Review of Digital image processing techniques for detection of diabetic retinopathy

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Abstract: Diabetic retinopathy (DR) is an eye disorder which appear when the blood vessels of retina stared to swell and leaks blood that at last leads to vision loss. Different types of DIP (Digital image processing) based methods are used for initial identification of DR on retinal images for example Image Enhancement, Segmentation, Image Fusion, Morphology, Classification, and registration. In this paper we have discussed different image processing based DR identification techniques.

IndexTerms **- Diabetic Retinopathy, retina Image, image processing, automated detection.**

I. INTRODUCTION

Digital Image Processing is the form of signal processing which basically change the property of the image as per requirement. It is widely used in medical field for identification of eye diseases with simple and effective way. It helps Ophthalmologists to examine their patients [1-3].

Diabetic retinopathy (DR) is the critical and most common retinal disease which becomes the main reason of new cases of blindness and vision impairment in developed countries among people aged 21 to 75 years [4]. It takes place due to the pathological alteration of the blood vessels that nourish the retina.

1.1 Causes of diabetic retinopathy:

The person who suffers from diabetes is in danger of advancing diabetic retinopathy. Below facts may increase the danger of having diabetic retinopathy [5,6].

- If the person doesn't properly manage his sugar level.
- If he has diabetes for a long time period.
- If he has very high blood pressure
- If the person has high cholesterol levels
- If the person smoke usually.
- Pregnancy is also one of the reasons.

Diabetic retinopathy is the reason for leakage fluid/blood in the retina's blood vessels, which distort the eyesight. As the time goes the abnormal blood vessels started to create on the retina side of eye that lead to injuring and cell loss in the retina [7].

1.2 Types of diabetic retinopathy:

DR is classified in basic two forms Non proliferative Diabetic retinopathy (NPDR) and proliferative Diabetic retinopathy (PDR) as explained below:

1) Nonproliferate Diabetic Retinopathy:

First phase of DR is NPDR in which blood vessels will start to damage and flow additional fluid into the eye. This phase includes microaneurysms (red dot), exudates (drop of fatty tissues), and hemorrhages (small spot of blood that flow in to retina). NPDR is again divided as mild, moderate or severe NPDR as explained below [8-10]:

- Mild NPDR: in this first stage of NPDR the small blood vessels of retina is started to swell which is known as microaneurysms.
- Moderate NPDR: in this stage the swelling is increases (called hemorrhage) and some retina's vessels are altered and because of that their capability of supply blood on retina is reduses.
- Severe NPDR: at the next stage of DR number of the blood vessels are started to block and yellow spots called cotton wool spots are stated to create on retina side.

2) Proliferate Diabetic Retinopathy

This is the last and most dangerous stage of DR in which the new but fragile blood vessels can begin to grow. These fragile vessels drop blood on the retina which causes severe vision loss and even blindness [11].PDR damage both vision peripheral and central which becomes the reason of serious vision loss. At this stage if patient left untreated then it can become the reason of serious vision loss which leads to the blindness.

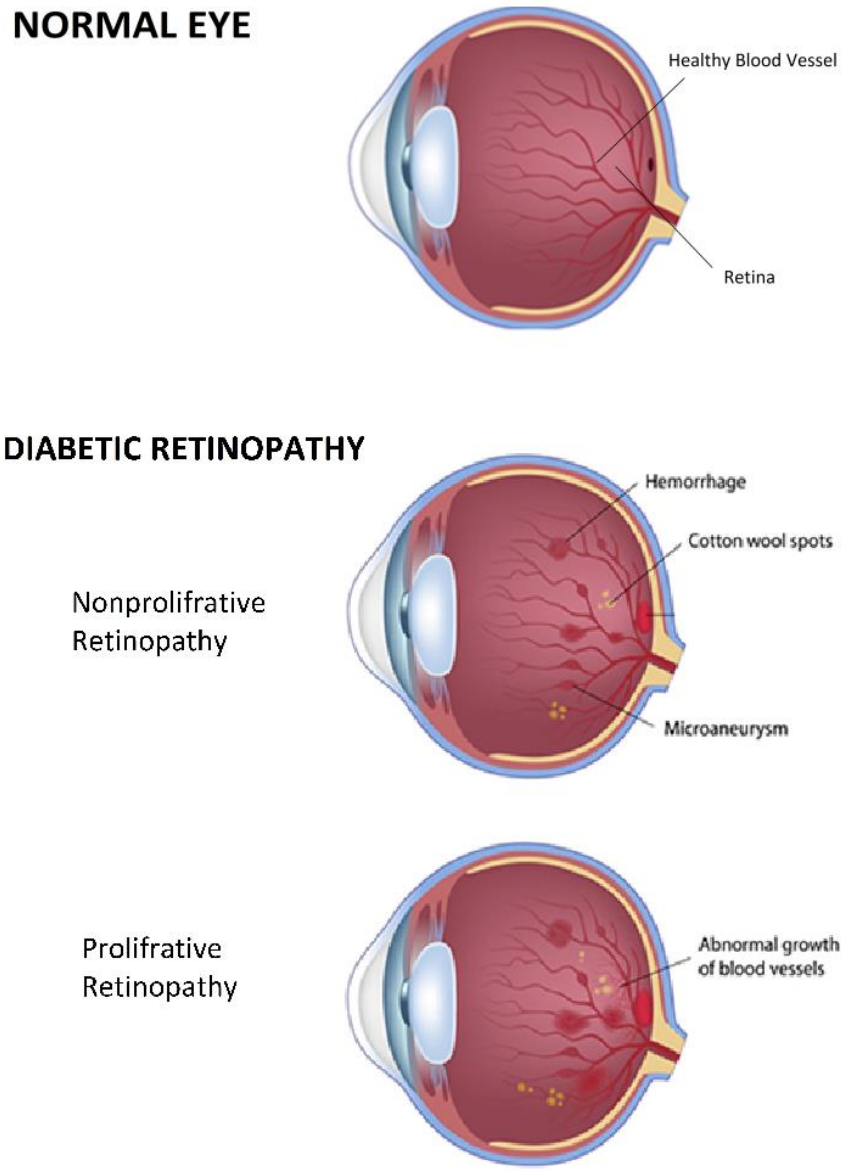

Figure 1. Retinal image

The IDF Diabetes Atlas Eighth edition 2017 evaluates that all over the world 425 million of public have the problem of diabetes and that will arises to 629 million of public by the year of 2045 [12, 13]. The DR disorder is a big issue among the diabetic patients. The level of diabetic retinopathy is raises in both developed and underdeveloped countries. The citizens of underdeveloped countries are usually having diabetic retinopathy because of the lacking in treatment and essential sources [14, 15].

Generally, the doctors find out the diabetic retinopathy based on some properties such as microaneurysms, hemorrhages, blood vessel areas, cotton wool spots and exudates [16-18]. In comparison of number of Diabetic patients the number of eye specialist or ophthalmologists is very small especially in rural areas [19]. That's why the automated DR detection technique is needed which could help and guide the doctors on finding & diagnosing DR more precisely.

Automatic study of retina's images using digital image processing has become popular for eye specialist and researcher. The digital image processing method is basically used to detect the abnormalities in retina like- microanerusym, hard exudates, soft ,exudates, neovascularisation, fovea location, blood vessel structure etc [20-22]. The purpose of this paper is to brief review the relevant literatures in the field of Diabetic retinopathy detection using digital image processing.

II. RELATED WORK

Previous recognition of Diabetic retinopathy becomes the important subject for the last couple of years. Latest improvement in the technique and performance of digital image processing, machine learning and computer perception methods has pick up a larger concern in this area [23].

An extensive survey of relevant investigation job has been made and reported here along with their features and limitations in some cases.

S. Kanth et. al [24] recognize different stages of DR- mild, moderate, severe and Proliferative Diabetic Retinopathy. The property of the retina's picture are analyzed by the proposed Multilayer Perceptron method and the experimental results have shown that the method give 94.11% accuracy.

Mingli et. al [25] presented the BP (back propagation) neural network based image processing technique that develop an automated system to notice the difference between the DR affected retinal images and healthy image. The obtained experimental results prove that the BP network can analyze the large number of images at a time which saves a lot of time and workload of eye specialist.

H. A. Hakkim et al. [26] presented an automated detection method which uses the combination of discrete wavelet transform (DWT) and Artificial Neural Network (ANN) to classify and analyze the exudates of retinal pictures. Firstly the DWT is applying on retinal image to detect hard exudates and then ANN is applying to find soft exudates and to find the difference between soft and hard exudates. The major advantage of this approach is that the DWT provide fastness and ANN give high efficiency to the detected system.

Sheetal et.al [27] presented an automated DR identification technique based on back propagation (BP) neural network to analyze the hard and soft exudates of retina. In this method decision tree and GA-CFS method used as a input to identify exudates and non-exudates. The authors reported maximum sensitivity of 96.97 %, Specificity of 100% and classification accuracy of 98.45%.

Chitalidesaiet. al [28] proposed a diabetic retinopathy diagnose method based on wavelet transform and dual tree complex wavelet transform image retrieval technique. In this method the user input the presents query retinal image and according to the similarity between query and database retinal images the desire image is retrieve. The method is experimented with database of three hundred retinal images of patients. In this paper the author proves that the method that effectively uses the data from picture is the main point of an efficient content based image retrieval system for DR diagnosis.

M. A. Al-Jarrah et al. [29] presented a Bayesian regularization (BR) and resilient back propagation (RP) based algorithm for detecting DR lesions. The BR and RP give training to the artificial neural network for classification of different stages of DR. The experimental result shows that the BR provide 96.6% and RP provide 89.9% accuracy.

Enrique et. al [30] presents the digital processing based retina image diagnosis system for the detection of diabetic retinopathy. This technique automatically classifies the stage of non-proliferative diabetic retinopathy by isolating blood vessels, soft and hard exudates and analyzing the retinal image by support vector machine (svm). This method provides the good sensitivity and capacity of 95% and 94% respectively.

Sayed et. al [31] compare the Probabilistic Neural Network (PNN) and Support vector machines (SVM) technique for the Diabetic Retinopathy (DR) identification. The experimental results show that the accuracy of detection in SVM and PNN is 90% and 80% respectively which proves that the SVM model performs better than the PNN model.

Jayakumari et. al [32] propose Echo State Neural Network (ESNN) method to classify the exudates for diabetic retinopathy detection. The method is experimented on 30 retinal pictures (5 healthy and 25 abnormal). The experimental result shows that the ESNN automatically removed the spurious noise and give sensitivity of 90%.

Tagra S. et al. [33] presented an exudates detection method based on the features extracted from color fundus images. Firstly the exudates separate from images by using morphological operation and then the features are extracted and according to that images is classify as exudates and non-exudates. This method reduces the ophthalmologist's work to probe on each and every fundus image instead of only on aberrant image.

Bayesian detection algorithm [34] is used to classify the changes in retinal image in order to diagnose the diabetic retinopathy. This method is very useful to detect hard and soft Exudates, Microancurysm & Cotton wool spots. The drawback of this method is it can't find the vascular changes in the retinal images.

III. Conclusion

From the literature survey and study of existing related research papers it is concluded that the initial screening of eye for identification of Diabetic Retinopathy can reduce the growth of it and prevent blindness. This paper is valuable for new investigators who want to do research work on automated identification of diabetic retinopathy by using digital image processing technique. This review give the guidance to investigators about what research work has been done, which type of method is used for DR identification and what improvement is needed on exciting methods.

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