METHODS FOR RETINAL HEMORRHAGE DETECTION AND CLASSIFICATION

Lekshmi Vikraman, Mrs. Janu R Panicker,
M.Tech Student, Assistant Professor,
Computer and Information Science, College of Engineering Cherthala
Alappuzha, Kerala

Abstract : Diabetic retinopathy (DR) is a potentially serious eye disease caused by diabetes that affects the retina. It is a light-sensitive tissue at the back of the eye that transmits visual messages to the brain. Damage to this soft tissue may result in visual impairment or blindness. The effect due to DR can reduce by early detection of Hemorrhages and treated at an early stage. In recent year, there is an increased interest in the field of medical image processing. Many researchers have developed advanced methods for Hemorrhage detection using fundus images. In this paper review techniques, and methodologies anteriorly proposed for the detection of hemorrhage from diabetic retinopathy.

IndexTerms **- Hemorrhage; Diabetic Retinopathy; Retinal Image; Image Processing; Medical Imaging**

I. INTRODUCTION

Diabetic retinopathy begins with a slight deterioration in the small blood vessels of the retina. The retina is organ of our body which converts light to signal which are sensed by optic nerve to the brain. In Diabetic retinopathy there is leak of fluid or hemorrhage in the retina resulting in distorted vision. The types of damages such as microaneurysms (MAs), hemorrhages (HEMs), exudates(EXs), and cotton wool spots (CWSs) etc that leads to diabetic retinopathy.

DR has classified into two types: First, stage is Non- Proliferative Diabetic Retinopathy (NPDR) in which symptoms will be mellow or non-existent that happen because of small amount of bleeding and fluid leaking into retina. Second, progressed or extreme stage is Proliferative Diabetic Retinopathy (PDR) happens because of new blood vessel beginning to develop in the eye that are fragile and can bleed. The diabetic retinopathy start with NPDR, firstly hemorrhage found where the disease progress the retinal vessel blocked and blood, fluid flow through the retina and cause blindness, So prior recognition of NPDR is helpful to improve automated screening system.

Diabetic Retinopathy is classified into 3 stages of nonproliferative retinopathy which are mild, moderate, and severe[13]. In Mild non-proliferative retinopathy microaneurysms, i.e., small swellings in the tiny blood vessels of theretina will be formed in this stage and exudates in case of fat or protein leakage. The Microaneurysm and hemorrhage are red in color while exudates are yellow. Moderate non-proliferative retinopathy stage the disease become progresses, some blood vessels that nourish the retina are blocked. In severe nonproliferative retinopathy, many more blood vessels are blocked, deposes several areas of the retina. The affected areas of the retina begin to show sign of ischemia (lack of oxygen) such as blot hemorrhages, bleeding of the veins and intra-retinal micro-vascular abnormalities.

One method to grade the DR is the Scottish Diabetic Retinopathy Grading Scheme[14]. An the other criterion for grading diabetic retinopathy[15] is taking numbers of microaneurysm and hemorrhages to grade the diabetic retinopathy stage. The aim of this paper is to review the relevant literatures in the field of hemorrhage detection and classification.

II. RELATED WORK

For early diagnosis of diabetic retinopathy detection of hemorrhage is most important factor. Recent survey indicate that many people suffer from diabetic which will effect the retina. This disease can be prevented by giving examination and treated in early stages. A lot of hemorrhage detection techniques have been proposed in the past. Here briefly mention here some of the methods that have been used in the past for detecting Diabetic Retinopathy in Retinal Hemorrhage.

Nutnaree Kleawsirikul, Smith Gulati et al. [1] used Morphological Top Hat and Rule-based Classification method for the detection of hemorrhage which is an early symptom of diabetic retinopathy. This method is an application of morphological operation together with rule-based classification. Here first, the fundus image is preprocessed and extract hemorrhage candidate. From the resulting image use morphological top hat operation, and rule-based classification to classify the hemorrhage based on predefined features such as instance, compactness, area and eccentricity. Opening operation is used on the image to obtain the filtered background using ball shape structuring element. Then the filtered background is subtracted from the original image. After that the image is binarized. This outputs the binary image with retinal vessels and hemorrhage candidates in white and the background in black. These white objects are called blobs. Here the study involves analysis of 7571 blobs from 20 fundus images. The proposed method is more reliable in terms of adaptability. If more images are added to thetraining set, the proposed method will have even better performance.

Harini R, Sheela N,et al.[2] proposed automated Detection of Diabetic Retinopathy using Feature Extraction and Classification. Here Fuzzy C-Means (FCM) grouping and morphological processing is proposed for the recognition of Diabetic Retinopathy. The characterization of images is finished by utilizing Support Vector Machine classifier. The Blood vessel can be separated using FCM clustering and Morphological processing is used for detecting microaneurysms, exudates. The exudates recognition, including the aftereffects of two morphological operation based methods. First strategy utilizes Top-Hat transformation and other method uses blood vessels removal, segmentation and logical AND operation. The microaneurysms area is identified by expulsion of blood vessels area from the larger area. The Gray Level Co-occurrence Matrix (GLCM) is used to separate textural features include contrast,correlation, energy and homogeneity. The arrangement is finished depending on the area of blood vessel, area of microaneurysms, area of exudates, and the values of texture features are classified using SVM

classifier. Here the performance of the classifier is assessed by considering the Accuracy, Sensitivity and Specificity. Performance of the classifier can be improved by including more number of textural features.

Priyakshi Bharali, Jyoti Prakash Medhi et al.[3] proposed a method for detection of Hemorrhages in Diabetic Retinopathy. Here appropriate preprocessing method and blood vessels elemination can be used to detected hemorrhage accurately. For hemorrhage detection, initially blood vessels are detected using median and average filtering , and then the image is processed in green channel of RGB color plane using region growing, morphological operations and modified NICKs local threshold algorithm. The algorithm calculates a pixel-wise threshold by sliding a rectangular window over the gray level image. This leaves behind the accurately detected hemorrhage candidates. Blood vessels are extracted accurately using region growing method. Median filtering is used for de-noising the retinal image and blur out the dark pixels. Then the result is subtracted from the original image. This output image contain only the information of BV and the hemorrhages. Then apply NICKs modified thresholding algorithm used for hemorrhage detection.

Amol Prataprao Bhatkar et al.[4] focus on detection of diabetic retinopathy in retinal images based on Multi Layer Perception Neural Network (MLPNN). Here the normal and abnormal images are classified using MLPNN classifier. The feature vector is formed with 64-point Discrete Cosine Transform (DCT) with different 9 measurable parameters. The parameters are entropy, mean, standard deviation, average, euler number, contrast, correlation, energy and homogeneity. A computerized screening framework is helpful for completely robotized mass screening. The system screens a large number of retinal images and recognizes abnormal images. The different modules of such automated system are Retinal Fundus Image input, Preprocessing, Feature extraction, formation of feature optimize vector, Multi layer perception (MLP) Classifier, Design of optimal MLP classifier by selecting hidden layers, learning rule, transfer function and step size etc and Testing of Cross validation/Test dataset. The features are first randomized and then fed to the MLPNN for training the neural network. The network test the feature vector of retinal images and then classify them into normal and abnormal images.

Inbarathi.R, Karthikeyan.R,et al.[5] proposes, a typical screening process for the Detection of Retinal Hemorrhage in Fundus Images by Classifying the Splat Features Using SVM. The obtained retinal images are pre-processed and set of splat features are separated. These features have been fed into the SVM classifier that are trained by supervised learning. The training data are from manually labeled features to detects the retinal hemorrhage and classifying the retinal abnormality. After pre-processing, retinal images utilizing pixel of same color and intensity, is partitioned into non-covering area called splat. The classification accuracy can be improve by Splat and GLCM feature. Some kind of splat features are color, splat area, texture, splat extent, splat orientation, Gaussian filter bank. Here, with the help of reference label the SVM classifier is prepared to recognize the hemorrhage by splat based feature vector. In order to arrange the given input images, filter and wrapper approaches are used to identify relevant and significant features. Then hemorrhage affected retina is detected by SVM classifier.

According to Smitha Meshram, Wani .V. Patil[6] deals with detecting and classifying three diseases of diabetic retinopathy that are macula Ischemia, neovascularisation and vitreous haemorrhage using image processing methods. Here automating detection of these three diseases in eye fundus images using digital image analysis methods. which allowing the examination of a large number of images in less time, with lower cost and reduced subjectivity than current observer-based techniques. This method also uses support vector machine(SVM) which is a supervised learning algorithm for both classification or regression challenges. Here LINDE-BUZOGRAY (LBG) image segmentation technique which can be used for segmentation and compression of images. Vector quantization is an efficient technique for image compression. The three diseases that have different features, and these are identified using feature extraction techniques. In this paper graph based method is used as a extracting technique for Macula Ischemia. Line Tracking method is used for Neovascularisation and Vector quantization is used for Vitreous haemorrhage. Finally, Support Vector Machine (SVM) classify image as normal, moderate or severe.

Anam Tariq, M. Usman Akram et al.[12], came with a new system for detection and classification of different DR lesions which are Microaneurysms (MAs), Hemorrhage (H), Hard Exudates (HE) and Cotton Wool Spots (CWS). It is a three phase frame work, the main stage extracts all possible candidate lesions exhibit in a fundus images using filter bank. Here utilizing different properties and features, feature sets are enumerate for each candidate lesion. Here proposed a method for classification of lesions contained in retinal image. It can be used as a screening system, but which only focus on abnormality detection. The 3 main fundamental phases of the system are image acquisition and preprocessing, candidate lesions extraction and feature set formation and detection of true lesions using classification stage. The lesions are developed and segmented using contrast enhancement technique and filter banks. Finally, the Support Vector Machine is used to classify the candidate regions into different lesions. The features of candidate regions is fed to SVM and it grades the candidate region in any of the four classes. Blood vessel and the pixels are wiped out in candidate detection phase to reduce the number of spurious lesions.

Dilip Sing, Shrutt Nair [8] proposes an approach for detecting DR. In this paper, fourteen features are a extracted from preprocessed images for quantitative analysis and the results are evaluated by considering the mean value and standard deviation for extracted features. The result attributed due to its complete absence in normal diabetic images and its simultaneous presence in the three classes of diabetic retinopathy images namely mild, normal and severe. The images were divided into two different datasets, the one was a normal stimulus, and the other was diabetic affected retinal images. The total 14 biologically significant features are extracted from normal and diabetic retinal fundus image data sets. Out of the total extracted features, seven most significant features are used for comparison and ranking these features is very simple and fundamental in the process of identifying a normal and a diabetic fundus image. From the results obtained, it is observed that exudate area is the best feature out of all the features which can primarily be used for diabetic detection, followed by blood vessels and other features, which suggests us that exudate is one of the major feature responsible for diabetic retinopathy. The features used in this study are specific due to their biological relevance and previously reported results. In future, many more features can be extracted from attributes such as red lesions, Kapoor entropy, edema, etc.

Reshma M. Mulla, Chavan M.S,et al.[9] proposes a hybrid method for automatically detecting hemorrhages. This scheme can be applied to the computer-aided diagnosis (CAD) system for diagnosing diseases detected in the eyes. Due to the detection of hemorrhages and exudates, efficiency and accuracy of diagnosing diabetic retinopathy has improved. Hybrid method Classification of DR is related on number of MA and hemorrhage present in the images. If there was no apparent retinopathy the the image was no any abnormality. If the presence of microaneurysms in fundus image then there will be a mild NPDR. If more

than just MA but less than severe NPDR and less then 20 hemorrhage then there will be a moderate NPDR. Definite bleeding, sign of proliferative and greater then 20 hemorrhage then it was classified as severe NPDR.

Li Tang, Meindert Niemeijer, et al.[10], method is a splatbased feature classification algorithm. This algorithm can be applied to detection of large and irregular hemorrhage. In supervised method, retinal color images are divided into non covering fragments covering the whole image, where each of the fragment is called splat. which contains pixels with comparative color and spatial area. From each splat a set of features are extracted to describe its characteristics. In this splat-based representation of images give a better way to model irregular shaped variation in medical images. In the view of neighboring pixels, the pixels are assembled into splat rather than the number of pixels contained in each splat. There are two major methodologies for feature determination: first is filter approach and the wrapper approach. After feature selection, the KNN classification algorithm identify irregular and large retinal hemorrhages. The supervised classification predicts the probability of splats being hemorrhages being with the ideal feature subset. From the resulting hemorrhages map, a hemorrhage index is assigned as the image level output. To model the shapes of various lesions efficiently, splat-based feature classification is used regardless of their changeability in appearance, texture or size

Priyanka Kale1, Prof. N. Janwe [11], proposed automated system used to identify patients having diabetic retinopathy using fundus images. Here extract texture features like standard deviation, area and size of pixels of image and apply classification on the basis of area and size of pixels and detect diabetic retinopathy diseases such as hemorrhages (red patches) which falls between normal, moderate and severe DR. The main aim of the system is to automatically classify hemorrhages from other symptoms of DR. Images processed with Contrast Limited Adaptive Histogram Equalization(CLAHE). The major goal of the CLAHE method is developed to define a point transformation within a local fairly large window. After enhancing the image, the designed matched filter is applied on the image to detect the blood vessels. ,The texture analysis used to extract feature values from the input images in feature extraction stage.

Kanika Verma, Prakash Deep et al.[7] propose a method which is based on nonparametric method. The aim of this work are: detection of blood vessels, detection of hemorrhages, and classification of different stages of DR such as normal, moderate non-proliferative diabetic retinopathy (NPDR) and severe NPDR. In this work[7] uses Random Forests(RF) classifier for classification. The Random Forests are ensemble methods using tree-type classifiers. In Blood Vessel Extraction, the RGB retinal image, contrast is greater when the green channel alone is utilized in image feature extraction. Adaptive histogram equalization is used to enhance the contrast of the features of interest against the background. The Classification of different stages of Diabetic Retinopthay is done by using Six features of the R, G, B components of the blood vessels such as area and perimeter and hemorrhages were obtained. Area is the number of white pixels present within the vessels and perimeter is the number of pixels present on the periphery of the vessels. These features are used as inputs to the Random Forests classifier for categorizing the three stages of retinal images.

Table 1: Comparison of different techniques

Technique	Classifier	Advantages	Disadvantages
Morphological Top Hat and Rule based[1]	Rule-based classifier	Robust, adaptive and efficient	Average sensitivity, specificity and low accuracy
FCM clustering and morphological operations are used to detect DR[2]	SVM	High sensitivity	FCM consume high computation time
Automated Computer Aided method used to detect haemorrhage[3]	Blood vessel extraction	High accuracy	Low sensitivity and high computation time
Detection of Retinopathy using MLP classifier[4]	MLP	High speed and specificity	Low accuracy and extract few features
Haemorrhage detection based on the size of lession[10]	Supervised Neural Network(NN)	High speed and sensitivity	Less accuracy and specifisity
Hybrid method for detect haemorrhage[9]	Hybrid classifier	High speed and saccuracy	Less specificity
Hemorrhages detection based on nonparametric method[7]	Random Forests(RF) Classifier	Detect haemorrage accurately	Low speed and less specificity

III. CONCLUSION

In recent years, people suffering from Diabetic retinopathy increases day by day. DR eventually lead to blindness. The Haemorrhage detection is a challenging task because of variation in the background. Similarly, Haemorrhage detection may difficult due to the confusion of different component present in the fundus image like blood vessels, microaneurysms, fovea etc. In this paper, review existing Haemorrhage detection methods so that based on this method researcher can implement a better Haemorrhage detection system.

REFERENCE

[1] Kleawsirikul, Smith Gulati, Automated Retinal Hemorrhage Detection Using Morphological Top Hat and Rule-based Classification in ICICS ,2013.
[2] Harini R, Sheela N, Feature Extraction and Classification of Retinal Images for Automated Detection of Diabetic Retinopathy" Second International Conference on Cognitive Computing and Information Processing (CCIP), 2015.
[3] Priyakshi Bharali, Jyoti Prakash Medhi, Detection of Hemorrhages in Diabetic Retinopathy analysis using Color Fundus Images in IEEE International Conference on Machine Learning and Applications, 2015.
[4] Amol Prataprao Bhatkar, Dr. G.U.Kharat, Detection of Diabetic Retinopathy in Retinal Images using MLP classifier inIEEE International Symposium on Nanoelectronic and Information Systems, 2015.
[5] Inbarathi.R, Karthikeyan.R, Detection of Retinal Hemorrhage in Fundus Images by Classifying the Splat Features Using SVM in International Journal of Innovative Research in Science, Engineering and Technology Volume 3, Special Issue 3, March, 2014.
[6] Smitha Meshram, Wani .V. Patil, An Efficient Automated System for Detection of Vision loss caused due to Diabetic Retinopathy inINTERNATIONALJOURNALOFENGINEERING SCIENCES AND MANAGEMENT, January-March, 2017.
[7] Kanika Verma, Prakash Deep and A. G. Ramakrishnan, Detection and Classification of Diabetic Retinopathy using Retinal Images in International Conference 2016
[8] Dilip Sing, Shrutt Nair, Diabetic Retinal Fundus Images: Preprocessing and Feature Extraction For Early Detection of Diabetic Retinopathy 2017.
[9] Reshma M. Mulla, Chavan M.S, Detection of Hemorrhage from Fundus Images using Hybrid Method in International Journal of Computer Applications (0975 8887) Volume 107 No 12, December , 2014.
[10] Tang, Meindert Niemeijer, Splat Feature Classification With Application to Retinal Hemorrhage Detection in Fundus Images in IEEE Transactions, 2013.
[11] Priyanka Kale1, Prof. N. Janwe2, Detection of Retinal Hemorrhage in Color Fundus ImageinInternational Journal of Advanced Research in Computer and Communication EngineeringVol. 6, Issue 3, March , 2017.
[12] Anam Tariq, M. Usman Akram, Computer Aided Diagnostic System for Grading of Diabetic Retinopathy in IEEE Transactions, 2013.
[13] Fleming, AD., Goatman, KA, et aI., JA Scottish Diabetic Retinopathy Clinical Research Network (2010), "The role of haemorrhage and exudate detection in automated grading of diabetic retinopathy" British Journal of Ophthalmology, vol 94, no. 6, pp. 706- 711.