Image Processing Technique for Hard Exudates Detection for diagnosis of Diabetic Retinopathy

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Abstract—Diabetic Retinopathy(DR) is a diabetic eye diseases which is referred as combination of various eye problems. These Problems are faced as a complication of diabetes by people, who are suffering from it. Prolongation of DR may result in permanent blindness. To avoid this, Detection of DR in an automated way at early stage is recommended. Hard Exudates are one of the primary abnormalities that can be seen in DR. In this paper, we have given various Image Processing Techniques that can be used for automated detection of Hard Exudates. We have evaluated the outcomes by using ground truth of the test images and the use of image databases in the particular digital algorithm for detection of Hard Exudates. Accuracy, sensitivity and Specificity are few of the parameters which are used for the concluding the better method for digital Processing

Keywords— *Diabetic Retinopathy(DR), Hard Exudates, Image Processing Techniques*

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I. INTRODUCTION

This Medical imaging has resulted in revolution in field of the medicine by providing cost-efficient health care and effective diagnosis in all major disease areas. Medical imaging allows scientists and physicians to understand various and important life-saving information and characteristics using less time consuming techniques. In medical imaging, the accuracy of the diagnosis of the disease depends upon the quality and interpretation of the acquired image. Computers have a huge impact on the medical images acquisition. They perform multi-pronged functions like pre-processing of the images, controlling hardware that is related to imaging, performance of reconstruction, post-processing of the image data and storage of the scans. In contrast, there are limitations to the role of computers in the interpretation and acquisition of medical images. Interpretation remains an almost exclusively human domain. Development of the applications which can interpret medical image are in process, which will result in aiding a physician for detection of possible abnormalities. The computer indicates the area in the image that may require extra attention from the physician because they could be abnormalities in that image. In recent times, many parts of the world have been faced with an increase in age and society related diseases, like diabetes. According to recent survey, it have been recognize and accepted as one of the main cause of blindness in the country if not properly treated and managed.

Detection and diagnosis at the early stages have been identified as a preventive way to reduce the percentage of visual impairment caused by diabetes, which can be achieved by more emphasis on medical check on regular interval of time, mostly yearly, by making the use of special facilities for detection and monitoring of the said disease. The effect of this on the medical professionals has not been over emphasized, it has lead to increase work load on the medical professionals and the medical facilities, due to increase in diabetes screening activities. A lot of approaches have been suggested and identified as means of reducing the stress caused by this constant check up and screening related activities . From all the methods described above, the use of medical digital image signal processing for diagnosis of diabetes related disease like diabetic retinopathy using retinal images.

Hard Exudates are primary sign of the DR. Exudates are an abnormality observed in the first phase of DR. Exudates are mostly in the form of clusters. These clusters may be adjacent to group of microaneurysms or near the anatomical area of fovea. Exudates are yellowish in color, and also they are deposits in the internal area of retina. The location of these hard exudates are normally in the posterior pole of the fundus. The analysis and diagnosis of the disease by ophthalmologists from detection of exudates necessarily needs the chemicals for dilation of pupils. These chemicals may lead to side effect on patients and also involves great deal of time investment, this becomes hectic task for ophthalmologists and inconvenience for the patients. Hence various digital image processing techniques are used for detection of exudates. Figure below shows the Retinal image with Hard exudates and showing typical components of retina such as optic disc ,etc

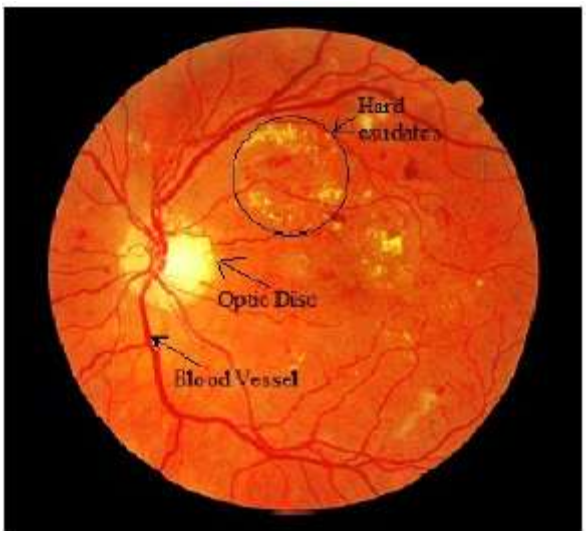

Fig1: Fundus with Hard Exudates

II. Literature Survey:

Various methods were used by several people for exudates detection. Few of them are described below in accordance with their proposed method and performance parameters.

Hussain et al [3] has presented an automated method for detection of hard as well as soft exudates. The author has used a split and merge technique. This method is based on the technique of coarse to fine segmentation principle. In this algorithm, along with the optic disk elimination, the green channel is also used for pre-processing. Local variation operator is used for Coarse exudates detection. Fine Exudate detection is obtained by adaptive thresholding technique. Thus a vast improvements in the results can be observed due to the combination of fine and coarse exudates. This method provides the measuring parameters as 89.7 sensitivity and 99.3 specificity. The author have used 140 images from different databases that are available globally. 89 images from DIARETDB1 , 17 images from MESSIDOR and 17 images from DRIVE database were taken. This method has also given the comparison of different methods using DIARETDB1 database.it provides with the improvement in the specificity and accuracy measure and reasonable sensitivity. It occasionally fails to exclude some non exudate object particularly to those that have similar features to real exudates.

JayaKumari et al [4] proposed a method for detection of exudates using contextual clustering technique. This technique has included the pre-processing of retinal images for the segmentation of hard exudates. In this study, a state-of-art image processing techniques which is used for automated detection of the presence of hard exudates in the fundus images are introduced. After the contrast adaptive histogram equalization as pre-processing stage, contextual clustering algorithms have been applied to segment the exudates. The key features are like the standard deviation, mean, intensity, edge strength and compactness of the segmented regions are extracted and fed as inputs into

Echo State Neural Network (ESNN) to discriminate between the normal and pathological image. A total of 50 images have been used to find the exudates out of which 35 images consisting of both normal and abnormal are used to train the ESSN and the remaining 15 images are used to test the neural network. Furthermore, it confirms 93.0 sensitivity and 100 specificity in terms of exudates based classification.

Osareh et al [5] proposed a system for Hard exudates detection using Fuzzy C-mean (FCM) clustering technique for the segmentation.The segmentation process is carried out on a normalized, contrast enhanced image obtained from the colour retinal image. Classification of segmented region as exudates or non-exudates was fulfilled by an artificial neural network classifier.this experiment was done on 142 colour retinal images .It provides 93.0 sensitivity and 94.1 specificity in terms of exudates based classification.The full computation comprising segmentation, removal of false positives (for example, the optic disc), and NN classification takes around 11 minutes.

Haniza et al [6]presents a new approach to detect exudates and optic disc from color fundus images based on inverse surface thresholding. The strategy involves the applications of fuzzy c-means clustering, edge detection, otsu thresholding and inverse surface thresholding.The main advantage of the proposed approach is that it does not depend on manually selected parameters that are normally chosen to suit the tested databases. When applied to two sets of databases the proposed method outperforms methods based on watershed segmentation and morphological reconstruction. The proposed method obtained 98.2 and 90.4 in terms of sensitivity for Standard Diabetic Retinopathy Database Calibration Level 1 (DIARETDB1) and a local dataset provided by National University Hospital of Malaysia (NUHM), respectively. The proposed method compares favourably against those using watershed and morphology.

Atul Kumar et al. [7]implements a method that identifying the feature of exudates from the image using segment based feature extraction A serious of experiments for extracting the feature is performed with the use of effective image processing techniques. To get these feature value from fundus retinal image various techniques like morphological pre-processing, image boundary tracing, adaptive threshold using Otsu methodology, Optic disk localization are implemented. The SVM classifier uses features extracted by combined 2DPCA instead of explicit image features as the input vector Combined 2DPCA is proposed and then for acquiring higher accuracy of classification we can use virtual SVM. Experimental evaluation on the publicly available data-set DRIVE demonstrates the improved performance of the proposed method for automatic detection of Exudates. These automatically detected exudates are validated by comparing with expert ophthalmologist's

hand-drawn ground-truths. The overall sensitivity of proposed method is 97.1 for the classifier and the specificity is of 98.3.

S. Kavitha et al [8] presents an automatic detection system of diabetic retinopathy exudates in color fundus retinal images. Initially the color fundus retinal images are subjected to pre-processing for CIELab color space conversion and Fundus region detection using binarization and mathematical morphology respectively. Subsequently nonlinear diffusion segmentation is employed to encapsulate the variation in exudates and lesion boundary criteria pixels. To prevent the optic disc from interfering with exudates detection, the optic disc is detected and localized with the aid of region props and color histogram. Exudates are detected with the aid of thresholding color histogram, which is used to classify the hard and soft exudates pixel from the color fundus retinal image. Experimental evaluation on the publicly available dataset DIARETDB1 demonstrates the improved performance of the proposed method for automatic detection of Exudates. These automatically detected exudates are validated by comparing with expert ophthalmologists hand-drawn ground-truths. Sensitivity, Specificity and Accuracy are used to evaluate overall performance. The overall sensitivity, specificity and accuracy of the proposed method are 89.78, 99.12 and 99.07, respectively.

C. Sinthanayothin et al[9] reports a system of automated detection of Diabetic Retinopathy by detection of exudates, haemorrhages and microaneurysms. The author introduced Recursive Region Growing Segmentation (RRGS), used on 10x10 window with selected threshold value, for detection of exudates. The author also proposed the detection of anatomical component of retina. The sensitivity and specificity for exudates detection were 88.5 and 99.7 respectively.

Akara et al [10] detected the exudates for Diabetic Retinopathy using a Fuzzy C-Mean (FCM) clustering technique. Optimal selection of number of cluster was done using FCM algorithm. Contrast enhancement pre-processing was employed using four features, such as intensity, standard deviation on intensity, hue and a number of edge pixels, and they were removed to provide input to the coarse segmentation using FCM clustering method. The detection results were validated by analyzing with expert ophthalmologists hand-drawn ground-truths. The number of clusters varied from 2 to 8 clusters and the processing time varied respectively from 1.5mins to 18 mins. With 2 clusters the sensitivity and specificity was 92.18 and 91.52 respectively.

Meindert Niemeijer et al.[11] have discussed and analyzed a machine learning-based ,automated system to detect exudates and cotton-wool spots in digital color fundus photographs, for early diagnosis of diabetic retinopathy. Three hundred retinal images from one eye of 300 patients with diabetes were chosen from a diabetic retinopathy tele-diagnosis database (non-mydriatic camera, two-field photography). A machine learning computer program was developed that can recognize and distinguish among hard exudates, and cotton-wool spots. A human expert standard for the 300 images was achieved by consensus annotation by two retinal specialists. Sensitivities and specificities of the annotations on the 300 images by the automated system and a third retinal specialist were obtained.

III. Conclusions

Several methods are developed to detect exudates from non-mydriatic, low-contrast, retinal digital images of retinopathy patients using various database available. The main intension is to help the ophthalmologists in the diabetic retinopathy screening process over the large population suffering from Diabetic Retinopathy, to detect symptoms faster and more easily. The proposed techniques work effectively even on a poor computing system. The results of this work can be developed to produce an automated system to detect exudates. Microaneurysm and haemorrhage detection could be added to the system in order to increase its ability to verify the degree of diabetic retinopathy. It will be useful to extend this work by developing a system to detect them.

Future work will address an issue of improving the sensitivity by improving the results. Further classification to specify the degree of DR can be done. A complete system can be developed that can be used to detect all the possible abnormalities and the anatomical organs.

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