A Survey on Detection of Diabetic Retinopathy

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***Abstract*: This paper describes an improved diabetic retinopathy detection scheme by the extraction of hard exudates and soft exudates (cotton wools). Exudates are one of the main symptoms of Diabetic Retinopathy (DR). DR is an eye disease which occurs due to the damage of retina as a result of long illness of diabetic mellitus which leads to blindness. The current technique of screening uses fundus photography and the data is sent to a grading centre for reading where expert human readers estimate the disease severity. This requires qualified experts and it fails to give timely treatment. An early detection of exudates prevents the patients from vision loss. This approach majorly focuses on the procedure of automated techniques for detection of exudates (hard and soft) and hence detects DR in early and advanced stages. After the exudates are detected, it is classified into normal eye, non-proliferative and proliferative DR eye. Linear SVM is used for the classification. Furthermore, this paper reviews the contribution of many researchers in this field and highlights the significant improvement achieved by them.**

***Keywords*: Diabetic Retinopathy, Hard exudates, Soft exudates (cotton wools), Non-Proliferative Diabetic Retinopathy (NPDR), Proliferative Diabetic Retinopathy (PDR), SVM.**

1. INTRODUCTION

Diabetes mellitus, commonly referred to as diabetes, is a group of metabolic disorders in which there are high blood sugar levels over a prolonged period. It affects the eyes when blood glucose is too high, that results in poor vision or even blindness. The retina is the inner lining at the back of eye that senses light and turns it into signals that brain decodes, so one can see the world around you. Damaged blood vessels can harm the retina, causing a disease called diabetic retinopathy. Diabetic retinopathy is an eye related disease which is the side-effect of prolonging diabetes. When the sugar level in the blood vessels of retina increases, it leads to dampening of blood vessels. Dampening of blood vessels results in leakage of blood or fluid like substance which usually gets deposited under macular edema. These depositions are called exudates. Exudates can be classified into two main categories, hard and soft exudates. The formation of exudates is the main symptom of Diabetic Retinopathy. DR has been classified into two major types such as Non Proliferative and Proliferative, based on the presence of neovascularization which is the abnormal blood vessel growth. The stage of the retina without any abnormal vessel growth (neovascularization) is called as Non Proliferative Diabetic Retinopathy (NPDR), which is the early stage of DR. The disease leads to the swelling in the side of the blood vessel called micro aneurysm. These micro aneurysm forms hemorrhage due to the rupture. Hence, the blood vessels are weakened and start to leak fluid in the retina. This fluid affects the function of macular edema by getting deposited under macular edema. This sediment is usually called as hard exudates. The other form of exudates is soft exudates (cotton wools). These are the greyish white patches present in nerve fibre layer which have fluffy edges. The presence of more than six soft exudates in one eye results in loss of vision. These exudates are detected and severity of disease is detected using digital image processing. The three main steps involved in the Diabetic Retinopathy are, pre-processing of fundus images, feature extraction and classification of DR. Pre-processing is an important stage in DR because retinal images suffer from uneven illumination, poor contrast and noise. Pre-processing of fundus image is executed in order to increase the contrast. Feature extraction aims at finding the features that are most relevant to exudates in a retinal fundus image. Extracted features are used for training the parameters of classifier. Classification of DR is performed by support vector machine (SVM). Through the research, the International Diabetes Federation says that, the number of adults with diabetes is around 415 million that is, 1 in 11 adults have diabetes.These people with diabetes are easily prone to diabetic retinopathy. The range of prevalence of diabetic retinopathy in the southern part of India is estimated to be 12.2% to 18.03% of the population who already have diabetes. In urban areas like Chennai, the prevalence of diabetic retinopathy is around 28.2%.

The paper is organised in following ways: Section 2 contains literature review of related work on automated method for DR detection. Section 3 concludes the overall work.

2. LITERATURE SURVEY

Shailesh kumar and Basant Kumar [1] proposed an improved Diabetic Retinopathy (DR) detection scheme by extracting accurate area and number of microaneurysm from color fundus images. Fundus images are taken from database DIARETDB1. The DR detection contains three steps: pre- processing of colour fundus images, diagnostic feature extraction and classification of DR. Pre-processing of fundus image is performed in order to improve the contrast. Adaptive histogram equalization (ADHE) is used for contrast enhancement. After pre-processing, exudates are extracted from colour fundus image using median filter by using morphological process. Second step is feature extraction. The last step is classification using SVM. Parameters of SVM classifier has been calculated based on features of microaneurysm. SVM classify the image into two classes such as DR eye and healthy eye.

The sensitivity and specificity of proposed system have been computed as 96% and 92% which shows that it is better for non-proliferative diabetic retinopathy.

Shuang Yu and Yogesan Kanagasiangam [2] proposed deep convolutional neural network (CNN) is adopted to achieve pixel-wise exudate identification. The CNN model is first trained with expert labelled exudates image patches and then saved as off-line classifier. For the image processing procedure, the retinal images first processed to remove optic disc and blood vessels. The ultimate opening algorithm is utilized to obtain the potential exudate candidates, i.e. the seed points. At last, the local patches that surrounds the seed points are passed to train deep learning model to identify whether they are exudates or not. The major advantage is, due to the nature of machine learning and deep learning, the increasing in training data quantity and variation will generally lead to the improvement of model performance. Though they give better results with high amount of data, they are expected to perform poorly with less amount of data.

Enrique V. Carrera, Andres Gonzalez, Ricardo Carrera [3] proposed a new computer assisted diagnosis based on the digital imaging in order to help people detecting diabetic retinopathy in advance. The objective is to automatically classify the non-proliferative diabetic retinopathy grade of any retinal image. The NPDR can be subdivided into mild,moderate and severe. The initial image processing stage isolates blood vessels, microaneurysms and hard exudates. In the feature extraction stage the RGB image is transformed into CMY image to enhance the intensity of the features. The noise is removed using dilation and erosion techniques.The multi-class SVM(one-to-one) classifier is trained with all the features for classification. SVM can detect DR with sensibility of 95%,while DR can be classified with an average accuracy of 85%.The drawback is that proliferative DR is not implemented to identify severity of DR.

Z. A. Omar, M. Hanafi, S. Mashohor, N. F. M. Mahfudz M. Muna'im [4] proposed automatic diabetic retinopathy detection and classification system, this paper proposed an algorithm that consists of DR detection method with the aim to improve the accuracy of the existing systems. The methods used in this proposed paper are image pre- processing, vessel and hemorrhages detection, optic disc removal and exudate detection. The proposed algorithm was trained and tested using 49 and 89 fundus images, respectively. The images were obtained from DIARETDB1 database. All of the images were categorized into four DR stages, namely mild Non-Proliferative Diabetic Retinopathy (NPDR), moderate NPDR, severe NPDR and Proliferative Diabetic Retinopathy (PDR). The parameters used to evaluate the performance of the proposed algorithm are sensitivity, specificity and accuracy. The high accuracy of classification results showed that the proposed system is reliable and the implementation of the proposed system could tackle the limitation of the manual screening process.

Harini R and Sheela N [5] proposed a method using the FCM clustering and Morphological operations to extract Blood vessels, Microaneurysms and Exudates.The input image is first resized to 576x720,and then CLAHE, contrast enhancement is applied in pre-processing stage to improve the quality of image.The Gray Level Cooccurence Matrix(GLCM) is utilized to extract textural features. The classification is done depending on the area of blood vessel, area of microaneurysms, area of existed, the values of texture features namely contrast, correlation, energy and homgenity using SVM classifier. The proposed method achieves 100% Sensitivity, 95.83% specificity and 96.67% of accuracy. The disadvantage of this approach is it only classifies as normal eye and DR .Further classification of DR is not implemented.

Anaswara Chandran, Nisha K K and Dr.Vineeth S [6] proposed Computer Aided Approach for Proliferative Diabetic Retinopathy (PDR) Detection in Color Retinal Images. The aim of proposed method is to detect PDR from the texture features and vesselness features obtained from the retinal image. The images are collected from two publically available databases MESSIDOR and STARE, and from Local hospital. Dataset are classified into three severity groups; PDR, Non-Proliferative Diabetic Retinopathy (NPDR) and Normal. Initially the images are divided into patches and from the training set the portions with optic disk were manually removed to avoid false detections. Retinal images are divided into patches and the features are extracted from each patch. Random forest classifier, an ensemble method for the classification will predict the label for the patches, followed by a rule based decision for input image. It works with the deep decision trees trained with the train patches from three different datasets. The limitation is that the false detections has to be manually removed. Segmentation techniques are not used which could have improved the vessel map extraction.

Dhanasekaran, Mahendran, Murugeswari, Mofiya Fargana

[7] proposed Investigation of Diabetic Retinopathy using GMM classifier the proposed system uses Gaussian Mixture Model (GMM) classifier to identify whether the input retinal images are normal or abnormal images.It mainly consists of 3 steps, preprocesssing, Feature Extraction, Classification using GMM classifier algorithm. Preprocessing consists of three stages: colour space conversion, image enhancement and image restoration The resultant image of pre-processing stage is fed as input to the feature extraction stage. The feature extraction methods employed in this work are Gabor, SURF and SIFT. The resultant extracted image is applied for image classification. The Gaussian Mixture Model (GMM) Classifier is an useful and basic supervised learning classifier algorithm to classify a large group of N dimensional signals.. The retinal input image were collected from STARE database.The classifier classifies the input image as either normal or abnormal image. The abnormal image is further classified as moderately affected or severely affected image. The performance of the classifier is assessed by calculating the classifier accuracy for the GMM classifier. The average classifier accuracy is found to be 97.78%.

Deepthi K Prasad,Vibha L, Venugopal K R [8] proposed a automated diagnosis system of DR. It starts with a data accumulation stage where retinal fundus image are obtained from a dataset.In the next stage,the input images are preprocessed to minimizing the intensity variation effect in the background and to eliminate noise. Various features are extracted from the image in the following phase. For the selection of optimal, features, Haar wavelet transform and principal component analysis (PCA) is used. In the data mining phase,classification is performed separately using one rule classifier and BPNN classifiers, to label the image into diabetic or non-diabetic. The major advantage is that it is competent enough with an accuracy of 93.8% for back propagation neural network and 97.75% for one rule classifier thereby making it more efficient than other methods. As a future work, a multi stage classification can be implemented to identify severity of DR.

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[9] proposed Automatic Exudates Detection in Fundus Image using Intensity Thresholding and Morphology. In the proposed method of detection of exudates, two independent approaches based on intensity thresholding and morphological processing are strategically combined to detect any small exudates present while removing all possible types of false positives. This strategic combination removes the noise sources from blood vessels and reflections during image capture making the detection of exudates accurate. The first approach is based on intensity thresholding, which utilizes the higher intensity levels of exudates as compared to the background. The second approach is based on morphological processing. Experimental results indicate that the proposed method has good accuracy in exudates detection without compromising the computational time and hence can be considered for screening purpose of DR.

Handayani Tjandrasa, Ricky Eka Putra, Arya Yudhi Wijaya, Isye Arieshanti[10] proposed Classification of Non-Proliferative Diabetic Retinopathy(NPDR) based on Hard Exudates Using Soft Margin SVM. The proposed system consists of classification system of NPDR based on exudate features. The main processes in this study are exudate segmentation, feature extraction and the classification of NPDR severity level. The exudate segmentation process segments exudates in a color retinal fundus image, preprocessing these exudates consists of resizing and gray scaling of image. The next step is feature extraction. Feature extraction transforms the segmented exudates into a binary image. Then, the four features (area, perimeter, energy and standard deviation) of each exudate image are extracted in this process. Finally, the extracted features are trained and tested using soft margin SVM as a classification model. Classification of severity level using SVM .The images are obtained from messidor database which consists of 147 retina fundus image. The experimental result shows that soft margin SVM model achieves high accuracy (90.54 %) when classify retinal fundus images as moderate NPDR or severe NPDR.

3. CONCLUSION

The proposed work detects the Diabetic Retinopathy in both non-proliferative and proliferative stages. This study proposes a classification system of DR based on exudate features. The main feature in this study are preprocessing, exudate segmentation, feature extraction, and classification of DR. The retinal images are obtained from DIARETDB1 database. The input images are preprocessed and the features were extracted. Based on the features extracted, the classifier classifies whether the input retinal image is normal or abnormal. Then the abnormal image is again classified as moderately affected or severely affected image. The feature extraction plays a very important role as the features are used in both training and testing phase of the classification. The performance of SVM classifier is measured by calculating the classifier accuracy with respect to the number of images tested. The result of classification is very useful information to the ophthalmologists for diagnosing the disease diabetic retinopathy and applying the necessary treatment in an early stage.

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