A Survey on Machine Learning Based Exudate Extraction

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Abstract: Diabetic retinopathy (DR) is an eye disease caused due to diabetes, which is one of the major causes of blindness. The exudates are one of the causes for diabetic retinopathy. Exudates are formed for an individual who has diabetes for longer period and has higher chances of developing diabetic retinopathy. This paper deals with the survey to develop a novel algorithm to identify and detect exudates.

Keywords: Diabetic retinopathy; Exudates; Literature; Survey; Image processing

I. INTRODUCTION

Diabetic retinopathy is a diabetes complication that affects the eyes. It is caused by damage to the blood vessels of the light sensitive tissue at the back of the eye [1]. Individuals who are suffering from diabetes have high risk of getting diabetic retinopathy which in turn leads to blindness. If it is treated at an early stage there is chance of curing.

The earliest stage of diabetic retinopathy are exudates, microaneurysms (MA), hemorrhages (HE) and cotton wool spots which are known to be the signs of NPDR. Early detection of diabetic retinopathy could lead to laser treatment and prevent or delay further vision loss. But when the disease develops to PDR stage where tissue formation and new blood vessels starts bleeding [2]. So, there is no chance of preventing vision loss. When there is a higher risk of diabetes then there is more risk of diabetic retinopathy so in this advance case laser treatment is done called pan-retinal photocoagulation. Ophthalmologists examine the retinal photographs and identify the exudates, hemorrhages and microaneurysms presence [3]. Among these, exudates are one of the earliest signs of diabetic retinopathy. The figure given below fig 1, illustrates exudates and optic disk on a typical retinal image also known as white lesions which are formed by a fatty yellow lipid deposits in the retina [3]. Detection of these signs may be difficult due to the presence of optic disk in retinal images.

Fig. 1 shows the typical retinal image marked with optic disk and some exudates. Optical disk is the bright circular region of the retinal images. therefore, removal of optic disk is must when using image processing techniques in order to detect to detect exudates. The intensity level of both exudates and optic disk are similar so detecting exudates is difficult for the doctors. This paper concentrates on survey conducted on methods proposed by several authors for automatic detection of exudates for early detection of diabetic retinopathy.

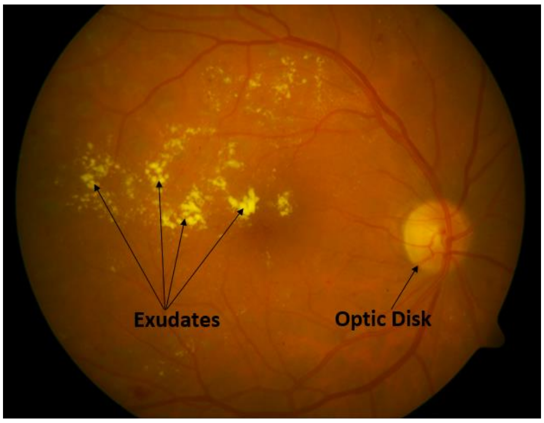

Fig 1. Illustration of exudates and optic disk on a typical retinal image

II. LITERATURE SURVEY

With the development of technology many studies have been conducted for the automatic detection of early signs of DR including exudates. The comparison with different parameters is done for five papers below [4-8] which includes different datasets with different techniques used.

In paper [4], the database used are DiaRetDb1, DiaRetDb0 and HRF. Image normalization was done where HSV space was used for brightness correction and 9*9 median filter was done to remove the noise and image was smoothened. Later gamma correction was done for obtaining normalization. The normalized HSV is converted back to RGB and the green component was selected due to the high contrast. Histogram on green component was performed. Also, for detecting optic disk, CLAHE method was used. Using the histogram, peak intensity value is considered as threshold and was used for segmentation to find exudates. Later a 3x3 median filter was used and the mask for optic disk was obtained. Using this mask, the OD was eliminated from the binary image, thus resulting in only the exudates. For two datasets chosen, the Sensitivity and specificity were found for gamma values 0.49, 0.5 and 0.51. The best results was obtained for gamma value of 0.49, which yielded the sensitivity and the specificity as 94.59% and 88.46% respectively.

In paper [5], the database used is STARE database. RGB images are converted to gray scale images which is used for detecting accurate pixel values. This provides high contrast. Gaussian filtering is used to enhance the contrast of the image. Initially Edge detection is done where the presence of an edge at a point in the image is found, and it produces two values for every edge in an image and zero crossings can be used for locating the center of thick edges. Using thresholding, gray scale image is converted to binary image. Texture feature extraction technique is used which combines both histogram of gradient (HOG) with gray level occurrence matrix (GLCM). Using KNN and CNN, classification of segmented regions into abnormal and normal regions is done. CNN bifurcated images to normal and non-healthy regions and the difference in CNN has layers of convolution and pooling. The dataset had 103 unhealthy and 90 healthy images, and to calculate the neural network the comparison is done between KNN and CNN and CNN classifier takes less than KNN classifier. Accuracy of 98% is seen in CNN.

In paper [6], the database used are DiaRetDb1 and DiaRetDb0. Contrast based adaptive histogram (CLAHE) technique was used to enhance the RGB image. Later, green channel was extracted. Median filter with a large kernel was applied to remove the background. The resulting image was subtracted from the retinal image to enhance the contrast. Global thresholding was found manually to detect the hard exudates. To find OD the local variance method was used. De-correlation was done to remove the false candidates and Recursive Region Growing Algorithm (RRGA) for detection of exudates. True positive rate is the term used for sensitivity and it was found to be 87%.

In paper [7], E-Ophtha and DiaRetDb1 are the 2 datasets with 148 and 89 images having the resolution 512*512 pixels. Preprocessing is done by performing blood vessel detection. Initially, the region of interest (ROI) is extracted. Image filtering is performed on the ROI. This helps to get normal retinal structure. Field of view (FOV) technique using only one horizontal and vertical scanning lines is performed. Later blood vessels are extracted by subtracting original image from guided filter output image. Local rank transform is used to get the higher spatial frequencies and extract dark and bright lesions from retinal images. Noise is removed using median filter operation. A delta value of 15 is considered with a threshold of 225. Line scanning-based localization method is used for detecting OD. A circle with radius of 65 pixels is used for masking out the OD region. Later a threshold was selected to remove OD and blood vessels. Thus, finally the exudates are detected. The microaneurysms are detected using negative delta value -13. The accuracy is found for both databases as 95.44% and 97% respectively.

In paper [8], the database used are DRIVE, DIARETDB1, MESSIDOR and AFIOS with total 1791 images. Initially the background is removed from foreground using adaptive threshold. Histogram equalization is used to suppress the noise in the image and Clip limited adaptive histogram equalization (CLAHE) is used to enhance the contrast of the image. Morphological operation is done to smoothen the dark lesion along with blood vessels. Minimum and maximum intensities are found, for which mean and variance are found. A Gabor filter is applied followed by OSTU's algorithm to convert grayscale image to binary image. Green and red channel is selected for feature extraction. Maximum, minimum and mean intensities are used for both channels. OSTU's method is used for identifying OD's intensity. SVM is used that has classification learning algorithm. Here the hyper plane is considered where margin is calculated to correctly identify the exudates. Real time system named ALBASR is implemented and the database accuracy is found where DRIVE database has 100%, DIARETDB1 has 95.24%, MESSIDOR has 95.75% and AFIO has 94.13% accuracies.

These are some papers we have researched where some machine learning and image processing techniques are used for finding the exudates and the result was found with respect to accuracy, sensitivity and specificity for detecting the exudates automatically.

III. CONCLUSION

The paper surveyed here provides highest accuracy though, however the most of the paper reviewed have worked on similar contrast based images. Thus an algorithm can be conceived which can learn the contrast of the image and adjust its parameters by itself. This helps in increase of result and reduce negative out comings. Therefore making doctors lives easy to detect the exudates and treat patients in early stage.

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