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A Smart Mobile App for the Detection of Diabetic Retinopathy using Artificial Intelligence

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Abstract*: Diabetic Retinopathy (DR) is the main cause of blindness for people who have diabetes in the world. This condition occur when high blood sugar levels cause damages to the blood vessel in the retina. These blood vessels can swell and leak thereby cause damage to the normal vision. In this system we are developing an Artificial intelligence-Based smart mobile application for the diagnosis and treatment of diabetic retinopathy. Using Tensor flow mathematical library, the app analyses the eye fund us image through deep learning from Kaggle database. The app would be useful in promoting self evaluation and timely treatment of Diabetic Retinopathy (DR) by physicians. The app would achieve an accuracy about approximately 80-90% and have an overall good performance.*

Keywords: Diabetic-Retinopathy (DR), Deep-Learning, Artificial Intelligence(AI) , TensorFlow, Eye Fundus Images

I. INTRODUCTION

Artificial intelligence has emerged as an advanced frontier in research field of computer Science. Health care cost effectiveness, quality and accessibility can be amplified using this technology. Deep learning one of the main branch of artificial intelligence can transform input data to patterns of prediction so that t becomes easier to detect the necessary cause of the severity of disease. The next is an attempt to speed up preliminary screening of DR to cater to the future requirement of such a huge amount of diabetic patients

[1] Unfortunately, Diabetic Retinopathy (DR) screening is manually acquired by an ophthalmologist, a process that can be considered erroneous and time-consuming. Accordingly, automated DR diagnostics have become an icon of research in recent years due to the massive increase in diabetic patients. On top of that, the recent achievement demonstrated by Convolutional Neural Networks (CNN) settle them as state-of-the-art for DR stage identification. The need to investigate the efficacy of light-weight deep learning architecture for fast and robust severity grading of diabetic retinopathy is necessary.

[2] In the recent years, several innovational Convolutional Neural Networks (CNN) have been proposed to detect the presence of DR with the help of publicly available datasets. However, these existing CNN-based classifiers focus on take advantage of different architectural settings to improve the performance of detection task only i.e. presence or absence of DR

[3] Using Automatic technology to detect DR at the early phase has very vital clinical significance. In order to detect the microaneurysms (MAs) and hard exudates (HEs) of DR, a novel detection method based on deep symmetric convolutional neural network is being used.

With the developments of smart applications likes the one presented in this concept it is easier to detect the causes and early treatment of Diabetic Retinopathy. The paper presents in this context describes the early detection and treatment of (DR) and thereby to reduce the severe effects of the disease and to reduce the mortality rate.

II. RELATED WORKS

[4] the technique is an attempt to speed up preliminary screening of DR to cater to thefuture requirement of such a huge amount of diabetic patients. It have trained and validated robustclassification models on publicly available datasets for

early detection of DR. It have applied state-of-the-art deep learning models based on Convolutional Neural Networks (CNN), to exploitdata-driven machine learning methods for the purpose.

[5] a novel and automated lesion detection scheme which includes four main steps: vessel extraction and optic disc removal, pre- processing, candidate lesion detection and post-processing. The optic disc and the blood vessels are suppressed first to ease further processing.

[6] the detection of DR can be performed manually by an ophthalmologists and can also be done by an automated system. In the manual process, analysis and explanation of retinal fundus images need ophthalmologists, which is a tedious and very expensive task, but in the automated system, Artificial Intelligence is used to perform an essential role in the area of ophthalmology and specifically in the early detection of diabetic retinopathy over the traditional detection approaches.

[7] A strong and adaptable method was proposed for the automated detection of longitudinal retinal changes caused by small red lesions. This approach influences normalized fundus images to effectively reduce illumination variations and thus enhances the contrast of small retinal features. To identify spatio-temporal retinal changes, a straightforward yet effective blobness measure is introduced, which calculates the primary difference between the extreme multiscale Blobness responses of fundus images taken at two different time points. Diabetic retinopathy-related changes are then detected using several intensity and shape features, classified by a support vector machine.

[8] proposed DR recognition and classification plays an important role diagnosing the early stages for DR. Doctors put patients under certain treatment to stop the disease from progressing and thus saving the patients eyesight. In this paper, three CNN models were proposed for the detection and classification of DR into the different classes according to disease severity. The proposed models includes different layers and parameters.

[9] A method was proposed that combines fuzzy image processing techniques with graph-cut methods to reliably segment Optical Coherence Tomography (OCT) images into five distinct layers. This approach defines a specific region of interest to reduce the impact of speckle noise. Fuzzy C-means is employed to construct data terms for smoother integration into the continuous max-flow framework, effectively addressing inhomogeneity. The method was tested and validated on a dataset of 225 OCT B-scan images

[10] A large, deep convolutional neural network was developed and trained to classify 1.2 million high-resolution images from the ImageNet LSVRC-2010 competition into 1,000 distinct categories. On the test data, it achieved top-1 and top-5 error rates of 37.5% and 17.0%, respectively, significantly outperforming the previous state-of-the-art. The network, containing 60 million parameters and 650,000 neurons, is composed of five convolutional layers—some followed by max-pooling layers—and three fully connected layers, ending with a 1,000-way softmax output.

[11] Discrimination capabilities in the texture of fundus images have been proposed to distinguish between pathological and healthy images. To achieve this, the effectiveness of Local Binary Patterns (LBP) as a texture descriptor for retinal images has been investigated and compared with other descriptors, including LBP Filtering (LBPF) and Local Phase Quantization (LPQ). The aim is the early detection of eye-related diseases, primarily due to diabetes, and to differentiate between age-related macular degeneration (AMD) and normal fundus images by analyzing retinal background texture, eliminating the need for prior lesion segmentation.

[12] This paper explores the feasibility of diagnosing both diabetic retinopathy (DR) severity levels and the presence of DR-related features using a two-step approach. First, it examines the quality of DR grading annotations by measuring inter-grader variability. Cosine similarity is used to assess the inter-grader variability in identifying DR-related features, while quadratic weighted Cohen's kappa is employed to evaluate variability in DR severity grading. Then, various annotation methods are compared for their impact on DR severity prediction using logistic regression, including: 1) Single Annotations by a Single Grader (SASG), 2) Single Annotations from Multiple Graders (SAMG), 3) Multiple Annotations by Voting (MAV), and 4) Double Annotations with Adjudication of Disagreement (DAAD)

[13] A novel and comprehensive methodology has been proposed, utilizing two distinct approaches to diagnose the progression of diabetic retinopathy (DR) by examining microaneurysm (MAs) turnover and associated pathological risk factors. The first approach follows the conventional image analysis pathway to determine MAs turnover, while the second approach investigates seven pathological features related to MAs turnover. These features are used to classify unchanged, new, and resolved MAs through statistical analysis and pattern classification techniques.

[14] We are developing both unsupervised and supervised techniques to intelligently address the detection of microaneurysms (MAs). Initially, retinal images are preprocessed to minimize background variation, enhancing detection accuracy.During the main processing phase, key landmarks like the optic nerve head and retinal vessels are identified and masked using the Radon transform (RT) in conjunction with multi-overlapping windows. Finally, MAs are detected and quantified through a combination of RT and a supervised support vector machine classifier. This method was evaluated on three publicly available datasets as well as a local database, totaling 749 images.

[15]This technique introduces a novel method for the early detection of diabetic retinopathy (DR) based on multifractal geometry. It involves analyzing macular optical coherence tomography angiography (OCTA) images to diagnose early non-proliferative diabetic retinopathy (NPDR). A supervised machine learning approach, specifically the Support Vector Machine (SVM) algorithm, is utilized to automate the diagnosis process and enhance overall accuracy..

[16] Deep learning is significantly impacting health informatics, with Residual Network being employed to identify diabetic retinopathy (DR) and its stages. Utilizing a transfer learning approach, the Residual Network model effectively detects the stages of diabetic retinopathy with high accuracy.

[17] This paper presents a new model for monitoring diabetic retinopathy that utilizes the Contrast Limited Adaptive Histogram Equalization method as a preprocessing step to enhance image quality and achieve uniform intensity equalization. For the classification phase, the EfficientNet-B5 architecture is employed, which is efficient in uniformly scaling all dimensions of the network. The final model is trained on a combination of two datasets, Messidor-2 and IDRiD, and its performance is evaluated using the Messidor dataset

[18] This paper presents a transfer learning-based approach for categorizing diabetic retinopathy. The dataset is resized to convert the diverse images into a uniform 224x224 format. Image augmentation is performed using AUGMIX, and the images are pooled with GeM. Pretrained models, specifically SEResNeXt32x4d and EfficientNetb3, are utilized, having been pretrained on the ImageNet dataset. The diabetic retinopathy images are then transferred to these models. Finally, based on the existing dataset, the output is categorized into five levels according to the severity of diabetic retinopathy

[19] The proposed system analyzes the presence of microaneurysms in fundus images using convolutional neural network algorithms that incorporate deep learning as a core component, accelerated by a Graphics Processing Unit (GPU). This setup enables high-performance medical image detection and segmentation with low-latency inference. A semantic segmentation algorithm is employed to classify the fundus images as either normal or infected, segmenting the image pixels based on shared semantics to identify microaneurysm features. This automated system will assist ophthalmologists in grading fundus images into categories of early NPDR, moderate NPDR, and severe NPDR.

[20] A heuristic-based data augmentation scheme is proposed that synthesizes neo-vessel (NV)-like structures to address the scarcity of proliferative diabetic retinopathy (PDR) cases in diabetic retinopathy (DR) labeled datasets. The neo-vessel generation algorithm leverages general knowledge about the typical locations and shapes of these structures. NVs are created and integrated into existing retinal images, thereby expanding the training sets for deep neural networks. This data augmentation scheme was assessed across several datasets and exhibited a greater ability for the model to identify neo-vessels (NVs).

[21] This paper presents an optimized deep learning neural network architecture for detecting diabetic retinopathy, utilizing features such as a Canny edge detector and histogram of oriented gradients.

[22] In this paper, we introduce a hybrid preprocessing and feature extraction technique named Microaneurysm Retinal Vein Hemorrhage Exudate (MRHE) extraction using Feature Enhancement and Edge Detection (FEED). This approach allows for the extraction of all features in a single step with significantly reduced complexity. To classify the presence of diabetic retinopathy (DR), we employ an effective Deep Convolutional Neural Network (D-CNN) model.

[23]This paper introduces an innovative, low-cost smartphone application that facilitates regular eye examinations and disease diagnoses for patients in remote and isolated areas. The mobile diagnostic system utilizes a KNN algorithm to analyze eye images captured by mobile phones to detect retinal diseases..

[24]This paper presents a new method for detecting diabetic retinopathy (DR) lesions at the pixel level. We have designed a multi-scale Convolutional Neural Network (CNN) that effectively utilizes complementary image information from different scales. Experiments were conducted using both private and public datasets..

[25] The primary goal of this approach is to enhance the diagnostic accuracy of diabetic retinopathy and reduce the time required for detection by utilizing an Optimized Back-propagation Neural Network (Op-BPN) algorithm, which is based on features extracted from various retinal image outputs.

[26] Manual detection of diabetic retinopathy (DR) is time-consuming. Although various computer-based techniques have been employed to detect DR and visualize retinal blood vessels, they often fail to differentiate between early stages and struggle with complex feature processing. Consequently, results from computer vision approaches tend to yield low accuracy. In this context, an Artificial Neural Network (ANN) is utilized to classify the different stages of diabetic retinopathy

[27] In this paper, we concentrate on identifying small lesions in diabetic retinopathy (DR) fundus images. Our analysis provides results that include both the lesion categories and their precise locations within the images, aiding in the assessment of DR severity based on its stages. Unlike traditional object detection methods for natural images, detecting lesions in fundus images presents unique challenges. Specifically, the size of lesion instances is typically very small relative to the original resolution of the fundus images, making them difficult to detect. We carefully examine the scale of lesions versus images and propose a large-size feature pyramid network (LFPN) to retain more image details for detecting mini lesion instances.

[28] This technique addresses the challenge of reducing the structural complexity of CNNs for diabetic retinopathy (DR) analysis by introducing a hierarchical pruning method. The original VGG16-Net is modified to reduce the number of parameters and is used for DR classification. Pre-trained model parameters from the ImageNet dataset are utilized to ensure effective feature extraction. Hierarchical pruning systematically removes connections, filter channels, and filters to simplify the network structure. The proposed pruning method is evaluated using the Messidor image dataset, a public dataset for DR classification.

[29]This paper employs a machine learning algorithm to detect diabetic retinopathy in the human eye. The proposed method applies classification algorithms to various features from an existing diabetic retinopathy dataset, such as optical disk diameter, lesion-specific characteristics (including microaneurysms and exudates), and the presence of hemorrhages. These features are extracted and utilized in the final decision-making process to predict the presence of diabetic retinopathy. The proposed system incorporates Decision Tree, Logistic Regression, and Support Vector Machine for prediction..

[30] Numerous deep learning-based computer vision techniques exist for detecting diabetic retinopathy (DR) using fundus retinal images; however, many of these methods do not accurately classify all stages of DR. The proposed approach utilizes an ensemble model consisting of five deep Convolutional Neural Networks (CNN) trained on images from the EyePACS dataset available on Kaggle. Each color channel of the image (Red, Green, Blue) is processed separately by all the models, allowing for an analysis of the impact of each individual channel on the results.

III. PROPOSED SYSTEM

In this paper eye fundus images is collected and it is uploaded in the smart mobile DR app. Through the analyzer it classify the uploaded images into four different classes(Cataract, Glaucoma, Diabetic retinopathy and normal).The main aim of this paper is the early detection of the diabetic retinopathy disease and to reduce the severity of the disease.

A. DATA DESCRIPTION

The dataset for the training is collected from the Kaggle database mathematical library. The data set contains 5000 images .This data is split into training and test set. The training set contains 2969 images and an 80-20% split is used from this set to train and test the CNN. The image samples are classified accordingly to four classes.

The following figure 3.1 shows sample images of dataset collected.

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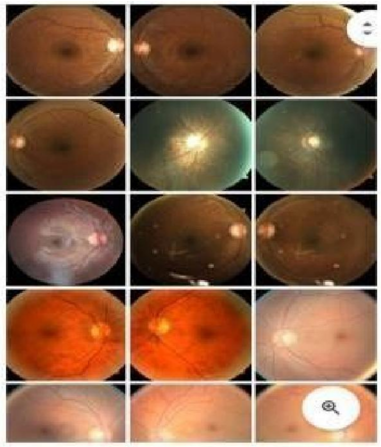

Figure 3.1 sample images of dataset

B. METHODOLOGY

The input is the eye fundus images dataset collected from the Kaggle platform which consist of mainly four classes. After uploading images in the proposed smart mobile application via analyzer classify images into different stages. Depending on the severity images is detected normal, cataract, glaucoma and finally diabetic retinopathy. If it is detected diabetic retinopathy then the app provides necessary regulations for the early diagnosis ,treatment and for consultation which makes the job of clinicians faster.

C. BENEFITS OF SMART DIABETIC RETINOPATHY MOBILE APP

- Enables better access to medical services.
- Provides early diagnosis and reduces mortality rate.
- Makes the job of physicians easier.
- Provides an instant report of detailed disease.
- Ease of use for anyone.
- Improved patient-provider communication.
- Minimum expenditure to services.

D. ANDROID APPLICATION INTERFACES

The following figures shows the layout of the mentioned smart mobile app for diabetic retinopathy detection. Each figures describes about the step-by-step execution of the android application installed.

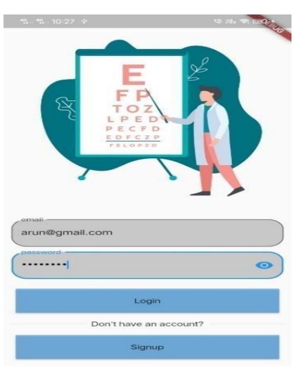

Figure 3.2 login page

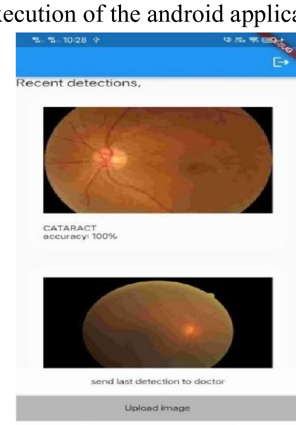

Figure 3.3 Image uploading page

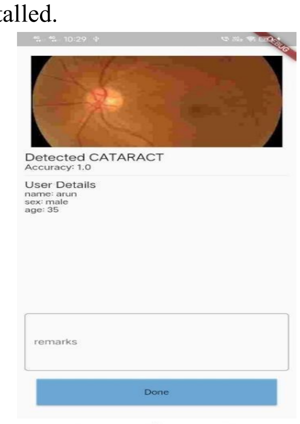

Figure 3.4 Disease detection page

IV. RESULTS

The objective of this smart app enables the early detection and analysis of the severity of the disease. As it is a mobile app the following figure 4.1 depicts in detailed about the validation accuracy and test accuracy of the proposed model using CNN Classification model and their process. This Smart app achieves an accuracy of about 83% in this process and predict the result accurately.

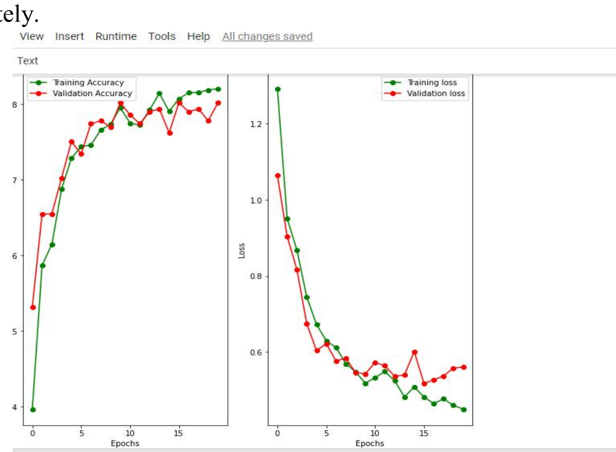

Figure 4.1 Result Visualization Using CNN Model

V. CONCLUSION

The use of Artificial Intelligence would go a long way to enhance smart healthcare which would be better accessible to the public. The implementation of smart healthcare system with the health of Artificial Intelligence, InternetOf Things, and other emerging technologies would improve healthcare and medical emergencies. Embedded mobile applications are emerging and have doubled compared to mobile devices using smartphones. Mobile applications aims to partially mitigate medical deserts and to improve the efficiency of care. Therefore, the examination of DR is currently a real big problem. My work is part of the medical assistance for the analysis of background images using telemedicine tools and techniques. In addition, improving the quality of patient care with the increase in the number of people with diabetes is being reviewed annually.

The Presented Application is A Smart Mobile App For Detection of Diabetic Retinopathy is an Android application that facilitate early detection and screening of diabetic retinopathy.It promotes smart healthcare and facilitates timely diagnosis and treatment of diabetic retinopathy, ultimately aiding in reducing mortality rates associated with the disease. As a perspective to this work, I will soon be able to implement deductions on heavy automatic learning models by integrating a fixed-point model with the TensorFlow Lite which has the role of optimizing the processing side. And also to enable the system to add more embedded system functionality to improve the overall performance in real life time. I conclude that Artificial Intelligence, Internet Of Things, and many other emerging technologies would shape the future of healthcare.

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