International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 07 | July - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Research Paper on Diabetic Retinopathy Detection Through Deep Learning Techniques

Payal Nannewar [1], Dr. Sanjay. L. Haridas [2], Ashwini Mate[3]

[1]*Student of M-Tech Electronics Engineering Department in J D college of Engineering & Management, Nagpur*
[2]*Dean Academics of J D college of Engineering & Management, Nagpur*
[3]*Assistant Professor of M-Tech Electronics Engineering Department in J D college of Engineering & Management, Nagpur*

---***---

Abstract - Diabetic retinopathy (DR) is a progressive and potentially blinding eye disease that affects a significant number of individuals with diabetes worldwide. Early and accurate detection of DR is crucial to prevent vision loss and improve patients' quality of life. In recent years, the emergence of deep learning techniques has revolutionized the field of medical image analysis, offering promising solutions for automated DR detection. This research paper presents a comprehensive review of the state-of-the-art in diabetic retinopathy detection using deep learning methodologies. The study encompasses an in-depth analysis of various deep learning models, their architectures, and the preprocessing techniques employed in DR detection. We also discuss the datasets commonly used in this domain and the performance evaluation metrics applied to assess the efficacy of these models. For this paper, the most innovative methods for classifying and detecting DR color fundus pictures using deep learning approaches have been investigated and tested. The color fundus retina DR datasets have also been looked at.

Key Words: Diabetic retinopathy, Vision loss, Detecting DR colour, Deep Learning.

1. DEEP LEARNING

Diabetic retinopathy (DR) is a leading cause of blindness among adults worldwide. Early and accurate detection of DR is crucial for timely intervention and preventing severe vision loss. In recent years, deep learning techniques have emerged as a powerful tool in medical image analysis, demonstrating promising results in diabetic retinopathy detection. This paper reviews the use of deep learning methodologies, particularly convolutional neural networks (CNNs), in the context of DR detection. Various CNN architectures, data preprocessing techniques, data augmentation methods, and interpretability approaches are explored to assess their impact on enhancing the accuracy and reliability of DR diagnosis. In recent years, DR detection and classification have made extensive use of DL. Even with a large amount of input data, it can successfully learn its features. sources of diversity combined. Numerous DL-based techniques exist, including convolutional neural networks (CNNs), auto encoders, and sparse coding. Contrary to machine learning approaches, these methods perform better as the amount of training data increases since the number of learned features increases. Additionally, DL techniques did not need manually created feature extraction. These variations between DL and machine learning techniques are presented in Fig 1. CNNs are employed more frequently than the other techniques in medical image processing, and they are quite successful.

Convolution layers (CONV), pooling layers, and fully connected layers (FC) are the three primary layers in the CNN architecture. Depending on the author's vision, the CNN's size, number of filters, and layer count can change. In the CNN design, each layer has a distinct function. Different filters convolve an image to extract its features in the CONV layers. Usually, the pooling layer comes after the CONV layer to shrink the size of feature maps. Although there are many pooling strategies, average pooling and maximum pooling are the most frequently used.

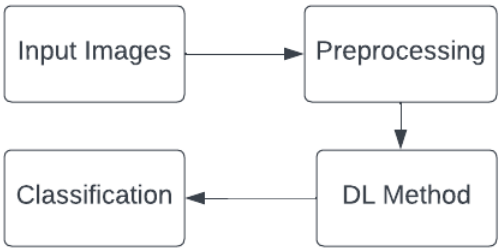

Fig 1: The Process of Classifying the DR images using DL

Generally, the process used to detect and to classify DR images using DL begins by collecting the dataset and by applying the needed preprocess to improve and enhance the images. Then, this is fed to the DL method to extract the features and to classify the images.

2. DIABETIC RETINOPATHY SCREENING SYSTEMS

Diabetic retinopathy screening systems refer to automated and computer-based tools designed to assist healthcare professionals in the early detection and diagnosis of diabetic retinopathy (DR) using retinal images. These systems leverage various image processing and deep learning techniques to identify signs of DR in diabetic patients, enabling timely interventions to prevent vision loss and blindness. Below are the key components and features of diabetic retinopathy screening systems:

Image Acquisition:

The first step in the screening process involves capturing high-resolution retinal images. This is typically done using specialized fundus cameras, which capture images of the back of the eye, including the retina and blood vessels.

Preprocessing:
Before analysis, the captured retinal images undergo preprocessing steps to enhance image quality and remove noise. Preprocessing techniques may involve image resizing, normalization, contrast adjustment, and noise reduction.

Feature Extraction:
In this stage, relevant features are extracted from the preprocessed retinal images. Traditional image processing techniques can be employed to extract features related to the presence of microaneurysms, hemorrhages, exudates, and other characteristic signs of DR.

Telemedicine and Remote Screening:
Diabetic retinopathy screening systems can be valuable in telemedicine settings, allowing for remote screening of patients in underserved or remote areas. These systems can enable ophthalmologists to review images and provide expert recommendations from a distance.

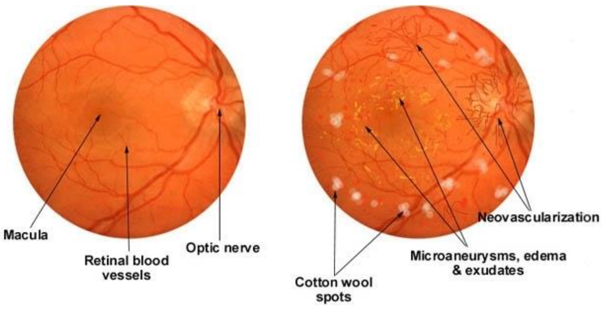

Fig 2: Diabetic Retinopathy Screening System

3. RETINA DATASET

There are various publicly accessible datasets for the retina that can be used to find vessels and detect DR. These datasets are frequently used to develop, test, and compare the systems' performance with that of other systems. Retinal imaging techniques include optical coherence tomography (OCT) and fundus color pictures. OCT images are low-coherence, two- and three-dimensional images of the retina that reveal a great deal about the structure and thickness of the retina, whereas fundus images are two-dimensional, reflected-light images of the retina. OCT retinal images have recently been developed.

DIARETDB1: It contains 89 publicly available retina fundus images with the size of 1500x1152 pixels acquired at the 50-degree field of view (FOV). It includes 84 DR images and five normal images annotated by four medical experts.

Kaggle: It contains 88,702 high-resolution images with various resolutions, ranging from 433x289 pixels to 5184x3456 pixels, collected from different cameras. All images are classified into five DR stages. Only training images ground truths are publicly available. Kaggle contains many images with poor quality and incorrect labeling.

Validation and Evaluation:
The model's performance is evaluated on a separate validation dataset to ensure it generalizes well to new data. Evaluation metrics, such as accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC), are used to assess the model's effectiveness.

Clinical Decision Support:
Once the model is validated, it can be integrated into clinical workflows to provide automated DR screening for diabetic patients. Healthcare professionals can use the system to aid in early DR detection and prioritize patients who need immediate attention.

DDR: This publicly available dataset contains 13,673 fundus images acquired at a 45-degree FOV annotated to five DR stages. There are 757 images from the dataset annotated to DR lesions.

4. DETECTION OF DR

Early detection of DR is extremely important in the prevention of visual impairment and in monitoring ocular complications, especially in young patients with T1DM.The current standard methods to screen DR are the best correct vision acuity (BCVA) examination, slit lamp bio microscopy, dilated fundus examination with ophthalmoscope, intraocular pressure measurement on patients with glaucoma risk, and most importantly digital fundus color photos graded by trained image graders and fluorescein angiography (FA).

Retinal Photography:
Retinal photography has been reported to be the most sensitive screening method for DR. Ophthalmoscopy has less sensitivity but conversely a higher specificity. It provides good results in the hands of trained professionals such as ophthalmologists and diabetologists, especially when used in repeated examinations. Retinal photography for DR has been promoted for decades for both the screening of the disease and in landmark clinical research studies, such as the Early Treatment Diabetic Retinopathy Study. Stereophotography is more reliable for detecting an increase in retinal thickness, but rather laborious and time consuming. Systematic review of evidence suggests that mydriatic photography is the most effective screening strategy, with high sensitivity (87–97%) and specify (83–92%) for detection of sight-threatening DR, but it has several disadvantages (time taken to obtain and interpret the photographs, the need for dilating drops and its associated issues related to patient compliance.

Nonmydriatic Photography:
The limitations of mydriatic photography prompted experts to propose the use of nonmydriatic retinal cameras for DR screening. Nonmydriatic digital stereoscopic retinal imaging is a sensitive and specific method for the screening and diagnosis of DR, which may help improve compliance with the standards of eye care for patients with diabetes. The nonmydriatic image capture with a scanning laser ophthalmoscope provides the additional benefits of easier operation, no pupil dilation, and more rapid acquisition. The limitations of nonmydriatic photography for DR screening are noticed in the literature. It should be noted that when retinal cameras are used without mydriasis, the technical failure rates

may be as high as 20–36%. Silva et al. compared nonmydriatic stereoscopic Optomap ultrawide field images with dilated stereoscopic Early Treatment Diabetic Retinopathy Study 7-standard field 35-mm colour 30-degree fundus photographs. There were 14 eyes, in which Optomap images did not identify PDR seen on ETDRS photographs. Authors conclude that the excellent photographic image quality is needed to identify subtle neovascularization that otherwise can be obscured easily without sharp focus, optimal illumination, high contrast, and good color balance.

Fluorescein Angiography:

The major advantage of FA over fundus photography is its ability to detect macular ischemia denoted by nonperfusion of the retinal capillaries and to detect subtle DME as evidenced by fluorescein leakage from the capillaries. Drawbacks to using FA as a screening procedure are its invasiveness, time constraints, expensive equipment, and adverse reactions. Allergic-type reactions have been reported in patients undergoing FA, although the incidence of serious complications is rare. In general, the use of FA is limited to determining method and location of laser photocoagulation for DME and for assessing the extent of nonperfusion. It has limited value over photography as a diagnostic tool and is not recommended for routine use. It is not needed to diagnose clinically significant ME or PDR, both of which are diagnosed by means of the clinical examination. The prolonged follow up of diabetic retinopathy in childhood demonstrated that the early changes are not necessarily a negative prognostic factor in the evolution of DR and early FA is not particularly useful in the management of children with diabetes.

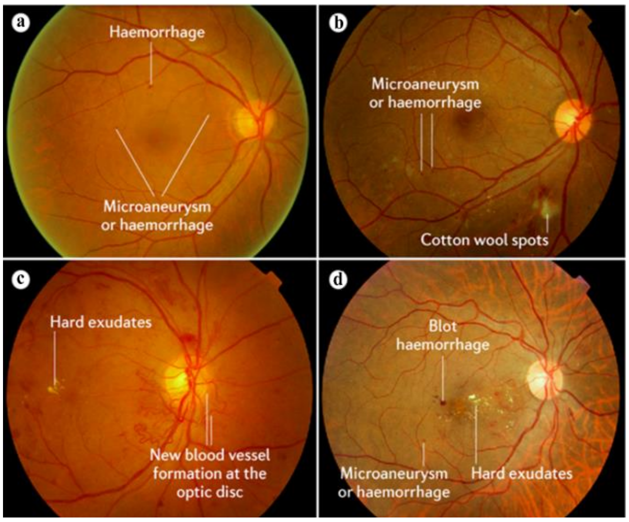

Fig 3: Detection of DR

5. RESULT

Young adults with diabetes should receive care from a team that includes an ophthalmologist, a pediatrician, and a diabetologist. The patient should receive ongoing care and continue to be under observation. This is crucial in T1DM since DR is more likely to develop quickly in this condition. Despite the numerous new medications and surgical procedures, it appears essential to keep blood sugar levels within a certain range. An insulin pump may prevent diabetic retinopathy from forming and lessen the need for eye surgery. Due to the potential for an enhanced proinflammatory response in the eyes of adolescents and young adults, surgical intervention should be carried out with prudence. Due to the complicated a etiology of diabetes in the case of retinopathy, combined therapy utilizing a variety of strategies and medications may be the most efficient.

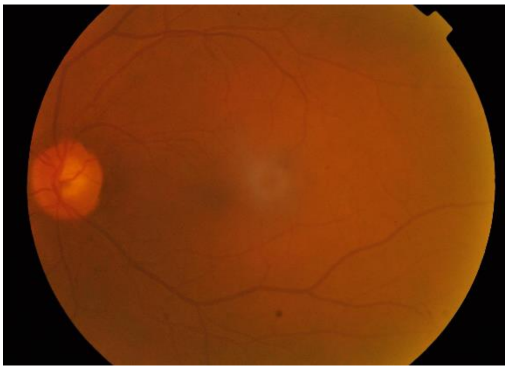

Fig 4: Diabetic Retinopathy with Mild DR

Fig 5: Diabetic Retinopathy with Moderate DR

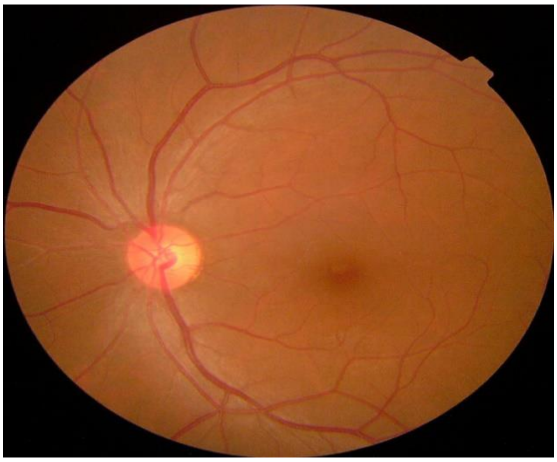

Fig 6: Diabetic Retinopathy with No DR

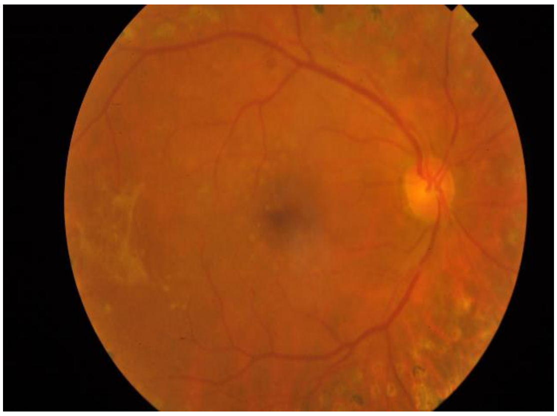

Fig 6: Diabetic Retinopathy with Proliferative DR

Fig 7: Diabetic Retinopathy with Proliferative DR

6. CONCLUSION

Automated screening techniques significantly reduce the amount of time required to get diagnoses, saving ophthalmologists' time and money and facilitating quick patient treatment. Automated DR system detection is essential for spotting DR early on. The types of lesions that form on the retina dictate the phases of DR. The most recent automated deep learning-based methods for diagnosing and classifying diabetic retinopathy have been discussed in this article. We have described the publicly available common fundus DR datasets in detail and given a brief overview of deep learning techniques. The bulk of researches use CNN for the identification and categorization of DR images due of its efficacy. This review has also examined the efficient techniques that may be used to locate and classify DR using DL.

REFERENCES

1. G. Kaidonis, S. Abhary, M. Daniell et al., “Genetic study of diabetic retinopathy: recruitment methodology and analysis of baseline characteristics, Clinical & Experimental Ophthalmology, 2021
2. Ting, D. S. W., Cheung, G. C. M. & Wong, T. Y. Diabetic retinopathy: Global prevalence, major risk factors, screening practices and public health challenges: A review. Clin. Exp. Ophthalmol. 44, 260–277 (2020).
3. Early Treatment Diabetic Retinopathy Study Research Group. Grading diabetic retinopathy from stereoscopic color fundus photographs-an extension of the modified airlie house classifcation: Etdrs report number 10. Ophthalmology 98, 786–806
4. Sayres, R. et al. Using a deep learning algorithm and integrated gradients explanation to assist grading for diabetic retinopathy. Ophthalmology 126, 552–564
5. A. A. K. Falck, J. M. Knip, J. S. Ilonen, and L. T. Laatikainen, “Genetic markers in early diabetic retinopathy of adolescents with type I diabetes,” Journal of Diabetes and Its Complications, vol. 11, no. 4, pp. 203–207, 2020
6. Rasmussen, M. L. et al. Comparison between early treatment diabetic retinopathy study 7-feld retinal photos and non-mydriatic, mydriatic and mydriatic steered widefeld scanning laser ophthalmoscopy for assessment of diabetic retinopathy. J. Diabetes Complicat. 29, 99–104 (2019)
7. Chakrabarti, C. A. Harper, and J. E. Keeffe, “Diabetic retinopathy management guidelines,” Expert Review of Ophthalmology, vol. 7, no. 5, pp. 417–439, 2021.
8. E. J. Mayer-Davis, C. Davis, J. Saadine et al., “Diabetic retinopathy in the SEARCH for Diabetes in Youth Cohort: a pilot study,” Diabetic Medicine, vol. 29, no. 9, pp. 1148–1152, 2020.