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A Review on Computer Vision based Classification of Diabetic Retinopathy using Artificial Intelligence

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ABSTRACT: Diabetic retinopathy (DR) is a retinal condition that affects people with diabetes and is the leading cause of blindness among the elderly. Changes in blood vessels might lead them to bleed or leak fluid, producing visual distortion. As a result, blood vessel extraction is critical in assisting ophthalmologists in early detection of this condition and preventing vision loss. Diabetes Retinopathy is a severe chronic condition that is one of the primary causes of blindness and visual impairment among diabetic individuals in affluent nations. According to studies, 90 percent of instances may be avoided with early identification and treatment. Physicians utilize retinal imaging to detect lesions associated with this illness during eye screening. The amount of photos that must be manually evaluated is growing costly because to the rising number of diabetics. Furthermore, training new staff for this form of image-based diagnosis takes a long time because it requires daily practice to gain skill. The review of retinopathy categorization for diabetic patients is discussed in this research utilizing several approaches using computer vision i.e. image processing with artificial intelligence.

KEYWORDS: Artificial Intelligence, Computer Vision, Diabetic Retinopathy, Machine Learning.

I. INTRODUCTION

Diabetic Retinopathy (DR) is human eye disease among people with diabetics which causes damage to retina of eye and may eventually lead to complete blindness. Diabetes mellitus is a metabolic disorder characterized by a hyper-glycaemia due to malfunction in the production of insulin by the pancreas. At long term, it can cause microvascular complications that affect the retina, resulting in Diabetic Retinopathy (DR), which is the leading cause of blindness in active population. Moreover, the World Health Organization (WHO) anticipates that 347 million people were diagnosed with diabetes in the world, and it is predicted that, can be affect more than 640 million people by 2040. According to some estimations, more than 75% of diabetic patients within 15 to 20 years of diabetes diagnosis are endangered by DR. Diabetic retinopathy is an asymptomatic retinal disease and primarily a consequence of diabetes, which involves changes to blood vessels, resulting in micro aneurysms, hemorrhages, exudates, malformation and vascular tortuosity (Non-Proliferative Diabetic Retinopathy) that can subsequently cause an abnormal growth of retinal blood vessels (Proliferative Diabetic Retinopathy) that can lead to blindness in the absence of appropriate treatment. Therefore, the extraction of blood vessels is crucial to help ophthalmologists to identify this disease at the early stage in order to prevent the loss of vision. Anatomy of eye for normal retina and DR-affected retina is shown in Fig-1 and Fig-2 respectively [1] [2].

Diabetes is a condition in which glucose metabolism is disrupted, resulting in a variety of problems. Diabetic retinopathy (DR) is a disorder in which blood vessels in the rear of the retina get damaged. According to the International Diabetes Federation (IDF), approximately million people worldwide have diabetes, and roughly one-third of them have indications of DR. No DR, Mild, Moderate, Severe, and Proliferative DR are the five stages of DR based on severity, as seen in the retinal fundus photography photographs or retinal fundus images in figure 3. Furthermore, later phases of DR are marked by the creation of aberrant blood vessels, known as neovascularization. DR can be effectively managed in the early stages, however DR detected at later stages may cause irreversible loss of vision.

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According to the Early Treatment Diabetic Retinopathy Study (ETDRS), the Diabetic Retinopathy (DR) risk levels are listed in Table 1 and their visual representation at different stages as shown in fig3.

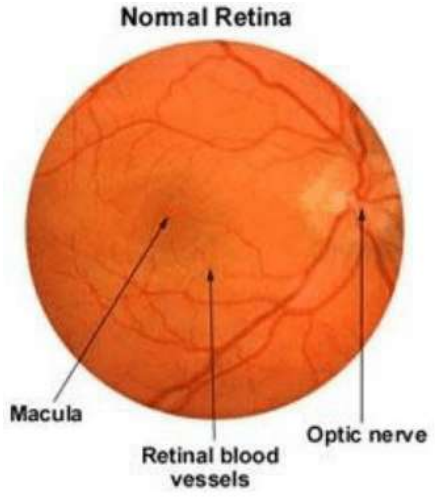

Fig-1: Normal Retina

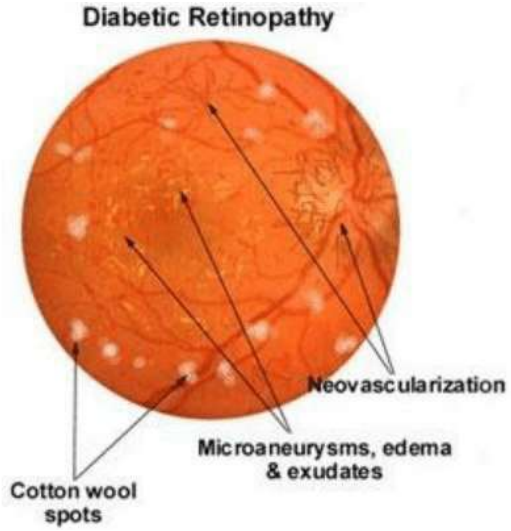

Fig-2: DR-affected Retina

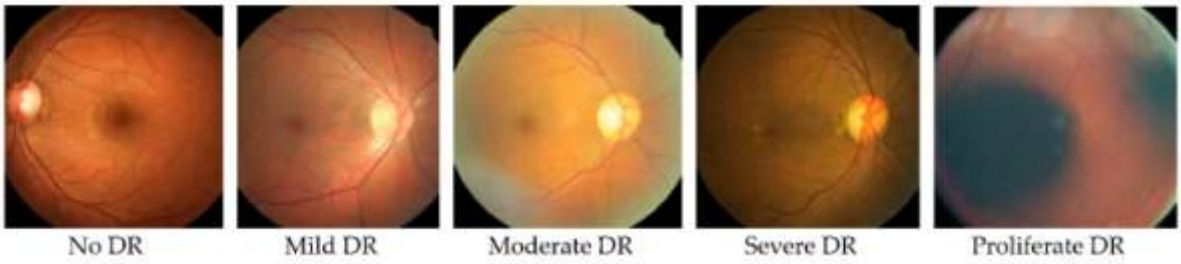

Fig3: Stages of Diabetic Retinopathy

Table 1: Diabetic Retinopathy risk levels

DR Risk level	**Lesions**
No DR	No lesions
Mild NPDR	Presence of MA
Moderate NPDR	Presence of MA and HM Presence of Cotton wool spots and Exudates
Severe NPDR	Any of the symptoms Venous beading in 2 quadrants Presence of MA and extensive HM in 4 quadrants Intraretinal microvascular abnormalities in 1 quadrant
PDR	Neovascularization Presence of preretinal & vitreous HM

Ophthalmologists urge diabetic people to have their fundus medically screened on a regular basis to detect DRs early. Nonetheless, diabetic retinopathies are often overlooked until significant damage to the patient's fundus has occurred (typically manifested as worsening or loss of vision). The proper identification and categorization of DR phases can assist clinicians in deciding on

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appropriate intervention techniques. Diabetic patients all over the world require regular screening to aid in early detection and treatment delivery. Nearly 90% of diabetes individuals can be detected with early illness detection and adequate screening, and disease development can be slowed by avoiding future repercussions. The main issue is that DR does not reveal characteristic symptoms until the disease has progressed to an advanced stage [3]. To avoid difficulties, periodic eye examinations and regular check-ups are encouraged. Human evaluation of retinal characteristics and morphological differences in fundus images, on the other hand, is a tedious and time-consuming operation. To address this shortcoming, numerous automated computer-aided diagnostic tools have recently been developed, which assist ophthalmologists in examining retinal abnormalities.

II. RELATED WORK

Researchers have devised or applied effective techniques for diagnosing diabetic retinopathy in two ways: binary classification and multi classification, as shown below.

Several techniques for detecting microaneurysms, hemorrhages, and exudates are discussed [1] for ultimate detection of non-proliferative diabetic retinopathy. Blood vessels detection techniques are also discussed for the diagnosis of proliferative diabetic retinopathy. A number of image processing techniques applicable to white light retinal fundus images have been proposed in the literature [2], which were used to design screening systems for this retinal disorder. A common prerequisite step used in all the approaches is the blood vessel network extraction. Based on the retinal image processing techniques used, the screening systems can be further categorized as those which are used to design DR referral systems focusing on localization of a single symptom and those DR referral systems focusing on isolation of multiple symptoms. Various conventional and deep learning-based diabetic retinopathy disease detection and classification methods are reviewed [3] and analyzed to provide a clear insight and future directions. Meher Madhu Dharmana et.al. [4] proposed method which has an effective feature extraction technique based on blob detection followed by classification of different stages of diabetic retinopathy using machine learning technique. This feature extraction technique could help automatic characterization of retina images for diabetic retinopathy with an accuracy of 83 per cent with the most efficient machine learning classification algorithm, which would help specialists to handily recognize the patient's condition in a progressively precise manner. Messadi Mohamed et.al. [5] presented approach is based on the segmentation of blood vessels and extracts the geometric features, which are used in the early detection of diabetic retinopathy. The proposed system was tested on the DRIVE and Messidor databases and achieved an average sensitivity, specificity and accuracy of 89%, 99% and 96%, respectively for the segmentation of retinal vessels and 91%, 100% and 93%, respectively for the classification of diabetic retinopathy. Doshna Umma Reddy et.al. [6] considered a convolutional neural network which uses the VGG- 16 model as a pre-trained neural network for fine-tuning, and, thereby classifying the severity of DR. The model also uses efficient deep learning techniques including data augmentation, batch normalization, dropout layers and learn-rate scheduling on high resolution images to achieve higher levels of accuracy.

J. Anitha et.al. [7] developed CAD techniques are analyzed with respect to performance evaluation and the challenges are discussed, some suitable solutions are suggested for improving the system to be more accurate. R. Subhashini et.al. [8] constructed a graphical user interface that can integrate image processing techniques together in order to predict whether the input fundus/retinal image received from the patient is affected with Diabetic Retinopathy or not; if affected, the graphical user interface will display the severity along with the required action needed to be undertaken by the user / patient. Manoj Kumar Behera et.al. [9] has proposed research two well-known predefined feature extraction techniques scale invariant feature transform (SIFT) and speeded up robust features (SURF) have been used simultaneously on each retinal images to capture the Exudates regions. These Exudates of each image stored in a feature matrix and used by the support vector machine (SVM) classifier for prediction of DR. Karan Bhatia et.al. [10] focused on decision about the presence of disease by applying ensemble of machine learning classifying algorithms on features extracted from output of different retinal image processing algorithms, like diameter of optic disk, lesion specific (micro aneurysms, exudates), image level (prescreening, AM/FM, quality assessment). Decision making for predicting the presence of diabetic retinopathy was performed using alternating decision tree, Ada-Boost, Naïve Bayes, Random Forest and SVM. Masoud Khazaee Fadafen et.al. [11] proposed method on the DIARETDB1 database, which includes 89 selected images for the diagnosis of diabetic retinopathy, was tested and with four models of methods available for

recognizing saliencies, frequency tuned method (FT) model, the spectral residual approach (SR) model, the SDSP model: a novel saliency detection method by combining simple prior has been compared. To evaluate the performance of the proposed method with other methods using Ground truth images, the ROC curve and the AUC calculation were used. Sumesh E P et.al. [12] created a DR detection technique, involving digital image processing, has been developed by utilizing retinal image, where fundus image has been obtained from patient's retina. This proposed work aims at segmenting the fundus image into Exudates, Micro aneurysm, Optical Disk and hemorrhage and examine whether the retinal condition is in Proliferative / Non Proliferative DR stage. Various performance measures has been utilized in validating the proposed technique. From those performance analysis, we could observe 98% accuracy in detecting PDR and NPDR within 39 seconds (half minute).

Ali Shojaeipour et.al. [13] developed system in which the Gaussian filter is used to enhance images and separate vessels with a high brightness intensity distribution. Next, wavelets transform is used to extract vessels. After that according to some criteria such as vessels density, the location of optic disc was determined. Then after optic disc extraction, exudates regions were determined. Finally they classified the images with a boosting classifier. With utilizing the boosting algorithm, the suggested system can have a power classifier. Mirthula Balaji et.al. [14] implemented a semantic analysis that utilizes for portraying the DR. In our proposed methodology, an innovative framework to overcome the issues of traditional methodology. The GLCM an effective feature is chosen for extracting the features with the co-occurrence matrix. After extracting the features, the classification process is performed using Probabilistic Neural Network (PNN) which provides an effective classifier output. It is concluded that this novel vessel segmentation framework acquired better accuracy, sensitivity, F measures, specificity and precision from this experiment. Yuhanis Yusof et.al. [15] focuses on classification of fundus image that contains with or without signs of DR and utilizes artificial neural network (NN) namely Multi-layered Perceptron (MLP) trained by Levenberg-Marquardt (LM) and Bayesian Regularization (BR) to classify the data. Nineteen features have been extracted from fundus image and used as neural network inputs for the classification. It is learned that MLP trained with BR provides a better classification performance with 72.11% (training) and 67.47% (testing) as compared to the use of LM. Shailesh Kumar et.al. [16] presents an improved diabetic retinopathy detection scheme by extracting accurate area and ate number of micro aneurysm from color fundus images. Diabetic retinopathy (DR) is an eye disease which occurs due to damage of retina as a result of long illness of diabetic mellitus. The recognition of MA at primary stage is very crucial and it is the first step in inhibiting DR. A variety of methods have been proposed for detection and diagnosis of DR. Classification of DR has been done by linear Support vector machine (SVM). The sensitivity and specificity of DR detection system are observed as 96% and 92% respectively. Bhavani Sambaturu et.al. [17] proposed a novel method to detect hard exudates with high accuracy with respect to lesion level. They tested our algorithm on publicly available DiaretDB database, which contains the ground truth for all images. They achieved high performance results such as sensitivity of 0.87 and F-Score of 0.78 and Positive Predict Value (PPV) of 0.76 for hard exudate lesion level detection, compared to the existing state of art techniques. Tanapat Ratanapakorn et.al. [18] has the automated software for screening and diagnosing DR, by using the combination of digital image processing techniques, has been developed. This software yields the good accuracy for the detection of DR from fundus photographs. It can be used as an alternative or adjunctive tool for DR screening, especially in the remote area where ophthalmologist is not available or in the rural area where ophthalmologist has many task overloads.

III. CONCLUSION

Although diabetic retinopathy cannot be healed, laser analysis can help prevent vision loss if done before the retina is negatively affected. The surgical removal of vitreous gel can enhance eyesight if the retina has not been severely damaged. This research aids in the early diagnosis of retinopathy, which can lead to irreversible visual loss if not treated promptly. This study detailed the authors' studies for detecting diabetic retinopathy. Technical people and researchers who need to leverage ongoing research in this field would benefit from our effort. Various approaches for detecting and treating diabetic retinopathy patients have been developed, including the categorization of different phases of diabetic retinopathy employing using artificial intelligence.

REFERENCES

[1]. Javeria Amin, Muhammad Sharif, Mussarat Yasmin, "A Review on Recent

Developments for Detection of Diabetic Retinopathy", Scientifica, vol. 2016, Article ID 6838976, 20 pages, 2016. https://doi.org/10.1155/2016/6838976

[2]. Sandhya Soman, Jayashree R, "A Survey of Image Processing Techniques for Diabetic Retinopathy", International Conference on Advances in computer Science and Technology (IC-ACT'18) – 2018, ISSN: 2395-1303

[3]. Valarmathi S, Dr. R. Vijayabhanu, "A Review on Diabetic Retinopathy Disease Detection and Classification using Image Processing Techniques", International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 09 | Sep 2020, pp 456-455.

[4]. M. M. Dharmana and A. M.S., "Pre-diagnosis of Diabetic Retinopathy using Blob Detection," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 98-101, doi: 10.1109/ICIRCA48905.2020.9183241.

[5]. E. Z. Aziza, L. Mohamed El Amine, M. Mohamed and B. Abdelhafid, "Decision tree CART algorithm for diabetic retinopathy classification," 2019 6th International Conference on Image and Signal Processing and their Applications (ISPA), Mostaganem, Algeria, 2019, pp. 1-5, doi: 10.1109/ISPA48434.2019.8966905.

[6]. N. B. Thota and D. Umma Reddy, "Improving the Accuracy of Diabetic Retinopathy Severity Classification with Transfer Learning," 2020 IEEE 63rd International Midwest Symposium on Circuits and Systems (MWSCAS), Springfield, MA, USA, 2020, pp. 1003-1006, doi: 10.1109/MWSCAS48704.2020.9184473.

[7]. A. G. P. H., J. Anitha and J. N. R. J., "Computer Aided Diagnosis Methods for Classification of Diabetic Retinopathy Using Fundus Images," 2018 International Conference on Circuits and Systems in Digital Enterprise Technology (ICCSDET), Kottayam, India, 2018, pp. 1-4, doi: 10.1109/ICCSDET.2018.8821200.

[8]. R. Subhashini, T. N. R. Nithin, U. M. S. Koushik, "Diabetic Retinopathy Detection using Image Processing (GUI)", International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878, Volume-8, Issue-2S3, July 2019

[9]. M. K. Behera and S. Chakravarty, "Diabetic Retinopathy Image Classification Using Support Vector Machine," 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA), Gunupur, India, 2020, pp. 1-4, doi: 10.1109/ICCSEA49143.2020.9132875.

[10]. K. Bhatia, S. Arora and R. Tomar, "Diagnosis of diabetic retinopathy using machine learning classification algorithm," 2016 2nd International Conference on Next Generation Computing Technologies (NGCT), Dehradun, 2016, pp. 347-351, doi: 10.1109/NGCT.2016.7877439.

[11]. Fadafen, Masoud&Mehrshad, Nasser & Razavi, Seyyed. (2018). Detection of diabetic retinopathy using computational model of human visual system. Biomedical Research (India). 29. 1956-1960. 10.4066/biomedicalresearch.29-18-551.

[12]. Hamood Ali Hamood Al shamaly, Sumesh E P, Vidhyalavanya R, Jayakumari C, "Diabetic Retinopathy Detection Using Matlab", International Journal Of Scientific & Technology Research Volume 8, Issue 11, November 2019

[13]. A. Shojaeipour, M. J. Nordin and N. Hadavi, "Using image processing methods for diagnosis diabetic retinopathy," 2014 IEEE International Symposium on Robotics and Manufacturing Automation (ROMA), Kuala Lumpur, 2014, pp. 154-159, doi: 10.1109/ROMA.2014.7295879.

[14]. V. Govindaraj, M. Balaji, T. a. Mohideen and S. a. F. J. mohideen, "Eminent identification and classification of Diabetic Retinopathy in clinical fundus images using Probabilistic Neural Network," 2019 IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing (INCOS), Tamilnadu, India, 2019, pp. 1-6, doi: 10.1109/INCOS45849.2019.8951349.

[15]. N. H. Harun, Y. Yusof, F. Hassan and Z. Embong, "Classification of Fundus Images For Diabetic Retinopathy using Artificial Neural Network," 2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT), Amman, Jordan, 2019, pp. 498-501, doi: 10.1109/JEEIT.2019.8717479.

[16]. S. Kumar and B. Kumar, "Diabetic Retinopathy Detection by Extracting Area and Number of Microaneurysm from Colour Fundus Image," 2018 5th International Conference on Signal Processing and

Integrated Networks (SPIN), Noida, 2018, pp. 359-364, doi: 10.1109/SPIN.2018.8474264.

[17]. K. K. Palavalasa and B. Sambaturu, "Automatic Diabetic Retinopathy Detection Using Digital Image Processing," 2018 International Conference on Communication and Signal Processing (ICCSP), Chennai, 2018, pp. 0072-0076, doi: 10.1109/ICCSP.2018.8524234.

[18]. Ratanapakorn, Tanapat & Daengphoonphol, Athiwath & Eua-Anant, Nawapak & Yospaiboon, Yosanan. (2019). Digital image processing software for diagnosing diabetic retinopathy from fundus photograph. Clinical Ophthalmology. Volume 13. 641-648. 10.2147/OPTH.S195617.