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Survey of Automatic Detection of Diabetic Retinopathy using digital image processing

Saurabh. S. Athalye[1*], Gaurav Vijay[2]

[1,2]School of Engineering, Career Point University, Kota, Rajasthan, India

[*]*Corresponding Author: saurabhathalye87@gmail.com, Mobl.: +91-9730020107*

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***Abstract*—** Diabetic Retinopathy is brutal eye disease, which is acting as a major cause of blindness in young or middle age population. In this disease there are major chances of losing vision by patient. According to many eye specialists, it is tough to detect this disease in its early stage. If we could able to detect this disease in early stage we can save patient's vision. For this purpose doctors recommend periodical checking of eyes by specialist. But in country like India, number of specialists available is not at all sufficient for the overall population of the country. It is also a fact that, these specialists are mostly available for city population. In rural areas there is scarcity of eye specialists and testing equipment's. In this scenario periodical screening programs and automated Diabetic Retinopathy detection can help a lot. Numbers of researchers are attracted towards research on Automatic DR detection. Proposed paper focuses on medical background of DR and comparison of some existing methods for automatic DR detection.

***Keywords*—**Diabetic Retinopathy (DR), exudates (EXs), microaneurysms (MAs), hemorrhages (HMs)

I. INTRODUCTION

Diabetes is a major chronic disease faced by the world population today and it is characterized by high levels of glucose in the blood. Damage to eyes primarily includes retinal complications collectively known as Diabetic Retinopathy (DR) [14]. The damage to retinal vasculature can lead to progressive retinal damage and result in partial vision loss or complete blindness DR is the most common reason for new cases of blindness among adult population [1]. Diabetic retinopathy (DR), also known as diabetic eye disease [1] and has become a major cause of blindness among the middle-aged population [2]. Early diagnosis through regular screening is recommended to diabetic patients, which can help them prevent blindness and visual loss. However, a large amount of diabetic patients need to be screened annually, which poses a heavy workload for ophthalmologists. Therefore, developing an automatic DR screening system is necessary, which can not only reduce the workloads of ophthalmologists, but also improve the accuracy of detection [3]. The early stage of DR is characterised by its distinctive qualities such as irregularities and leakiness of blood vessels, but may progress to its severe form, which leads to blindness.

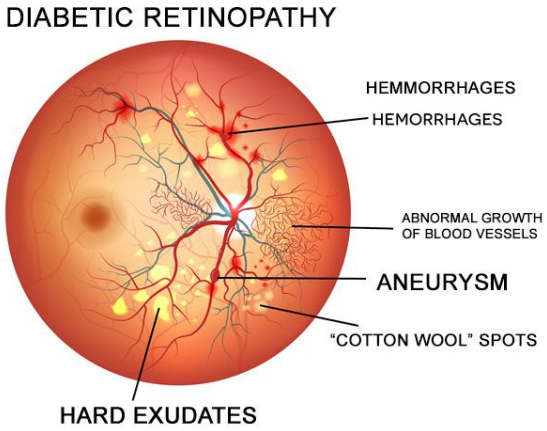

Fig 1: Sample fundus image of eye affected by diabetic retinopathy [16].

Main signs of DR are exudates (EXs), microaneurysms (MAs) and hemorrhages (HMs). MAs are a primary indication of non-proliferative diabetic retinopathy (NPDR) caused by thin vessels dilations. MAs appear in round shape, red color and small size. Next indication of DR is HMs known as dot HMs or blot [4]. The fundus camera provides high quality of digital photographs, where the fundus photos

can be instantly viewed and shown to the patients to increase the patient's understanding of the disease [15].

Diabetic retinopathy (DR) is classified into two major classes such as non-proliferative DR (NPDR) and proliferative DR (PDR) [7]. The NPDR is further subdivided according to the level of damage in the retina into three different stages such as mild, moderate and severe. According to clinical experts, the color fundus images should be classified into five categories such as normal, mild NPDR, moderate NPDR, severe NPDR and PDR [7].

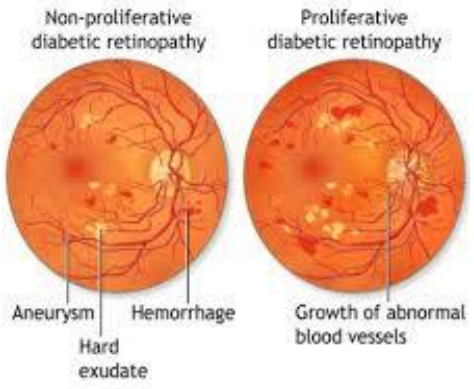

Fig 2: Comparison of non-proliferative and proliferative diabetic retinopathy [17]

While manual segmentation is laborious, time consuming, and demands expertise, automatic delineation is known to be feasible with high accuracy. Of all the automated segmentation algorithms, machine learning based method [16] has appeared as an important technique, with major attention being focused on convolutional neural networks (CNNs) [6]. Automatic detection of exudates is a challenging issue, since the retinal fundus images often have uneven illumination and are poorly contrasted. Under these complex conditions, several related exudate detection methods have been proposed, which can be divided into the following four categories: (1) thresholding-based, (2) region growing-based, (3) morphological-based and (4) pixel-based classification [8].

Automated detection of optic disc (OD) is also important for early detection of DR. Disc size, neuro-retinal rim and cup area features are used to detect a DR. OD and the position of vessel origin (VO) are the main anatomical features in retinal fundus images. There are several ways in which image analysis helps to diagnose DR from colour fundus images of the human retina. One such contribution is image enhancement, by which the contrast and the sharpness of the images are improved to reduce noise. The other methods of image processing which help in the diagnosis of DR are detection and classification methods [11]. The conventional methods such as Canny filtering, Laplacian filtering or its modifications viz. Laplacian of Gaussian filtering result in blurred edges. Moreover, they are very susceptible to noise since noise appears as false edges in an image. Also, images contain polynomial nonlinearities, which are usually not accounted for in conventional edge detection filtering methods.

II. RELATED WORK

In literature may research papers available with variety of methods and classifiers used for detection of DR. some of which with good results are compared here.

Fraz, M.M. in "Multiscale segmentation of exudates in retinal images using contextual cues and ensemble classification," [1] used ensemble classifier of bootstrapped decision trees. This method is simple for implementation, even provides better robustness. But is not suitable for large database.

Zhu, C. in "Retinal vessel segmentation in colour fundus images using Extreme Learning Machine," used Extreme Learning Machine (ELM). This is very good realtime computer-aided diagnosis and disease screening but it's training model is expensive.

W. Zhou, C.in "Automatic Microaneurysm Detection Using the Sparse Principal Component Analysis-Based Unsupervised Classification Method," used unsupervised classification method based on sparse PCA. This method avoids the problem of class imbalance, but features do not categorize the microaneurysms and false positive.

Amin, J. in "A method for the detection and classification of diabetic retinopathy using structural predictors of bright lesions," used Structural Predictors of Bright Lesions. Which is mixture of statistical and geometrical features are used for the classification, but cotton wool spots, hemorrhages and microaneurysms are not identified.

Leontidis, G in "A new unified framework for the early detection of the progression to diabetic retinopathy from fundus images," used framework for retinal imaging and feature analysis for retinal diseases. This method uses geometric features, but requires manual processing.

L. Ngo and J. H. Han in "Multi-level deep neural network for efficient segmentation of blood vessels in fundus images," used Multi-level deep neural network. This method improves upon generalisation of the training procedure, but gives lower classification accuracy.

III. CHALLENGES

The various challenges involved in the automatic classification of diabetic retinopathy using retinal fundus images are briefed as follows,

- There are no early warning signs of DR until the vision is affected. Proper screening helps in early detection, timely treatment and reduces chances of complete blindness.
- The optic disc segmentation has the challenges of fixing the circle and searching the circular points in the image. Determination of optimal threshold in binarization faces a challenge of fixing the exact threshold for vessel segmentation.
- Vessel detection is performed using either a multilayer perceptron or multiscale morphological closing. Unfortunately, the major limitation to this approach is that most of the false positives at the vessel segmentation step are actually lesions. After their removal along with the detected vessels, these lesions are lost and not retrieved in subsequent processing.
- Automatic detection of exudates is a challenging issue, since the retinal fundus images often have uneven illumination and are poorly contrasted.

IV. CONCLUSION AND FUTURE SCOPE

If DR detection is done with the traditional decision tree based classification algorithm. Use of deep learning allows the deep study of the features of DR and thus classification accuracy can be improved.

The recognition of the MA during the DR recognition is a prime factor since the MA primarily indicates the non-proliferative diabetic retinopathy. In the, features representing the MA are not extracted from the fundus images.

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Authors Profile

Mr. Saurabh S. Athalye[1] pursed Bachelor of Engineering (Electronics & Telecommunication) and Master of Engineering (Electronics) from Mumbai University, India. He is currently pursuing PhD from Career Point University, Kota, India. He is working as an Assistant Professor in Department of Electronics & Telecommunication Engineering at Finolex Academy of Management & Technology, Ratnagiri, Maharashtra-India. He has 10 years of teaching experience. He is member of ISTE & IETE. His research work focuses on Automatic detection and classification of Diabetic Retinopathy using Digital Image Processing.

Dr.Gaurav Vijay[2] Professor (Research Supervisor) Career Point University, kota. Completed P.hd, M.Tech, B.Tech in the field of Communication. He is the member of ISTE society of Journal.He has over 20 Research papers in reputed International Journal to his credit. He also has the knowledge about the field of Projects based on Engineering applications.
Published many books in the field of Engineering such as Digital signal processing, Telecommunication Engineering, Signals and systems,Telecommunication fundamentals and many more..

