DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

CATEGORY:ARTIFICIAL INTELLIGENCE

A PROJECT REPORT

Submitted by

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CONTENTS

ABSTRACT

Diabetic retinopathy (DR) is a diabetes complication that affects the eye and can cause damagefrom mild vision problems to complete blindness. It has been observed that the eye fundus images showvarious kinds of color aberrations and irrelevant illuminations, which degrade the diagnostic analysis andmay hinder the results. In this research, we present a methodology to eliminate these unnecessary re□ectanceproperties of the images using a novel image processing schema and a stacked deep learning technique forthe diagnosis. For the luminosity normalization of the image, the gray world color constancy algorithm isimplemented which does image desaturation and improves the overall image quality. The effectiveness of theproposed image enhancement technique is evaluated based on the peak signal to noise ratio (PSNR) and meansquared error (MSE) of the normalized image.

To develop a deep learning based computer-aided diagnosticsystem, we present a novel methodology of stacked generalization of convolution neural networks (CNN).Three custom CNN model weights are fed on the top of a single meta-learner classier, which combinesthe most optimum weights of the three sub-neural networks to obtain superior metrics of evaluation androbust prediction results. The proposed stacked model reports an overall test accuracy of 97:92% (binaryclassication) and 87:45% (multi-class classication). Extensive experimental results in terms of accuracy,F-measure, sensitivity, specicity, recall and precision reveal that the proposed methodology of illumination normalization greatly facilitated the deep learning model and yields better results than various state-of-art techniques.

1.INTRODUCTION

Diabetic retinopathy (DR) is a medical condition thatis caused by the damage to the blood vessels of thelight-sensitive tissue at the back of the eye (retina), which caneventually cause complete blindness and various other eyeproblems depending on the severity of the disease. Thoughthe treatment is available, it is estimated that numerous peoplego blind every day because of this disease. It is observed that 40% – 45% of diabetic patients are likely to have DR intheir life, but due to lack of knowledge and delayed diagnosis,the condition escalates quickly. The Early Treatment DR Study Research Group (ETDRS)has shown that if DR is correctly diagnosed on time, it mayreduce the chances of vision loss by 50%. The prevalenceof DR is maximum i.e., 25:04% in the people whofall in the age bracket of 61-80. Till now retinal imagesare manually assessed by ophthalmologists and cliniciansfor predicting DR after the eye fundoscopic exam and toanalyze signs such as cotton wool spots, retinal swellings,and hemorrhages. However, it is usually observed thatduring image the acquisition process, the fundus images showvarious kinds of irrelevant illuminations, non-uniform lightdistribution, blurred or darkened candidate regions, whichsub sequently affect the diagnostic process and result in biasedpredictions. To detect DR, it is essential to obtain resultswith high precision irrespective of any bias to avoid a wrong judgment that may lead to a serious problem or in somecases, even permanent blindness. During the fundoscopictest, if the obtained image is highly saturated, it becomesdifcult to carry out a proper visual assessment test even bya trained ophthalmologist or a clinician and hence, the presenceof non-uniform illuminations can impede correct predictions.

The previous diagnostic studies of DR can be classiedinto two types: Automatic detection of the disease (binary),and b) Classication of different stages of the disease (multiclass).In our study, our focus is to automate the diagnosticprocess and to combine the luminosity normalizationpre-processing pipeline with an advanced articial intelligencetechnique. Till now various image processing techniqueshave been presented to detect DR by consideringthe denitive candidate regions such as cotton wool spots,exudate, hemorrhages, and blood vessels, as reported in. These methods rely on manual feature extraction but,since most of the retinal images depictinon-uniform features,thus generalizing feature set for all images may give inappropriate diagnostic results when a large database isconsidered.

2.LITERATURE SURVEY

Diabetic Retinopathy

Diabetic retinopathy is a diabetes complication that affects eyes.It's caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina).At first, diabetic retinopathy may cause no symptoms or only mild vision problems. Approximately four hundred and twenty million people worldwide have been diagnosed with diabetes mellitus. The prevalence of this disease has doubled in the past 30 years and is only expected to increase, particularly in Asia. Of those with diabetes approximately one-third are expected to be diagnosed with diabetic retinopathy (DR), a chronic eye disease that can progress to irreversible vision loss. Early detection which is critical for good prognosis, release on skilled readers and is both labour and time-intensive. Automated techniques for diabetic retinopathy diagnoses are essential to solving these problems.

1.Diabetic Retinopathy Detection and Retinal Image Generation (2021)

• To visualize the symptom encoded in the descriptor, they propose PathoGAN, a new network to synthesize medically plausible retinal images.

• By manipulating this descriptors, they could even arbitrarily control the position, quantity, and categories of generated lesions. They also show that their synthesized images carry the symptoms directly related to diabetic retinopathy diagnosis. Their generated images are both qualitatively and quantitatively superior to the ones by previous methods.

• Besides, compared to existing methods that take hours to generate an image, their second level speed endows the potential to be an effective solution for data augmentation.

2.Transfer Learning based Detection of Diabetic Retinopathy from small Dataset (2019)

• Transfer learning from an already trained deep convolutional network can be used to reduce the cost of training from scratch and to train with small training data for deep learning.

• In this work, they used a pretrained Inception-V3 model to take advantage of its Inception modules for Diabetic Retinopathy detection.

• In order to tackle the labelled data insufficiency problem, they subsampled a smaller version of the Kaggle Diabetic Retinopathy classification challenge dataset for model training, and tested the model's accuracy on a previously unseen data subset. Their technique could be used in other deep learning based medical image classification problems facing the labelled training data insufficiency.

3.AUTOMATIC SEGMENTATION OF RENTINAL VASCULATURE:

• Author developed an unsupervised method for segmenting the retinal vessel.the entire algorithm consist of 4 stages:contrast enhancement,edge enhancement,optic disk removal and vessel segmentation and the post processing.

4.Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs (2018)

• The original study used non-public fundus images from EyePACS and three hospitals in India for training. This Study used a different Eyepatch data set from Kaggle.

• The original study used the bench mark data set Messidor-2 to evaluate the algorithm's performance. This study used the same dataset. In the original study, ophthalmologist regraded all images for diabetic retinopathy, macular edema, and image gradeability.

• There was one diabetic retinopathy grade per image for data set, and assessed image gradability ourselves
.
• The original study did not provide hyper-parameter settings. But some of these were later published.

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3. 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).

3.PROPOSED SOLUTION

Proposed solution Template:

Project team shall fill the following information in proposed solution template:

S.NO	Parameter	Description
1.	Problem Statement (Problem to be solved)	Diabetic retinopathy is a leading cause of blindness.it becomes need of the hour to build safe and reliable system that will work on early detection of this disease and will provide genuine result.
2.	Idea / Solution description	Patient's retinal images are captured via smart phone camera and uploaded to a cloud based web application for patient data entry, image capture and uploading , integration with the AI model
3.	Novelty/Uniqueness	User can detect their disease in early stage.
4.	Social impact /customer satisfaction	Helps in preventing the loss of visibility to the needed through CSR activities or through healthcare camps.
5.	Business Model (Revenue	●Can collaborate with

	Model)	diagnosis centers and hospitals. ●Can collaborate with government for health awareness camps.
6.	Scalability of The Solution	Laser treatment- is used to treat new blood vessels at the back of the eyes in the advanced stages of diabetic retinopathy .

4.TECHNOLOGY ARCHITECTURE & STACK

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

Table-1 : Components & Technologies

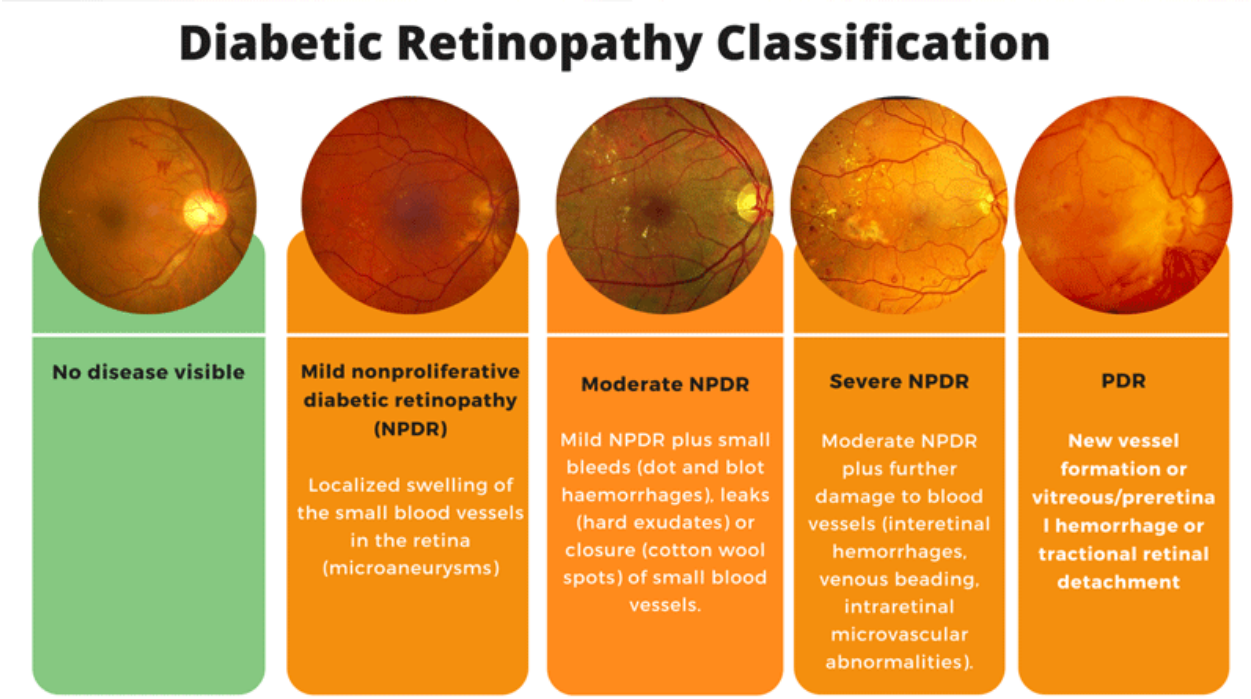
S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript, Bootstrap, React JS.
2.	Application Logics	Logic for each and every process in the application	Python, JavaScript.
3.	Cloud database	Used for integrating components while using python flask	IBM Cloudant.
4.	API	Used to call the functions in order to access the execution in another framework	Python Flask , NodeJS (if needed).
5.	Deep Learning Model	The model is developed to predict the rainfall using ML algorithms	Sklearn, DL Algorithms.
6.	Data Pre-processing and Analysis	The available data is formatted or converted into the format which will be suitable for the ML model	Matplotlib,Tensorflow,opencv.
7.	External API	API to fetch FUNDUS Image from Kaggle	Google’s Kaggle API

Table-2: Application Characteristics

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Backend Framework, Non-structured Database, CSS Framework.	Python Flask / NodeJS, IBM Cloudant, CSS-3.
2.	Security Implementations	Email Verification and authentication, Authentication and authorisation using JSON object by comparing the data exists in database	Encryptions, Direct verification using Backend Framework.
3.	Scalable Architecture	To ensure that enough resource is allocated on the hosting platform to keep up with demand	IBM Cloud Kubernetes Service.
4.	Availability	The website will be made available by hosting it in cloud hosting platforms	IBM Cloud Kubernetes Service.
5.	Performance	The website will be made available by hosting it in cloud hosting platforms	IBM Cloud Kubernetes Service.

5.RESULT AND CONCLUSION

PREDICTION:



CONCLUSION:

The performance of image normalization ismeasured using statistical metrics such as the PSNR and MSEof the original and enhanced images. The stacked ensemble model is an advanced technique of stacking different neuralnetworks whose combined results are produced based on afusion strategy that combines the best weights of the individualneural networks. Machine learning models are extensivelyutilized to classify and detect DR in fundus images. However,these techniques require suitable pre-processing andfeature extraction methods to improve the results especially when the images are from different sources. DR images aregenerally taken from different cameras under different lightingconditions and to mitigate these effects we adopted anefcient color constancy technique.