

Drushti Mitra- A Deep Learning Algorithm to Classify Diabetic Retinopathy Stages: A Review

Rakesh L¹, Raghu S², Chandan A³, Karthik M S⁴

^{1,2,3,4}Student, Dept. of Electronics and Communication Engineering, VVCE, Mysuru, Karnataka, India

Abstract - Diabetes is one of the most harmful disease of each age group. More number of people getting diabetes. so, the diabetes numbers are still rising more which is increase patient count around the world, Diabetic Retinopathy to leads to permanent blindness if left untreated and it one of the most threatening consequences of diabetes. For treatment success early detection is very important. Unfortunately, it requires expert human interpretation of fundus images, to know the exact identification of the diabetic retinopathy stages. In this review, the different stages of retinopathy and its detection method will be covered. Our review is based on different severity level of diabetic retinopathy and its classification.

Key Words: Diabetic Retinopathy Stages, Transfer learning, Deep Learning

1. INTRODUCTION

Diabetic Retinopathy (DR) is one of the most threatening consequences of diabetes in which damage occurs to the retina and causes permanent blindness. It damages the blood vessels within the retinal tissue, causing leakage of fluid and distort vision. People with diabetic retinopathy might not feel any symptoms in the beginning stage of the disease, the patient will not get feel any symptoms until final stage. So, the chances of patient losing vision is more. Diabetic retinopathy patients will suffer from diabetic retinopathy stages as mentioned below: -

1.1 Stages of Diabetic Retinopathy

No Diabetic Retinopathy: In this stage the patient eye condition will be normal (Normal eye).

Mild Non-proliferative Retinopathy: This is the beginning stage of the disease, the eye is affected by microaneurysms, formation of small balloon-like swellings inside the retina's tiny blood vessels.

Moderate Non-proliferative Retinopathy: By this stage, retina is blocked due to a significant increase in number and size of those balloon-like swellings or microaneurysms due to the blockage of the blood vessels, nourishing the retina in the eye.

Severe Non-proliferative Retinopathy: At this stage, a considerable number of blood vessels are blocked and spread some areas in retina, you will find cotton wool spots,

venous beading, and severe intraretinal microvascular abnormalities.

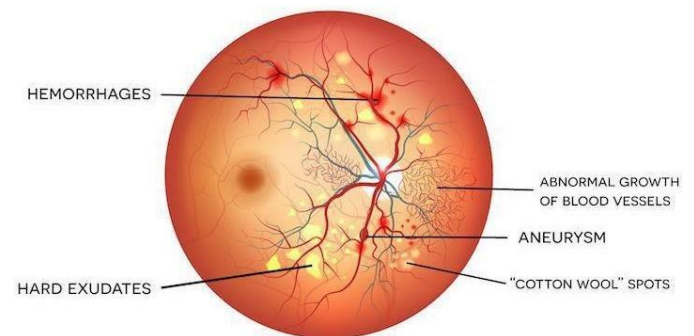


Fig 1: Fully affected DR image

Proliferative Retinopathy: This is the most advanced stage of Diabetic Retinopathy. In PDR new blood vessels and hemorrhages will be formed in the eye, that will spread to another parts present in the eye. This will cause many problems with eye sight and might lead to complete vision loss.

1.2 Deep Learning Approach

Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans. Deep Learning models will be trained by using a large set of labelled data and neural network architectures that contain large number of layers. Deep learning provides more accuracy when compare to machine learning technique.

1.3 Transfer Learning

Transfer learning improves learning in a new task through the transfer of knowledge from a related task that has already been learned. It is a part of deep learning algorithm. It takes a network trained on different network trained on different domain source and also adopt it for domain and it transfer learned knowledge to a particular task. When training the data, it takes lots of time (some time it takes days together or a week) due to this reason transfer learning has been used.it reduces the training time and it do multi-tasking works.

2. LITERATURE SURVEY

Previous work has been done using machine learning and various models for automated DR screening. For

development of our method and result analysis, we have conducted a literature survey describing DR features and past work done to detect DR.

Dinesh Peter [1] have studied that most prominent ophthalmic cause of blindness is diabetic retinopathy. They are using Contrast Limited Adaptive Histogram Equalization for pre-processing, Tandem Pulse Coupled Neural Network (TPCNN) model for segmentation and feature extraction, Deep Learning Based Support Vector Machine (DLBSVM) for classification of diabetic retinopathy stages they are using MATLAB for coding.

Karan Bhatia, Shikhar Arora, Ravi Tomar [2] have presented the various machine learning the detection of diabetic retinopathy (DR) in early stage is essential to avoid complete blindness they are using image level components, lesion-specific components, Anatomical components used for feature extraction. The algorithm will be trained using those features and classified accurately. The algorithm is based on machine learning.

Rishab Gargeya, Theodore Leng [3] has explained the DR is most severe disease they have taken deep learning algorithm as a novel diagnostic tool for automated DR detection. The algorithm processed color fundus images and classified them as healthy (no retinopathy) or having DR, identifying relevant cases for medical referral.

Yi-Peng Liua, Zhanjiang Lib, Cong Xuc, Jing Lid, Ronghua Lianga [4] have stated that the detection of diabetic retinopathy is a serious disease caused by diabetic mellitus and the disease is a common cause of vision loss. Diagnosis of a diabetes over computer- assisted system is performed for receiving human efforts are request to provide basic diagnosis and discrimination between diabetic and healthy subjects. In retinal fundus image enhancement approach a practice face including HE and CLAHE used accordingly these two methods are well known image and method which is very fast and easy to build.

Worapan Kusakunniran, Jirat Rattanachosin, Krittanat Sutassananon, Phuthimeth Anekkitphanich [5] has explained about the severity of diabetic retinopathy occurred in diabetic patient. In this method they had extracted 80% of the image from all data set as a training with level 0 and 1 under processing we use one more method called image augmentation in which images position of a retinal fundus image keeps changing. Convolution layer as a feature extraction in CNN the structure of a CNN is proved to be an efficient way to improving deep learning models in classification in test

D. Jude Hemanth, Omer Deperlioglu, Utku Kose [6] has illustrated that diabetic retinopathy is commonly diagnosed to diabetic patients. This disease is likely to indicate right blindness or vision loss. This paper proposes a method to access the image quality to segment image component for analyzing diabetic severity level of retinopathy fundus image.

The methodologies used in this paper are Pre- processing, in this method it filters the noise from the retinal fundus image by using Gaussian blur. Next one is segmentation, In this method it enhance accuracy of detection by removing unwanted noise and distortion where fundus image convert RGB color space into Lux color space than the next method is morphological process. At last Closing operation erosion is used to restore the boundary of the optic disc.

Suvajit Dutta, Bonthala CS Manideep, Syed Muzimal Basha, Ronnie D Caytiles and N. Ch S N Iyengar [7] have stated that there are several approaches to diabetic retinopathy detection and classification. The work done have proved to be a novel approach while considering machine learning algorithm for DR, many techniques based on mathematical morphology, neural network, fuzzy c-means, cluster histogram are available from the literature. The proposed methodology focusses on enhancing image filtering of a noise detection of the blood vessels and identifying optic disc.

Harry Pratt, Frans Coenen, Deborah M Broadbent, Simon P Harding, Yalin Zheng [8] have explained about aims to detecting the various stages of DR by using U-Net segmentation with region merging and Convolutional Network. The retinal segmentation is the process of automatic detection of boundaries of blood vessels within the retina. The U-Net is a convolutional neuron network, where architecture consists of an impending as well as an advancing path. The impending path is used to captivate context & the symmetric. This is the fastest method to carry out retinal segmentation. The data lost during retinal segmentation is retracted through region merging. Due to the inclusion of retinal segmentation this method completely outperforms previous models with accuracy up to 93.33%.

Sairaj Burewar, Anil Balaji Gonde, Santosh Kumar Vipparthi [9], have investigated about two features namely area of microaneurysms, blood vessels, fluid drip, exudates, hemorrhages into different stages. Model will calculate the weight which gives variety level of the patient's eye. For detection of microaneurysm PCA (Principal Component Analysis) algorithm, morphology process, median filtering histogram, has been used. The accuracy DR detection system are observed as 72.5 respectively most of the studied literature lacking the image processing step which might lead to enormous result.

Shivashish Naithani, Shivam Bharadwaj, Dhiraj Kumar [10] have introduce to an automatic Researchers make use of 50 layers deep model called ResNet50. Modified version of Google Net as a baseline 2-ary, 3-ary and 4-ary classification models are use. A Deep Learning GPU Training System (DIGITS) with prebuilt convolutional neural networks for image classification facilitated data management, model prototyping and real-time performance management.

Ratul Ghosh, Kuntal, Ghosh, Sanjit Maitra [11], have explained about Convolutional Neural Networks developed by Theano.

Researchers make use of six layered architecture consisting of Convolutional Layers, Carpooling Layers, Activation Layers, Dropout Layers, Fully Connected Layers, Classification Layers.

Yashal Shakti Kanungo, Bhargav Srinivasan, Dr. Savita Choudhary [12], have introduced to a model based on Inception- v3 architecture. This architecture makes use of multiple convolution filter inputs which are processed on the same input data which performs pooling at the same time. This architecture helps in Avoiding extreme compression of information, Higher dimensional representations, Spatial combination without loss in representational power. Inception-v3 achieves higher scores and accuracy level.

3. CONCLUSION

Millions of people all around the world are suffering from diabetes which is a prominent cause of diabetic retinopathy. Within the next few years diabetic retinopathy will reach dangerous level. Early detection of DR help to treat and reduce the number of diabetic patients. In this report, a part of the literature that proposed to classify the different stages of diabetic retinopathy was discussed. It helps to automate the disease which might contribute to detect or classify in early stages and cure the disease and it is very crucial to save lives.

REFERENCES

- [1] T. Jemima J, C. Anand Durai, J. Dinesh Peter "Segmentation of retinal blood vessels from ophthalmologic Diabetic Retinopathy images" 2018 Elsevier Ltd
- [2] Karan Bhatia, Shikhar Arora, Ravi Tomar "Diagnosis of Diabetic Retinopathy Using Machine Learning Classification Algorithm" NGCT-2016
- [3] Rishab Gargeya, Theodore Leng "Automated identification of diabetic retinopathy using deep learning" by the AAIO 2017
- [4] Yi-Peng Liua, Zhanjiang Lib, Cong Xuc, Jing Lid, Ronghua Lianga "Referable diabetic retinopathy identification from eye fundus images with weighted path for convolutional neural network" AIIM-2019
- [5] Worapan Kusakunniran, Jirat Rattanachosin, Krittanat Sutassananon, Phuthimeth Anekitphanich "Automatic Quality Assessment and Segmentation of Diabetic Retinopathy Images" 2016 IR10C (TENCON)
- [6] D. Jude Hemanth, Omer Deperlioglu, Utku Kose "An enhanced diabetic retinopathy detection and classification approach using deep convolutional neural network" NCAA- 2019.
- [7] Suvajit Dutta, Bonthala CS Manideep, Syed Muzimal Basha, Ronnie D Caytiles and N. Ch S N Iyengar "Classification of Diabetic Retinopathy Images by using Deep Learning models" IJOG &DC 2018
- [8] Harry Pratt, Frans Coenen, Deborah M Broadbent, Simon P Harding, Yalin Zheng "Convolutional Neural Networks for Diabetic Retinopathy" Procedia Computer Science (2016)
- [9] Sairaj Burewar, Anil Balaji Gonde, Santosh Kumar Vipparthi "Diabetic Retinopathy Detection by Retinal segmentation with Region Merging using CNN" Researchgate- 2020
- [10] Shivashish Naithani, Shivam Bharadwaj, Dhiraj Kumar "Automated Detection of Diabetic Retinopathy using Deep Learning" IRJET-2019
- [11] Ratul Ghosh, Kuntal, Ghosh, Sanjit Maitra "Automatic Detection and Classification of Diabetic Retinopathy stages using CNN" SPIN-2017
- [12] Yashal Shakti Kanungo, Bhargav Srinivasan, Dr. Savita Choudhary "Detecting Diabetic Retinopathy using Deep Learning" RTEICT-2017
- [13] Drs D. S. Ting and T. Y. Wong Drs He, Cheng, G. C. M. Cheung, Tin, Hsu, Lee, and T. Y. Wong "Development and Validation of a Deep Learning System for Diabetic Retinopathy and Related Eye Diseases Using Retinal Images from Multiethnic Populations with Diabetes", American Medical Association. 2017
- [14] M. U Akram, Shehzad Khalid, Anam Tariq, Shoab A. Khan a, Farooque Azam, "Detection and classification of retinal lesions for grading of diabetic retinopathy", Elsevier. 2013
- [15] "CS231n Convolutional Neural Networks for Visual Recognition" <https://cs231n.github.io/convolutional-networks/>