INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD
ISSN: 2455-0620 [Impact Factor: 6.719]
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value : 86.87
Volume - 8, Issue - 2, FEB - 2022 Publication Date: 28/02/2022

Diabetic Retinopathy Detection by Area and Microaneurysm from Colour FundusImage

[1] Mr.Nikunj Bhavsar, [2] Mr. Arpit S Shah
[1] Assistant Professor, Parul University, Gujarat, India
Email - Nikunj.bhavsar14521@paruluniversity.ac.in

[2] Assistant Professor, Parul University, Gujarat, India
Email - Arpitkumar.shah14454@paruluniversity.ac.in

Abstract: *This paper presents an improved method of diabetic retinopathy diagnosis based on identification of microaneurysms from color fundus images.* The need for regular screening of eyes is vital to detection and treatment of diabetic retinopathy. An eye disease caused by diabetic retinopathy (DR) is caused by damage to the retina after a long illness with diabetes. An aneurysm (MA) is a small red spot on the retina caused by a fragile part of the blood vessel expanding. The role of MA recognition at the primary stage is essential to inhibiting DR. A variety of methods have been proposed for diagnosis and detection of DR. In this paper, two features of MA have been identified: the number of MAs and the area of MAs. The pre-processing techniques used initially included green channel extraction, histogram equalization, as well as morphological processes. The method of principal component analysis (PCA), contrast-limited adaptive histogram equalization (CLAHE), morphological process, and averaging filtering have been used to detect microaneurysms. Support Vector Machines (SVMs) have been applied to categorize DR. DR detection system has a sensitivity of 96% and a specificity of 92%.

Keywords: *Diabetic retinopathy, Microaneurysm, PCA, CLAHE, Morphological process, SVM.*

1. INTRODUCTION :

Agreeing to WHO (world wellbeing organization) more than 347 million individuals are enduring from diabetes and it'll be 7th noticeable reason of passing around the world in 2030 [1]. Over the a long time, patients with diabetes tend to appear variation from the norm in retina, due to developing deterrent called DR. Individuals over 30 a long time having diabetes for more than 15 a long time, carry 78% chance of creating DR. [1]. DR is due of long term standing of diabetic mellitus. Retinopathy implies- harm of retina and as a result, the blood vessels gotten to be choked, cracked and develop subjectively [2]. DR is asymptomatic; it does not influence with see until it comes to at advance arrange. In this manner, screening of DR is significant for type1 (affront subordinate) and type2 (non affront subordinate) diabetic patients as both sorts are at hazard of Diabetic retinopathy. DR has two stages, to be specific non proliferative diabetic retinopathy (NPDR) and proliferative retinopathy (PDR). NDPR is early arrange of retinopathy.

In this organize, blood vessels diminish in measure, extend like swell and harm retinal blood vessels (RBV) start to spill liquid into retina. PDR is progress organize of retinopathy. In this arrange, unusual RBV drains into vitreous. In expansion to this, scar tissue may be shaped from cracked blood vessels, which may drag on the retina driving to retinal detachment. The point of this paper is to create a framework that will be able to recognize patients with DR from retinal colour fundus pictures. Colour fundus pictures are broadly utilized for early location of diabetic retinopathy. Test of computerized retinal colour fundus picture is appeared in Fig 1. Microaneurysm, retinal hemorrhages, difficult exudates, and cotton fleeces are the different demonstrative highlights of diabetic retinopathy. In this paper, we are centering on the early location of diabetic retinopathy by finding the microaneurysm in fundus pictures. Microaneurysms are little ruddy specks on retina which is the primary critical sign of diabetic retinopathy. Pre-processing is important stage of detection of microaneurysm.

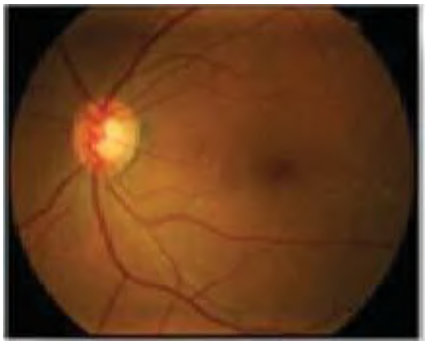

Fig 1. Sample digital colour fundus image

Since restorative pictures endure from uneven brightening, destitute differentiate and clamor. There are a few strategies proposed to distinguish DR utilizing computerized colour fundus picture. All strategies require a pre-processed picture. Pre-processing of fundus picture is executed in arrange to extend the differentiate. Highlight extraction plays lead part in computer vision. Extricated highlights are utilized for preparing the parameters of classifier. Classification of diabetic retinopathy is performed by back vector machine (SVM). SVM minimizes upper bound of generalization blunder through maximizing the edge between the isolating planes and information. SVM has extraordinary victory in classification. It can moreover be utilized for relapse. Optimization is accomplished by Lagrange multiplier and Quadratic Programming. The paper is composed in taking after ways: segment II contains writing audit of related work on mechanized strategy for diabetic retinopathy discovery, particularly on microaneurysm discovery. Segment III clarifies pr.

2. LITERATURE REVIEW:

Diabetic retinopathy screening and diagnosis is a popular research topic, and many research scholars are working to advance the field's knowledge in this area. Automated detection of diabetic retinopathy screening was proposed to address the issues associated with manual screening, such as high cost, low sensitivity and specificity, time consuming, and low human detection ability. The goal of automated detection for screening is to determine whether or not further treatment is required. Sergio Bortolin junior et al. [1] proposed an automated detection of microaneurysms and haemorrhages in colour eye fundus images. This method consists of five steps: pre-processing, enhancement of low intensity structure, detection of blood vessels, elimination of blood vessels, and elimination of fovea. Pre-processing is done with the green channel and CLAHE. The use of alternating sequential filtering was used to improve low-intensity enhancement (ASF). Blood vessel detection and removal were accomplished using ASF and morphological opening with a multiscale structuring element. Sarni Suhaila Rahim and her colleagues. [2] proposed a few strategies for location of microaneurysm. In framework I, they have utilized versatile histogram equalization, discrete wavelet change, and sifting and morphology prepare for pre-processing. Region of pixels, cruel and standard deviation are the extricated highlights of DR. Choice tree, K-nearest neighbor, polynomial bit SVM and Outspread premise work (RBF) part SVM have been utilized for classification. Result of framework I has been appeared in [3]. For pre-processing, they used histogram equalisation, shade correction, vessel segmentation, and morphological operations. The pre-processed fundus images are used to extract features such as pixel area, mean, and standard deviation. Diabetes retinopathy has been detected using decision trees, KNN, and SVM. Balint Antal and colleagues. [4] has proposed an ensemble-based system for detecting microaneurysms. To improve microaneurysm detection, they proposed an ensemble-based framework. They used a combination of pre-processing techniques such as Walter-Klein contrast enhancement, contrast limited adaptive histogram equalization (CLAHE), vessel expulsion and extrapolation light equalization and candidate extractors are utilized in location of microaneurysm. MAs extraction based on their perceivability & spatial area. An versatile weighting approach for ensemble-based MAs location too displayed. Sopharak A et al [5] proposed crossover strategy for fine MAs location from non-dilated DR retinal pictures, utilizing numerical morphology, naïve Bayes classifier. Adal K M et al.. [6] utilized scale-adopted blob examination and semi-supervised learning for mechanized discovery of microaneurysms and assess the execution on ROC competition database. R. A. Welikala et al. [7] utilized two vessel division strategies, such as standard line administrator and adjusted line administrator and last mentioned apply SVM for double classification. PROPOSED DIABETIC RETINOPATHY DETECTION SCHEME Diabetic retinopathy detection system consists three main steps: Techniques for pre-processing, feature extraction, and classification A variety of techniques for

pre-processing, feature extraction, and classification of DR have been proposed in the literature. To improve DR detection, we propose various combinations of pre-processing, feature extraction, and classification techniques.

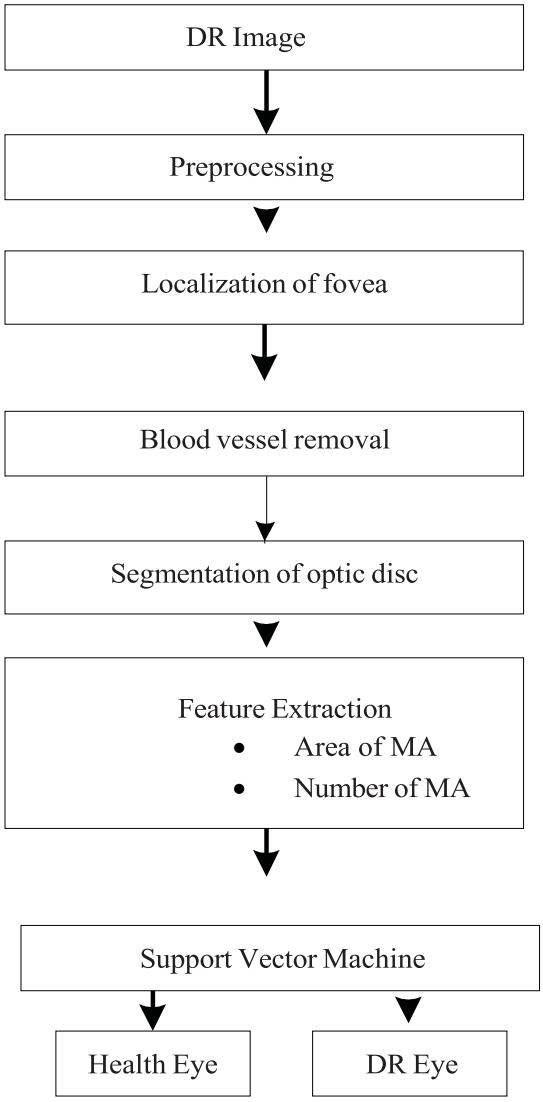

Figure 2 depicts the system's architecture. The fundus images are from the DIARETDB1 database.

A. *Pre-processing*

Because colour retinal fundus images frequently exhibit light variation, poor contrast, and noise, they must go through a pre-processing stage. The enhancement is required because fundus images have non-uniform illumination and noise. The contrast of the fundus image is improved through pre-processing. Some information, such as the red and blue components of the image, is commonly discarded before processing in order to improve the contrast of retinal images. The green channel is widely used in pre-processing because it has the best vessel/background contrast and the greatest contrast between the optic disc and retinal tissue. The red channel is relatively bright, and the vascular structure of the choroid can be seen. The retinal vessels are visible as well, but with less contrast than the green channel.

Enhancement of contrast ADHE computes several image histograms and uses them to reallocate image intensity values. As a result, ADHE is more appropriate for improving regional contrast and edge enhancement in each image region [8]. For noise removal, a mathematical morphology operation is used. The closing operation is used to remove noise from the object region. Pre-processed images have been shown in Fig. 3.

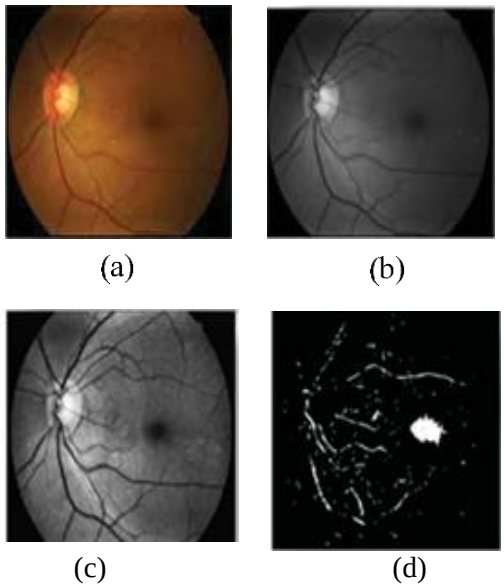

Fig. 3 (a) Colour fundus image of eye (b) Green channel image (c) Enhanced image (d) Pre-processed image

Exudates are extracted from a colour fundus image after pre-processing. Exudate detection is required in the detection of microaneurysms because the colour of exudates is the same as that of the microaneurysm. The pre-processed green channel image is obtained for detection of exudates, which is then enhanced by ADHE. After that a marker has been generated using median filter which subtracted from the median filtered image using morphological process to extract the exudates. Exudates extraction image is shown in Fig. 4

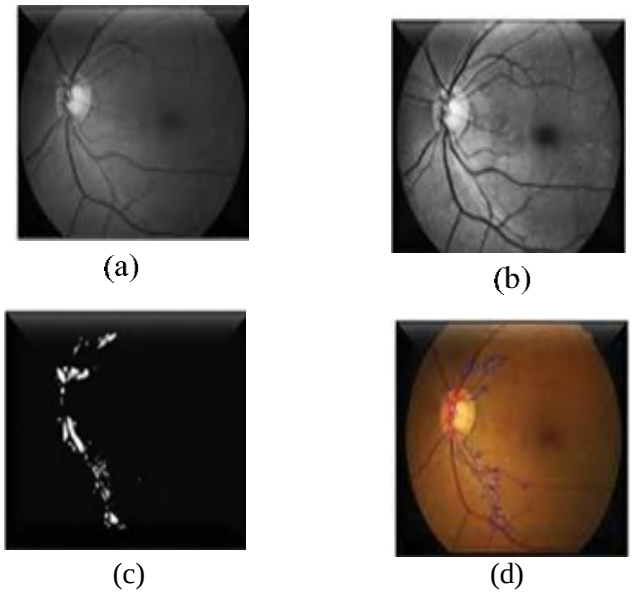

Fig. 4 (a) Green channel image (b) ADHE image (c) Extracted exudates (d) Exudates in colour image

After the exudates have been extracted, blood vessels are removed. To improve contrast, the RGB image is first converted into a grey channel. Principal component analysis is used to convert greyscale images (PCA). PCA is a statistical procedure that employs an orthogonal transformation to convert a set of observations of potentially correlated variables into a set of correlation and dependence variable values known as principal components. PCA is a powerful data analysis tool [9], [10]. It is primarily employed in dimensional reduction. It is used here to convert a three-dimensional (RGB) matrix to a two-dimensional matrix (grey). CLAHE is also used to improve contrast. CLAHE is primarily used to improve low contrast retinal images. In case of CLAHE, a transformation function is derived to each neighbourhood pixel using a contrast-limited procedure CALHE was created primarily to prevent the over amplification of noise caused by ADHE [8]. Background is removed by averaging and subtracting the enhanced image from the enhanced image. After removing the background, the

image is converted to binary scale, and the retinal blood vessels are extracted. Resulting image is shown in Fig. 5.

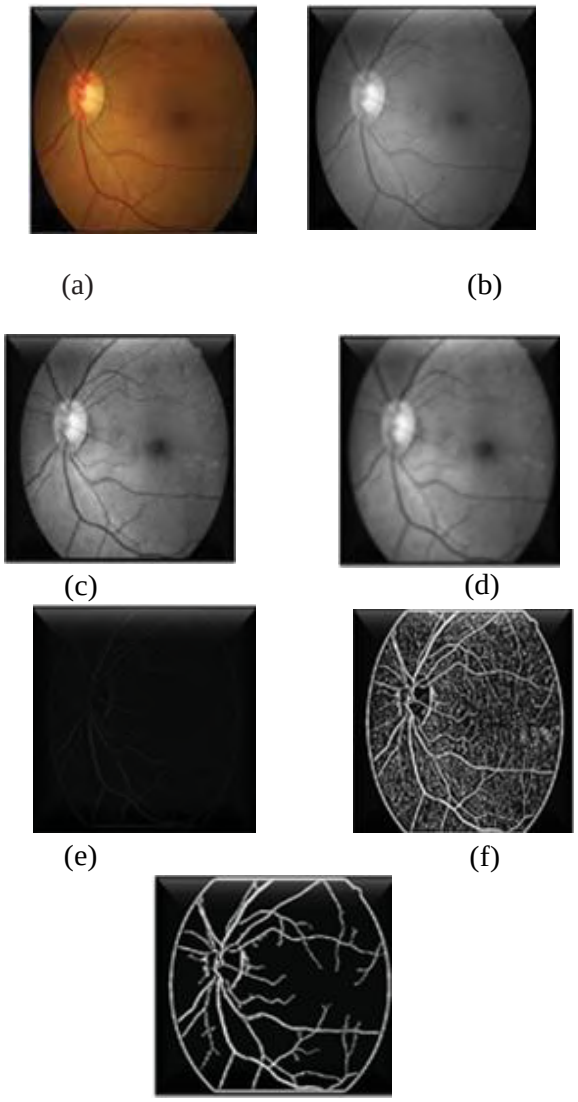

Fig. 5 (a) Colour fundus image (b) Gray image (c) CLAHE image (d) Filtered image (e) Difference of filtered and gray image (f) Binary image (g) Extracted blood vessels.

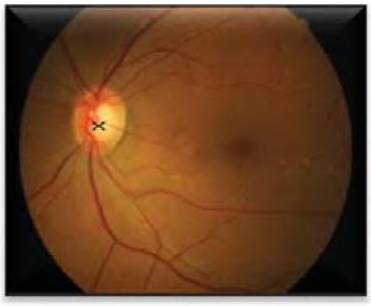

Fig. 6 Located optic disc in colour image

Fig. 7 (a) Pre-processed image (b) Fovea

Fig.8. Extracted microaneurysm from fundus image

The optic disc is segmented in two steps: localization and detection. To begin, we create a template by blurring an image with a (6x6) window and extracting the (80x80) pixel optic disc. Furthermore, we extract and store the histograms of the colour components such as red, blue, and green. This process is repeated on all images in the database, and the average is calculated. Located optic disc is shown in Fig. 6.

A pre-processed image was used to localise the fovea. Because fovea contains more area than other structures, the basic morphological operation is used to remove less than 25 pixels. Fovea localization is essential since it helps to reduce the false detection of microaneurysm. Its area varies from image to image. Fovea is shown in Fig. 7 (b).

By subtracting the exudates, blood vessels, optic disc, and fovea from the pre-processed image, a microaneurysm was detected. Extracted microaneurysm has beenshown in Fig. 8.

B. *Feature Extractions*

Fundus images have been used to extract two features of microaneurysms: the area of the microaneurysm and the number of MAs.

The total number of white pixels in the extracted image of microaneurysms, as shown in Fig. 8, is used to calculate the area of the microaneurysm. The number of microaneurysms is calculated as the number of discontinuities between white and black pixels.

C. *Classification*

For DR detection, an SVM classifier was used. SVM divides the image into two categories: DR eye and healthy eye. SVM classifier parameters were calculated using microaneurysm features.

D. *Support vector machine (SVM)*

SVM is derived from learning theory by Bladimir Vapnik.

Sensitivity is defined as the ability of a test to detect correctlypeople with disease.

Objective function in SVM is convex function which neverstuck into the local maximum. Optimal hyperplane is the form of the separating hyper plane and objective function of optimization problem do not depend explicitly on dimensionality of the input vector but depends only on the inner products of two vectors. This fact allows to construct the separating hyperplanes in high dimensional spaces (even in infinite dimension) [11].

The SVM parameters were trained using two input features: the area of MAs and the number of MAs. The average number and area of microaneurysms are used as a criterion for DR classification. SVM parameters were trained using a linear kernel with fivefold validation. After training the SVM, new testing data is fed into the SVM classifier, yielding a better result.

Sensitivity is defined as the ability of a test to detect correctly people with disease.

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

Specificity is defined as the ability of a test to exclude properly people without disease condition.

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

separating hyperplanes in high dimensional spaces (even in infinite dimension) [11].

The SVM parameters were trained using two input features: the area of MAs and the number of MAs. The average number and area of microaneurysms are used as a criterion for DR classification. SVM parameters were trained using a linear kernel with fivefold validation. After training the SVM, new testing data is fed into the SVM classifier, yielding a better result.

3. RESULT :

The outcome of the DR diagnosis is depicted in Fig. 9. One hundred ten images (normal and abnormal) were taken from the DIABETDB1 database. Fifty-eight eye images are used as a training sample with fivefold validation, and fifty-two images are used as a testing sample. As shown in Fig. 9, there are six testing samples in the result that accurately classify using the linear SVM classifier. The simulation was carried out in MATLAB R2015a. The sensitivity and specificity of the proposed DR detection system are used to assess its accuracy.

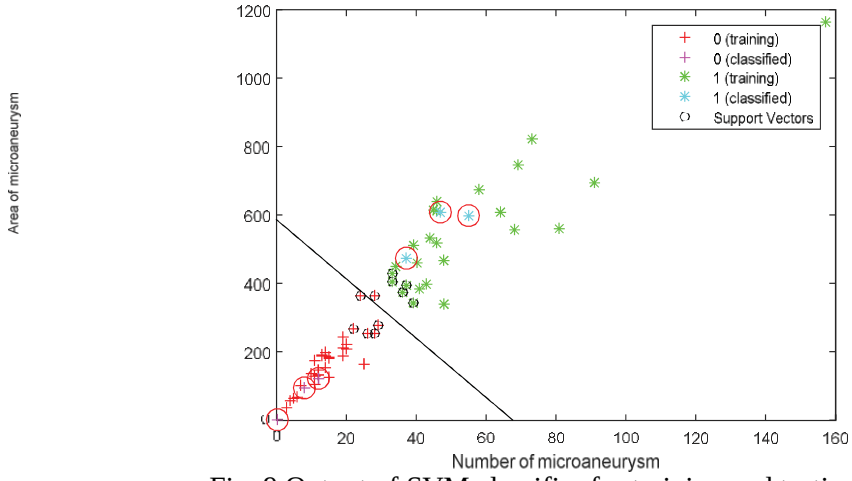

Fig. 9 Output of SVM classifier for training and testing images

TABLE 1. COMPARE RESULT OF PROPOSED METHOD AND SARNI SUHAILA RAHIM ET AL. METHOD

	Sarni Suhaila Rahim et al. method		Proposed method
	RBF kernel SVM	Polynomial kernel SVM	Linear kernel SVM
Sensitivity	0.81	0.80	0.96
Specificity	1	0.55	0.92

When a test result is positive and an individual develops the disease, this is referred to as a TP (True positive). When the result is negative, the individual cannot have the disease. This is referred to as a TN (True Negative). When a test result is positive but the individual is unable to express it, this is referred to as a false positive (FP). When a result is negative and an individual can have it, this is referred to as a false negative (FN). This system has a total of twenty-five true positives, twenty-four true negatives, two false positives, and one false negative. The proposed system's sensitivity and specificity have been calculated to be 96 and 92 percent, respectively. Table 1 compares the results of the proposed DR detection scheme with those of Sarni Suhaila Rahimet al.

detection system [3]. Proposed method gives better sensitivity and specificity.

4. CONCLUSION

This study presented an improved method for detecting diabetic retinopathy by accurately determining the number and size of microaneurysms. The achieved sensitivity and specificity values indicate that the proposed diagnostic system is superior for detecting non-proliferative diabetic retinopathy. This paper's future work will propose a proliferative diabetic retinopathy detection system based on cotton wools and abnormal blood vessels as features in colour fundus images. By using Feed Forward Neural Network, Radial Basis Function Neural Network (RBFNN), and SVM, the DR detection system could be extended to classify diabetic retinopathy into healthy, mild non-proliferative, moderate non-proliferative, severe non-proliferative, and proliferative diabetic retinopathy.

REFERENCES

1. Segio B. Junior and D. Welfer, "Automatic Detection of Microaneurysms Ang Haemorrhages in Color Eye Fundus Images," *Southeast Asian J Trop Med Public Heal.*, vol. 34, no. 4, pp. 751–757, 2003.
2. S. S. Rahim, C. Jayne, V. Palade, and J. Shuttleworth, "Automatic detection of microaneurysms in colour fundus images for diabetic retinopathy screening," *Neural Comput. Appl.*, vol. 27, no. 5, pp. 1149– 1164, 2016.
3. S. S. Rahim, V. Palade, J. Shuttleworth, and C. Jayne, "Automatic Screening and Classification of Diabetic Retinopathy Fundus Images," *Commun. Comput. Inf. Sci.*, vol. 459 CCIS, no. Dm, pp. 113–122, 2014.
4. B. Antal and A. Hajdu, "Improving microaneurysm detection in color fundus images by using context-aware approaches," *Comput. Med. Imaging Graph.*, vol. 37, no. 5–6, pp. 403–408, 2013.
5. Sopharak, B. Uyyanonvara, and S. Barman, "Fine Microaneurysm Detection from Non-dilated Diabetic Retinopathy Retinal Images Usinga Hybrid Approach," vol. II, pp. 6–9, 2012.
6. K. M. Adal, D. Sidibé, S. Ali, E. Chaum, T. P. Karnowski, and F. Mériaudeau, "Automated detection of microaneurysms using scale- adapted blob analysis and semi-supervised learning," *Comput. Methods Programs Biomed.*, vol. 114, no. 1, pp. 1–10, 2014.
7. R. A. Welikala *et al.*, "Automated detection of proliferative diabetic retinopathy using a modified line operator and dual classification," *Comput. Methods Programs Biomed.*, vol. 114, no. 3, pp. 247–261, 2014.
8. Sharad Kumar Yadav, Shailesh Kumar, Basant Kumar, and R.Gupta "Comparative Analysis of Fundus Image Enhancement in Detection of Diabetic Retinopathy." *Humanitarian Technology Conference (R10-HTC), 2016 IEEE Region 10,* 21-23 Dec. 2016
9. W. Zhou, C. Wu, D. Chen, Y. Yi, and W. Du, "Automatic Microaneurysm Detection Using the Sparse Principal Component Analysis-Based Unsupervised Classification Method," *IEEE Access*, vol. 5, pp. 2563–2572, 2017.
10. Deka and K. K. Sarma, "SVD and PCA features for ANN based detection of diabetes using retinopathy," *Proc. CUBE Int. Inf. Technol. Conf. - CUBE '12*, no. April, p. 38, 2012.
11. E. Ricci and R. Perfetti, "Retinal blood vessel segmentation using line operators and support vector classification," *IEEE Trans. Med. Imaging*, vol. 26, no. 10, pp. 1357–1365, 2007.