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Glaucoma Detection using Convolutional Neural Network

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Abstract –*Glaucoma is a group of related eye disorders that cause damage to the optic nerve that carries information from the eye to the brain which can get worse over time and lead to blindness. It is very important that glaucoma is detected as early as possible for proper treatment. In this paper, we have proposed a Convolutional Neural Network (CNN) system for early detection of Glaucoma. Initially, eye images are augmented to generate data for Deep learning. The eye images are then pre- processed to remove noise using Gaussian Blur technique and make the image suitable for further processing. The system is trained using the pre-processed images and when new input images are given to the system it classifies them as normal eye or glaucoma eye based on the features extracted during training.*

Key Words: **Glaucoma, Convolutional Neural Network, Deep Learning, Gaussian Blur.**

1. INTRODUCTION

Glaucoma is often linked to a build-up of pressure inside the eyes. Glaucoma tends to run in families and one usually doesn't get it until later in life. The increased pressure in eyes, called intraocular pressure, can damage the optic nerve, which sends images to the brain. If the damage worsens, glaucoma can cause permanent vision loss or even total blindness within a few years. Most people with glaucoma have no early symptoms or pain. One must visit the eye doctor regularly so they can diagnose and treat glaucoma before one has long-term vision loss. If a person loses his vision, it can't be brought back. But, lowering eye pressure can help keep the sight that he has. Most people with glaucoma who follow their treatment plan and have regular eye exams are able to keep their vision. An optic disc and cup are present in all individuals but an abnormal size of the cup with respect to the optic disc is a characteristic of a glaucoma infected eye.

Traditional methods of detecting glaucoma include an eye doctor analysing the images and finding the abnormalities in it. This method is very time consuming and not always accurate because the image contains noise and other factors which make it difficult for proper analysis. Also, if a machine trained for analysis it becomes more accurate than human analysis.

Most of the literature works present mainly focus on optic cup and disk segmentation and some focus on Cup/Disk ratio. Through our analysis we have found using Convolutional Neural Network model to be better than other literature works proposed. Convolution neural networks are one of the most popular deep learning techniques for image analysis. In this technique, training data sets of previously classified images are used to develop the system. This deep learning technique implies that computers can perform feature learning and classification simultaneously. In deep learning algorithms, a model is formed using many layers which transform the given input data to an output.

2. METHODOLOGY

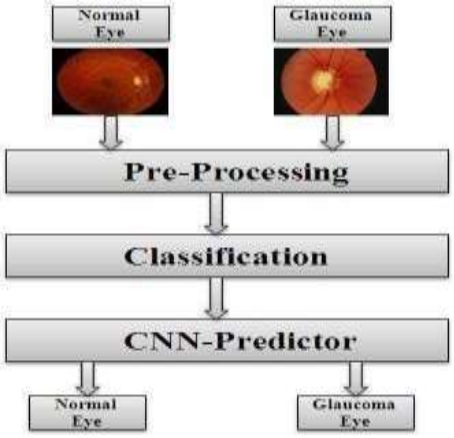

Figure 1: Workflow

A. Database

The database contains total 100 eye images for training and testing. Out of 100 images, 50 images contain glaucoma and 50 images are healthy (without glaucoma). All the images are of varying sizes and in different formats.

B. Pre-processing

As mentioned above, all images in the dataset vary in size and format which may consist of noise in them. The image pre-processing technique will help in reducing the noise and convert the data into a standard format for further classification of images. Gaussian Blur is applied on the fixed size images(256x256 pixel) in order to reduce and remove noise.

C. Classification

The process of classification is to classify an image according to its visual content. The classifier used is k-nearest neighbour. The number of neighbour (k), distance matrix and dataset is given as an input for the algorithm.

D. CNN Model

The pre-processed image is given as an input to the CNN model which consists of an input layer, convolution layers and a fully connected layer. The input image of 256x256pixel acts as the input layer. In the first convolution layer, 16 filters of 3x3 size kernels each are applied to the input image by gliding one by one through the position and a total of 16 feature maps are generated. This method is called as feature extraction. These features are then applied to the ReLU activation function, which performs a threshold operation for each input variable with values below zero. On the output of the ReLU layer, a max pooling layer of 2x2 window size is applied which results in down-sampling of the feature maps to 128x128 pixel.

The output of the last convolution layer acts as an input for the next convolution layer. The next convolution layer contains of 32 3x3 scale kernel filters that are applied to each of function maps retrieved from the last layer. Specific operations like ReLU and max pooling are carried out to generate 64x64 pixel down-sampled data.

The same operations are performed on the third layer which is the last layer where 64 filters of 3x3 size kernels are used which produce 32x32 pixel data.

The third convolution layer has an output of 64 32x32 pixel feature maps. These features are then leveled to a single 32x32x64 = 65536 long vector, that acts as an input to a fully-connected layer. These features are then used to evaluate the image type whether it is an healthy eye or glaucoma- infected eye.

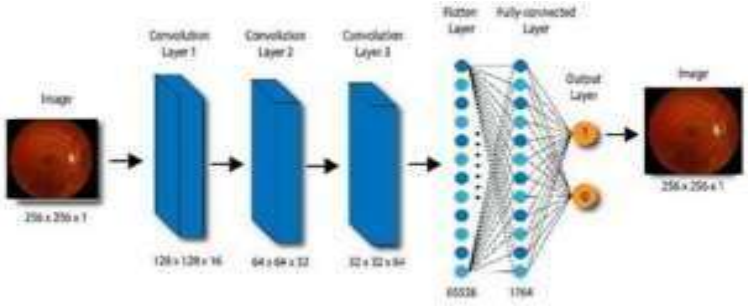

Figure 2: CNN Architecture

3. RESULTS AND DISCUSSION

There are many computer-based techniques are present to identify Glaucoma disease, but these systems have advantages as well as disadvantages. We have developed a system having more advantages and fewer drawbacks by using a smarter algorithm. The aim of our project is to improve the performance and accuracy of the system by using a different algorithm.

To develop the proposed system, we have used the Convolutional Neural Network technique which is considered as the best technique to classify images and detect whether the eye is infected by Glaucoma disease or not.

The process for detecting Glaucoma disease starts by selecting the eye image and then eye image is given as input to the

system and then after processing image on an algorithm we get result whether the eye is infected by Glaucoma or not. The proposed system can be used by the doctor, lab assistant or any other person who can handle the computerized system because this system is very much user- friendly.

We have used 100 images for training the algorithm and 100 images for testing. Out of 100 images taken for testing, we have 50 images with a normal eye and 50 images that are infected by Glaucoma.

After testing all images we obtained result (Confusion Matrix) as given below:

	Predicted as Normal Image	Predicted as Infected by Glaucoma	Total
Normal Images	TN=48	FP= 2	50
Glaucoma Images	FN=1	TP=49	50
	49	51	100

Figure 3: Confusion Matrix

TN=True Negative FP=False Positive FN=False Negative TP=True Positive

Precision= TP/ (TP+FP) = 49/ (49+2) = 0.9607

Recall=TP/ (TP+FN) = 49/ (49+1) = 0.98

Accuracy=97%

3.1 IMAGE WITH GLAUCOMA

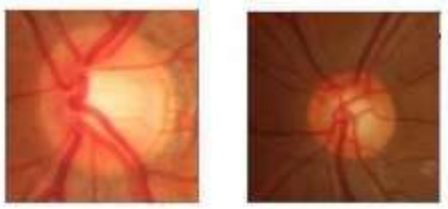

Figure 4: Output image of Glaucoma detected eye

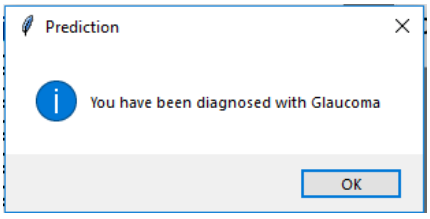

Figure 5: Detection of Glaucoma

3.2 IMAGE WITHOUT GLAUCOMA

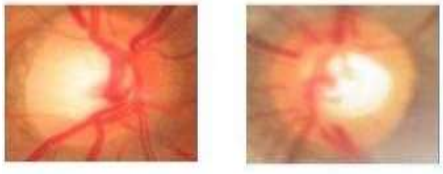

Figure 6: Output image of Healthy eye

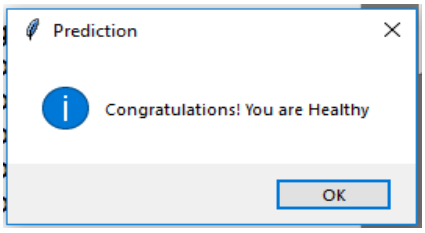

Figure 7: Absence of Glaucoma

4. CONCLUSION

In this paper, we have designed and implemented the project using Convolutional Neural Network. Our system will provide a better solution for detecting Glaucoma in the earlier phase in less time which will save the vision of many people. To implement this project we have used the Region of Interest (ROI) to take the only region of the image in which Glaucoma can be detected, also we have used Gaussian blur to remove noise from image and then preprocessed image is given to CNN. Our system gave 0.9607 and 0.98 value of precision and recall respectively. In future, we will try to increase Accuracy of our project by using different technologies.

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