Automated Detection of Diabetic Retinopathy using Smartphone-Based Photography

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ABSTRACT

According to WHO (World Health Organization), Diabetic retinopathy (DR) is one of the world's leading causes of blindness. It is a complication caused by diabetes. This project focuses on the detection of DR using a 20D (20 Diopter) Lens and a smartphone camera to capture fundus images that are further classified and compared against different deep learning models. The model with the best accuracy is integrated into a mobile application for the development of a cost-effective and portable method for DR screening in rural areas.

INTRODUCTION

- One in every three diabetics is prone to develop a visual impairment called "Diabetic Retinopathy (DR)" that can cause permanent blindness if left untreated in its early stages.
- Diabetics are required to go through an annual eye examination that involves taking images of the eye using an expensive fundus camera that is only available in specific urban hospitals.
- Additionally, there is a lack of ophthalmologists. There are only 1,500 ophthalmologists in Pakistan, which means one ophthalmologist for just under 100,000 people, out of which about 80% provide their services in urban locations.
- We aim to develop a smartphone-based cost-effective handheld AI-integrated product to detect visual Impairment and generate reports of the patient.

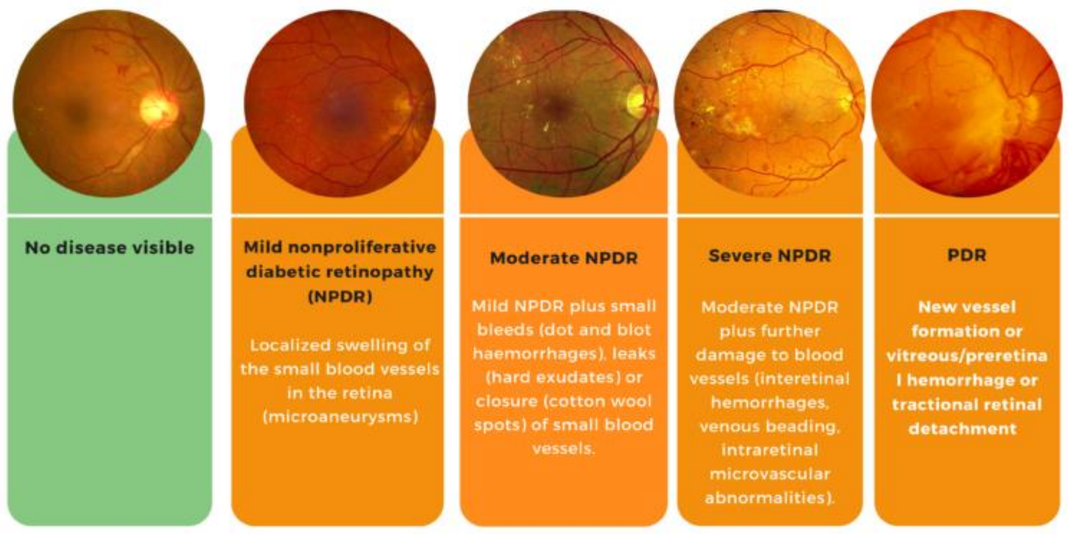
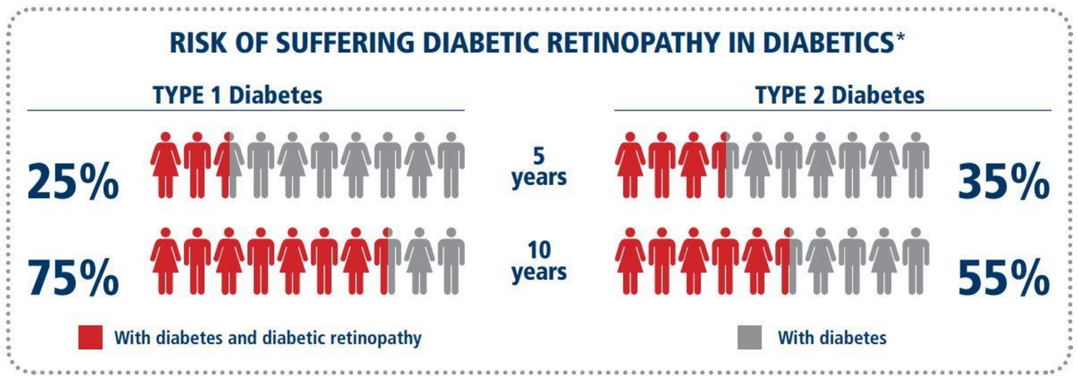


Figure 1 Classification of Stages of DR



OBJECTIVE

- Detection of preventable blindness
- Data can be analyzed to identify trends and improve diagnosis.
- Making cost-effective DR screening possible in low-income areas

METHODOLOGY

The fundus image dataset was collected from Sindh Institute of Ophthalmology and Visual Sciences (SIOVS) hospital. It was merged with an open-source Kaggle data. Three different deep learning algorithms were used along with transfer learning to train our model which includes VGG16, Resnet50, and Custom CNN.

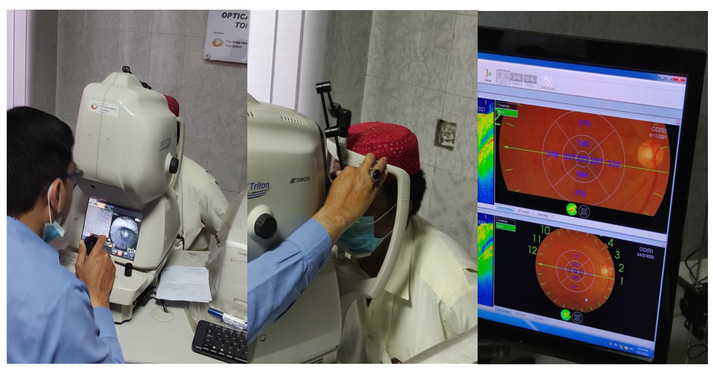
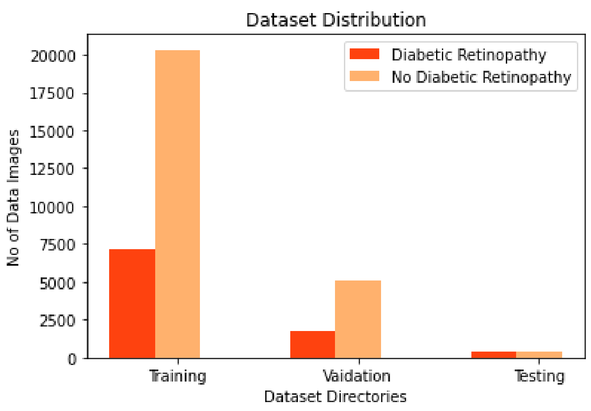
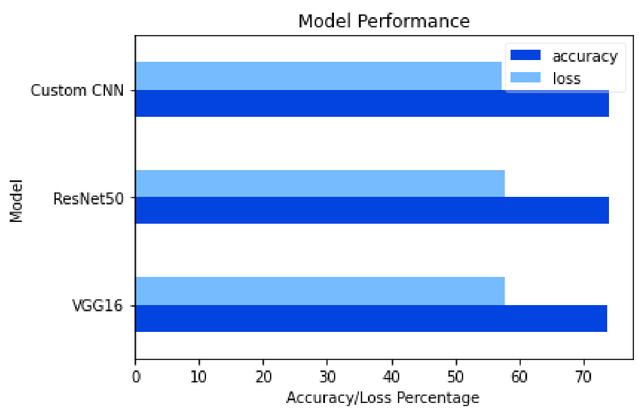


Figure 2 Traditional Methods

Figure 3 Device Prototype





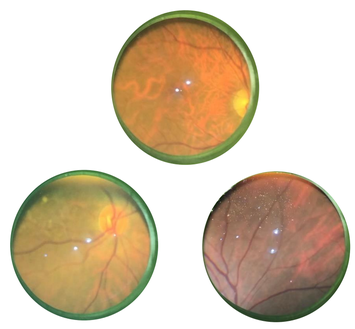


Figure 4 20D Fundus Images

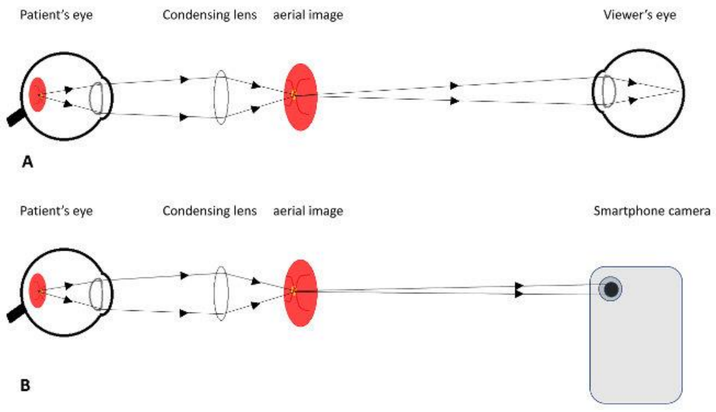


Figure 5 Image Acquisition

RESULTS

After comparing the results of all the trained deep learning models, **VGG16** outperformed other models by obtaining the highest validation accuracy i.e., **74.53%** as well as the lowest validation loss of **55.94%**. Thus, VGG16 performed best on the dataset provided and is deployed in the smartphone application.

Table 1 Comparative Analysis

Model	Training Accuracy	Training Loss	Validation Accuracy	Validation Loss	AUC
VGG16	0.7372	0.5767	0.7453	0.5594	0.6174
ResNet50	0.7399	0.5762	0.7408	0.5872	0.5464
Custom CNN	0.7399	0.5736	0.7405	0.5726	0.5

ANALYSIS

Our proposed method classifies the DR disease in two classes, namely DR (Diabetic Retinopathy) and NO DR (Patient is healthy). With the VGG16 model, our highest obtained accuracy is 74.53% respectively. The metrics that we operated on in this work are contrasted with previous efforts.

CONCLUSION

After researching the existing systems and approaches for the detection of Diabetic Retinopathy using Smartphone-Based photography with a 20D lens or Fundus on a phone Photography, we conclude that our proposed DR detection technique is successful in detecting Diabetic Retinopathy.

Future Recommendations

A larger dataset with direct ophthalmic 20D images needs to be constructed for training data using deep learning frameworks in order to obtain optimum accuracy. Dataset images need to be labelled using expert opinion and must have consistent and high resolution. Additionally, dataset image frames must be kept identical. With more good resolution training data obtained from 20D lens the accuracy can be increased and an efficient and robust system can be developed to diagnose Diabetic Retinopathy.

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