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Detection of Macular Edema from Fundus Images

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Abstract - *Diabetic Macular Edema(DME) is a common disease for diabetic patients. If the disease is not properly treated in the earlier stage it may result in permanent blindness. Macula is the important region for sharp and perfect vision. Center of the macula region is called Fovea. Fovea region has lack of Blood Vessels(BV). To detect the macular edema in earlier stage we proposed image processing technique using MATLAB software. Here the process undergo preprocessing, macula and fovea detection, segmentation, feature extraction and KNN (K-nearest neighbor) classification for classifying the fundus into normal or affected.*

Key Words: Diabetic Macular Edema, Macula, Fovea, KNN.

1. INTRODUCTION

Normal Fundus image consists of Macula, Fovea, Blood Vessels and Optic disc. Soft exudates, hard exudates, cotton wool spots, hemorrhages and microaneurysms are present in the fundus image are called infected fundus image. Center of the Retinal fundus image is called macula region. Macula region is the important region in the Retinal fundus image. Center of the macula is called Fovea. Cone cells are present in the fovea and these cells are responsible for identifying the colour when the light falls on it. Fovea region is also called as the Blind spot of the eye because if the light does not properly falls on the fovea region the person cannot able to see anything. Macula region is responsible for sharp and clear and perfect vision. If the person having edema in the macula region he/she may experience blurred vision or distorted vision. Diabetic Macular Edema(DME) is a common disease for diabetic patients. Edema means swelling. Macular Edema happens if there is any fluid deposits or build up of fluids in the macula region. This edema blocks the central vision and causes severe problems. Fig. 1 shows the colour retinal fundus image with macula, fovea, blood vessels and other features. Fig. 2&3 shows the normal and affected fundus image. Fig. 4 shows the macular edema vision. If the person is not treated properly it may results in severe problem and it may cause irreversible blindness. To detect the Macular Edema in earlier stage we proposed Image Processing technique using MATLAB software. Firstly, fundus images go with preprocessing step i.e. normalization, contrast enhancement, noise removal and optic disk removal. Secondly Fovea and macula region are detected. Macula is the important region for sharp and perfect vision. The center of the macula is called Fovea. The Fovea region has lack of Blood Vessels (BV). Based on the macula region exudates, we detect the diabetic macular edema. Color segmentation, thresholding and morphological models are proposed for identifying the exudates in fundus images. After the segmentation is done, the color and texture features were extracted and fed to the classifier, K-nearest neighbor for classifying the fundus into normal or affected. From the proposed method the results provide the accuracy, sensitivity and specificity.

2. LITERATURE SURVEY

By referring various conferences and journals various techniques and methods are used to detect the Macular Edema from the Retinal fundus images and the OCT(Optical Coherence Tomography) images. Regular screening is necessary for the maculopathy patients.

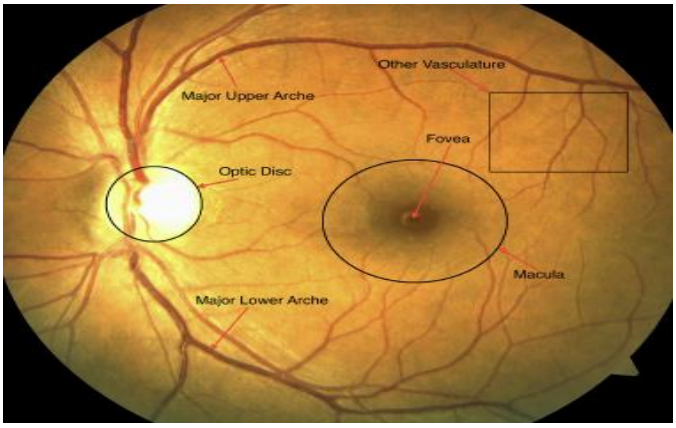

Fig -1: Colour retinal fundus image with features

Shweta Reddy[3] used Robust classifier to detect and the grading of diabetic maculopathy. Various assessment of image processing techniques are projected in this paper and it is used to detect the macular edema and to identify and classify the severity levels. This image processing technique includes Pre processing, ROI detection and the feature extraction. This paper uses MESSIDOR, STARE, DRIVE, DIARETDB0, DIARETDB1 databases. Exudates are the important cause for macular edema and it is identified by using the thresholding method. Morphological image processing techniques and other clustering methods are used to detect the maculopathy. And for the classification of the images SVM, ANN, GMM techniques are been used. This

method was tested using various databases which was discussed earlier and it produces 97.85% of accuracy.

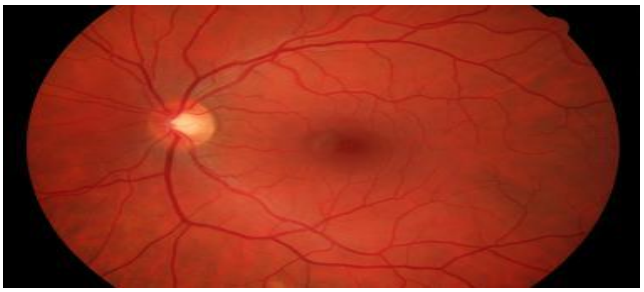

Fig -2: Normal fundus image

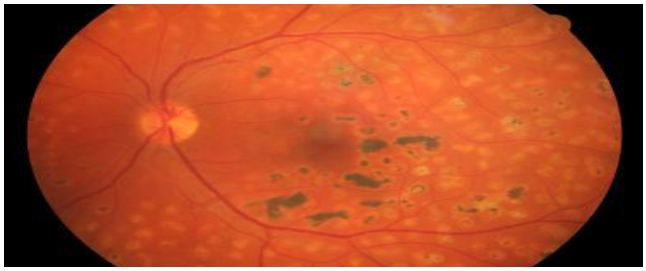

Fig -3: Infected fundus image

M.A.Fkirin[4] used image filtration method to segment the Blood Vessels. Image filtration is used to perform specific task like sharping, blurring, noising and other features. Laplacian of gaussian (LOG) filter is used and it detects the area of high spatial frequencies in the fundus images. Sobel method is used to detect the edge of the blood vessels. The important step in this proposed method is the Registration step and it has to be done manually and this step is to detect the change in the Blood vessels and it is easy to detect and to diagnose the problem.

Fig -4: Macular Edema vision

C.R. Dhivyaa[5] used K-means Clustering algorithm for segmentation of the hard exudates and by using this algorithm the hard exudates are identified with the better accuracy than the other approaches. After identifying the hard exudates the variance based method is used for segmenting the exudates and the mathematical morphological method is used to reconstruct the original image into the image features for better segmentation. Automatic thresholding of the hard exudates had been done using the Entropy based technique. This method results in 96.4% of Sensitivity and 97.2% of Specificity.

N.M. Fraz[6] used computational methods to detect exudates using different techniques. Image analysis and computer vision techniques are also used for the segmentation of exudates for better accuracy. This method clearly explains about the different techniques of detecting exudates and effectiveness of each technique. And finally performance measures of the each technique is also discussed. The main motto of this survey paper is to provide the Ready reference for the researches to find the best technique to detect the exudates efficiently.

Sarni Suhaila Rahim[7] detected the automatic screening and classifying the diabetic maculopathy and retinopathy from the color fundus image using fuzzy image processing technique. Fuzzy image processing techniques, the Circular Hough Transform and several feature extraction methods are implemented in this paper and also represents the novel technique for macula region localization in order to detect the maculopathy. The classification had been done using some Machine learning algorithms.

3. PROPOSED METHOD

The paper proposes a Image processing technique using MATLAB software to detect the macular edema to identify the exudates in the neighboring region of fovea.

The image processing technique involves preprocessing, segmentation, feature extraction and compare the detected images with the trained database and to identify the given image is normal or affected. The proposed method is time saving method. We have to train the computer with many images with the normal and affected fundus images so that the computer can identify the given input image is normal or affected in a efficient way.

Here the input image is first preprocessed. In the Pre-processing method the image undergo normalization, contrast enhancement, noise removal and optic disk removal.

Then the pre-processed image is used for further process that is detection of macula and fovea region. Firstly the fovea region is detected and based on the center of the fovea region the macula is detected by marking the radius.

Then the background of the macula region is removed the image undergo feature extraction method and then classification. After the process the image is compared with

the trained database to detect whether the image is normal or affected by using KNN classification. After the classification of KNN the performance analysis is calculated.

3.1 Pre-processing

Pre-processing is the essential step in image processing technique. Pre-processing is important for the further processing of the image. During Pre-processing the unwanted noise or distortions in the image will be suppressed. It enhances some image features. The aim of pre-processing is an improvement of the image data that normalize the image, suppresses unwanted distortions, enhances some image features and removal of OD important for further processing.

We are applying multiscale image decomposition, illumination adjustment (gamma correction) for retinal image normalization and adaptive histogram equalization (AHE) process for contrast enhancement.
To reduce the noise by median filtering applied on the enhanced image without reducing the sharpness of the retinal image.
Finally, high intensity pixel detection is used for detection and removal of optic disc.
The output achieved after this stage is an image with a normalized luminosity, enhanced contrast, reduced noise and removed OD.
Once the pre-processing step is done the image is further move on to the further processing steps.

3.2 Fovea and Macula detection

After the preprocessing the ROI (Region of Interest) should be cropped first for further segmentation. Then firstly the fovea region is detected based on thresholding and morphological closing and filling operation. Second, macula region is detected based on fovea that means based on fovea centre point and radius value. And then the background of the macula region is removed. Then the extracted macula region is used for further processing.

3.3 Segmentation

From the extracted macula region the color segmentation technique (YCbCr color segmentation) is applied to variant the colors. After the color segmentation the thresholding and morphological operation is used for exudates detection. The thresholding operation is used to convert the image into binary image containing black and white pixels. While thresholding the maximum contrast in the image will be converted to white pixels. After the thresholding operation the morphological operation should be done. It is used to extract the information from the image then the boundary pixels and the low frequency pixels are eliminated from the image.

3.4 Feature extraction

Feature extraction plays an important role for detection of DME. In our work, considers statistical color feature and texture features for classification. In statistical color based, color moments such as mean and standard deviation are extracted for each channel of segmented image. In texture features, GLCM (Gray-Level Co-Occurrence Matrix) based energy, contrast, correlation and homogeneity features are extracted for segmented image.

3.5 Classification

The classification process is done over the extracted features. The main novelty here is the adoption of K-nearest neighbour.KNN is applied over the features and the classification is done.

4. RESULT

The proposed method will detect the Exudates in the surrounding of the fovea region and identify the image is normal or affected. The input image is given to the system first it undergo preprocess sing. In preprocessing the image will be normalized and the median filter is applied to remove the noise in the image and then the detection and removal of optic is done in the preprocessing step. After the removal of optic disc the region of interest will be cropped and then the fovea and the macula region is detected. First the fovea region is detected and based on the center of the fovea the macula region is detected by thresholding and morphological operation. After the extracted result of macula, the macula region undergo YCbCr color segmentation, thresholding and the morphological operation to detect the exudates in the macula region. After the thresholding and morphological operation the image is compared with the trained data base to detect the given fundus image is normal or affected. By using the final feature vector, that is mean, standard deviation, contrast, correlation, energy and homogeneity the final result is classified. If the predicted class is 1 the classified result is normal and if the predicted class is 2 then the classified result is affected. And the performance analysis of the image is calculated using the confusion matrix.

5. CONCLUSION

Macula and Fovea are the important region in the eye and it is responsible for the clear and perfect vision. If there is any abnormalities in the macula region it should be screened properly if not it may result in irreversible blindness. If the person is affected by maculopathy in one eye if it is not detected in earlier stage it may affect the other eye. So here the proposed method will detect the earlier stage of the macular edema from the fundus images and classify whether the given image is normal or affected.

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