Glaucoma Detection and Classification

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Abstract — Glaucoma is a chronic eye illness that results from optic nerve damage caused by high intraocular pressure. There are no symptoms of glaucoma in the early stages, but as the disease continues, it can lead to irreversible blindness. Diagnosis of glaucoma in the clinical environment includes intraocular pressure measurement, visual field testing, or examination of the optical disk of fundus images. In large-scale screening scenarios, these manual assessments are not precise, mostly in developing countries due to the insufficiency of trained experts and scarce modern imaging equipment. In this paper, several models are being used to study glaucoma detection. The models chosen are: VGG19, VGG19+LSTM, InceptionV3, and InceptionV3+LSTM. Every model is being worked with K-fold cross-validation and data augmentation to overcome the limitation of a small dataset. The features extracted are used to classify the input image and are then projected to be either glaucomatous or normal. Finally, the values obtained for various performance evaluation parameters are compared.

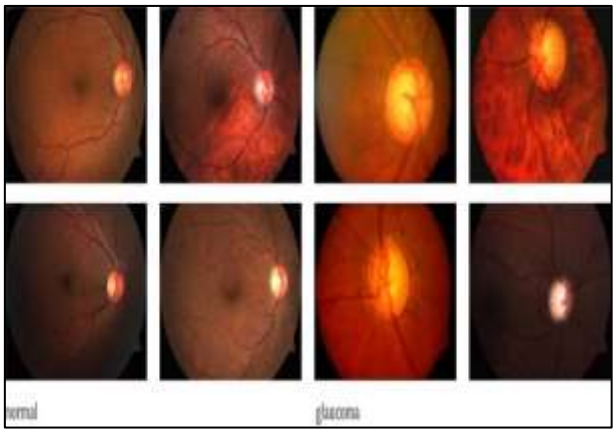
Keywords: CNN, VGG, LSTM, CSV, GPU, Precision, Recall, Accuracy, Glaucoma

I. INTRODUCTION

Glaucoma is a chronic eye disease that results from visual nerve damage caused by intraocular pressure in the eye. In the early stages of glaucoma, there are no symptoms of vision loss, but as it progresses, it may result in irreversible blindness. It is often associated with an accumulation of pressure within your eye. Glaucoma is common among families. It usually happens later in life. Diagnosis of glaucoma in the clinical environment includes intraocular pressure measurement, visual field testing, or examination of the optical disk of fundus images. The majority of people have no symptoms. If symptoms occur, it is usually around the end of the illness. The primary sign is generally a loss of lateral vision or peripheral vision. There's no way to prevent glaucoma. But if you find it early, you may reduce your chance of eye damage.

A. Dataset

The ACRIMA dataset is being used, and it consists of 705 fundus images. In which there are 396 glaucomatous and 309 normal images. 632 images are being used for training, and 73 is being used for testing, with a 90-10 split.



B. Proposed Solution

We have developed a system that focuses on detecting glaucoma using four deep learning models.
The models chosen are:

1) VGG19
2) VGG19+LSTM
3) Inception v3
4) Inception v3+LSTM

Every model is being worked with K-fold cross-validation and data augmentation to overcome the limitation of a small dataset. The features extracted are used to classify the input image and are then projected to be either glaucomatous or healthy. Finally, the values obtained for various performance evaluation parameters are compared.

II. METHODOLOGY

The process begins with the user inputting a fundus image into the system. The system then reads and performs pre-processing on the image, which includes tasks such as image resizing, normalization, and contrast enhancement.

The pre-processing helps to improve the quality of the image, which enhances the accuracy of the detection and classification process.

The image is then processed using a deep learning model that has been trained to detect and classify glaucoma in fundus images. The model analyzes the features and patterns in the image and makes a prediction based on its learned parameters.

The classification process involves identifying the presence of glaucoma by analyzing the optic nerve head, retinal nerve fiber layer, and other structures in the image. The system detect and classify glaucoma in fundus images

It produces an output prediction of whether the image is glaucomatous or normal.

This technology has the potential to improve early detection and treatment of glaucoma, which could significantly reduce the number of people who lose their sight due to this disease.

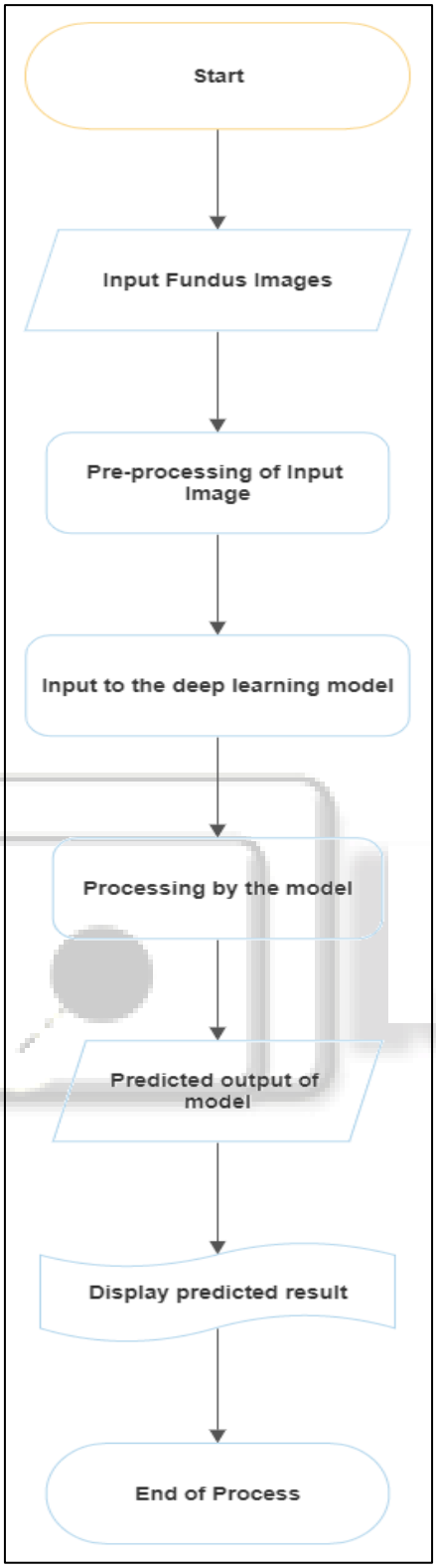


Fig. 1: Methodology for detecting & classifying Glaucoma

III. RESULTS

Model	Accuracy (%)	Class Name	Precision	Recall	F1 Score
VGG19	91.78	Normal	0.85	1.00	0.92
		Glaucoma	1.00	0.84	0.91
VGG19+LSTM	94.52	Normal	0.90	1.00	0.95
		Glaucoma	1.00	0.89	0.94
Inception v3	90.41	Normal	0.88	0.91	0.90
		Glaucoma	0.92	0.90	0.91
Inception v3+LSTM	93.15	Normal	0.91	0.94	0.93
		Glaucoma	0.95	0.93	0.94

Table 1: Summary of Results using evaluation parameters

According to the observations made, the VGG19 model achieved an accuracy of 91.78%, with a better performance on normal images than glaucoma images. The VGG19+LSTM model achieved an accuracy of 94.52%, with a better performance on normal images than glaucoma images. The Inception v3 model achieved an accuracy of 90.41%, with a better performance on glaucoma images than normal images. Finally, the Inception v3+LSTM model achieved an accuracy of 93.15%, with a better performance on glaucoma images than normal images. These results suggest that VGG19-based models perform better on normal images, while Inception v3-based models perform better on glaucoma images.

During the training, we used four models and applied the k-fold cross validation technique with k=3 to overcome the small dataset's limitation. After training the models for 35 epochs, the VGG19-based models achieved an average training accuracy of 96% and an average testing accuracy of 93.15%. The Inception v3-based models achieved an average training accuracy of 99% and an average testing accuracy of 91.78%. The addition of LSTM to both models resulted in an increase in training and testing accuracy. Furthermore, we observed that the VGG19+LSTM model produced the best results with the highest accuracy.

IV. CONCLUSIONS

Glaucoma, a retinal disease affecting numerous people globally, can cause permanent blindness if not detected early. To aid in its detection, a deep learning mechanism that combines Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) was used. Several models, including VGG19, VGG19+LSTM, Inceptionv3, and Inceptionv3+LSTM, were tested using the ACRIMA dataset. Results showed that the VGG19+LSTM model had the highest accuracy, predicting glaucoma and non-glaucoma classes with 94.52% accuracy, which is comparable to clinical setups. The project's goal is to provide a fast and effective solution for glaucoma detection using deep learning, and transfer learning and data augmentation were used to achieve state-of-the-art accuracy. The study also found that VGG19-based models perform better on normal images, while Inception v3-based models perform better on glaucoma images. This project has significant potential and can lead to more advancements in glaucoma detection.

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