Deep Learning Based System for Detection of Retinal Diseases

Capstone Project Proposal

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BE Third Year- COE

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Mentor Consent Form

I hereby agree to be the mentor of the following Capstone Project Team

Project Title:		
Roll No	**Name**	**Signatures**
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Problem Statement

Diabetes is a metabolic disease that causes high blood sugar. This in turn causes damage to retina resulting in irreversible vision loss. In this project we have proposed a deep learning based system for detection of eye diseases. This system will assist the medical experts and will allow early detection of eye diseases to control and possibly prevent irreversible vision loss.

Project Overview

Nowadays every one in six people suffers from diabetes. High blood sugar can lead to many conditions including eye problems. The most common eye diseases are diabetic retinopathy, macular edema, glaucoma etc. The timely detection of these eye diseases is necessary to prevent irreversible vision loss.

Traditionally, the detection of eye disease is done by ophthalmologist who basically inspects the patient's retina for abnormalities like micoraneurysms, hard exudates, cotton wool spots etc. However due to unavailability of medical expert or errors in manual inspection the detection of disease may get delayed which then may result in vision loss.

To overcome the drawbacks of manual system, we have proposed a convolution neural network based automatic detection of eye diseases. A CNN can automatically look at a patient's retina image and determine the severity of disease in the patient. The focus of the model will be towards severity detection of the disease like diabetic retinopathy, macular edema etc. The model will be trained using fundus image set and will determine the severity of the diseases from healthy to most damaged retina

This automated process can reduce a lot of time, thereby screening the process of treating DR at a large scale. To make the project available to everybody in a way that is quick, free of cost, and hassle-free, the DL model is hosted as a free service on a website, which is made with CSS, JS, HTML etc. Such a system will help in highly accurate mass screening of patient's retina and can even assist doctor for disease detection.

Need Analysis

Diabetic eye diseases of the retina impacts sufferers with diabetes mellitus. Among them Diabetic Retinopathy is by far the primary cause of blindness in human beings between the ages of 20-64 [1, p. 112]. Indexed amongst WHO's top ten list of priority eye diseases, it's a tremendously omitted micro-vascular problem in developing international locations, particularly India, where most number of type 2 Diabetes Mellitus sufferers are dwelling. Macular edema rarely causes a permanent loss of vision and can usually be easily treated, but the recovery is often a slow, gradual process. Though the condition is typically not considered serious, it can be a sign or symptom of a more serious health problem that may need to be addressed. The damage caused by glaucoma can't be reversed. But treatment and regular checkups can help slow or prevent vision loss, especially if you catch the disease in its early stages

The probability of developing DR or other eyes diseases is related to the period of the ailment. Type 2 diabetes has an insidious onset and may get overlooked for years. As a result, patients may additionally already have DR, Macular edema or Glaucoma at the time of diagnosis. Type 1 diabetics, then again, when diagnosed early in the course of their disease, usually do not expand to retinopathy until years after the prognosis [2, p. 1].

Even though technological improvements, powerful treatments are available nowadays to prevent the extreme tiers, the wide variety of trained ophthalmologists capable of diagnosing retinal scans and the supply of desirable medical treatment facilities are still massively outnumbered by the global burden of problem. Globally, an expected 422 million adults were suffering from diabetes in 2014, in comparison to 108 million in 1980. The global incidence of diabetes has almost doubled since 1980, growing from 4.7% to 8.5% in the adult population [3, p.6]. The increasing prevalence of diabetes along with the growing incidence of blindness due to diabetes is anticipated to propel the market growth over the forecast period.

Traditionally, the classification of DR involves weighting numerous features and then locating such features. This is highly time-consuming for clinicians. Retinal photograph with medical interpretations is a widely accepted screening tool for DR. Computers can obtain quicker classifications once trained. Automated grading of DR has potential benefits such as increasing efficiency, reproducibility, reducing barriers to access, and improving patient outcomes by providing early detection and treatment. This does not absolve the doctor from his duty but merely provides a second opinion. Thus, to maximize the clinical utility of automated grading, an algorithm to detect DR is required. The project also enables patients to get checked for DR remotely. This can be vital in times when in-person evaluation cannot be done or is not preferred [25]. Also – as the general problem being solved here is that of image processing of blood vessels – by making a few changes to the project's CNN model, we should be able to detect various other diseases involving blood vessel abnormalities, like blood clots, brain aneurysms, and abnormal blood vessel knots.

Literature Survey

S. NO.	Name and Roll no.	Paper Title	Authors	Model/Technology	Dataset	Findings
1.	Arshdeep Singh 101903217	Computer-Assisted Diagnosis for Diabetic Retinopathy Based on Fundus Images Using Deep Convolutional Neural Network [5]	Yung-Hui Li , Nai-Ning Yeh, Shih-Jen Chen , and Yu-Chien Chung	DCNN, SVM classifier	Kaggle Dataset	This paper presents a novel algorithm based on DCNN used for the automated detection of DR. Unlike the traditional DCNN approach, the commonly used max - pooling layers is replaced with fractional max-pooling.
2.		Deep Learning Approach to Diabetic Retinopathy Detection [6]	Borys Tymchenko, Philip Marchenko, Dmitry Spodarets	Deep learning, Deep CNN, multi-target learning, ordinal regression, classification	EyePACs, 2015	Automated deep-learning based method for stage detection of DR by single photography of the human fundus
3.		Iris – Diabetic Retinopathy Detection	Noel J Philip , Romi Roji , Rosme Jose ,	CNN, transfer learning, GoogLeNet,	Kaggle dataset of 35,000	Use of CNNs on colour fundus images

		Software [7]	Rehna Cherian, Dr. Arun K.S	AlexNet, ImageNet	images with 4-class labels (normal, mild, moderate, severe).	to diagnose DR staging.
4.	Abhey Kumar Singla 101917089	Retinopathy and Mortality [8]	Emily Frith, Paul D Loprinzi	CNN	Data from the 2005–2008 National Health and Nutrition Examination Survey were used to identify 4,777 adults with complete data regarding screening for nonproliferative retinopathy using Early Treatment Diabetic Retinopathy Study grading criteria	Brief explanation on CNN, pooling layers and convolutional layers.
5.		Microaneurysm detection in fundus images using a twostep convolutional neural network [10]	Noushin Eftekhari, Hamid-Reza Pourreza, Mojtaba Masoudi, Kamaledin Ghiasi-Shirazi & Ehsan Saeedi	CNN	Retinopathy Online Challenge dataset and E-Ophtha-MA dataset	In this paper, an approach for automatic MA detection in retinal images based on deep-learning CNN is developed to address the

						previous works problems such as imbalanced dataset and inaccurate MA-detection
6.	Hitesh Garg 101903544	Automated Detection of Diabetic Retinopathy Using Deep Learning [11]	Carson Lam, MD, Darvin Yi, Margaret Guo, and Tony Lindsey	CNN	Kaggle dataset of 35,000 images with 5-class labels (normal, mild, moderate, severe, end stage) and Messidor-1 dataset of 1,200 color fundus images with 4-class labels (normal, mild, moderate, severe)	In this paper an automatic DR grading system capable of classifying images based on disease pathologies from four severity levels is introduced.
7.		Diabetic Retinopathy Detection Using Prognosis of Microaneurysm and Early Diagnosis System for NonProliferative Diabetic Retinopathy	Lifeng Qiao , Ying Zhu , and Hui Zhou	DCNN	https://ieee-dataport.org	This paper presents the Prognosis of MA and early diagnostics system for NPDR capable of effectively creating DCNNs for the semantic segmentation

		Based on Deep Learning Algorithms [12]				of fundus images which can improve NPDR detection efficiency and accuracy.
8.	Himanshu Mahajan 101903212	Automated Identification of Diabetic Retinopathy Using Deep Learning [13]	Rishab Gargeya , Theodore Leng	Data driven Deep Learning Algorithms	MESSIDOR 2 and E-Ophtha databases	A fully data-driven artificial intelligencebased grading algorithm can be used to screen fundus photographs obtained from diabetic patients and to identify, with high reliability, which cases should be referred to an ophthalmologist for further evaluation and treatment
9.		Deep Transfer Learning models for medical DR detection [9]	Nour Eldeen M. Khalifa, Mohamed Loey, Mohamed Hamed N. Taha, and Hamed Nasr Eldin T. Mohamed	CNN, ML, Deep transfer learning	APTOS 2019 dataset	The AlexNet model has proven to be most accurate in categorizing DR images, with accuracy of 97.9%.

Objective

The main objectives of the project are as follow-

1. To study various models for eye disease detection.
2. To design and implement deep learning model for detection of eye diseases.
3. To analyse the performance of the proposed model and compare it with existing models in literature.
4. To design a deep learning based web application for the detection of eye diseases.

Methodology

Data Collection

In the project, fundus imageset will be used for detection of eye diseases. The dataset should be labelled for various eye diseases like diabetic retinopathy, macular edema etc.

Pre-processing of data

The fundus images will be pre-processed and cleaned. Further data augmentation will be employed for image instances. The images will be split into training and test ratio for training of model.

Model Design and implementation

A deep learning based model will be proposed for detection of various eye diseases. Further, the model will be analysed on various performance parameters like accuracy, sensitivity, precision etc.

Comparative analysis

The proposed model will be compared with existing models in literature on the basis of performance parameters like accuracy, precision, senstivity etc.

Web Application

A web application will be developed based on the proposed model. The web application will assist medical experts in automatic detection of eye diseases.

Project Outcomes

The main outcomes of the project are as follow-

1. A deep learning based model for detection of various eye diseases.
2. A web application that can assist ophthalmologists in detection of eye diseases.

Individual Roles

1. Abhey Kumar Singla[Team Leader]:
    - Documentation
    - Dataset Collection
    - Dataset Pre-processing
    - Model design and training.

2. Hitesh Garg:
    - Documentation
    - Dataset Collection
    - Dataset Pre-processing
    - Model design and training.

3. Arshdeep Singh:
    - Literature survey
    - Front-end and Back-end Development
    - Documentation
    - Database management.

4. Himanshu Mahajan:
    - Literature survey
    - Front-end and Back-end Development
    - Documentation
    - Database management.

Work Plan

Sr. No.	Activity	March				April				May				June				July				August				September				October				November				December			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	Literature Survey																																								
2	Problem Selection																																								
3	Dataset Selection																																								
4	Dataset Preprocessing																																								
5	Model Designing and Implementation																																								
6	Comparative Analysis																																								
7	Front end development																																								
8	Back end development																																								
9	Integration and Testing																																								

Course Subjects

Subject Code	Subject Name	Description
UML501, UCS538	Machine Learning, Data Science	▪ Deep learning and machine learning models
UCS503	Software Engineering	▪ To make SRS
UCS542	UI & UX Specialist	▪ To deploy the model
UCS662	Test Automation	▪ Testing the final product

REFERENCES

[1] Chaudhry S., “Pharmacotherapy in Obesity.” IP International Journal of Comprehensive and Advanced Pharmacology, vol. 5(3), pp. 110-117, 2020.

[2] Vislisel J., Oetting T., “Diabetic Retinopathy: From One Medical Student to Another.”, EyeRounds.org, Sept. 1, 2010.

[3] WHO, “Global report on diabetes.” 2016.

[4] Lee R., Wong T. Y., Sabanayagam C., “Epidemiology of diabetic retinopathy, diabetic macular edema and related vision loss.” Eye and Vision, vol. 2(17), 2015.

[5] Li Y-H., Yeh N-N., Chen S-J., Chung Y-C., “Computer-Assisted Diagnosis for Diabetic Retinopathy Based on Fundus Images Using Deep Convolutional Neural Network.” Mobile Information Systems, 1-14.10.1155/2019/6142839, 2019.

[6] Tymchenko B., Marchenko P., Spodarets D., “Deep Learning Approach to Diabetic Retinopathy Detection.” 2020.

[7] Philip N. J., Roji R., Jose R., Cherian R., S A. K., “Iris – Diabetic Retinopathy Detection Software.” International Journal of Engineering Research & Technology (IJERT), vol. 9(10), pp. 336-338, Oct. 2020.

[8] Frith E., Loprinzi P. D., “Retinopathy and Mortality.” Diabetes Spectrum, vol. 31(2), pp. 184-188, 2018.

[9] Khalifa NEM, Loey M., Taha MHN, Mohamed HNET, “Deep Transfer Learning Models for Medical Diabetic Retinopathy Detection.” Acta Inform Med., vol. 27(5), pp. 327-332, 2019.

[10] Eftekhari N., Pourreza H-R., Masoudi M., Ghiasi-Shirazi K., “Microaneurysm detection in fundus images using a two-step convolutional neural network.” BioMed Eng OnLine 18, 67, 2019.

[11] Lam C., Linsdey T., Guo M., Yi D., “Automated Detection of Diabetic Retinopathy Using Deep Learning.” AMIA Jt Summits Transl Sci Proc. 2018; 2017:147-155. Published May 18, 2018.

[12] Qiao L., Zhu Y., Zhou H., “Diabetic Retinopathy Detection Using Prognosis of Microaneurysm and Early Diagnosis System for Non-Proliferative Diabetic Retinopathy Based on Deep Learning Algorithms.” IEEE Access, pp. 1- 1.10.1109/ACCESS.2020.2993937, 2020.

[13] Gargeya R., Leng T., “Automated Identification of Diabetic Retinopathy using Deep Learning.” American Academy of Ophthalmology, vol. 124(7), pp. 962-969, 2017.