Deep Learning Approach For Early Stage Detection Of Diabetic Retinopathy

Sai Chethan Singu
Msc. Data Analytics
(School Of Computing)
National College of Ireland
Dublin, Ireland
x18181937@student.ncirl.ie

I. Motivation

Diabetes is one of the major chronic health problems in many countries across the world. Diabetic Retinopathy (DR) is a type of retinal disease caused due to prolonged diabetes which will eventually lead to blindness or loss of vision, if not detected in the early stages of the disease. The major challenge for DR is that it will not exhibit early warning signs. Currently, this problem is being dealt with well-trained doctors to check manually the abnormalities. As the number of diabetic patients is increasing, the need for performing screening examinations is also unmet need. As the current process is tedious and required a larger number of trained ophthalmologists to assess and look at eye fundus image, which leads to lost subsequent meetups, miscommunication and treatment postponed. Infrastructure to accommodate the patient is not available due to large number of DR patient and treatment process is not that fast, to solve these issues automatic detection of disease minimize the requirement of trained doctor, infrastructure and treatment process would be faster.

Even though the solution is effective, it was time-consuming and costly. Detection of DR in the early stages is an important step in the diagnosis. To address this problem, Deep learning methods have been used to detect Diabetic retinopathy in the early stages to avert or slow down vision impairment. Detection of DR in the early stages can avoid damage to the retina. A Convolutional neural network (CNN) based deep learning technique has been implemented for the detection of several stages of diabetic retinopathy. CNN is being used significantly in the field of computer vision such as image classification, object detection and many other fields.

II. Research Question

RQ. How can transfer learning with image augmentation can improve the classification of diabetic retinopathy severity.

III. Initial literature review

As automatic filtration of Diabetic Retinopathy is very crucial in the stages of diagnosis, many approaches have been made by the researchers. One such approach is by using weighted class activation maps that can illustrate the suspected positions of lesions. And image augmentation technique was also taken into consideration for the better performance [1].

The most frequent disease that can be found in diabetic patients is Diabetic Retinopathy. The tools available for the examination of this disease with respect to the mass population was scarce. The feature extraction quality was improved by deep learning algorithms rather than using machine learning alone [2]. It automatically recognizes the patterns and classifies the images of the retina.

As a complication of prolonged diabetes, diabetic retinopathy disease is commonly found. Based on a deep convolution neural network, this problem of classifying DR was addressed by using the deep neural network method and then training the images using support vector machine algorithm where it achieved the fine accuracy [3].

The major cause of blindness that is Diabetic Retinopathy was addressed by using deep learning techniques. Proposed multi-channel GAN for the classification of DR and for dealing with inadequate labeled data. The second proposed model is that feature extractor was used to suppress the noise and extract important features [4].

To classify the seriousness of the diabetic retinopathy patient, fractal dimension technique has been applied along with random forest but feature extraction along not sufficient, to produce the best result hence, statistical method is used [5].

Retinal fundus images are used in study [6] and to pre-process them transformation, histogram equalization and gaussian low-pass filter methods are used to distinguish the patient using convolutional neural network and result displays 97 % accuracy.

Paper [7] proposed the multiple technique i.e data amplification, flipping, folding and contrast adjustment for classification of DR using transfer learning with 60 % accuracy. This technique required more epochs round for better accuracy which consumes more computational resources.

To detect the DR severity automatically support vector machine is used with feature extraction method and results as 94.6 % sensibility but 80 % accuracy which can be improved with texture analysis method [8].

An approach of identifying normal and abnormal retinal images with the help of multiple classifiers has been implemented with an accuracy of around 90% [9]. In this process, author has used only bright lesions of retina to identify abnormality in the images [9].

In year 2108, 95 million people suffered from DR. [10] S. Suriyal et al. developed an Android application that was trained on 16,798 fundus images, these images were pre-processed by eliminating noise and used for classifying Diabetic Retinopathy using deep neural network architecture MobileNets [10].

The knowledge of DR is necessary for doctors as well as patients in order to control the risk of eye losses, to achieve accuracy of 89.07% in identifying DR, CNN was applied and focused on pre-processing by using contrast-enhanced filter [11].

IV. Data Source

Diabetic Retinopathy Dataset
https://www.kaggle.com/dola1507108/diabetic-retinopathy-classified
Dataset consists of approximately 35k eye retina images (Both Left and Right Eye) where it was classified on a scale of 0 to 4 from no diabetic retinopathy to proliferative diabetic

References

[1] H. Jiang, K. Yang, M. Gao, D. Zhang, H. Ma and W. Qian, "An Interpretable Ensemble Deep Learning Model for Diabetic Retinopathy Disease Classification," 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Berlin, Germany, 2019.

[2] M. Arora and M. Pandey, "Deep Neural Network for Diabetic Retinopathy Detection," 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), Faridabad, India, 2019.

[3] L. Yung, Y. Ning, C. Shih, C.Chien " Computer-Assisted Diagnosis for Diabetic Retinopathy Based on Fundus Images Using Deep Convolutional Neural Network," 2019 Mobile Information Systems, 2019.

[4] S. Wang et al., "Diabetic Retinopathy Diagnosis Using Multichannel Generative Adversarial Network With Semisupervision," in IEEE Transactions on Automation Science and Engineering.

[5] Farrikh Alzami, Abdussalam, Rama Arya Megantara, Ahmad Zainul Fanani and Purwanto, "Diabetic Retinopathy Grade Classification based on Fractal Analysis and Random Forest", 2019 International Seminar on Application for Technology of Information and Communication (iSemantic), Semarang, Indonesia, Indonesia.

[6] Ömer Deperlıoğlu and Utku Köse, "Diagnosis of Diabetic Retinopathy by Using Image Processing and Convolutional Neural Network", 2018 2nd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT), Ankara, Turkey.

[7] Yuchen Wu and Ze Hu, "Recognition of Diabetic Retinopathy Basedon Transfer Learning", 2019 IEEE 4th International Conference on Cloud Computing and Big Data Analysis (ICCCBDA), Chengdu, China, China.

[8] Enrique V. Carrera, Andrés González and Ricardo Carrera, "Automated detection of diabetic retinopathy using SVM", 2017 IEEE XXIV International Conference on Electronics, Electrical Engineering and Computing (INTERCON), Cusco, Peru.

[9] J. Goh, L. Tang, G. Saleh, L. A. Turk, Y. Fu and A. Browne, "Filtering normal retinal images for diabetic retinopathy screening using multiple classifiers," 2009 9th International Conference on Information Technology and Applications in Biomedicine, Larnaca, 2009, pp. 1-4, doi: 10.1109/ITAB.2009.5394392.

[10] S. Suriyal, C. Druzgalski and K. Gautam, "Mobile assisted diabetic retinopathy detection using deep neural network," 2018 Global Medical Engineering Physics Exchanges/Pan American Health Care Exchanges (GMEPE/PAHCE), Porto, 2018, pp. 1-4, doi: 10.1109/GMEPE-PAHCE.2018.8400760.

[11] M. S. Chowdhury, F. R. Taimy, N. Sikder and A. Nahid, "Diabetic Retinopathy Classification with a Light Convolutional Neural Network," 2019 International Conference on Computer, Communication, Chemical, Materials and Electronic Engineering (IC4ME2), Rajshahi, Bangladesh, 2019, pp. 1-4, doi: 10.1109/IC4ME247184.2019.9036614.