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Survey on Diabetic Retinopathy Detection from Retinal Images

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Abstract: ***Diabetes is the term most commonly referred to diabetes mellitus. DM is a condition in which the body is not able to satisfactorily process ingested sugar. Diabetic Retinopathy (DR) is a disorder of the retina resulting vision loss. It is usually due to damage to the blood vessels of the retina, occurring (for example) as a complication of diabetes (diabetic retinopathy) or high blood pressure. For the analysis and detection of DR retinal fundus images are commonly used. Therefore, to detect these retinal abnormalities such as blood vessels, exudates, haemorrhages, microaneurysms automatic detection systems are used. So the automated analysis of the fundus image is an important task which will be helpful for the doctors to analyse any sectional blindness or thorough blindness. The objective is to present briefly various works in segmenting and detecting different lesions occurring in diabetic retinopathy patients. In this paper, we present a review for the detection of diabetic retinopathy from retinal images and few approaches of SVM and KNN.***
Keywords: Diabetic Retinopathy, Retinal Images, SVM, KNN.

I. INTRODUCTION

Diabetes mellitus (DM) is diabetes that starts in childhood or adolescence, is usually more severe than that beginning in the middle or old age. Lack of balance in the diet or the amount of insulin takes lead to hypoglycemia. As a result of the imbalance, the body is adversely affected. However, a great many diabetic lead healthy, normal lives through a program of balanced diet and medication. When the diabetic's condition is not controlled, certain disorders may occur. Long term complications of diabetes include thickening of the arteries, which can affect the eyes which is called as diabetic retinopathy. Diabetic retinopathy is a silent disease. This disease can be effectively treated only in its early stages. This is the reason why early detection is very important by regular screening. Automatic screening reduces the human effort but the expense in this case is quiet high. This can be made cost effective; by detection of different retinal features in retinal images should be automated though digital image capturing and image processing techniques. It has been seen that periodic screening and treatment done on timely basis reduces the risk of blindness.

This paper is further organized in three sections. Section II is a brief introduction on diabetic retinopathy and Section III gives a survey of different existing works on diabetic retinopathy detection.

II. DIABETIC RETINOPATHY

Examination of eyes with diabetic retinopathy shows thickening of membranes, loss of pericytes and progressive closure of the retinal capillaries. Formations of dilations of vessels which are microaneurysms are the initial loss of pericytes. Leakage of vascular contents into the surrounding area is mostly due to breakdown of the blood-retinal barrier. Hard exudates and some localized deep haemorrhages are present around such areas. Poor control of diabetes mellitus is associated with the early onset of diabetic retinopathy. Diabetic retinopathy may affect both old and young, for it is the diabetic age and not the chronological age that is important.

Blood vessels are the main source of nourishment of retina starts leaking the fluid and blood in DR, which results in formation of red and white lesions. Various lesions are explained as: The first ting in detection of DR is segmentation of blood vessels. Microaneurysms appear as small red dots on the fundus images. They are the earliest signs of DR appearing as small bulges which are developed from the weak blood vessels. The further bursting of the microaneurysms, lead to bright yellow lesions which are exudates. Retinal haemorrhages become more evident as the grade of DR advances. They indicate loss of oxygen in the retina. DR is categorized as four different categories which are; mild, moderate, severe NPDR and PDR. Depending upon certain DR features the above categories can be identified. Considering the first category, the mild non-proliferative DR there is presence of microaneurysms plus hard exudates, cotton wool spots, and/or mild retinal haemorrhages. Second category, moderate non-proliferative DR there is presence of microaneurysms along with mild intra retinal microvascular abnormalities and retinal haemorrhages. In this category there can also be presence of severe retinal haemorrhages or venous beading in one quadrant.

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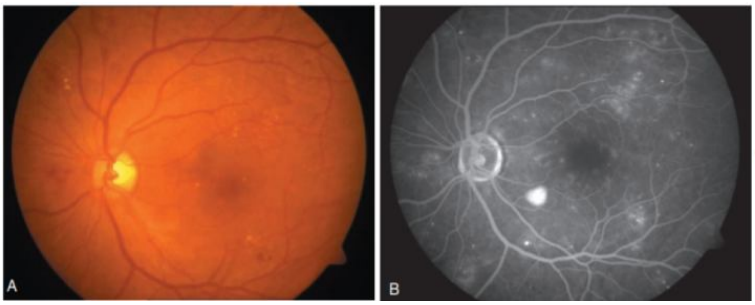

Fig. 1. Early background of DR

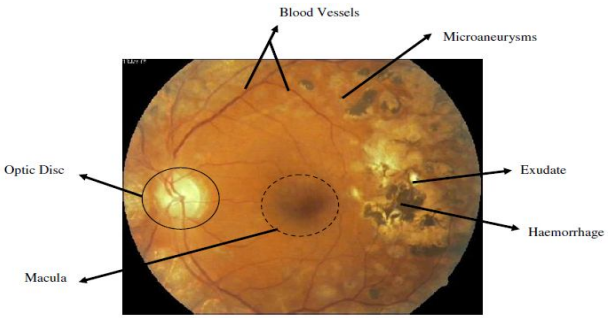

Fig. 2. Various lesions of retina

In the third category, severe non-proliferative DR there is presence of numerous microaneurysms and severe retinal haemorrhages in the four quadrants of the retina or venous beading in at least two quadrants of retina or presence of moderately severe intraretinal microvascular abnormalities in at least one of the retinal quadrant. The fourth and final category is Proliferative DR which is the advanced stage of DR. This is a propelled phase which triggers the growth of extra fresh blood vessels and they don't lead to symptoms or vision loss but they are very delicate which might lead to a high risk that they leak blood. If the blood vessels leaks it contaminates the vitreous chamber and causes severe vision loss and even blindness [37].

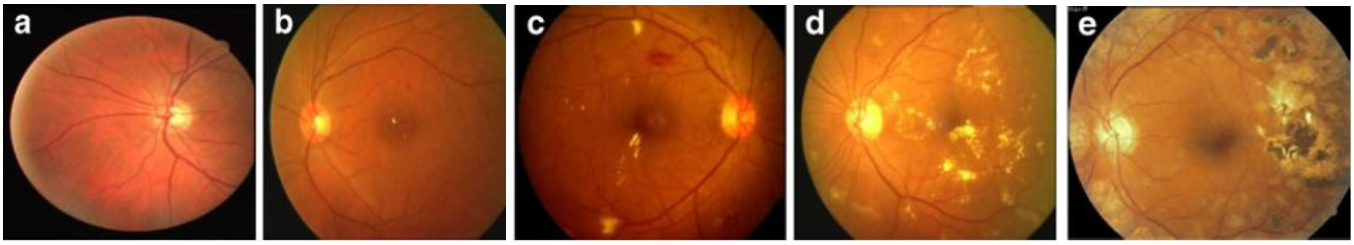

Fig. 3. Stages of DR. (a) Normal Fundus (b) Mild NPDR (c) moderate NPDR (d) severe NPDR (e) PDR

III.LITERATURE SURVEY

In [4], the authors presented a method of localizing different features and lesions in a fundus image. A constraint of detecting optic disc was proposed where; the blood vessels were detected first and used the intersection of these to find the approximate location of the optic disc.

They have also stated by using different morphological operations, different features such as Blood Vessels, Exudates, Microaneurysms and Haemorrhages can be detected. In [23], the authors N.B. Prakash, G.R. Hemalakshmi and M. Stella; used SVM classifier for the classification of the disease. The authors proposed a methodology for detecting optic disc, blood vessels and exudates.

Based on the statistical features of exudates grading of DR was done. The classification was done using SVM classifier and classified the images as no exudates, low, medium and severe. In [24] a method is proposed for the discovery of DR using SVM classifier. The authors built a framework that will have the capacity to distinguish patients with PDR and NPDR. For the extraction of features, the authors used middle filtering method followed by histogram equalization. Classification was done using SVM classifier.

[2, 5] used Artificial Neural Networks for the classification of the disease. [2] used the classifier for classification of the image as normal and abnormal and [5] used the classifier for the classification of the image as moderate, mild and severe stages. However, one of the methods from [5] fails because of the non-detection of soft exudates which occurred in the optic disc because of its removal. The authors in [6] proposed a system that classifies the image into categories such as normal, NPDR and PDR. In their paper, DR detection is done using image processing and machine learning techniques. For the detection purpose they have used probabilistic neural networks and support vector machine.

In [28] the authors Prakash N.B, Hemalakshmi G.R and Stella M., have proposed a method of detecting DR based on the determination of Haemorrhages and Exudates. The detection is done using image processing and machine learning. The detection is done using and appropriate image processing technique and the level of diabetic retinopathy is done using SVM classifier.

TABLE I
Comparative Study of Papers

Name of the paper	Problem Statement	Technology, Datasets	Future Work
E.M. Shahin, T.E. Taha, W. Al-Nuaimy, S. El Rabaie, O.F. Zharan, F.E. A. El-Samie [2]	DR Classification of normal and abnormal retinal images	Artificial Neural Networks. STARE, DRIVE, DIARETDB0, DIARETDB1	NA
S. Ravishankar, A. Jain and A. Mittal [4]	Detection of DR	Image processing. STARE, DRIVE, DIARETDB0, Red Atlas	NA
S. Sayed, V. Inamdar, S. Kapre [6]	Detection and classification of DR into PDR and NPDR	Probabilistic Neural Network, Support Vector Machine	Retina scanner on android app
A. Gupta, R. Chhikara [14]	Survey paper on Feature Extraction and Classification	Machine Learning, Deep Neural Network. DRIVE, STARE, CHASE, Messidor, Messidor-2	NA
P.N. Sharath, R.U. Deepak, S. Anuja, V. Sahasranamam, K.R. Rajesh [35]	Detection and Classification of DR	Image Processing. Regional Institute of Ophthalmology, Kerela	Improving detection rate of mild NPDR
V. Ramya [24]	Detection and Classification of DR	Image Processing, Support Vector Machine	Automated screening method for detecting DR
N.B. Prakash, G.R. Hemalakshmi, M. Stella [23]	Detection and classification of Exudates	K-means clustering, Support Vector Machine. e-Optha-Ex	Optimize features, Use different classifier techniques
S. Sahana, B.K. Kaveri, A.R. Jayantkumar [25]	Detection and classification of DR	Support Vector Machine.	Developing database and evaluation methodology
A. Z. Foeady, F. Muhammad., D.C.R. Novitasari, A.H. Asyhar, M. Firmansjah [26]	Classification of DR	GLCM, Support Vector Machine. DIARETDB1	NA
A. Taj, K. Kumari [27]	Detection of Exudates	GLCM, K means clustering, Support Vector Machine	Detection of retinal blood vessels
M. Bhagyashri, R. Nitin [28]	Detection of DR	Support Vector Machine	NA
K. Malathi, R. Nedunchelian [29]	Detection and Classification of DR	Image Processing, Recursive Support Vector Machine (RSVM). Images collected from Local Hospital	Proposing a system which classifies images using successive SVM method
A. Biran, P.B. Sobhe, A. Almazroe, A. Laxshminarayan, K. Raahemifar [30]	Detection and classification of DR	Support Vector Machine. STARE	Proposed algorithm can be used for automatic DR diagnosis purpose
V. Enrique, G. Andres, C. Ricardo, P. Colegio [31]	Detection of diabetic retinopathy	Digital Image Processing, Support Vector Machine.	Detection of soft exudates and Application of texture analysis
Dr. K. Sakthivel, G. Keerthana [36]	Detection of Haemorrhage	Support Vector Machine	NA
S.K. Deva, G.R. Nitta [32]	Detection of DR	GLCM, Support Vector Machine. DIARETDB0, DIARETDB1	NA
V.A. Aswale, J.A. Shaikh [34]	Detection of Microanuerysms	Support Vector Machine . Images from Nandadeep eye hospital, Sangli	NA

Gupta and Chhikara [14] proposed a literature survey which reviewed various techniques used for detecting DR. the retinal features used is BV, MA, and haemorrhages. Comparison of the results of various machine learning techniques based on parameters like sensitivity, specificity, area under curve, accuracy was done. An approach for early detection of DR from fundus images is presented in [16]. The authors pre-processed raw retinal fundus images using extraction of green channel, histogram equalization, image enhancement and resizing techniques. For evaluation of the results by considering the mean value and standard deviation for the extracted features was done. An approach for detecting DR is presented in [25]. The author's study beings by pre-processing, then eliminating optic disc, and then separating the vascular tissue of the damaged are of the retina. Mathematical morphology methods were used to detect dark lesions. With the help of SVM the fundus images were classified into, mild-NPDR, moderate-NPDR and severe-NPDR. In [26, 32] the authors have taken up GLCM as a method for feature extraction and SVM for classification. [32] includes the CLAHE, Kirch's operator for detecting blood vessels and in both [26] and [32], the features obtained through feature extraction using GLCM, its result is used to classify DR based on the features of MA and MA , vessel and haemorrhages using SVM. [27], presents detection of exudates in retinal images using Support Vector Machine (SVM). The proposed method involves K-means clustering algorithm for segmentation and SVM for classification. V.A. Aswale and J.A. Shaikh in [34] proposed a method for detecting Microaneurysms in retinal fundus images. The authors have briefed about segmentation and feature extraction methods. SVM was used for classification based on the parameters related to MA and categorized as normal, mild, moderate and severe condition. As stated by authors Enrique V, Andres G, Ricardo C, Colegio P in [31] have proposed a computer assisted diagnosis system to detect DR in advance using digital image processing. Image processing techniques were used in order to detect blood vessels, microaneurysms and hard exudates and extract the features. Support Vector Machine model was used as classifier. Final evaluation on robustness with respect to changes in parameters of algorithm was done.

IV. CONCLUSIONS

In this paper, a brief description on diabetic retinopathy and a review on several different concepts relating to how diabetic retinopathy could be detected at an early stage were presented. The information presented in the review paper is just some of the work done by various authors till date so that the researchers can know about some recent advances in the work done on DR and can further redefine their work with some additional information. This paper thus gave a brief insight into the research work that is going on the detection of diabetic retinopathy which could be detected using novel pre-processing and segmentation techniques.

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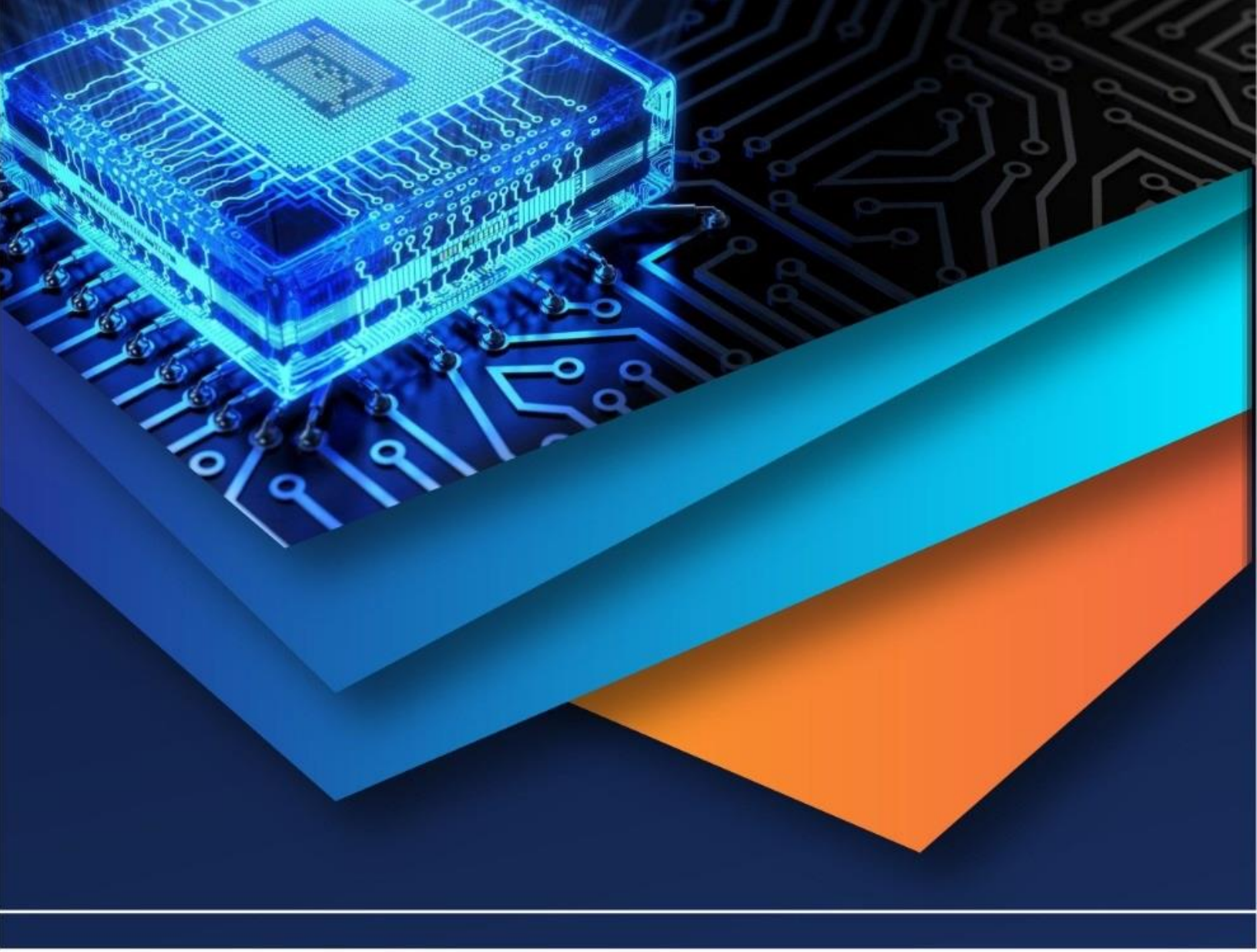

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