GLAUCOMA DETECTION USING CONVOLUTION NEURAL NETWORKS

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ABSTRACT

GLAUCOMA is an unending and irreversible eye infection in which the optic nerve is consistently hurt, causing disintegration in vision and individual fulfillment. Glaucoma is rated as the leading cause of blindness in the working age population all over the world. Glaucoma is also rated as the leading cause of irreversible vision loss worldwide. Early detection of glaucoma is important for providing timely treatment and minimizing vision loss. The diagnosis of Glaucoma through color fundus images requires experienced clinicians to identify the presence and significance of many small features which, along with the complex grading system, makes this difficult and time-consuming task. Hence this issue is the right problem that can be solved by automatically diagnosing glaucoma with the help of the deep learning approaches. In this project Glaucoma is detected using a network with Convolution Neural Network (CNN) architecture. Convolutional Neural Networks (CNN's) are appropriate to find the solution for this type of issue as they can extract various levels of data from the input image, and which encourages to differentiate among non-glaucomic and glaucomic images. This model is trained and tested on a kaggle dataset.

Keyword : - *Convolution neural networks, Glaucoma, Non-glaucoma, ReLU, VGG-19.*

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1. INTRODUCTION

Glaucoma is a condition that causes damage to your eye's optic nerve and gets worse over time. It's often linked to a buildup of pressure inside your eye. Glaucoma tends to be inherited and may not show up until later in life. The increased pressure, called intraocular pressure, can damage the optic nerve, which transmits images to your brain. If the damage continues, glaucoma can lead to permanent vision loss. Without treatment, glaucoma can cause total permanent blindness within a few years. Glaucoma is an irreversible neuro-degenerative eye disease that is considered one of the main reasons for visual disability in the world. According to the World Health Organization (WHO), glaucoma affects more than 65 million people aroundthe globe.

2. METHADOLOGY

Here, we used CNN approach to detect glaucoma.There are various methods involved in detecting glaucoma like adaptive thresholding algorithm and other CNN models, one of such technique is CNN model is VGG19 model.

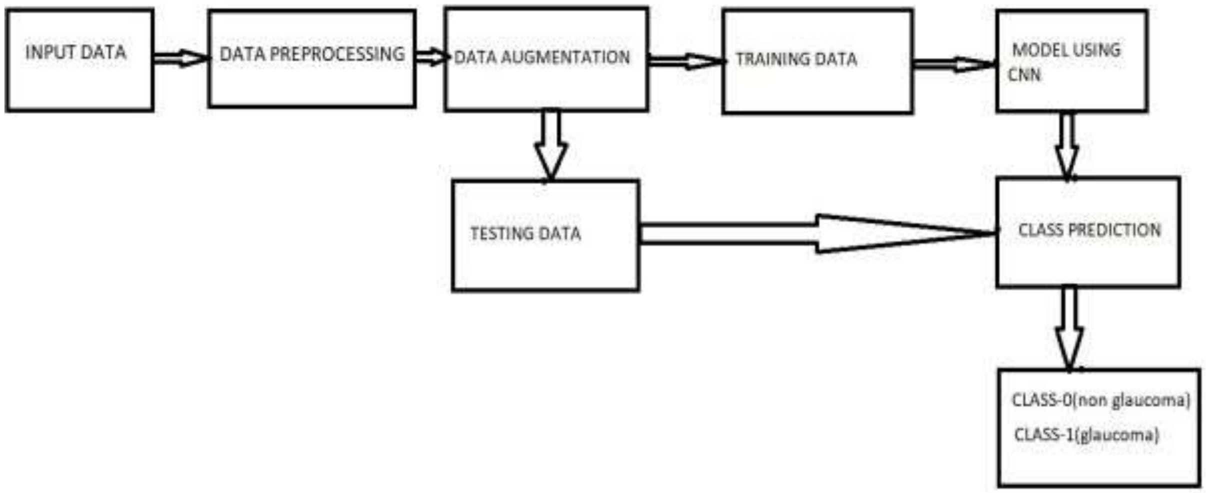
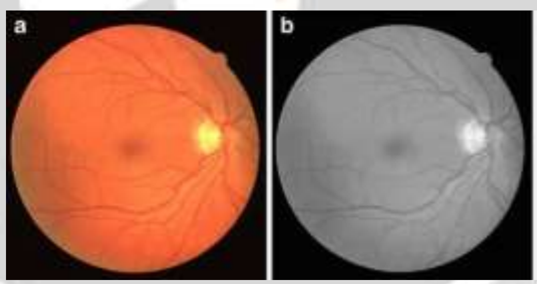


Fig: SYSTEM ARCHITECTURE

2.1 Data preprocessing:

Input images are collected from Kaggle open-source dataset. Retinal image is used as the input image. The input retinal images are preprocessed before it is applied to the further process. Conversion of RGB images to Grayscale images. Conversion to grayscale images are done to improvement in testing accuracy.



a.Color image b.Gray scale image

2.2 Data Augmentation:

Rotation, Zooming, Shearing, Horizontal and Vertical Flip are done on images of all classes. Data augmentation is done for balancing the classes with equal number of images.

- **Training**: The training set is used to learn the details as each of the classes and its position in the image. This step is known as training a classifier or learning a model.
- **Testing**: The quality of the classifier is evaluated by asking it to predict labels for a new set of images that it has never seen before. The more the values are matched the more is the accuracy of the classifier.

2.3 CNN model:

Training the model by using CNN layers. We have used convolutional & max pooling layer, Flattening layer and a Fully Connected Layer. Here, we used VGG-19 pre-trained model.

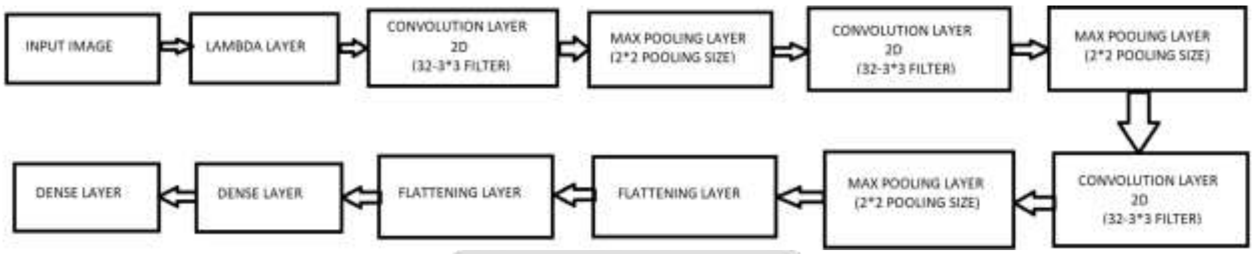


Fig: Architecture of CNN model

The architecture of the VGG19 model with sixteen convolution layers followed by three fully connected layers. The activation function uses a non-linear ReLU for the output of each convolution layer. It has in-built softmax classifier which is used for classification. Softmax classifier is a binary classification of logistic regression.

- Lambda layer has its own function to perform editing in the input data, it helps to transform the input data, it is an easy way to customize a layer to do simple arithmetic.
- Different features of the input are extracted by the convolution operation. The first convolution layer extracts low-level features like edges, lines, and corners. Higher-level layers extract higher-level features.
- The pooling (subsampling) layer helps to reduce the resolution of the features. The features are robust against noise and distortion
- Flattening is used to convert 2-D arrays from pooled feature maps into a single long continuous linear vector.
- Dense layer is also called as fully connected layer. Fully connected layers are generally used as the final layers of a CNN. These layers sum a weighting of the previous layer of features. This indicates the accurate mix of ingredients to determine a specific target output result. In case of a fully connected layer, all the elements of all the features of the previous layer are used in the calculation of each element of each output feature.

2.4 Class prediction: Class prediction is a supervised learning method where the algorithm learns from samples with known class membership (training set) and establishes a prediction rule to classify new samples (test set). At the final stage, output is classified as class 0 or class 1, class 0 represents non-glaucoma, class 1 represents glaucoma.

3. RESULTS

Our experimentation is implemented on fundus images in Table 1. We used Keras Deep Learning Library with the tensor flow as a backend. All experiments related to this study were conducted on Colab or Google Colaboratory – a product from Google Research that provides free GPU service for education and research purposes. The GPUs obtainable in Colab often include T4s, Nvidia K80s, P4s, and P100s.

3.1 Confusion Matrix:

Confusion matrix is used to describe the performance characteristics of proposed model.

Some important terms

- **True Positive** (TP): Positive correctly classified as positive in our case glaucoma is correctly classified as glaucoma.
- **False Positive** (FP): Positive incorrectly classified as negative in our case glaucoma is incorrectly classified as non-glaucoma.
- **True Negative** (TN): Negative correctly classified as negative in our case non glaucoma is correctly classified as non-glaucoma.
- **False Negative** (FN): Negative incorrectly classified as negative in our case non-glaucoma is incorrectly classified as glaucoma.

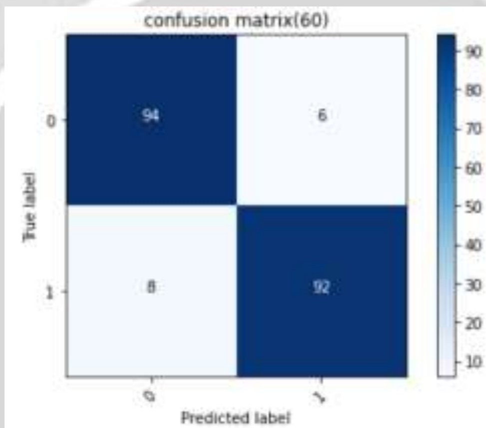


Fig: Confusion Matrix

METRICS	CNN-SOFTMAX
True positive(TP)	94
True negative(TN)	92
False positive(FP)	6
False negative(FN)	8
Accuracy	93.7%
Precision	94%
Sensitivity	97.4%
Specificity	83.6%
Recall	94%
F1-Score	94%

Fig: Performance characteristics

- **Accuracy**
  The number of elements correctly classified among total elements classified.
  Acc = (TP+TN)/(TP+TN+FP+FN)
- **Sensitivity or Recall**
  Proportion of positive class correctly classified
  Se = TP / (TP + FN)
- **Specificity**
  Proportion of negative class correctly classified
  Sp = TN / (TN + FP)
- **Precision**
  Ratio of correctly predicted positive to that of total predicted positive.
  Pre = TP/(TP + FP)
- **F1 Score**
  Harmonic mean of precision and sensitivity
  F1 = 2 x Pre x Se / (Pre + Se)

4. CONCLUSION

Glaucoma is an irreversible neurodegenerative illness that damages the optic nerve and is responsible for vision loss and blindness. The conventional manual detection of glaucoma by eye specialists is costly and time-consuming and depends on human error, experienced ophthalmologists, and expensive instruments. This paper attempts to implement an automatic glaucoma diagnosis system based on deep learning approaches. This study uses a private dataset comprising of 2738 normal (Non-glaucoma) and 1315 glaucoma color fundus images.

5. REFERENCES

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