Detection of microaneurysm in fundus retinal images using SVM classifier

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***Abstract*— An eye disease caused due to diabetes is called as Diabetic Retinopathy (DR).This effects on small blood vessels in the retina, which may lead to blindness. The first sign of DR is detecting microaneurysm(MA),which appears in small circular spot. In this paper we proposed a method for detecting microaneurysm in retinal fundus images.Support vector machine(SVM) is used for giving the grades such as Normal, Mild, Moderate,& severe condition, based on the parameters related with MA like Area, perimeter, eccentricity, centroid. Matlab based GUI is implemented. According to the parameters, Accuracy, Sensitivity, Specificity is calculated. According to the Experimental results SVM has 93.33% accuracy.**

***Index Terms*— Fundus images, Diabetic retinopathy (DR), Microaneurysm(MA), Support vector machine (SVM) classifier, GUI.**

I. INTRODUCTION

Diabetes is a rapidly increasing worldwide problem which is characterized by defective metabolism of glucose that causes long-term failure of various organs. The most common complication of diabetes is Diabetic Retinopathy (DR), which is one of the primary causes of blindness and visual impairment in adults. Hence early detection through regular screening and timely intervention will be highly beneficial in effectively controlling the progress of the disease. Since the ratio of people affected. With the disease to the number of ophthalmologists who can screen these patients is very high, there is a need of automated diagnostic system for diabetic retinopathy changes in the eye so that only diseased persons can be referred to the ophthalmologists for further intervention and treatment.

Microaneurysms(MA) are the first clinical sign of diabetic retinopathy. The key to the early detection of DR is to recognize Microaneurysms (MAs) in the fundus of the eye in time. MAs appear as small circular dark spots on the surface of the retina and number of Microaneurysms indicate the severity of the disease. Their walls are thin and rupture easily to cause Haemorrhages, which is the next or moderate stage of Diabetic Retinopathy (DR) and if not examined or treated in time, disease may spread and lead to further stages of DR like Hard and Soft exudates or Neovascularisation which are the severe stages and may cause blindness in the patients.

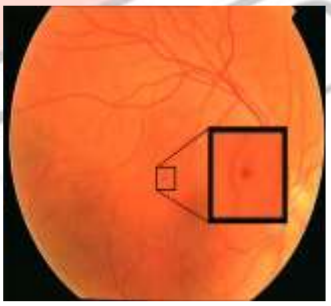

Fig. (a) Sample digital fundus image with a Microaneurysm(MA).

This paper is organized as follows: A brief description on diabetic retinopathy is given in section II. Section III describes previous work related with detection of Microaneurysm(MA), Methodology is presented in section IV. In section V results are discussed. And conclusions are drawn in section VI.

II DIABETIC RETINOPATHY

Diabetic retinopathy (DR) is a disorder of the retina that eventually develops to some degree in nearly all patients with long-standing diabetes mellitus. Diabetic retinopathy is a common complication of diabetes which affects the small blood vessels in the lining at the back of the eye. This lining is called the retina.The retina helps to change what you see into messages that travel along the sight nerve to the brain. A healthy retina is necessary for good eyesight. Diabetic retinopathy can cause the blood vessels in the retina to leak or become blocked and damage the sight. When someone has diabetes for long time, the blood vessels in the retina become thicker and the blood flowing in the blood vessels slows down. People with diabetes are 25 times more likely to develop blindness than individuals without diabetes. For any type of diabetes, the prevalence of diabetic retinopathy in people more than 40 years of age was reported to be 40.3%. In the early stages, diabetic retinopathy will not affect the sight, but if the changes get worse,

eventually the sight will be affected. The diabetic retinopathy typically begins as small changes in the retinal capillaries. The smallest detectable abnormalities, Microaneurysms (MA) as shown in figure (a), appear as small red dots in the retina.

Fig.(b) Normal vision & Diabetic Retinopthy

III LITERATURE SURVEY

Manasi Purandare *et.al* [1] proposed a hybrid system for automatic classification of DR,in which various features like blood vessels area, exudates area, bifurcation point and these features are applied to SVM classifier. This classifies the subjects to Normal and DR.

Vijay M Mane *et.al* [2] proposed an algorithm for red lesion detection. For enhancing blood vessels Modified matched filter is implemented & entropy thresholding is used for segmentation of blood vessels.

Arjun Narang *et.al* [3] represented a system for detecting hard exudates based on Lifting wavelate transform and for classification SVM classifier is used.

To identify abnormal region on fundus images region based approach is used .Two different classifiers are used SVM & MLP (Multilayer percepton) [4].

Eman M.Shahin *et.al* [5] proposed a system for automatic classification of normal and abnormal retinal images by detecting MAs, hard exudates, entropy and blood vessels etc. These objectives are fed to artificial neural network (ANN). For automatic classification.

IV METHODOLOGY

In this work, we have proposed a system based on the image processing for detecting Microaneurysm in fundus retinal images. The features are fed to the support vector machine (SVM). The system can help the ophthalmologist to detect diabetes retinopathy at the early stage.

The method adopted in this for early detection of DR disease in humans is reliable and shows accurate results. The method implemented can be used for screening of patients eyeballs for detecting level of DR in a cost effective manner. This technique helps in determining levels of DR in its early stage and thus preventing vision loss.

A.Materials A total color images were obtained from Nandadeep eye hospital, Sangli. The retinal images were taken using fundus camera VISUCAM NMPIA ZEISS.

Fig. shows the flow chart of proposed system. The database contains 50 fundus images. The input image taken is of 640*640 pixels.

Fig. (c) Input Image.

The image is taken from database. The first step is to read 3D RGB image, after that green channel is extracted, because fundus image absorbed less green light. Hence MAs are represented with highest contrast in green channel.

B.Preprocessing: Pre-processing of fundus images is required in order to obtain an image which is noise free and contrast enhanced.

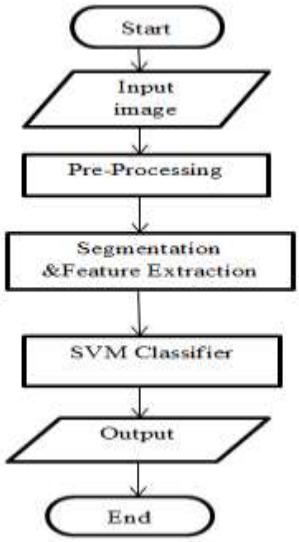

Fig (d) flow chart for proposed system.

To reduce the imperfections such as poor contrast and noise and to form an image more suitable for extracting pixels features required for classification stage preprocessing is done.

1. Walter–Klein Contrast Enhancement-This method is used for improving the contrast of retinal images. This can be done by applying grey level transformation. [6]
2. Contrast limited adaptive histogram equalization (CLAHE) – To make major part of an image more clear and visible and also to enhance the clarity this method is used. [7]
3. Vessel Removal-MAs near vessels can be easily identified with the help of this method. [8 ,9]
4. Illumination Equalization-This step helps to enhance the MAs which appear on the border of retina & also uneven illuminations are getting reduced. [10]

Algorithm	Purpose
Walter–Klein	Enhancing Contrast
CLAHE	Enhancing Major Objects
Vessel Removal	Enhancing MA near vessels
Illumination Equalization	Enhancing MA at the border

Table.1 Summary of preprocessing method.

C) Segmentation & Feature Extraction:

Image segmentation is to partition an image into mutually exclusive and exhausted regions. The feature extraction includes evaluating the various features of a segmented image in order to form a feature vector required to input the SVM classifier. The feature extraction is a process where various features of the segmented image are extracted. The feature extraction is a process where various features of the segmented image are extracted.

1. Walter: Extraction is completed by greyscale diameter closing. This method is help to find out small dark patterns on green channels. Finally grey threshold is applied.[11]
2. Flem: This uses contrast normalization method .This increases the capability to differentiate MAs and other dark spots which appear on the retina. [12]
3. Zhang: A hierarchical approach based on multiscale correlation filtering is used to detect all MAs from color retinal images. This can be done by maximal correlation coefficient with 5 Gaussian masks. The correlation response is threshold. [13]
4. Lazar: To make multidirectional height map pixel-wise cross sectional profile with multiple orientations are used. This map gives set of height values which defines the distinction of the pixel from its surroundings. [14]
5. Circular Hough-Transformed image:

It is a basic technique for detecting circular objects. This is feature extraction technique used to find the circles in imperfect image input. [15]

Algorithm	Method
Walter	Diameter closing
Flem	Contrast normalization.
Zhang	Matching multiple guassian masks.
Lazar	Cross section profile analysis
Circular Hough-Transform	Circular hough transformation

Table.2 Summary of candidate extraction

D) SVM Classifier:

In machine learning, support vector machines (SVM) also support vector networks are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification.

The SVM classifier is a technique in which, the classifier undergoes two phases: Learning/Training phase and Testing Phase. The Learning Phase is wherein the classifier is made to learn the known set of images. Here the feature vector of each known image is fed to the classifier and the output is labeled accordingly. The Testing Phase is wherein the unknown images feature vector is fed to the classifier and based on its mapping with the Learning Phase, the image is classified appropriately. [16] The features extracted are fed to SVM classifier to classify the images for levels of DR in patients. Classification done to detect Microaneurysm and grading is given.

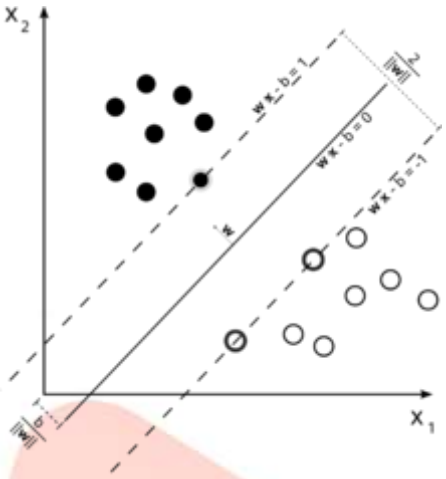

Fig. (e) SVM Classifier

V EXPERIMENTAL RESULTS AND DISCUSSION

The proposed system gives the classification of the images using SVM. From the database 30 images are tested & accuracy obtained is 93.33% using SVM classifier. The images are classified and grading is given.

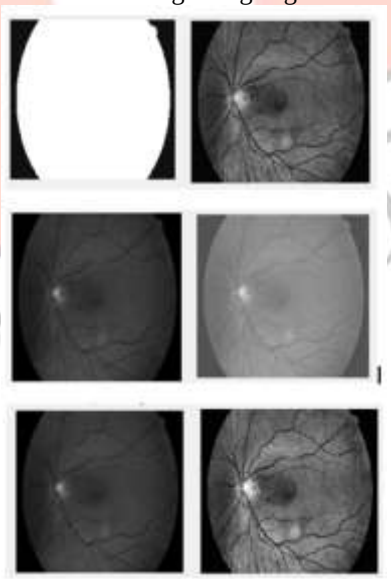

Fig.(f) Result of Preprocessing.
(Contrast enhancement,CLAHE,Vessel removal,illumination equalization No preprocessing,clahe image)

Fig. (g) Final result with grade.

The performance of classification can be examined by sensitivity, specificity, and accuracy. Here TP(true positive), TN(true negative), FP(false positive),& FN(false negative).

$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

$$\text{Specificity} = \frac{TN}{TN+FP}$$

$$\text{Accuracy} = \frac{TP+TN}{TP+FN+TN+FP}$$

Author	Method	Accuracy
R.Priya	PNN	89.60%
Md.Jahiruzzaman	K-means clustering	92.3%
K.Narasimha	Bayesian	90%
Proposed	SVM	93.33%

Table3.Comparision of our Technique with previous methods.

The proposed technique is compared with existing methods. [17,18, 19]. The accuracy of proposed system is good.

VI CONCLUSION

Diabetic Retinopathy (DR) if left untreated may cause the blindness. The input images from the database have poor quality. So preprocessing is done. For classification purpose features were extracted from preprossed image. DR has been classified and grading is given using SVM.SVM is good in performance as compared to others. Thus this system gives successful diagnosis with accuracy 93.33%. Therefore, this tool not only detects microaneurysm but also the further stages of DR, which could assist the ophthalmologists accordingly for intervention, thus making it a very effective tool for effective screening of Diabetic Retinopathy patients.

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