A Review on Automatic Detection of Diabetic Retinopathy

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Abstract: Diabetic retinopathy is a quickly spreading condition caused by diabetes around the world. DR can lead to total vision loss in diabetic patients. Early DR detection is more critical in this scenario for a restoration of the eye and timely care. The manual analysis of fundus photos for the regulation of microaneurysm, exudates, blood vessels, bleeding and macula is a very long and tiring process. It is very repetitive and time-consuming work. It can easily be achieved using the computer-aided method and the observer's intervariability. In this paper a comprehensive review of the new non-proliferative diabetic retinopathy therapies for microaneurysms, hemorrhages and exudates are presented.

Keywords: Diabetic Retinopathy, automatic Detection, microaneurysms.

I. INTRODUCTION

Blood sugar regulation in the body, including diabetes, induces diabetic retinopathy (DR). Eye problems are caused by diabetes and are the main factor of blindness worldwide. This is due to blood vessel damage caused by diabetes. DR is caused by chronic or acute retina damage. DR is also the eye manifestation of different systemic conditions. DR is the most frequently encountered microvascled symptom of diabetes and the most common cause of blindness and vision loss worldwide. DR is classified into two types: Non-proliferative DR (NPDR) and Proliferative DR (PDR). DR affects the vascular retinal structure and leads to progressive damage to the retinal. Gradual DR induces loss of vision and blindness. DR is the leading cause of workplace blindness in developed nations, and the problem is growing as a significant global public health issue. In Great Britain, some drei million people may experience diabetes in the future and in the next 15-30 years. Diabetic retinopathy (DR) is more likely to affect a person with diabetes. A micro blood vessel that is susceptible to unrestricted blood sugar level supplies blood to all layers of retina. When a large quantity of glucose or fructose gains blood, the vessels begin to crash because oxygen has not been properly distributed in the cells. Blockages in these vessels cause serious damage to the eyes. Consequently, metabolic vessels that are internally active in DR slower and lead to structural anomalies. DR is a progressive disease and its early detection is crucial to

saving a vision of the patient; regular screening is necessary. An automated DR screening system can help to reduce the chances of total blindness due to DR and reduce ophthalmologist workload. The DR screening system is designed to differentiate a retina from a normal retina with potential DR. Microaneurysms (MAs) result in abnormal sugar levels in retinal blood vessels. MA is an early sign of diabetes retinopathy, which can be regarded as a fundamental element of DR. MA is almost oval in shape and dark in color and tiny in scale. Later on, abnormal blood retinal vessels can split into the form of a retinal neovascular network. Retina. Diabetic retinopathy also contains certain other anomalies, including spotting of cotton wool, bleeding, exudates leading to non reversible blindness and impaired vision.

This paper looks at automated systems for DR detection. In order to evaluate its causes and effects on the human body, this review is structured as follows: first of all we talk about the diseasing behind them. We focus on the impact of diabetes on the eye following the aims of this article. This leads to features like blood flow field, workouts, hemorrhages, microaneurysms and textures. Such technologies are used to automatically identify DRs. They reviewed several automated detection systems documented in the scientific literature for automatic detection of DR stages.

II. DIABETES

Diabetes mellitus is a chronic, systemic condition that affects our lives. Hormones insulin are not properly secreted or controlled in people with diabetes. This contributes to an unexpected rise in blood glucose. A elevated level of glucose causes damage to the blood vessels over time, particularly in the retina. DR has an effect on the retina, which is a thin layer of tissue; this damage contributes to an eye condition called DR. The width of the inner portion of the eye is around 0.5 mm. The entire retina is a spherical disk with a diameter between 30 and 40 mm. The optical disks have a diameter of 3 to 4 mm. Figure 1.1 displays a healthy picture of the retina obtained using a fundus camera.

Due to the elevated blood glucose level that leaks blood and fluid into the retina, the vascular walls are impaired. The leakage due to high glucose levels can have a detrimental impact on the system and causes some clinical characteristics in the retina, listed briefly below. During the early stage of diabetic retinopathy, there are no noticeable signs. But, in the latter stage of DR, the signs are blurred vision, swellings and sudden vision loss.

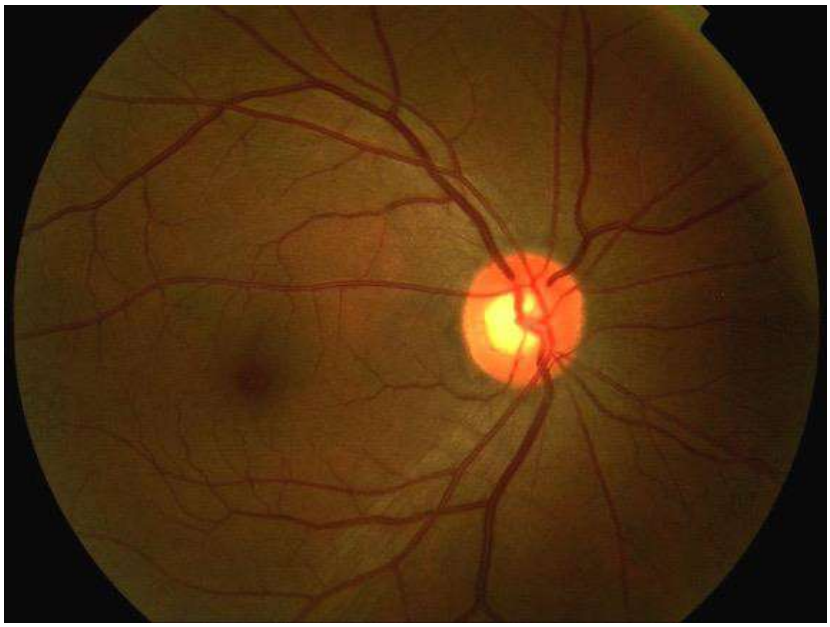

Figure 1: Healthy Fundus Image

III. EYE ABNORMALITIES

Micro-aneurysm: Micro-aneurysm is the early crucial symptom of retinal injury. Micro-aneurysms consist of slight swelling of the retina's minuscule blood vessels and occur in capillary vessels as slight outpouchings. These are very small capillaries and are typically not seen in retinal pictures. Because of the local growth in scale, however, Micro-aneurysm appears as tiny red spots in colored fundus images between the visible retinal blood vessels. Figure 2 provides an example of Micro-aneurysm below.

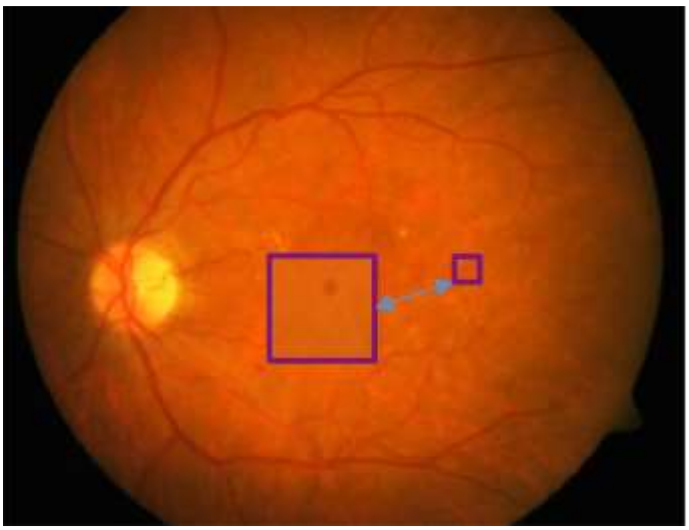

Figure 2: Micro Aneurysms

Hemorrhages: Hemorrhages are evident with the degree of diabetic retinopathy. This is attributable to a poor capacitor leakage and the rise in retinal vessels is causing further damage and leakage. This suggests progression of diabetic retinopathy. It is known as a red spot with a margin that is irregular and is larger than micro aneurysms. Figure 3 gives an example of hemorrhages.

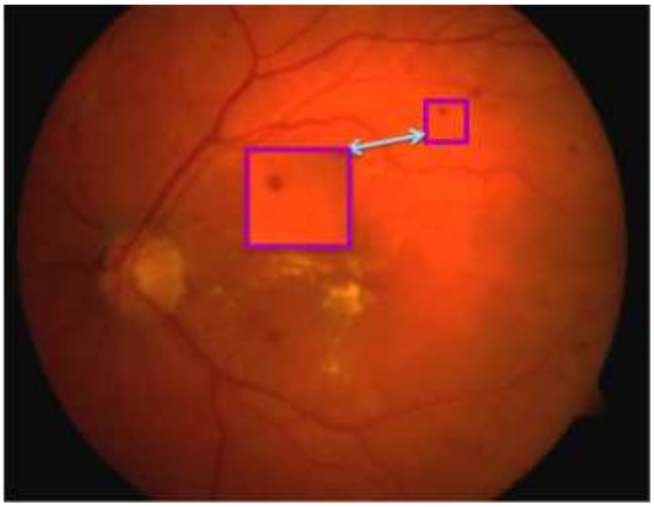

Figure 3: Hemorrhages

Hard Exudates: Hard exudates are white or yellowish, with small margins. They also look waxy, shiny or metallic. This is found deep within the retinal vessels in the outer layers of the retina. Exudates are often deposited along the retinal veins A fundus image with hard exudates is shown in Figure 4

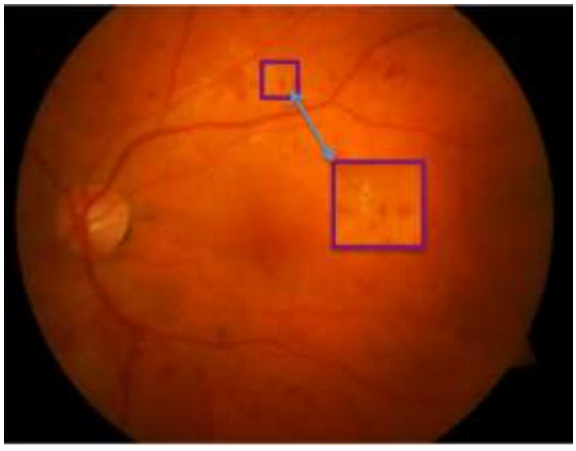

Figure 4: Hard Exudates

Soft exudates: Cotton-wool spot (CWS) are infarcts of nerve fiber layer or arterial precapillary occlusions, also often referred to as soft exudates. In other words, it is a very small tissue ischemic case. Figure 5 shows a fundus image with cotton wool spots or soft exudates.

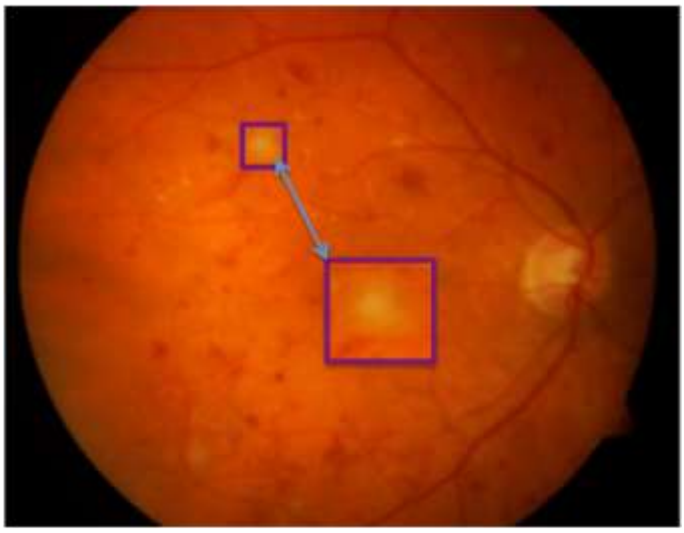

Figure 5: Cotton Wool Spots

Neovascularization: Neovascularization is a normal development, typically in the form of functional micro-vascular network, of new blood vessels (neo-+ vascular+ ization) which can perfude with red blood cells and acts as a collateral blood circulation in the reaction of local infusions or ischemia. The primary cause is a lack of corneal oxygen. Long-term contact lens use is a major factor, but lens or solution contamination may also be caused by damage or injury, chemical burns or the deposition of a film of a lens. Figure 6 shows an example of neovascularization in a fundus image.

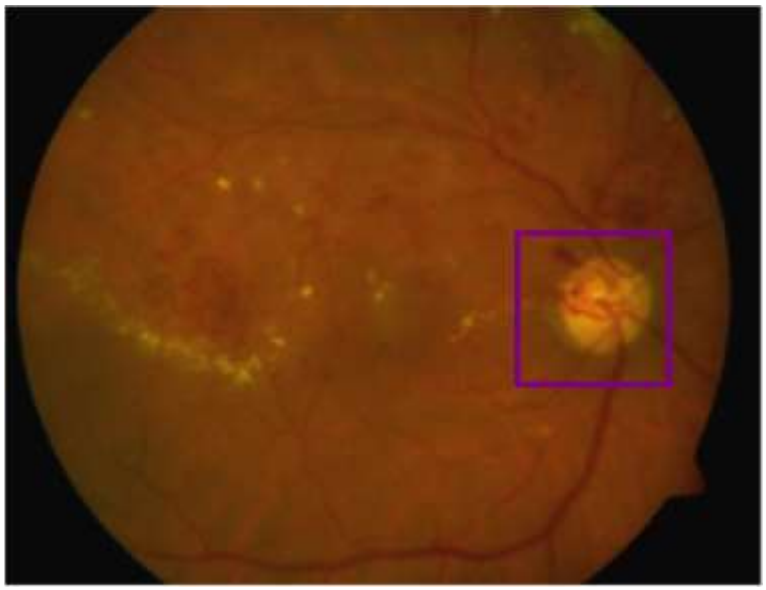

Figure 6: Neovascularization

Diabetic Retinopathy develops through four stages, consisting of mild diabetic non-proliferating retinopathy (NPDR), moderate NPDR, extreme NPDR, and proliferative DDR. Mild NPDR is the first step in which micro aneurysms occurs early in this state. In this point, MAs and H appear as this disease progresses to moderate NPDR. Not only micro aneurysms, hard exudates,hemorrhages cotton wool spots appear in the severe NPDR phase. New blood vessels grow as this disease advances to the PDR stage. As a result, micro aneurysms are present in all of these four stages. For an automated pre-screening system, detection of micro aneurysms is critical.

IV. METHODS OF DETECTION

DR detection is important because the progression of the disease may be reduced by treatment methods. Laser processing is used with most care procedures. Laser photocoagulation cauterizes the eye vessels which stops their leakage effectively. The fixation laser method decreases the thickening of the retinal. This can prevent retinal swelling from deteriorating. In particular, the risk of vision loss is reduced by 50 percent by this treatment. Improvement is possible in a small number of cases, with total vision loss.

Maher et al. [1], presented an automated system to analyze the retinal abnormal features. Better preprocessing techniques was utilized to attenuate the noise to improve the contrast and mean intensity. Hard exudates were detected and segmented from database images. Also, dark lesion detection methods were proposed by utilizing polynomial contrast enhancement. SVM based supervised learning tool were applied for data classification based on regression.

In a study by Somfai et al. [3] presented and evaluated a non-linear prediction method for early detection of DR on OCT images.

Shruthi et al. [4] developed an automated system to identify early signs of DR. Retinal features were detected and extracted using Top-Hat and Bottom-Hat operations and K-means clustering technique. Statistical parameters were calculated and K-NN classifier was used to identify healthy and unhealthy retinal images.

Welikala et al. [7] described an automated method for detection of new vessels in the retinal images due to DR. Two vessel segmentation approaches were applied by using standard line operator and a novel modified line operator. Both operators were processed and features were measured from each binary vessel map to produce two separate feature sets. SVM were used for independent classification of each feature set and the combination of individual classification was used for final decision.

In different studies an automated analysis and detection of exudates due to DR was developed [8]. Both Fuzzy Logic and NN tool were utilized to identify the abnormalities in the foveal region. The BPN algorithm was used to minimize the objective function which was a multi-stage dynamic system optimization method. Kaur et al. [10] developed an automated system for normal and abnormal features from retinal fundus images for DR. Filter based approach was applied to segment the vessels and were tuned to match the vessels extracted and non-vessels based on thresholding method.

In another study, anatomical structures such as blood vessels, exudates and Mas were segmented [11]. Based on the segmented features, the gray level co-occurrence features were used to classify DR images. The classifier utilized was the SVM classifier.

Kumar et al. [12] developed an automated system for MAs detection in non-dilated RGB Fundus images. Early symptoms of DR were aimed to be detected to reduce the incidence of blindness. The proposed method followed fundamental steps as preprocessing, feature extraction based on texture feature and the last to classify the severity of DR.

Sopharak et al. presented an automated exudates detection using optimally adjusted morphological operators even for low contrast images [14]. The proposed system, work effectively even on a poor computing system.

V. CONCLUSION

Digital imagery was recently made available as a DR screening tool. It offers high quality permanent retinal appearance records that can be used for progression monitoring and treatment response and that can be checked by an ophthalmologist, and the possibility to process digital images using automated analysis. In more than 50 % of the cases, blindness caused by DR can be prevented by a combination of both correct and early detection and adequate care. It is therefore essential to perform frequent DR screenings in patients with diabetes. We addressed several methods for extracting characteristics and automated DR level identification in this paper.

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