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A Comparative study for Detection of stages of diabetic retinopathy of diabetic patients using machine learning

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Abstract - *People in their middle years who work are most commonly suffering from diabetic retinopathy. Due to inadequate resources, diabetic retinopathy can be tough to identify in remote regions. Many scientific and medical techniques are available to For the most part, the disease is examined for and identified by retinal fungal imaging. Here, the goal is to be capable to automatically screen images for retinopathy caused by diabetes. This will be achieved via developing an application for smartphones that makes use of fundus images and a model developed using machine learning to evaluate an eye image and calculate the patient's level of blindness. This strategy will help shorten the time required for diabetic retinal disease screening.*

Key Words: **Diabetic retinopathy, Machine learning, Fundus photographs, CNN, Android application.**

1. INTRODUCTION

An excessively elevated blood sugar level can lead to diabetes, a chronic organ disease. Individuals suffering from diabetes may get diabetic retinopathy, a major cause of vision loss resulting from chronic damage to the blood vessels in the eyes. It is common to categorize diabetic retinopathy as either non-proliferate or proliferate. Blood vessels start to degenerate and more fluid enters the eye during the first stage of DR, or NPDR. In this phase, there are three different structures that are visible: hemorrhages (small area of blood streaming into the retina), exudates (drop of fatty tissues), and micro aneurysms (red dot). Proliferate diabetic retinopathy is a condition where there is a reduction in blood flow due to the constriction of blood vessels in the retina. PDR reduces eyesight in both the center and periphery.

1.1 Literature review

Sanskruti Patel [1] - A Comprehensive Analysis of Convolutional Neural Network Models - Image, speech, and text processing are just a few of the many domains that deep learning—an emerging subject of machine learning—applies to with high success rates. In comparison to conventional machine learning techniques, experiments demonstrate its great performance and high adaptability. Deep learning algorithms, also referred to as deep neural networks, are essentially an offspring of artificial neural network architectures with a larger number of hidden layers. Convolutional Neural Networks (CNNs) are a kind of feed forward network and one of the most popular deep neural network models. A synopsis of popular and well-respected CNN models is provided in this presentation. A comparative assessment of these models with various parameter considerations is also included.

Abhishek Samanta [2] - Automated detection of diabetic retinopathy using convolutional neural networks on a small dataset - Patients with either type 1 or type 2 diabetes may experience a condition known as diabetic retinopathy. The condition must be detected early on since complications like glaucoma, vitreous hemorrhage, and retinal detachment can impair vision. Both non-proliferative and proliferative diabetic retinopathy are the two main stages of the disease. This work presents a transfer learning based CNN architecture on color fundus photography that recognizes classes of Diabetic Retinopathy from hard exudates, blood vessels, and texture, and performs reasonably well on a much smaller dataset of skewed classes of 3050 training images and 419 validation images. With its limited processing capability, this model can function rather well in small real-time applications, as it is incredibly lightweight and durable, which could expedite the screening process. Google Colab was used to train the dataset. With four classes—I, No DR, ii) Mild DR, iii) Moderate DR, and iv) Proliferative DR—we trained our model. We obtained a Cohens Kappa score of 0.8836 on the validation set and 0.9809 on the training set.

Thippa Reddy Gadekallu [3] - Deep neural networks to predict diabetic retinopathy - A major contributor to blindness in the elderly is diabetic retinopathy, which has emerged as a major global health concern in recent years. Retinal fungal imaging is mostly used for the majority of the disease's detection, while there are other scientific and medical methods for screening and diagnosing it. The current study employs deep neural networks based on principal component analysis. Classification of the collected features from the diabetic retinopathy dataset using a network model and the Grey Wolf Optimization (GWO) technique. Selecting the best parameters for training the DNN model is made possible by the use of GWO. In this study, the diabetic

retinopathy dataset is first normalized using a standardscaler normalization method. Next, dimensionality is reduced using PCA, optimal hyperparameter selection is done by GWO, and the dataset is trained utilizing A DNN model. Based on the performance metrics of accuracy, recall, sensitivity, and specificity, the suggested model is assessed. The model is also contrasted with the support vector machine (SVM), naive bayes classifier, decision tree, and xGBoost classical machine learning algorithms. The findings demonstrate that, in comparison to the previously described algorithms, the suggested model performs better.

Maximilian W.M. Wintergerst, MD [4] - Diabetic Retinopathy Screening Using Smartphone-Based Fundus Imaging in India - Indirect ophthalmoscopy-based SBFI, which uses a smartphone to obtain fundus images, has been found to have the greatest picture quality and diagnostic accuracy among the several SBFI methods evaluated in this study for diabetic retinopathy (DR) screening in India.The burden of DR screening in low- and middle-income countries may be lessened with the use of smartphone-based fundus imaging in low-resource settings.

Nikita Kashyap [5] - Mobile Phone Based Diabetic Retinopathy Detection System Using ANN-DWT - Fluid passage from blood vessels to the retina can cause diabetic retinopathy (DR), a common retinal condition.The best treatment for DR is early detection and eye exams. a way to slow the spread of this illness. With the use of artificial neural network (ANN) algorithms, we describe in this research a low-cost, portable mobile phone-based result finding method for the early identification of diabetic retinopathy. In order to make a decision, the mobile device will use a condensing lens to capture retinal images and then an ANN detection algorithm. The first screening for DR. An existing database of retinas is examined to gauge the amount of work completed. Our goal is to design an affordable, efficient testing method that can be used by everyone, even in less developed areas.

Bhavana Sosale [6] - Simple, Mobile-based Artificial Intelligence Algorithm in the detection of Diabetic Retinopathy (SMART) study - High sensitivity for referable and sight-threatening diabetic retinopathy is demonstrated by the study's unique AI system, Medios AI, which detects diabetic retinopathy using a smartphone fundus camera when used offline. With the Remidio NM fundus-on-phone camera and Medios AI, diabetic retinopathy screening is made accessible and scalable in situations with limited resources.

Jianan Yuan [7] - Single-Label Image Classification - In recent decades, image categorization has become a prominent topic for study. It draws a lot of people to conduct study because it is so potent in the majority of fields. Single-label image classification is the simplest basic method of picture classification. There are three distinct tiers to it. Every level has a different level of difficulty. Neural Networks (NN) are among the most effective technologies for classifying photos. In addition to introducing a few relevant, well-known picture databases, the main focus of this paper will be on convolutional neural networks, or CNNs. This article includes illustrations of several indicators, such as the Top-5 and Confusion Matrix, to assess the model.

S. Majumdera [8] - A deep learning-based smartphone app for real-time detection of five stages of diabetic retinopathy - The use of deep neural networks in real-time on smartphone platforms to identify and categorize diabetic retinopathy from eye fundus images is shown in this research. This version takes into account each of the five stages of diabetic retinopathy, expanding upon a previously published version. The first two deep neural networks trained are one utilizing transfer learning and fundus images from the EyePACS and APTOS datasets for the purpose of identifying four phases and an additional two for further classifying the final stage. Next, a demonstration of how these trained networks are incorporated into an Android and iOS smartphone app is provided, which enables real-time image processing from smartphone cameras. Smartphones can now take and process fundus photos in real time thanks to the app's design accompanied by commercially accessible lens attachments. For first-pass diabetic retinopathy eye exams in outlying clinics or places with restricted access to fundus cameras and ophthalmologists, a real-time smartphone software has been developed that is both affordable and easily used.

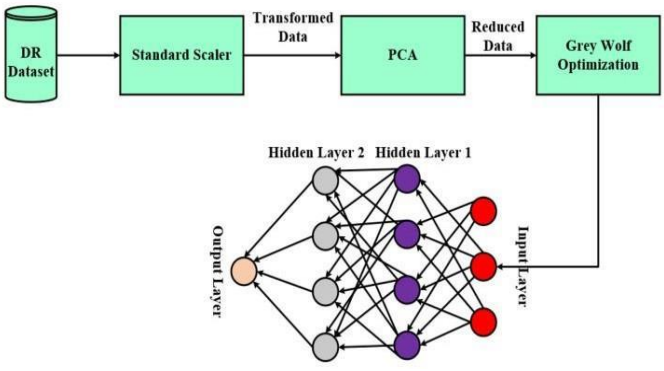
2. COMPARISION TABLE

Sr no.	Paper Tittle	Author	Approach	Model / Algorithm	Outcome
1	A Comprehensive Analysis of Convolutional Neural Network Models	Sanskruti Patel	Machine Learning	Image Processing, NLP, CNN	• Convolutional Neural Networks (CNNs)—particularly in computer vision, image processing, object recognition, and natural language processing—outperform other techniques.
2	Automated detection of diabetic retinopathy using convolutional neural networks on a small dataset	Abhishek Samanta	Machine Learning	CNN, KNN	• The study emphasizes the use of deep learning, namely convolutional neural networks (CNNs), in automating activities such as disease recognition (DR) categorization and stresses the need for routine screening to lower the incidence of DR-related blindness.
3	Deep neural networks to predict diabetic retinopathy	Thippa Reddy Gadekallu	Machine Learning	Grey Wolf Optimization, SVM	Using the Debrecen dataset, the study presented a Deep Neural Network (DNN) model in conjunction with Principal Component Analysis (PCA) and Grey Wolf Optimization (GWO) to classify Diabetic Retinopathy.
4	Diabetic Retinopathy Screening Using Smartphone-Based Fundus Imaging in India -	Maximilian W.M. Wintergerst, MD	Machine Learning	SBFI, Diagnostic technology	• In outreach settings in low- and middle-income nations, smartphone-based fundus imaging (SBFI) can successfully satisfy the requirements for diabetic retinopathy (DR) screening.

5	Mobile Phone Based Diabetic Retinopathy Detection System Using ANN-DWT	Nikita Kashyap	Machine Learning	Discrete Wavelet Transform, Principal of smart phone indirect opthalmogy	This research paper describes a mobile phone-based system for the early diagnosis of diabetic retinopathy (DR) that uses discrete wavelet transform (DWT) and artificial neural network (ANN).
6	Simple, Mobile-based Artificial Intelligence Algorithm in the detection of Diabetic Retinopathy (SMART) study	Bhavana Sosale	AI, Machine Learning	Medios AI, CNN	• Using non-mydriatic (NM) photos taken with the Remidio fundus on a phone camera, the study assessed the proficiency of the Medios AI algorithm in identifying referable diabetic retinopathy (RDR) and sight-threatening diabetic retinopathy (STDR).
7	Single-Label Image Classification	Jianan Yuan	Machine Learning	Image Classification, LeNet, CNN	• With single-label picture classification as its primary focus, the study discusses three different levels of categorization: Species Level, Subclass Fine-grained Level, and Instance Level.
8	A deep learning-based smartphone app for real-time detection of five stages of diabetic retinopathy	S. Majumdera	Machine Learning	DNN, Inception V3	Using a smartphone app that interprets camera images in real-time, the research aims to develop an affordable and easily accessible first-pass diabetic retinopathy (DR) eye inspection.

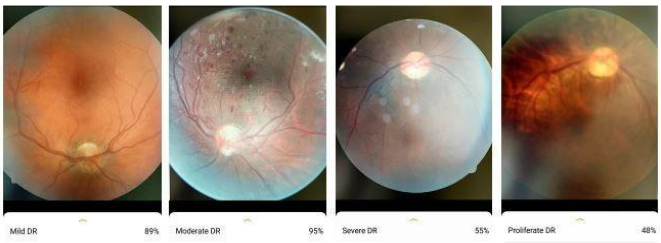
Year of Inception	CNN Model	Developed By	Top-5 error rate	Time taken to Train the Model
1998	LeNet	Yann LeCun et al	--	--
2012	AlexNet	Alex Krizhevesky et al	15.3%	Five to six days (Two GTX 580 GP)
2013	ZFNet	Matthew Zeiler et al	14.8%	Twelve days (GTX 580 GPU)
2014	GoogleNet	Christian Szegedy	6.7%	Week (few high-end GPUs)
2014	VGGNet	Simonyan et al	7.3%	Either Two to three weeks (4 Nvidia Titan Black GPUs)
2015	ResNet	Kaiming he	3.6%	Either Two to three weeks (8 GPU machines)

Fig -1: Result of different CNN models



DNN-PCA-GWO model for diabetic retinopathy

Figure 7. Sample screenshots of the app running in real-time on iPhone 7



Sample screenshots of the app running in real-time on Google Pixel 2.

3. CONCLUSIONS

A mobile gadget was used to detect DR. A convolutional neural network called ResNet50 is used to classify diabetic retinopathy into five phases. This model uses about 3500 images for training, validation, and testing. This model is then used to create a Flutter mobile application that runs on Android. A 98.8% accuracy rate is obtained from this result.

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