DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

INTRODUCTION

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that affect vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time, effort and cost-consuming and prone to misdiagnosis unlike computer-aided diagnosis systems.

Transfer learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. We used Transfer Learning techniques like Inception V3, Resnet50, XceptionV3 that are more widely used as a transfer learning method in medical image analysis and they are highly effective.

The aim of this project is as follows:

- ✓ Know the fundamental concepts and techniques of transfer learning like XceptionV3.
- ✓ Gain a broad understanding of image data.
- ✓ Know how to pre-process/clean the data using different data pre-processing techniques.
- ✓ Know how to build a web application using the Flask framework

- The user interacts with the UI (User Interface) to choose the image.
- The chosen image analyzed by the model which is integrated with flask application.
- The Xception Model analyzes the image, then the prediction is showcased on the Flask UI.

LITERATURE REVIEW:

1.Early Detection of Diabetic Retinopathy by Using Deep Learning Neural Network

This project presents a method to detect diabetic retinopathy on the fundus images by using deep learning neural network. Alexnet Convolution Neural Network (CNN) has been used in the project to ease the process of neural learning. The data set used were retrieved from MESSIDOR database and it contains 1200 pieces of fundus images.

The images were filtered based on the project needed. There were 580 pieces of images types.tif has been used after filtered and those pictures were divided into 2, which is Exudates images and Normal images. On the training and testing session, the 580 mixed of exudates and normal fundus images were divided into 2 sets which is training set and testing set. The result of the training and testing set were merged into a confusion matrix. The result for this project shows that the accuracy of the CNN for training and testing set was 99.3% and 88.3% respectively.

ADVANTAGES:

- This project successfully detects the diabetes by using deep learning on a fundus image and it can be used as one of method to detect the diabetes on the future.

DISADVANTAGES:

- On the testing set, it shows that the accuracy was 88.3% while on the training sets the accuracy was 99.3% which is approximately 100%. This shows a huge difference between the accuracy.It needs some improvement to make the accuracy of the project nearest to 100%.

ALGORITHM: MESSIDOR

2.Tomas, R., Halim, S., Gurudas, S., Sivaprasad, S. & Owens, D. Idf diabetes atlas:

A review of studies utilising retinal photography on the global prevalence of diabetes related retinopathy between 2015 and 2018. Diabetes Research and Clinical Practice, p. 107840(2019).

The purpose of this study is to assess the prevalence of diabetic retinopathy (DR) world-wide from articles published since 2015 where the assessment of the presence and severity of DR was based on retinal images.

ADVANTAGES:

- The global prevalence of DR and DME, for the period 2015 to 2019 were 27.0% for any DR comprising of 25.2%, NPDR, 1.4% PDR and 4.6% DME.

DISADVANTAGES:

- This study illustrated difficulties in deriving a meaningful global prevalence rate for DR and DME due to the lack of uniformity in defining the study populations, methodological differences, retinal image capture and grading criteria.

3.Convolutional Neural Networks for Diabetic Retinopathy

The diagnosis of diabetic retinopathy (DR) through colour fundus images requires experienced clinicians to identify the presence and significance of many small features which, along with a complex grading system, makes this a difficult and time-consuming task. In this paper, we propose a CNN approach to diagnosing DR from digital fundus images and accurately classifying its severity.

We develop a network with CNN architecture and data augmentation which can identify the intricate features involved in the classification task such as micro-aneurysms, exudate and haemorrhages on the retina and consequently provide a diagnosis automatically and without user input. We train this network using a high-end graphics processor unit (GPU) on the publicly available Kaggle dataset and demonstrate impressive results, particularly for a high-level classification task. On the data set of 80,000 images used our proposed CNN achieves a sensitivity of 95% and an accuracy of 75% on 5,000 validation images.

ADVANTAGES:

The potential benefit of using this trained CNN is that it can classify thousands of images every minute allowing it to be used in real-time whenever a new image is acquired.

DISADVANTAGES:

The dataset itself is a disadvantage because the number of healthy eyes is in large number which makes the network has no learning issue to detect an image of a healthy eye. Whereas in case of having large number of unhealthy retinal images makes the network inappropriate to learn and detect. In training the learning required to classify the images at the extreme ends of the scale was significantly less. The issues came in making the network to distinguish between the mild, moderate and severe.

4. Image based early detection of diabetic retinopathy:

Diabetic Retinopathy (DR) is a disease that damages the retina of the human eye due to diabetic complications, resulting in a loss of vision. Blindness may be avoided If the DR disease is detected at an early stage. Unfortunately, DR is irreversible process, however, early detection and treatment of DR can significantly reduce the risk of vision loss. The manual diagnosis done by ophthalmologists on DR retina fundus images is time consuming, and error prone process. Nowadays, machine learning and deep learning have become one of the most effective approaches, which have even surpassed the human performance as well as performance of traditional image processing-based algorithms and other computer aided diagnosis systems in the analysis and classification of medical images.

This paper addressed and evaluated the various recent state-of-the-art methodologies that have been used for detection and classification of Diabetic Retinopathy disease using machine learning and deep learning approaches in the past decade. Furthermore, this study also provides the authors observation and performance evaluation of available research using several parameters, such as accuracy, disease status, and sensitivity.

ADVANTAGES:

This study concludes that the currently available AI based techniques have a great potential in developing computer aided diagnosis systems to assist the ophthalmologist for accessing the DR grading and early detection of DR

Usage of large databases can result in better performance scores for DCNN architecture.

DISADVANTAGES:

PCA and LDA are used for dimension reduction and selection of optimal features in these studies. These techniques have been used most frequently. However, the main disadvantage of these algorithms is that only a few parameters remain after feature reduction, which might not provide a complete insight into the data.

5.Diabetic retinopathy detection through deep learning techniques:

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that effect vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time effort and cost consuming and prone to misdiagnosis unlike computer-aided diagnosis systems.

Recently, deep learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. Convolutional neural networks are more widely used as a deep learning method in medical image analysis and they are highly effective. For this article, the recent state-of-theart methods of DR colour fundus images detection and classification using deep learning techniques have been reviewed and analyzed

ADVANTAGES:

It is notable that the accuracy of the system which built their own CNN structure is higher than those using the existing structures

DISADVANTAGES:

One of the limitations of the usage of deep learning with medical field faces is the size of the datasets needed to train the DL systems, as DL is required large amount of data. The results of DL systems depend heavily on the size of the training data as much as its quality and balance its classes.

ALGORITHM:

convolutional neural networks (CNNs).

6.Early Treatment Diabetic Retinopathy Study Research Group. Grading diabetic retinopathy from stereoscopic colour fundus photographs-an extension of the modified airlie house classification:

The Early Treatment Diabetic Retinopathy Study (ETDRS), a multicenter collaborative clinical trial supported by the National Eye Institute, was designed to assess whether argon laser photocoagulation or aspirin treatment can reduce the risk of visual loss or slow the progression of diabetic retinopathy in patients with mild-to-severe nonproliferative or early proliferative diabetic retinopathy. The 3711 patients enrolled in the ETDRS were assigned randomly to either aspirin (650 mg per day) or placebo. One eye of each patient was assigned randomly to early argon laser photocoagulation and the other to deferral of photocoagulation. Both eyes were to be examined at least every 4 months and photocoagulation was to be initiated in eyes assigned to deferral as soon as high-risk proliferative retinopathy was detected.

Examination of a large number of baseline ocular and patient characteristics indicated that there were no important differences between randomized treatment groups at baseline.

REFERENCE:

1. Marshall, S. M. & Flyvbjerg, A. Prevention and early detection of vascular complications of diabetes. *BMJ.* **333**(7566), 475–480 (2006).
2. Hutchinson, A. *et al*. Effectiveness of screening and monitoring tests for diabetic retinopathy–a systematic review. *Diabet Med.* **17**(7), 495–506 (2000).
3. Taylor, R. & Batey, D. *Handbook of Retinal Screening in Diabetes: Diagnosis and Management*. Wiley (2012).
4. Gulshan, V. *et al*. Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs. *JAMA.* **316**(22), 2402–2410 (2016).
5. Ting, D. S. W. *et al*. Development and Validation of a Deep Learning System for Diabetic Retinopathy and Related Eye Diseases Using Retinal

Images From Multiethnic Populations With Diabetes. *JAMA.* **318**(22), 2211–2223 (2017)

6. Wilkinson, C. P. *et al*. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. *Ophthalmology.* **110**(9), 1677–1682 (2003).
7. Summanen, P. *et al*. Update on Current Care Guideline: Diabetic retinopathy. *Duodecim.* **131**(9), 893–894 (2015).
8. Krause, J. *et al*. Grader Variability and the Importance of Reference Standards for Evaluating Machine Learning Models for Diabetic Retinopathy. *Ophthalmology*. **125**(8), 1264–1272 (2018).
9. Guan, M. Y., Gulshan, V., Dai, A. M. & Hinton, G. E. Who Said What: Modeling Individual Labelers Improves Classification. *arXiv e-prints*., https://ui.adsabs.harvard.edu/\#abs/2017arXiv170308774G. (Accessed March 01, 2017).
10. Wang, F., Casalino, L. P. & Khullar, D. Deep Learning in Medicine-Promise, Progress, and Challenges. *JAMA Intern Med*. (2018).
11. MedicalResearchAct, https://www.finlex.fi/en/laki/kaannokset/1999/en19990488_20100794.pdf (2010)
12. Goodfellow, I., Bengio, Y. & Courville, A. Deep Learning. MIT Press (2016).