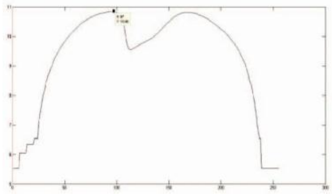

Fig 4.Entropy threshold curve

$$P_{ij} = \frac{t_{ij}}{\sum_i \sum_j t_{ij}}$$

Obviously $0 \le P_{ij} \le 1$

$$P^{(1)} = \frac{t_{ij}}{\sum_{i=0}^{s}\sum_{j=0}^{s} t_{ij}}$$

$$P^{(2)} = \frac{t_{ij}}{\sum_{i=s+1}^{L-1}\sum_{j=s+1}^{L-1} t_{ij}}$$

$$H^{(1)}(s) = 1/2 \sum_{i=0}^{s}\sum_{j=0}^{s} P_{ij}^{(1)} \log_2 P_{ij}^{(1)}$$

The local entropy of background

$$H^{(2)}(s) = -1/2 \sum_{i=s+1}^{L-1}\sum_{j=s+1}^{L-1} P_{ij}^{(2)} \log_2 P_{ij}^{(2)}$$

Total Entropy $H_T(s) = H^{(1)}(s) + H^{(2)}(s)$

Fig 5. After local entropy and thresholding

Experimental and simulation results

Matlab 2013 software platform is used for simulation. In this paper statistical result like area of hard exudates was found in terms of pixels. This will help ophthalmologist to know the severity of the disease. Since hard exudates are very small to locate it, so highlighting them by coloring provides us vivid visualization of hard exudates. The algorithm used in this paper is very simple and execution time is also very less as compared to other method.

Fig 6 color retinal image proposed result

Conclusion

This method is suitable as automatic tool for hard exudates detection. This paper first introduces Gabor filter and local entropy and thresholding for hard exudates detection automatically. And also it provides both statistical and visualized results of diabetic retinopathy. The area in terms of pixels helps to find the real hard exudates area. The proposed algorithm is highly promising for detection of hard exudates.

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