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# DETECTION OF HAEMORRHAGE FROM RETINAL FUNDUS IMAGE: A MATHEMATICAL MORPHOLOGICAL APPROACH

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## ABSTRACT

The Diabetic retinopathy is the one the principal cause of blindness, and it is very challenging eye screening method. DR is categorized by two type of lesion viz. Hemorrhages and Microaneurysms. Early detection of these lesions may prevent the person from blindness. The paper introduced a morphological approach for lesion detection. The proposed early Microaneurysms detection method is processed through following steps namely fundus image acquisition, preprocessing, filtering, thresholding and FP reduction. The proposed system achieves the sensitivity of 83%, specificity of 89% and accuracy of 86%.

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

## INTRODUCTION

Diabetic retinopathy is becoming the major issue for person's blindness. This is mostly found in the working persons having the age more than 40 years. The major cause of DR is diabetics. In the diabetic patient, it is found more because when sugar level in the blood gets increases, it can damage the small vessels called capillaries in the eye. Capillaries are the vessels which provide the blood to the retina. If this is continued for extended periods, then the capillaries leaked the fats and fluid causes swelling in the eye. This may lead to permanently blockage of vessels called Ischemia.

According to the survey, developing countries like India having more number of diabetic patients. [1] To prevent the diabetic person from permanent blindness, early detection of lesions is a very important aspect. The diabetic retinopathy is the one of the best technique for identification of the lesions. DR reduces the risk of blindness by 50%. DR process required the skilled doctors, and existing manual lesion detection methods are very time consuming and risk of misidentification. [2] To reduce the false alarms of the manual techniques automatic lesion detection method. Automated DR Detection system is performing to detect abnormalities in the fundus image like Microaneurysms, hemorrhages, hard exudates and cotton wool spot.

The presented paper is organized as follow: Section 2 reviewed the different techniques to lesion detection. Section 3 described the proposed hemorrhage detection method. Results of the proposed system by qualitative and quantitative analysis are presented in section 4. In the last section, the paper has been concluded.

## LITERATURE SURVEY

Manal Bouhaimed et al. [3] explains diabetic retinopathy by automatic detection of single fundus cuts looks to be done with minimal false negativity. This study advocates the complete calculation of retinopathy at or above a minimum retinopathy threshold. It can help to reduction the burden of manual diabetic retinopathy screening.

Reshma M. Mulla et al. [4] describes the detection of Haemorrhage from Fundus Images using Hybrid Method. Template matching technique is used to detect the Haemorrhage. We can find the proper size of Haemorrhage

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region using segmentation method. False positive fovea filter used for elimination of wrongly identified blood vessels. It will develop the performance of analysis system for detection of Haemorrhage.

Giri Babu Kande et al. [5] have suggested an innovative system for red lesion detection in fundus images centered on mathematical morphology and pixel classification. The planned method takes into explanation the advantages of the strength information from both red and green channels of the same retinal image, matched filtering, and the local relative entropy based thresholding. The planned method reaches a specificity of 91% and sensitivity of 100%.

Sunrita Poddar [6] defines robust systems for separation of clinically significant features of fundus images, from recognition and degree of Diabetic Retinopathy as well as Maculopathy. They extract clinically significant features from the fundus images and use them for the discovery of diabetic retinopathy and categorize the abnormal images according to the severity of their abnormality. Pre-processing, Optic Disk Detection, Exudates Segmentation, Haemorrhage Segmentation, Fovea Detection, Grading of Non-Proliferative Diabetic Retinopathy (NPDR) are the steps use for Diabetic Retinopathy.

Ruchir Srivastava at al. [7] describes the detection of red wounds associated with DR from retinal fundus images. The paper challenges to contract with two difficulties in identifying red lesions from retinal fundus images, false detections on blood vessels and diverse extent of red lesions. Frangi filters are proposed for detecting the DR since it was robust to the presence of blood vessels. Frangi filters help in dealing with errors in vessel segmentation. The proposed method surpassed the performance of associated works for both MA and H.

Sarni Suhaila Rahim et al. [8] present an original automatic detection of DR and maculopathy in eye fundus images by employing fuzzy IP (image processing) procedures. The paper first introduces the existing schemes for DR selection, with an importance of the maculopathy recognition systems. Proposed medical system consists of four parts viz: image acquisition, image preprocessing including four retinal structures localization, feature extraction and the cataloging of DR and maculopathy. A mixture of fuzzy IP procedures, the Circular Hough Transform, and numerous feature extraction methods are applied in the proposed system.

M. Usman Akram et al. [9] explain a scheme containing a new hybrid classifier for the detection of retinal lesions. The proposed system consists of preprocessing, extraction of candidate lesions, feature set formulation, and classification. The proposed system is evaluated using standard databases with the help of performance parameters (sensitivity, specificity, accuracy and the Receiver Operating Characteristics curves) for statistical analysis. It is mainly emphases on segmenting MA using pre-processing, mathematical morphology and filtering.

## PROPOSED SYSTEM

The proposed system is implemented on fundus image to detect hemorrhages detection through the given steps viz. pre-processing, Thresholding, Filtering, and FP reduction.

The proposed algorithm is shown in below block diagram:

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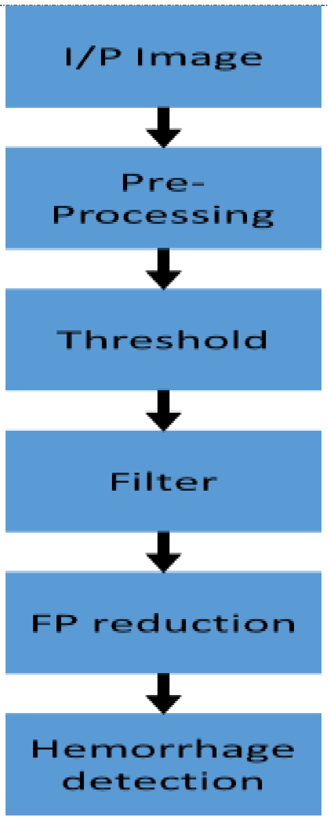


Fig: 1. Block Diagram of Proposed system

**Fundus image**

Fundus image is input image which is in RGB format. It is used to detect the Haemorrhage. The original image is shown in the figure.

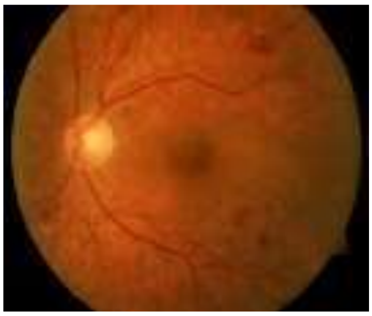

Fig: 1Input fundus image

**Pre-processing**

We want to minimize image details of fundus image for hemorrhage detection. For hemorrhagic detection, we combined the red and green color channel. Green color channel- It contains good contrast, Red color channel- It provides good brightness. Hence the combination of red and green color channel is preferable. To enhance the contrast of image, Histogram equalization is used

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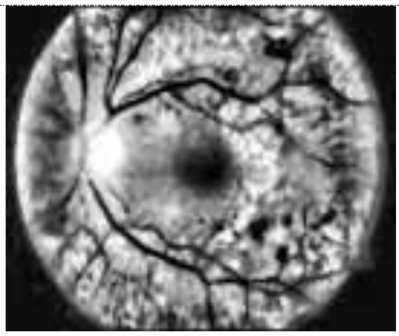

Fig: 3Pre-processing image

## Filtering

The red lesion is present on the fundus image which will be detected by using the brightness of that image. The smoothing operation is applied by using matched filter. The Matched filter is applied over the image and subtracts it from an input image.

The two-dimensional matched filter kernel is given as

$$f(x, y) = -e^{-\frac{x^2}{2\sigma^2}} \text{ For } |y| \leq L/2 \quad (1)$$

Here, L is the length of the kernel segment.

## Threshold

The threshold operation is applied after extraction of the red lesion. We implement adaptive thresholding technique. The entropy based thresholding algorithm is used which distributes gray pixels in the spatial domain. It minimizes the relative entropy between co-occurrence matrix of the original fundus image and relative binary image. The threshold operation is shown in the figure.

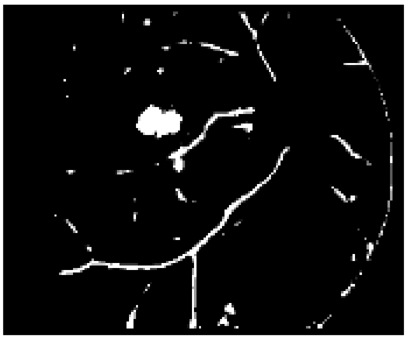

Fig: 4. Thresholding output

## FP detection

The hemorrhages have their 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)**
   The area plays an important role for hemorrhage detection. Here, the contestant whose area is between10-800 square pixels were selected, and other were rejected. So after this filtering, we got small dot hemorrhages.

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2. **The aspect ratio r1=w/h, where w is the width and h is the height of the bounding box of the haemorrhage**

Aspect ratio= width to height. In our method, we apply the threshold of 0.76 -1.3 for filtering. It will remove the extended spot of vessels.

3. **The mean intensity under the 5×5 kernel from the center of haemorrhage**

To calculate the mean intensity of an image, the kernel of size 5×5 is created, and this patch is applied over binary fundus image. The filter removes the deviations which are imperfectly recognized as the haemorrhage.

4. **Density**

The 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.

Fig: 5. hemorrhage output

Fig: 5. Hemorrhage detection system output

## RESULTS AND DISCUSSION

Quantitative analysis is done using two metrics i.e. sensitivity and specificity.  It is calculated built on ensuring factors:

True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN)

TABLE 1: performance metrics

| | **Original** | **System output** |
|---|---|---|
| **TP** | Present | detected |
| **TN** | not present | not detected |
| **FP** | not present | detected |
| **FN** | present | not detected |

These scalars are combined to define the following metrics

$$\text{Sensitivity} = \frac{TP}{(TP+FN)} \quad (2)$$

$$\text{Specificity} = \frac{TN}{(FP+TN)} \quad (3)$$

$$\text{Accuracy} = \frac{(TP+TN)}{(\mathrm{TP}+\mathrm{TN}+FP+FN)} \quad (4)$$

The result of the qualitative analysis is tabulated in below Table 2**.**

| **Method** | **Sensitivity** | **Specificity** | **Accuracy** |
|---|---|---|---|
| Proposed method | 83% | 89% | 86% |
| Bounding Box Closing [5] | 74% | 86% | 80% |

## CONCLUSION

The approach to detect haemorrhage and Microaneurysm is presented in this paper. The mathematical approach is robustly detecting the haemorrhage. This approach can remove the vessels and segment the small haemorrhage and Microaneurysm from the fundus image. The analysis is carried on the fundus image of the DIARETDB1 database. The proposed system achieved the sensitivity of 83%, specificity of 89% and accuracy of 86%. In future, machine learning approach will implement by considering texture features.

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