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AUTOMATIC DETECTION OF HEMORRHAGES USING IMAGE PROCESSING TECHNIQUE

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ABSTRACT

Diabetic Retinopathy is condition in which the eye retina gets damaged due to leakage of blood leakage from the vessels into retina. Effect of this may be the loss of vision. Hemorrhages detection in the retina is the first symptom of DR so earlier detection of hemorrhage can help to reduce the blindness. Our approach introduced new robust method for automatic detection of hemorrhage. This can be achieved by three steps, removing noise from fundus image, vessel removal, removing the fovea and detection by considering shape, area, aspect ratio, density and mean intensity. This approach strengthens the hemorrhage detection.

KEYWORDS: Diabetic Retinopathy (DR), FP reduction, hemorrhage detection, Mathematical Morphology, Microaneurysms.

INTRODUCTION

Nowadays, medical imaging is grooming field in case of image processing. It provides assistance in medical disease diagnosis. In propose approach automatic detection of hemorrhage is necessary because it is very important to detect hemorrhages at early stage. If it is not detected at early stages then it may causes the permanent loss of vision of a patient. Ophthalmologists assess retinal images for various types of lesions like hemorrhages, exudates.

Diabetic retinopathy is the second most cause of blindness among the blind peoples ad DR found mostly in case of diabetic patients in the working age of 30 to 60[1]. Lots of study is done on diabetic retinopathy, on the basis of this study several epidemiologist have provides the preventive measures to prevent patients from DR. Another is the Eye Disease Prevalence Research Group collects the eye diseases including DR. India has the largest number of diabetic patients in the world.

Periodic screening and early detection of DR helps to reducing the progression of this disease and prevent from the loss of vision. The fundus images are capture by two ways: fundus photography or fluorescein angiography. Fundus photography is technique for photographing the fundus eye. It is mostly used current method for hemorrhages detection. Second method is Fluorescein angiography, which is based on intravenous injection of a fluorescent substance, which produces enhanced contrast images. Bus this technique is not recommended for large scale screening. Also it has some side effect such as nausea and vomiting. To avoid such a side effect and provide better detection rate, we propose a robust hemorrhages detection system which provide high detection rate.

In most of the hemorrhage detection method, red lesion candidate extraction and classification is proposed. Preprocessing is the first step of image processing to reduce the noise and enhance the image. Vessel segmentation is the next step applied to extract blood vessels. And feature analysis and classification is the final step [2].

The paper is organized as follows. The study of previous method and techniques are explained in "literature survey" section. Proposed methodology and its detail implementation are present in section 3. Experimental results are presented based on qualitative and quantitative analysis bases in section 4. Finally propose system conclude in the "Conclusions" section.

LITERATURE SURVEY

Istvan Lazar et al [3] proposed a method to detect retinal Microaneurysm in digital fundus images. This approach does not need complicated preprocessing steps. It gives good results in images with varying contrast and shade. The algorithm is rapid, well parallelizable.

Neera et al. [4] proposed a method to detect a detect exudates, hemorrhages and microaneurysms. The proposed algorithm also counts size and location of hemorrhage so that disease can be diagnosis earlier and patient may take an advice from doctor.

Kose et al.[5] propose a method for separation of the healthy and unhealthy region by using inverse segmentation method. The textures of healthy and unhealthy region are different. After inverse segmentation the remaining part is the dark lesion which is also removing using the intensity value which is below the background intensity value.

Quellec et al [6] propose method for detection of hemorrhage using template matching where candidate were matched with a lesion template in sub-bands of wavelet transformed images.

Luca Giancardo et al [7] had shown Radon Cliff operator based detection of microaneurysms. Mizutani et al [8] proposed a method of double-ring filter.

Lay and Baudoin proposed morphological approach for the detection of microaneurysms Spencer et al. [9]. M. J. Cree et al. [10], T., and A. Frame et al. proposed a mathematic morphological segmentation in MA with different preprocessing techniques and classification them within fluorescein angiograms. Structuring elements is the main limitation in morphological approach [11]. Large structuring element results in the detection of vessel curvings as MA or Hemorrhage. Other side small linear structuring element would results in missing of true microaneurysms or hemorrhages.

Zhang [12] proposed a method which based on constructing correlation response image from input retinal images. Antal and A. Hajdu [13] proposed a robust technique that collecting several preprocessing steps and candidate extractors before moving to classification step. Lazar et al [14] proposed analysis of directional cross-section profiles for Microaneurysms detection. Those Robust MA or Hemorrhages detection from the background is necessary to diagnose the DR. Basic MA can be detected through following four stages: 1) Preprocessing 2) Candidate extraction 3) Feature extraction and 4) classification.

This paper mainly focuses on segmenting MA using pre-processing, mathematical morphology and filtering.

PROPOSED METHODOLOGY

To detect hemorrhages form fundus image, propose system implemented through preprocessing, Thresholding, Filtering and FP reduction. The block diagram for proposed system shown below-

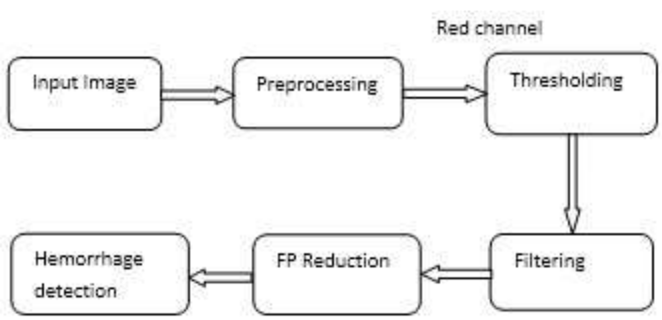
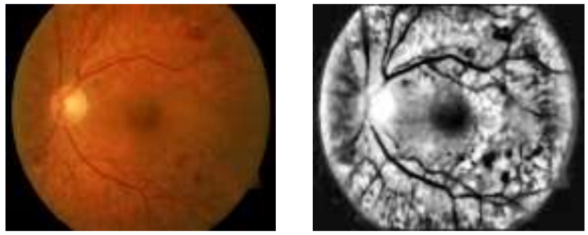


Fig.1Block Diagram of Proposed system

Input fundus image is in RGB format. For hemorrhage detection in fundus image we need to minimize image details. For hemorrhage detection basically green color channel is mostly preferable because it contains good contrast and red channel contain good brightness as compare to other channel. So for further processing, advantages of green and red channel were combined. Histogram equalization is used for contrast enhancement.



(a) *(b)*

Fig. 2 (a) Original Image (b) Preprocessed image

Brightness is the key factor for red lesion detection. To detect red lesion brightness is equally spread over the entire fundus image. It is followed by smoothing operation using matched filter. Matched filter of kernel size 15×15 is applied over image and subtract it from original fundus image. So the large vessels are removed. A matched filter kernel is given as

$$f(x,y) = -\exp\left(-\frac{x^2}{2\sigma^2}\right) \quad \text{for } |y| \leq L/2 \qquad \ldots (1)$$

Where, L is the length of the kernel segment. 15×15 pixel kernels are applied on the fundus image for convolution.

After extracting the enhanced red lesion segments, proper thresholding operation is necessary. The entropy based thresholding algorithm is considered for thresholding operation, which distribute gray pixels in spatial domain. In proposed system, we implement an adaptive thresholding technique [15]. The entropy thresholding minimize the relative entropy between co-occurrence matrix of the original fundus image and relative binary image. Regular patch of 15×15 is applied o binary image to remove extra growth part of an image. The result after thresholding operation is shown below.

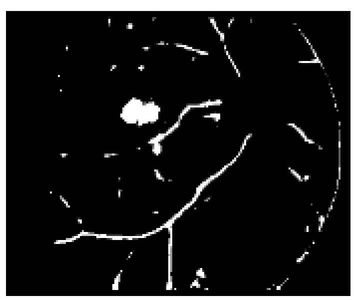


Fig. 3 Thresholding output

The hemorrhages have their own shape, size, structure. So need to filter out only hemorrhages i.e. false positive reduction. The False positive reduction is possible after binarization. For classification of Red lesion and non-red lesion, four filters are used shown below.

1. Area (hemorrhages has small area so remove out large area part)
2. The aspect ratio r1=w/h, where w is the width and h is the height of the bounding box of the hemorrhage
3. The mean intensity under the 5×5 kernel from the center of hemorrhage.
4. Density

Area plays important role for hemorrhage detection. In this filter, the candidate whose area is between10-800 square pixels were selected and other were rejected. So after this filtering we got small dot hemorrhages.

The ratio of width to height is called aspect ratio. In proposed approach we apply threshold of 0.76 -1.3 for filtering. This will remove the elongated spot of vessels.

To calculate mean intensity of image, the kernel of size 5×5 is created and this patch is applied over binary fundus image. This filter removes the variations which are wrongly recognized as the hemorrhage.

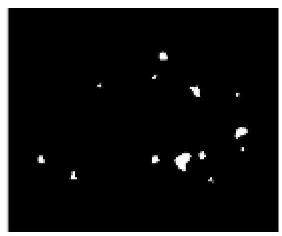
Density of the hemorrhages is calculated with the image and the part where density found to be below 40 pixels considered and other are remove out.

After applying these four filters, we got promising results shown in fig 4 (b)

EXPERIMENTAL RESULTS

Qualitative analysis

(a)



(b)

(c)

Fig.4 Qualitative analysis (a) Original image (b) results after classification (c) Final result of the proposed algorithm.

Quantitative analysis:

Quantitative analysis is done using below two metrics i.e. sensitivity and specificity. These metrics are calculated based on following parameters:

1. **True Positive (TP):** hemorrhage detected and shown detected.
2. **True Negative (TN):** hemorrhage not detected, shown not detected.
3. **False Positive (FP):** hemorrhage not detected but shown detected, (also known as false alarms).
4. **False Negative (FN):** hemorrhage detected but shown not detected. (Also known as misses).

These scalars are combined to define the following metrics

Sensitivity = TP / (TP + FN) …….2

Specificity = TN / (FP + TN) ……3

Table1. Quantitative results

METHOD	SENSITIVITY	SPECIFICITY
Proposed Method	87.71%	94.62%

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