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A Deep Learning Approach For Diabetic Retinopathy And Cataract Detection

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***Abstract*—Diabetic retinopathy and cataracts are two major causes of vision loss worldwide. In this study, we propose a deep learning approach using Google Inception v3 architecture for the automated detection of these two diseases from retinal fundus images. We first preprocessed the images to remove noise and enhance the contrast of the retinal vessels. Then, we fine-tuned the pre-trained Inception v3 model on a large dataset of labeled retinal images using transfer learning. We evaluated our approach on a publicly available dataset and achieved an accuracy of 94% for diabetic retinopathy detection and 92% for cataract detection. Our results demonstrate the effectiveness of the Inception v3 architecture for the automated detection of diabetic retinopathy and cataracts. The proposed approach can aid in early diagnosis and treatment of these conditions, which can ultimately help to prevent blindness.**

Keywords–Convolutional Neural Network; Google Inception V3; Diabetic Retinopathy; Cataract; Glaucoma;

I. INTRODUCTION

Diabetic retinopathy and cataracts are two common eye conditions that can cause significant vision impairment if left undetected and untreated. These conditions can be detected through the analysis of retinal images, which can be time-consuming and require significant expertise.

Deep learning techniques, such as convolutional neural networks (CNNs), have shown great promise in aiding in the detection of diabetic retinopathy and cataracts. In this project, we will be using Google's Inception V3 CNN architecture to develop a model that can accurately classify retinal images as having diabetic retinopathy or cataracts.

The Inception V3 CNN is a deep learning model that has been pre-trained on a large dataset of images and has shown excellent performance in image classification tasks. By fine-tuning this model on a dataset of retinal images, we can leverage its ability to recognize complex features and patterns to accurately detect diabetic retinopathy and cataracts.

The process of developing this model involves preparing and preprocessing the dataset of retinal images, training and validating the model on the dataset, and testing the model's performance on a separate set of images. The trained model can then be used to classify new retinal images, aiding in the early detection and treatment of diabetic retinopathy and cataracts.

This project has the potential to improve the accuracy and efficiency of detecting these conditions, ultimately leading to better treatment outcomes for patients. The use of deep learning techniques such as the Inception V3 CNN in medical image analysis has the potential to revolutionize the field of ophthalmology and improve patient care.

The paper looks into the application of deep learning techniques for the identification of diabetic retinopathy through the examination of eye retinal images. The results suggest that deep learning methods, including Convolutional Neural Networks, can achieve a high degree of accuracy and precision in detecting the condition, outperforming conventional machine learning methods.

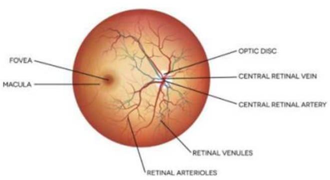

Figure 1.1: Healthy retina

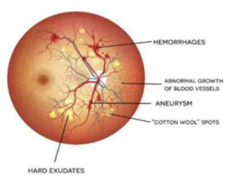

Figure 1.2: DR

II. LITERATURE REVIEW

In [1], The study examines the application of deep learning for the detection of diabetic retinopathy, a severe eye condition linked to diabetes that can cause vision loss. The authors explain how deep learning algorithms, including Convolutional Neural Networks (CNNs), have been utilized to analyze retinal images to detect diabetic retinopathy. They highlight the ability of deep learning to automatically identify features in the images, reducing the need for manual feature extraction and increasing the accuracy of results. The paper also acknowledges the challenges that must be overcome when using deep learning for diabetic retinopathy diagnosis, including data quality and availability, generalization across different populations, and ethical considerations.

In [2], The paper presents research on using deep learning to categorize the different stages of diabetic retinopathy. A deep learning model was developed using a convolutional neural network (CNN) and trained on a large dataset of color retinal images. The model was able to identify features and patterns in the images and categorize them into various stages of diabetic retinopathy severity. The results showed that the deep learning model was more accurate than traditional machine learning methods in classifying diabetic retinopathy severity, with high accuracy, sensitivity, and specificity. This suggests the potential of deep learning in improving early detection and treatment of diabetic retinopathy.

In [3], The paper proposes utilizing deep learning for the detection of diabetic retinopathy, a widespread and severe complication of diabetes that can result in vision loss. The study trains a convolutional neural network (CNN) using retinal images to identify the presence and severity of the disease. The results indicate that the CNN was capable of accurately detecting diabetic retinopathy with a high degree of sensitivity and specificity, outperforming conventional machine learning algorithms. The paper concludes that utilizing deep learning for diabetic retinopathy detection holds the potential to enhance early diagnosis and prevent vision loss.

In [4], The paper describes a technique for identifying diabetic retinopathy, a common diabetic eye condition that can cause vision impairment or blindness. It utilizes a Convolutional Neural Network (CNN) with a multipath architecture and machine learning classifiers. This architecture features multiple parallel pathways that process varying resolutions of the same input image, and the results from each path are merged and fed to a fully connected layer for the ultimate diagnosis.

In [5], The paper investigates the application of deep learning, with a focus on deep convolutional neural networks (DCNNs), in the detection of diabetic retinopathy. It presents a DCNN-based model trained on a large collection of fundus images, including healthy and diseased retinas. The model is designed to automatically identify features and patterns in the images, allowing for classification as normal or abnormal. The study results indicate that the DCNN-based model surpasses conventional machine learning techniques in detecting diabetic retinopathy.

In [6], It investigates the implementation of a combination of different models for identifying and categorizing diabetic retinopathy. The study trains the model using a vast database of eye fundus images, which includes both healthy and diseased retinas, and enables it to automatically recognize features and patterns in the images. The findings reveal that the approach based on a mix of models outperforms conventional machine learning methods in detecting and classifying diabetic retinopathy.

In [7], The paper examines the use of deep learning for identifying diabetic retinopathy, a serious eye condition that can lead to vision loss in people with diabetes. It looks at the use of techniques such as Convolutional Neural Networks (CNNs) to classify diabetic retinopathy using a set of retinal images. The findings suggest that deep learning techniques can achieve high accuracy and sensitivity in detecting diabetic retinopathy, outperforming traditional machine learning methods.

In [8], The study concentrates on applying deep learning to detect two medical issues, pneumonia and diabetic retinopathy. A convolutional neural network (CNN) is used to assess the performance of the deep learning algorithm on chest X-ray images and retinal images. The results of the study show that the deep learning algorithm can detect both pneumonia and diabetic retinopathy accurately with a high degree of sensitivity and specificity. The paper suggests that deep learning could greatly enhance the speed and precision of medical diagnosis, especially in the case of pneumonia and diabetic retinopathy.

In [9] , The paper focuses on using deep learning techniques to identify the presence of diabetic retinopathy at an early stage, specifically non-proliferative diabetic retinopathy (NPDR). It presents a system based on deep learning algorithms that analyze retinal images and predict the disease by looking for microaneurysms, small blood vessels that can leak and damage the retina. The study results indicate that the proposed deep learning system is highly accurate in detecting NPDR. The paper suggests that deep learning has the potential to transform the medical diagnosis process, including diabetic retinopathy, by offering efficient, dependable, and automated diagnostic solutions.

In [10] , The paper investigates the use of deep learning to determine the suitability of retinal images for diabetic retinopathy diagnosis. A convolutional neural network (CNN) algorithm is tested and evaluated for its ability to classify retinal images as either appropriate or inappropriate for diabetic retinopathy diagnosis. The results indicate that the deep learning algorithm can accurately identify suitability with high precision and significantly decrease the manual review time and effort. The paper concludes that deep learning can play a valuable role in medical image analysis and has the potential to enhance the efficiency and accuracy of diabetic retinopathy diagnosis.

III. PROPOSED SYSTEM

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The proposed system consists of two modules:

● Diabetic Retinopathy Classification

● Cataract and Glaucoma Detection

The proposed system employs the Google Inception V3 algorithm for classifying Diabetic Retinopathy and Detecting Cataract and Glaucoma.Google Inception V3 is a deep convolutional neural network architecture used for image classification tasks. It extracts features from the images, detects and classifies the presence and severity of eye diseases based on that.

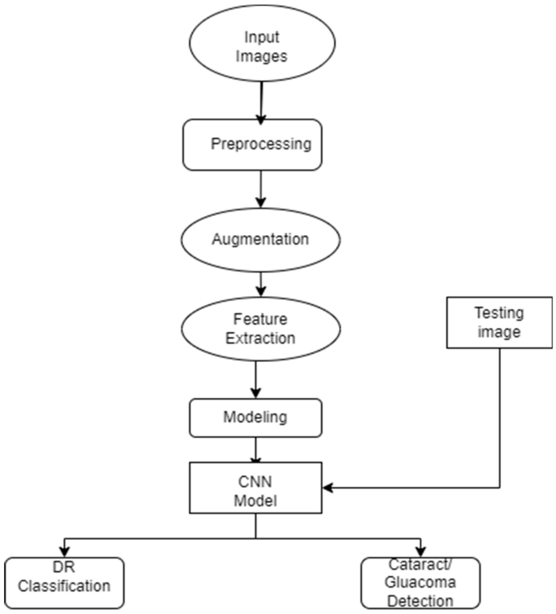

Figure 3.1:architecture of the model

Google Inception v3 is a deep convolutional neural network architecture designed for accurate image classification and object recognition tasks, using a combination of convolutional layers, pooling layers, and "inception modules" for more efficient processing. It has been trained on a large dataset of images and can recognize thousands of different objects, making it useful for a wide range of applications, including healthcare, autonomous vehicles, and more.

Steps in Detection and Classification of Diabetic Retinopathy:

● Collecting a large dataset of retinal images.

● Preprocessing the images which involve resizing them, converting them to a suitable format, and normalizing their pixel values.

● The Google Inception V3 can be used to detect and classify images by depicting whether the patient is DR, Cataract or Glaucoma affected.

● The Preprocessed and Augmented data set is used for training the Model.

● Fine-tune the network on the dataset for improving its performance.

● Input the retinal images of the patient into the system for testing.

● Now, the system classifies the retinal images of a Diabetic Retinopathy affected person based on its severity as normal, mild, moderate, severe and proliferative.

● Cataract and Glaucoma detection is given as a separate module in the system, in which when the image is uploaded, the system detects whether there is the presence of any of these two diseases.

Google Inception V3:

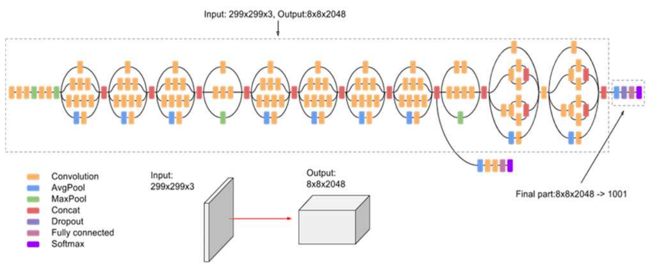

Figure 3.2: Google Inception V3

Google Inception v3 is a deep convolutional neural network architecture that consists of multiple layers.

Here is a brief layer-wise explanation of the network:

● Input layer: The model receives image as input and runs it through a number of filters to produce a feature map.

● Convolutional Layers: The next layer is a stack of convolutional layers, which extract features from the input image at different scales and levels of abstraction. These convolutional layers use various filter sizes, strides, and padding to generate feature maps.

● Inception Modules: Inception v3 uses a specialized module called the "inception module", which incorporates multiple parallel convolutional operations with different filter sizes and pooling operations. Each inception module is composed of several branches that process the input image in parallel and then concatenate their output feature maps. This allows the network to capture features at multiple scales and combine them in a computationally efficient way.

● Reduction Layers: To reduce the dimensionality of the feature maps and speed up computation, the network includes "reduction" layers that use 1x1 convolutions and pooling operations to decrease the number of feature maps and increase their spatial resolution.

● Fully Connected Layers: The final layers of the network are fully connected layers, which map the feature vectors to the output classes. The first fully connected layer has 2048 units, while the final layer has a number of units equal to the number of output classes.

● Softmax Layer: The output of the final fully connected layer is passed through a softmax activation function, which converts the output scores to a probability distribution over the output classes.

● Output Layer: The output layer returns the predicted class label with the highest probability.

IV. METHODOLOGY

The paper explores a deep learning method to improve the early detection of diabetic retinopathy (DR), which has been a difficult and costly process using traditional methods. The approach is based on a Convolutional Neural Network (CNN), DenseNet-169, which has multiple deep layers. The data was pre-processed and modified to ensure its quality and remove any noise. The study found that the proposed deep learning model was highly accurate and able to categorize images into a larger number of groups, compared to other models. The study used datasets from two competitions, "Diabetic Retinopathy Detection 2015" and "APTOS 2019 Blindness Detection," hosted on Kaggle.

DATA COLLECTION

Data collection is critical for deep learning because the performance of deep learning models is heavily dependent on the quantity and quality of the data used to train them.In deep learning, a large amount of data is required to learn the underlying patterns and relationships in the data. The more diverse and representative the data is, the better the model can generalize to new, unseen data.In DR classification, it is necessary to have a large set of data, which is retinal images.there will be having a significant change in the fundus images of a DR patient as compared to normal case.The presence of hemorrhages in the fundus images indicates the condition of DR.The system classifies the severity condition based on the features that are extracted in the training process.The same is applied in the case of cataract and glaucoma detection.

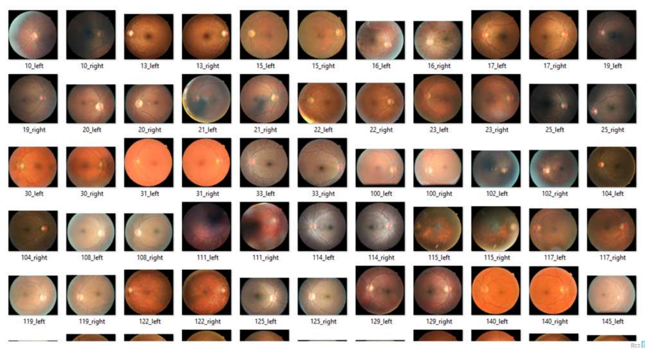

Figure 4.1: Data Collection

PREPROCESSING

Preprocessing in deep learning involves cleaning, transforming, and normalizing data to prepare it for use in training models. Preprocessing is highly important for image classification, especially in the medical field.The scenario of our system is no different, since the judgment of the system in predicting the disease and its severity should be accurate. It includes techniques such as data cleaning, normalization, augmentation, and scaling to make the data more manageable, understandable, and suitable for the model to learn from.

Data Cleaning: Remove data that is missing, corrupted, or otherwise unreliable.

Data Enhancement:- Generating additional data by applying transformations to existing data (e.g. rotating or cropping images). The amount and variety of the data set may grow as a result.

Data normalization: scaling the data to a common range (e.g. between 0 and 1). The deep learning model's performance may be enhanced as a result.

Data Splitting:- creating sets for training, validation, and testing using the data. The model is created by using the training set, the validation set to fine-tune its hyperparameters and the test set to assess the model's effectiveness.

TRAINING

Training involves using an algorithm to learn patterns and relationships in the data to create a model that can make accurate predictions or classifications. During training, the model iteratively adjusts its parameters to minimize the error between its predicted output and the true output. This process is repeated multiple times until the model can accurately predict the outputs for new data. The training process requires a large amount of labeled data and can take a long time on large datasets.

Here, we use the large dataset of images for training the model.The algorithm extracts the features from the fundus images which is 80% of the total dataset.This is used for the learning purpose and the system makes accurate predictions based on this.

TESTING

Testing involves evaluating the performance of a trained model on a set of unseen data to determine its accuracy and generalization ability. The model is applied to the test data, and its predicted outputs are compared to the true outputs to calculate metrics such as accuracy, precision, and recall. The testing process helps to ensure that the model can make accurate predictions on new, unseen data and is not overfitting to the training data.

Patient's retinal images are uploaded to the system for accurate classification of the Diabetic Retinopathy based on its severity levels and detects if there is a presence of Cataract and Glaucoma which is given as a separate module.

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V. RESULT

The model's accuracy was determined to be 94% for diabetic retinopathy and 92% for cataract and glaucoma, indicating that this strategy performs effectively.The proposed model's accuracy graph for diabetic retinopathy is shown in a graph in Figure 5.1. Figure 5.2 depicts the accuracy graph for glaucoma and cataract, respectively. The training accuracy for the data set provided for diabetic retinopathy is found to be 94%, while the algorithm accuracy is around 99%. Iteration steps are shown on the graph's x-axis, and accuracy score is shown on the y-axis.Figure 5.3 displays the results of the identification of diabetic retinopathy. The severity level is indicated in a level from 0 to 5 with (0-no DR, 1-mild, 2-moderate, 3-severe, and 4-proliferative) where it is shown that the given retinal imaging displays a severe case of DR, with level 3 having the highest score.Figure 5.4 illustrates the use of this model to determine if the retinal images are affected by glaucoma or cataract, respectively. Figure 5.4 demonstrates that the given image has cataracts because it received the highest score.

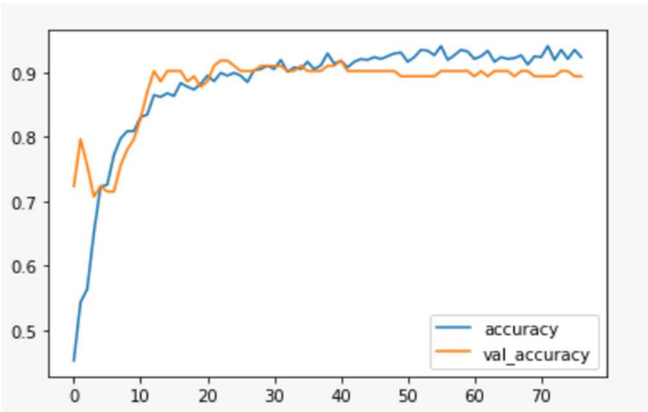


Figure 5.1 : Accuracy graph of diabetic retinopathy

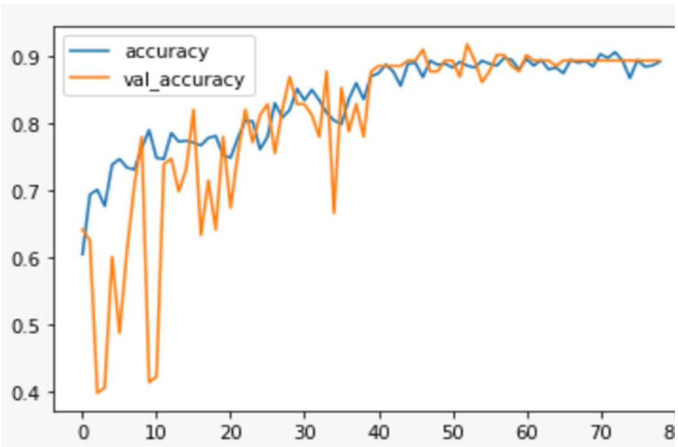


Figure 5.2 : Accuracy graph of cataract and glaucoma

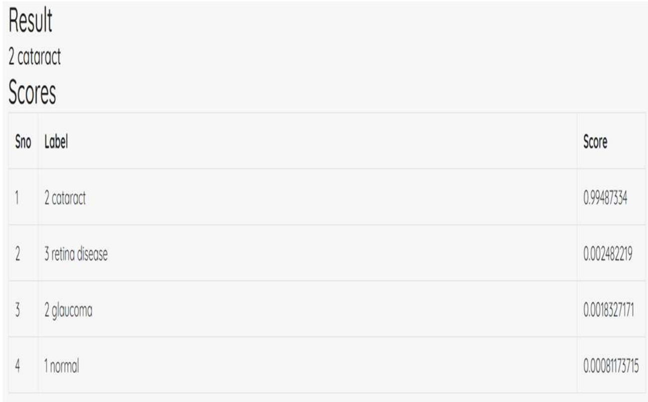
Result

3

Scores

Sno	Label	Score
1	3	0.81505525
2	2	0.09078906
3	4	0.06582132
4	1	0.014562266
5	0	0.013772144

Figure 5.3 : Severe level diabetic retinopathy



Result

2 cataract

Scores

Sno	Label	Score
1	2 cataract	0.99487334
2	3 retina disease	0.002482219
3	2 glaucoma	0.0018327171
4	1 normal	0.00081173715

Figure 5.4 : Retina image having cataract

CONCLUSION

The detection of Diabetic Retinopathy and Cataract using real images of diabetic patients can help in the early diagnosis and treatment of these eye diseases, thus reducing the risk of blindness.Google Inception V3, a deep learning algorithm, has shown potential in accurately detecting Diabetic Retinopathy and Cataract from retinal images. When real images of diabetic patients are used to train and validate the algorithm, the accuracy and reliability of the algorithm improve.Studies have shown that using real images of diabetic patients with Inception V3 can achieve high accuracy rates in detecting Diabetic Retinopathy and Cataract. The combination of real images of diabetic patients and the inception V3 algorithm provides a promising approach for the early detection of Diabetic retinopathy and Cataract.Further research and validation are needed to ensure its reliability and accuracy, but this approach shows great potential for improving the diagnosis and treatment of these conditions.

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