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MSc. Data Science and Computational Intelligence
7151CEM
Computing Individual Research Project

Diabetic Retinopathy Detection Using Deep Learning

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I declare that a proposal for this project has been submitted to the Coventry University ethics monitoring website (https://ethics.coventry.ac.uk/) and that the application number is listed below (Note: Projects without an ethical application number will be rejected for marking)

Signed :

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Introduction

One of the major causes of eye vision loss is diabetes. While delayed examination would have a higher effect on the retinal area of the eye, early detection of diabetes is crucial. The key factors affecting the rise in the occurrence of this disease are people's lifestyles and other contributing factors, and it is anticipated that this trend will continue. According to Tien Y Wong et al, among the 285 million diabetics worldwide, 33 percent of those individuals exhibit DR symptoms(R, Ty, and C 2015). Nearly 90% of individuals can be diagnosed, and long-term effects can be reduced, with thorough screening and regular checkups. The significant issue here is that DR is primarily an asymptomatic eye condition that does not manifest distinctive symptoms until a late stage is reached. The manual examination of retinal image features is a challenging and taxing task, nevertheless. Many automated diagnostic technologies have been created recently to help ophthalmologists examine retinal abnormalities, which has helped to solve this problem.

Background to the Project

Project Objectives

Can DL outperform other methods such as SVM, Logistic Regression, Decision Tree in producing a high performing classifier for DR on unseen data?

Overview of This Report

Literature Review

In recent years, numerous deep learning based automatic DR detection systems have emerged. In this section, some of the recent research projects have been addressed.

Using transfer learning, Esra Kaya and Ismail Saritas created CNN for the identification of diabetic retinopathy (Kaya and Saritas 2022). They utilised the DRIVE dataset (Digital Retinal Images for Vessel Extraction). They utilised contrast-limited adaptive histogram equalisation to improve the clarity of the image. They assessed the ResNet18, GoogleNet, and SqueezeNet CNN architectures' performances as feature extraction techniques and classifiers. ResNet18 was discovered to be the most effective architecture as a classifier with 100% accuracy.

Fundus images from the Kaggle opensource dataset were used by Nikhil Sathya Kumar and Dr. B. Ramaswamy Karthikeyan to identify DR using CNNs, Transformers, and MLPs (Kumar and Ramaswamy Karthikeyan 2021). The findings show that, in comparison to CNN and MLP based models, Transformer based models were more accurate. The most accurate Transformer-based model was Swin with 92.49% accuracy.

ImageNet model was proposed by Jayakumari.C et.al (Jayakumari, Lavanya, and Sumesh 2020). The model's training accuracy was 98.6%.

A CNN method was suggested by Frans Coenen et.al to diagnose DR with a sensitivity of 95 % and accuracy of 75% (Pratt et al. 2016).They train the network using a high-end graphics processor unit (GPU) on the publicly available Kaggle dataset.

Table 2: DR detection methods

Methods & Ref	Datasets Used	Techniques	Performance metrics
CNN (Kaya and Saritas 2022)	DRIVE dataset (40 images in the database were chosen randomly from 400 images)	They assessed the ResNet18, GoogleNet, and SqueezeNet	ResNet18 - 100 %, GoogleNet - 68.2 %, SqueezeNet - 67.4 %
CNN, MLP & Transfomer (Kumar and Ramaswamy Karthikeyan 2021)	Aptos dataset from Kaggle (6590 Images)	EfficientNet, ResNet, MLP-Mixer, ViT , ViT+MLP, Swin and Swin+ViT	EfficientNet -91.18 %, ResNet - 89.63%, MLP-Mixer - 94.47%, ViT - 91.13 %, ViT+MLP - 89.73%, Swin - 92.49%, Swin+ViT - 91.91 %
ImageNet (Jayakumari, Lavanya, and Sumesh 2020)	Kaggle Dataset	ImageNet	98.6%
CNN (Pratt et al. 2016)	Kaggle Dataset (80,000 Images)	CNN	75%

Methodology

Dataset

This study using dataset available at Kaggle("Diabetic Retinopathy Detection" 2015). This Retinal images were provided by EyePACS. The dataset containing large set of high-resolution retina images taken under a variety of imaging conditions. For each image, a left and right field is provided. Images are identified by a image id and either the left or right eye (for example, 1 left.jpeg represents the patient number 1's left eye).

Table 3: ("Diabetic Retinopathy - Stages" 2017)

DR classes	Level	Description
No DR	0	Healthy Retina (Normal)
Mild	1	Retina with tiny bulges (microaneurysms)
Moderate	2	Retina with microaneurysms, higher risk of developing vision problems in the future
Severe	3	Retina with severe and widespread microaneurysms, including bleeding into the retina
Proliferative	4	New blood vessels and scar tissue have formed on your retina, which can cause significant bleeding and lead to retinal detachment

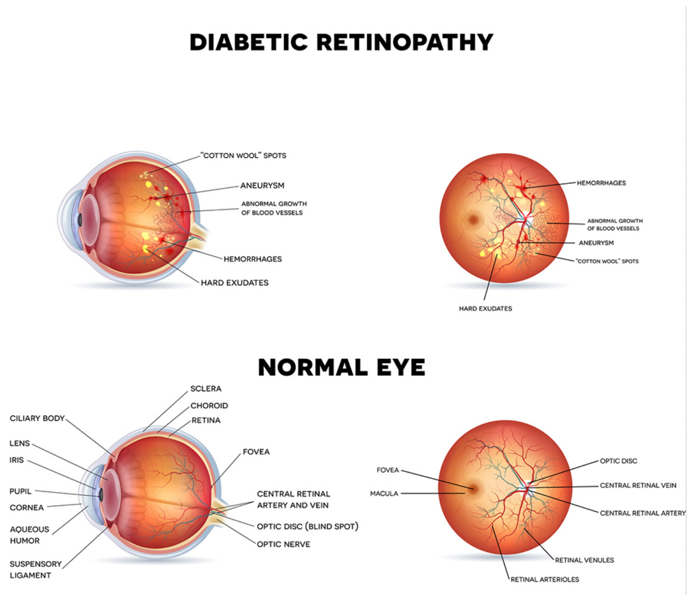

Figure 1: Normal Retina Vs Diabetic Retinopathy Retina ("Diabetic Retinopathy Vs Normal," n.d.)

Data pre-processing

Image pre-processing was performed with the aim to decrease unclear image and reduce image size. The plot below illustrates the class imbalance in the original dataset.

The dataset consist of 35,126 set of images. The orginal image have 1944 * 2592 * 3 size, and all images are jpeg format. The classes have an uneven distribution of images.

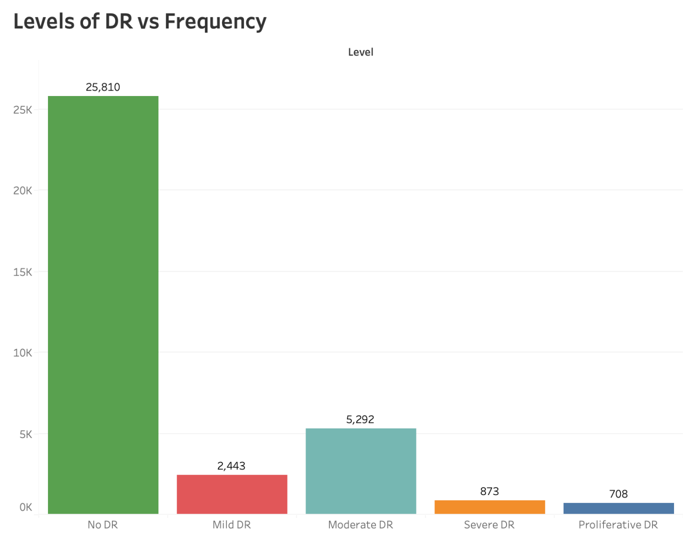

Figure 2: Sum of number of records for each level

1. Image Resizing

   Due to the enormous size of the dataset, it was drastically downsized before being sent to the network. Each input image is 256 * 256 in size after resizing.

2. Removing Unclear Image

   Some images have a blackish or white tint. Because it might affect the outcome, this type of image cannot be fed into the network. The removal of an unclear image is a crucial step that must be taken.

3. Dividing images into classes

   Images are classified into 5 folders based on the DR levels.

Requirements

Analysis

Design

Implementation

Testing

Project Management

Project Schedule

Risk Management

Quality Management

Social, Legal, Ethical and Professional Considerations

Critical Appraisal

Conclusions

Achievements

Future Work

Student Reflections

References

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Appendix A – Project Specification

Appendix B – Interim Progress Report and Meeting Records

Appendix C – Requirements Specification Document

Appendix D – User Manual

Appendix E – Project Presentation

Appendix F – Certificate of Ethics Approval