Survey on Diabetic Retinopathy Classification using Various Machine Learning Techniques

1st Dr G.V.Ramesh Babu, 2nd O.Yamini

[1]Research Supervisor, [2] Research Scholar

Department of Computer Science, S V University, Tirupati A.P., India

Abstract - People who have insulin problems frequently develop diabetes. Only diabetic persons have diabetic retinopathy (DR), a serious micro vascular consequence that damages the retina and, if undiagnosed and not treated promptly, can result in irreversible partly or whole blindness. Addition to the amount it takes for a patient to visit an ophthalmologist who scans the patient's retinal, several diabetes individuals neglect to recognise their illness and eventually develop visual impairments. Such human analysis is labor-intensive, slows down the DR diagnosis procedure, allowing the illness to progress to more advanced stages within the window period, and isn't always correct. This article surveys and evaluates the most recent studies and survey journals addressing the precise diagnosis & designation of DR into separate sections, ranging from mild to serious, depending on the different methods used from fundus image collections for picture pre-processing, disease detection, & classification.

INDEXTERMS - ***Diabetic Retinopathy, Convolutional Neural Networks, Fundus images***

I. INTRODUCTION

Diabetes is conditions in which the body can't properly use insulin or the gland don't secrete enough of it. According to WHO estimates, there are 442 million individuals with diabetes globally. This is a serious problem because India is the world's diabetes capital because 77 million of such individuals reside there. When diabetes progresses, it gradually damages the retina's blood vessels and accumulates over time, lowering the patient's quality of life vision and resulting in diabetic retinopathy. As blood sugar levels rise abnormally, the extra blood sugar that is produced has no choice except to collect in the blood vessels of a human eye. Among patients with diabetes who have had it for 10 to 15 years, 10% develop blind and 2% or so experience significant visual impairment. The sixth most common reason for partial blindness in people of working age is DR. Diabetic retinopathy has multiple stages, including According to Fig. 1, diabetic retinopathy can be classified as mild, non-proliferative, proliferative, moderate, or severe. The NPDR retina swells as a result of glucose buildup that causes blood vessel leaks in the eyes. The patient may lose some of their eyesight as a result of partial vascular blockage brought on by severe edoema. PDR, in the other hand, does not appear until the retina's fresh blood vessels begin to develop. These were more likely to scar because the fresh blood vessels were so sensitive thin and separate from the retina, impairing both central and peripheral vision and ultimately causing total blindness. Blurred vision, fuzzy spots, haemorrhages, doubled vision, & micro vascular abnormalities are among the signs and symptoms of NPDR and PDR. The haemorrhage's blood causes partial or total eyesight loss. Moreover, patients may have floaters, black spots, and problems with colour perception. The most common method for diagnosing DR involves injecting a dye into to this photographing the dye as it travels through the blood vessels in the eyes to check for blockages, leaks, & haemorrhages as it passes through the patient's arm vein. The alternative method involves photographing the retina in cross-section, which aids in detecting problems related to fluid leaks or retinal tissue damage. These conventional techniques are pricy, labor-intensive, time-consuming, and occasionally inaccurate. So, it is clear that early illness detection is crucial for sparing patients from vision losses. The longer the illness is left undiagnosed or untreated, the more severe the effects may get. Many different diseases are predicted using machine learning (ML) approaches. CNN has successfully aided in analysis & decision-making in the fields of computer vision, medicine design, medical image processing, etc. By assisting in pathological screening and disease prediction, the application of the these cutting-edge machine learning algorithms has significantly reduced the stress of human interpretations. With the only purpose of reducing the incidence, use of CNN and ML in the identification of retinopathy was indeed a natural and inescapable issue. If diabetic retinopathy given the exalted results of these technologies in several other healthcare domains.

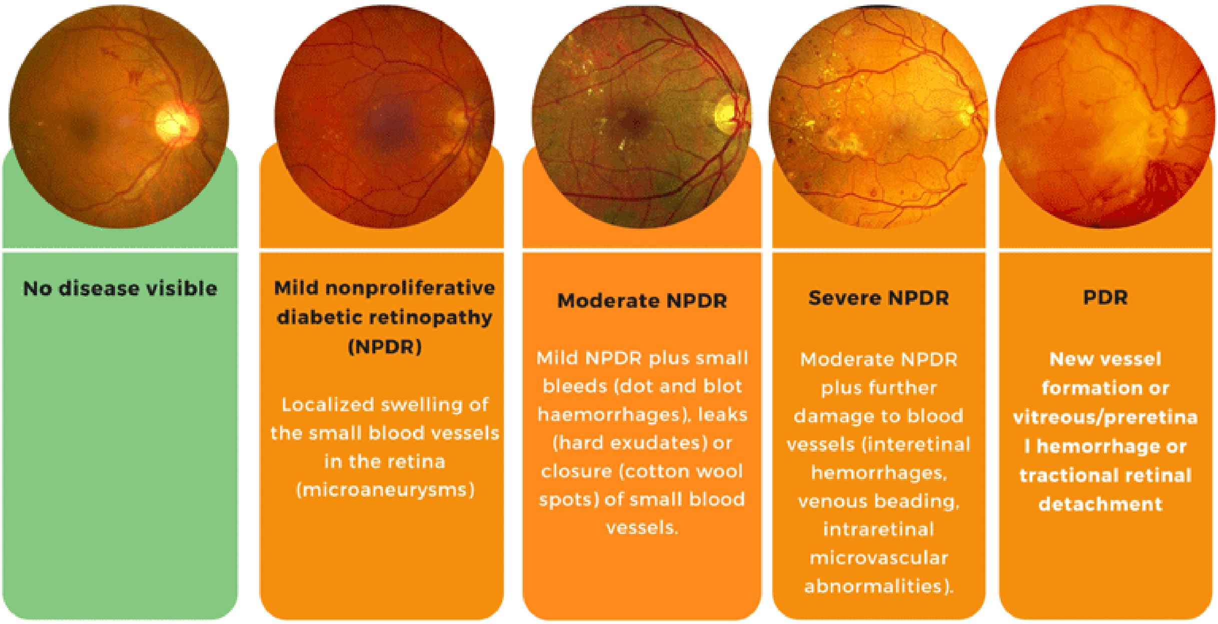

Fig.1 *: Five Classifications of Diabetic Retinopathy*

II. LITERATURE SURVEY

Before the trial began, AI systems operators underwent a standardised training process. In paper [1], Abramoff et al., made the system the very first FDA-approved automated AI diagnosis device almost in any area of medicine may be able to assist thousands of people from losing their vision diabetics each year. Authorised the technology for use by healthcare professionals to detect much milder DR & diabetic macular edoema.

In paper [2], Surasak et al., developed an application to recognise persons in videos. They built an application with three primary components: human detection, human counting, and histogram generating. They identified the human during the human identification process, displayed the outcome by adding a green frame, and provided the amount of people for every video frame. To detect and count people, they examined every frame of the movie using the HOG Algorithm. The programme creates a histogram to display the number of persons detected over the course of the movie's playing time after analyzing the film from beginning to conclusion.

The types of lesions that form on the retina dictate the phases of DR. Wejdan et al. investigated the most recent automated deep learning-based systems for identifying and categorising diabetic retinopathy in paper [3]. We have described the openly available common funds DR datasets & given a brief overview of deep learning techniques. Owing to its efficacy, CNN has been accepted by the most of studies for the identification and categorization of DR photos. The analysis has also discussed doable strategies that can used to identify and categorise DR using DL.

In paper [4], Alyoubi et al., suggested two deep learning-based models, YOLOv3 and CNN512. In order to categorise CNN512 & YOLOv3 were coupled to locate DR lesions from DR pictures. To reduce the risk of blindness, DR must be identified and treated as soon as possible. With the severity of DR's effects growing, the manual diagnosing technique grew ineffective. Hence, utilising computer-aided screen systems (CASS) to automate DR's diagnosis reduces work, costs, and time.

In paper [5], Al-Mukhtar et al., combines weakly-supervised localization techniques with automatic detection again for classification of diabetic retinopathy. The model contains four steps, the first of which involves smearing the data set using a variety of pre-processing approaches. Because this network has sharpened its focus just on optic disc section in stage two to obviate any are somewhat false predictions because exudates had its same colour pixel as the optical disc. At the third stage, the network is given training data to classify each label. Finally, the layers of the a convolution neural network are modified to localise the impact of DR just on patient's eye. The framework addresses the technique of matching between two essential notions, and the supervised learning approach is used to solve the classification problem.

In paper [6], Kumar et al., proposed the unique Deep-in-Net technique, which consists of three main steps and produces constellations of different DR severity degrees. At the picture step, these datasets are trained under supervision. The attentiveness maps for the suspected disease area are generated by the Deep-in-Net. According to the purpose, the technique can validate and discover.

In paper [7], P. Kaladevi et al., In 2021, Qureshi et al. A 7-layered CNN design that automatically & simultaneously recognises the five steps of DR with the localization of lesion using some ground-truth annotation fundus sample instead than the whole set of training images was proposed utilising active deep learning (ADL)-CNN. The input fundus image was initially pre-processed to enhance the contrast within uniform-color space and augmentation techniques before being fed into the algorithm for learning distinguishing traits.

In paper [8], Yu Wang et al., (Firke, et al, 2021) created that can identify DR without the aid of a professional. CNN-based deep learning algorithms are efficient and accurate at classifying images. They compared that performance accuracy of the an existing model in this experiment. To improve efficiency, they implemented the method by changing certain parameters like the amount of convolution layers and the pooling layer optimizer.

In paper [9], Piyush Jain et al., (Nderitu, et al, 2022) created and tested Classification of grad capability, retinal presence, retinal field, & single- & multi laterality using a deep learning (DL) model for automated curation. DL effectively detects laterality, retinal present, retinal field, & gradability of DR screening images with generality between centres and populations. DR screening may use DL models for automated image curation. Early diagnosis of sight-threatening DR (STDR) by retinal photography-based DR screening enables prompt referral and treatment, which can reduce the chance of mild vision loss.

In paper [10], Amit Sawant et al., (Raumviboonsuk, et al, 2019) presented one of the largest population-based clinical trials for the deep having to learn system other than the one it was trained on. In order to accomplish this external validation, it was compared directly to the screening program's actual graders from the same demographic.

In paper [11], Abhishek Punde et al., (Dai, et al, 2021) a system that grades DR from early to late stages, detects retinal lesions, and offers real-time feedback on picture quality has been established that is automated, interpretable, and validated. With such features, the DeepDR technology is able to increase the calibre of image collection, offer clinical references, and simplify DR screening. In DR grading, the DeepDR method attained great sensitivity and specificity. It provides visual indications that assist users in recognising the presence & location of various lesion types rather than just producing a DR grading. Lesion-aware and picture quality sub networks were added to DeepDR, which increased diagnosis performance and closely mirrored ophthalmologists' thought processes.

In Paper [12], G. M. Shahariar et al., (Krause, et al, 2018) feel that accurate ground truth determination is a crucial component of creating therapeutically relevant machine learning algorithms for application in the identification or screening of retinal illness. Improved algorithmic accuracy is provided through the live adjudication process by numerous subspecialists, which results in a consensus grade and enhanced screening models.

III. LITERATURE SURVEY DETAILS

PN	Short notes	Advantages	Disadvantages
[1]	Although The accessibility, affordability, & quality of healthcare have long been improved by artificial intelligence (AI), yet the FDA had never before authorized an autonomous AI diagnostics device. Finding diabetics with diabetic retinopathy (DR) is the most crucial test for an AI system.	All previously defined superiority endpoints were surpassed by the AI system, which had a picture ability rate of 96.1% and a sensitivity of 87.2%.	Scalable clinical implementation may face difficulties due to selective dilatation.
[2]	Building an application to import and recognise humans in videos using the HOG The (Histograms of Oriented Gradients) method is used to recognise people in videos. Every frame of the video is analysed using the HOG Algorithm to detect and count persons.	The average human detection accuracy across 10 videos is 81.23 percent, with a standard deviation of 10.95 percent.	The programme is currently in the early stages of development.
[4]	The suggested system localises the affected lesions on the retinal surface and divides No-DR, mild, moderate, severe, & proliferative DR are the five stages of DR. The system includes two deep learning-based models. The first model (CNN512) used the complete image as an input to classify the image into one of the five DR phases. Using a recognised YOLOv3 model, the second model concurrently identified & localised the DR lesions.	In order to categorise DR images and pinpoint DR lesions, The results of CNN512 and YOLOv3's fusion beat current state results with just a accuracy of 89%, sensitivity of 89%, and specificity of 97.3%.	The findings which the model obtained are impacted by the incorrect tagging of the photos.
[5]	The model combines weakly-supervised learning-based localization techniques with automatic detection again for classification of diabetic retinopathy.	Technology under loose supervision achieved 0.954.	The network's ability to feed the model gloomy, tenebrous, dim data will reduce its effectiveness.

[6]	Convolutional neural networks were suggested as a method for finding other potential locations and diagnosing diabetic retinopathy (CNN). uses machine learning techniques along with Deep-in-Net, a reliable illness detection tool.	This method is effective at seeking attention mapping.	Around 80–86% accuracy is the greatest rate.
[7]	A new multi-layer active deep learning architecture is suggested to enable automatic detection of the DR stage (ADL). We employed a convolutional neural network (CNN) models to automatically extract the features as opposed to handcrafted-based features when creating the ADL system.	For identifying the five DR severity levels and identifying DR-related lesions on various fundus images pictures, ADL-CNN architecture is outperformed.	It has been noted that ADL-CNN method suffers from a computational problem while processing big amounts of data.
[8]	Introduced a method for detecting diabetic retinopathy using convolution neural networks. It performed early image processing, primarily picture resizing, pixel rescaling, and label encoder on the image while training a convolution neural network using the freely accessible Apatos Blind Detection dataset. This convolution neural network models is then given an image to determine if the patients has diabetic retinopathy or not.	Using dropout techniques, our network design has attained a sufficient level of classification accuracy.	The test samples are provided to the system, but the real goals are compared before reporting the model's numbers of errors.
[9]	developed and tested deep learning (DL) algorithms for grad ability classification, retinal presence, single and multiple output laterality, and retinal field for automated curation. With generalisation between center & populations, DL efficiently identifies laterality, retinal present, retinal field, and gradability of DR screening images.	Despite large variations in image sensors, DR severity, and DR screening techniques, Study methods based on DL models for sequence categorization work effectively.	Retinal present Because there were so few non-retinal samples, specificity cannot be verified with such high confidence.
[10]	Expert-level accuracy has been achieved in the Using deep learning algorithms, diabetic retinopathy (DR) can be detected. This study aims to validate one such approach on a sizable clinical population and evaluate the algorithm's performance with that of human graders.	Deep learning considerably decreased the false negatives rate (by 23%) across various DR severity levels for detecting referable disease, albeit at the expense of marginally greater false positive rates (2%).	have an impact on the eventual prevention, progression, and outcomes of disease.
[11]	Early diagnosis and prompt treatment of diabetic retinopathy are made possible through retinal screening. We create DeepDR, and deep learning system that can identify diabetic retinopathy in its early to late stages, to simplify the screening procedure. Utilizing 466,247 fundus photos from 121,342 diabetes patients were used to train DeepDR in lesion detection, grading, and real-time image clarity rating.	In DR grading, the DeepDR method attained great sensitivity and specificity.	Further study is needed to determine how well deep learning algorithms are able to detect and predict the progression of DR.
[12]	Adjudication can be used to measure grading errors for diabetic retinopathy (DR), according to each grader individually and the majority vote, as well as to develop a better automated system for DR grading.	The algorithm's AUC for moderate or worse DR increased from 0.934 to 0.986 when higher-resolution photos were used as input and As a tuning dataset, a modest number of adjudicated consensus grades were used.	The algorithm's AUC increased from 0.934 to 0.986 for moderately or worse DR when it was combined with higher-resolution photos and as a unifying dataset, a limited set of adjudication consensus grades.

Table 1 Literature Survey Details

IV. CONCLUSION

One of the frequent eyesight issues seen by people with diabetes is diabetic retinopathy. For appropriate and precise therapy, early diagnosis and accurate classifications are essential. This study reviewed a number of research and survey publications that discussed and evaluated the primary methods used to diagnose and categorize diabetic retinopathy. The study investigated multiple methods at each stage, including feature extraction, pre-processing, and classification. Additionally, it highlighted several significant advancements made by these algorithms. According to the poll, It may be more beneficial to use machine learning or the deep-learning strategy and useful for therapeutic objectives in slowing the development of diabetic retinopathy in patients and enabling the ophthalmologist to expedite additional retinal treatment. The demand for developing alternative DR recognition approaches to current techniques has increased due to the growth in the proportion of diabetic individuals with DR. The results of this assessment will aid investigators in this subject advance their work by letting them know about the approaches and procedures that are currently used for DR detection and classification.

V. REFERENCES

[1]. Abramoff, M.D., Lavin, P.T., Birch, M. et al. Pivotal trial of an autonomous AI-based diagnostic system for detection of diabetic retinopathy in primary care offices. npj Digital Med 1, 39 (2018).

[2]. T. Surasak, I. Takahiro, C. -h. Cheng, C. -e. Wang and P. -y. Sheng, "Histogram of oriented gradients for human detection in video," 2018 5th International Conference on Business and Industrial Research (ICBIR), 2018, pp. 172-176.

[3]. Wejdan L. Alyoubi, Wafaa M. Shalash, Maysoon F. Abulkhair, Diabetic retinopathy detection through deep learning techniques: A review, Informatics in Medicine Unlocked, Volume 20, 2020, pp. 1-11.

[4]. Alyoubi, W. L., Abulkhair, M. F., & Shalash, W. M. (2021). Diabetic Retinopathy Fundus Image Classification and Lesions Localization System Using Deep Learning. Sensors, 21(11), 3704, pp. 1-22.

[5]. Al-Mukhtar, M., Morad, A.H., Albadri, M. et al. Weakly Supervised Sensitive Heatmap framework to classify and localize diabetic retinopathy lesions. Sci Rep 11, 23631 (2021).

[6]. Kumar, KG & Karunakara, K & GS, Dr.Thyagaraju & Dixit, Sunanda. (2021). Detection of Diabetic Retinopathy using Deep Mining. IOP Conference Series: Materials Science and Engineering. pp. 1-9.

[7]. Qureshi, I., Ma, J., & Abbas, Q. (2021). Diabetic retinopathy detection and stage classification in eye fundus images using active deep learning. Multimedia Tools and Applications, 80(8), pp. 11691–11721.

[8]. S. N. Firke and R. B. Jain, "Convolutional Neural Network for Diabetic Retinopathy Detection," 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS), 2021, pp. 549-553.

[9]. Nderitu, P., Nunez do Rio, J.M., Webster, M.L. et al. Automated image curation in diabetic retinopathy screening using deep learning. Sci Rep 12, 11196 (2022), pp. 1-12.

[10]. Raumviboonsuk, P., Krause, J., Chotcomwongse, P., Sayres, R., Raman, R., Widner, K., Webster, D. R. (2019). Deep learning versus human graders for classifying diabetic retinopathy severity in a nationwide screening program. Npj Digital Medicine, 2(1), pp. 1-9.

[11]. Dai, L., Wu, L., Li, H., Cai, C., Wu, Q., Kong, H., Jia, W. (2021). A deep learning system for detecting diabetic retinopathy across the disease spectrum. Nature Communications, 12(1), pp. 1-11.

[12]. Krause, J., Gulshan, V., Rahimy, E., Karth, P., Widner, K., Corrado, G. S., Webster, D. R. (2018). Grader Variability and the Importance of Reference Standards for Evaluating Machine Learning Models for Diabetic Retinopathy. Ophthalmology, 125(8), pp. 1264–1272.

[13]. World Health organization: WHO, “Diabetes,” Who.int, May, 2019. https://www.who.int/health-topics/diabetes.

[14]. “Mayo Clinic – Mayo Clinic”, MayoClinic.org, 2021. https://www.mayoclinic.org/ (accessed Feb. 10, 2021).

[15]. “Latest Medical News, Clinical Trials, Guidelines – Today on Medscape,” Medscape.com, 2021. https://www.medscape.com/.