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A Glaucoma Detection using Deep Learning Technique

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Abstract- Glaucoma is a disease that relates to the vision of human eye. This disease is considered as the irreversible disease that results into the vision deterioration. Many deep learning (DL) models have been developed for the proper detection of glaucoma so far. SO here we have presented an architecture for the proper glaucoma detection based on the deep learning with making use of the convolutional neural network (CNN). The differentiation between the patterns formed for the glaucoma and the non glaucoma can be finding out with the use of the CNN. The CNN provides a hierarchical structure of the images for differentiation. Proposed work can be evaluated with total six layers. Here we also used the dropout mechanism for the effective performance in the glaucoma detection. The datasets used for the experiments are the SCES and the ORIGA. The experiment is performed for both the dataset and the obtained values are .822 and .882 for the ORIGA and SCES dataset respectively.

Keywords- Glaucoma Detection, Deep Learning, Convolutional Neural Network, Glaucoma Prediction.

I. INTRODUCTION

Glaucoma is one of the critical diseases that may lead to the blind vision of the person. Glaucoma is one of the cases in which the optic nerve of the eye gets effected and this is the main reason for the vision loss.The first operation of glaucoma of human was done in 1856 by Graefe [1]. The whole population that are dealing with the problem of glaucoma may loss their vision without proper treatment and the care for that. The specialist in the eye care can fine the patients who suffers from this disease [1]. The glaucoma internally contains various diseases that having the similar characteristics. There are many works done in this field for the early detection of this disease. The system used various Deep learning

algorithms for proper detection. As stated, that the early detection can prevent the blindness in human being and the vision can be saved. SO, the proper detecting model is required for the detection of this disease. There are many attempts taken for developing such system, we also here presented an approach to detect the glaucoma pattern in the patients. The presented system will make the use of

1. Glaucoma Detection

Glaucoma is aa affection in human eye that may cause permanent blindness in the human eye. This situation is seen as the complex to deal with, so the proper detection is must. This problem if detected at early stage then it may be improved else it may lead to loss of vision. As per the earlier evaluation a single checkup can not find the symptoms of glaucoma. The regular eye check up may gives the symptoms of glaucoma and the further treatment and check up may be suggested. The eye specialist checks five times at least for the confirmation of this disease in human eye. Following are some health diagnosis that is analyzed fir the confirmation of the glaucoma.

1.1 Tonometry- It determines pressure within eye of a patient.

1.2 Optical Coherence Tomography: This scan is very important for diagnosis of glaucoma. It is used to find important sign of early glaucoma damage that is retinal nerve fibre layers around optic nerve.

1.3 Ophthalmoscopy: Optic nerve is examined in this test. As glaucoma is severe disease related to optic nerve, so this is a very important test. Eye drops are used to enlarge the size of pupil of patient's

eye to look optic nerve more clearly to find signs of disease related nerve cell loss in eye.

2 **Perimetry:** Glaucoma is a disease which causes peripheral vision loss at initial stage. Therefore, this test is done to detect vision loss. This test is also called as a visual field test. It includes testing each eye distinctly with an automatic device that flashes lights in the periphery of eye of person.

3 **Gonioscopy:** It s the test related to intraocular fluid outflow drainage angle. Fluid is constantly being prepared in eye & then it flows out at fixed angles. This test is done to find that whether the high eye pressure is caused by a blocked angle that is known as angle closure glaucoma or if angle is open but not working properly then it is known to be as open angle glaucoma.

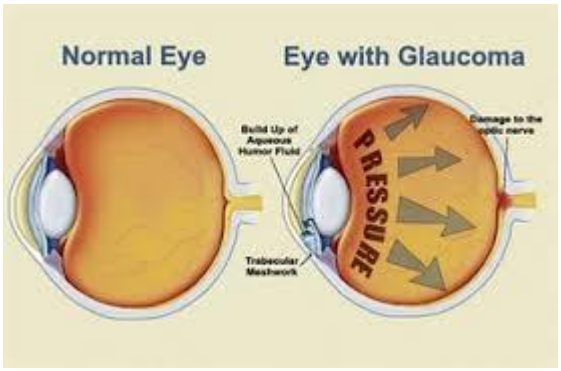

Figure 1. Image for the glaucoma infected eye.[1]

II. LITERATURE REVIEW

Rashmi Panda et.al [2] put forward a automated model for Retinal nerve fiber layer defect detection. As it is an early proof of glaucoma condition in fundus images. Early detection & prevention are the ways to stop loss of vision. New method performs detection in fundus images using patch characteristics driven RNN. Fundus images dataset is used for purpose of evaluating performance. High RNFLD detection and accurate boundary localization is obtained by this system.

Kavita Choudhary et. al [3] presented a paper with the aim of detection of glaucoma at early stages using cross validation algorithm. Authors analysed symptoms prevailing in persons & computed & generalized those symptoms to reach to conclusive evidence. It was found that measures such as blood pressure, Age, Sugar level, & myopia were combined for various datasets are related with chances of person suffering from glaucoma. Authors in their study have done analysis of glaucoma disease by Classification methodsuch as cross validation algorithm & split validation algorithm. Outcome reveals that patients which have high blood pressure, high sugar level, myopia & with the family history of this disease can suffer from glaucoma. It is also observed that the patients with age more than 50 have higher chances of glaucoma.

Seong Jae Kim et. al [4] in this paper studied and made an attempt to design machine learning models that have robust power of predicting& interpretability for glaucoma diagnosis on basis of RNFL thickness & visual field. Different features were collected after examination of RNFL thickness & visual field. Authors used 4 machine learning algorithms like C5.0, random forest, SVM & K-nearest neighbor to design glaucoma prediction model. Learning models are constructed using training dataset & their performance was evaluated by using validation data set. Finally, authors observed that random forest model gives best performance & remaining other models show similar accuracy.

Shwetha C. Shetty et. al[5] disused and analyzed that Glaucoma is an ocular disorder and its identification includes measuring the shapes and also the optic cup sizes. Pre-processing of data is then clustered using K-means clustering which is used for segmenting the optic curves. It is again executed to find its various dimension. Since fractional dimension is used to determining the various dimension of non regular identities, authors presented a new method for detection of glaucoma using method of perimeter for the fractional analysis. Outcome reveals,the new approach is accurate in detecting glaucoma.

Liu li et. al [6] in this paper presented an attention based convolutional neural network for detecting glaucoma, known as AGCNN. Approaches which were proposed in past for automatic detection system based on fundus images are insufficient to remove high redundancy, which may lead to reduced reliability & accuracy of detection. To overcome this shortcomings, new proposed method establishes a large-scale data set, which includes fundus images labelled as (+) ve or (–) ve. The attention maps of some images are taken from ophthalmologists through a simulated experiment. Then a new AG-

CNN structure is constructed which includes a sub net, a pathological area localization sub net and a glaucoma classification sub net. Experiment on LAG database& other available datasets reveals that the proposed method gives a detection performance superior than previous models.

Jin Mo Ahn et. al [7] here they have presented a method for the detection of the glaucoma disease which utilizes fundus photography and uses the deep learning. Author discussed that advanced & early glaucoma both can be correctly identified using machine learning along with fundus images. Dataset of 1,542 images was used and divided into training, validation & test datasets. Newly put forward model that is trained using CNN is more effective and accuratein detection of early glaucoma.

Annan Li et. al [8] suggest that automatic detection of disease is important for retinal image analysis. When studied and compared with segmentation-based approaches it is found that image classification-based approaches perform better. But challenges are always there due to improper sample, effective features and also shape variations of optic disc. Toovercome these, a new classification-based model fordetection of glaucoma is put forward by authors in these papers, in which deep convolutionalnetworks is usedto represent visual appearance, holistic & local characteristics are combined to reduce or remove misalignment.

Ali Serener et. al [9] discussed about Open angle glaucoma as it is one of basic kind of disease & slowly a person tends to lose his sight. Diagnosis of this disease manually by experts is possible but it either takes a huge time or costly. Authors in this paper presented a method for detection of both early & advanced glaucoma automatically. 'ResNet-50' & 'GoogLeNet' deep CNN algorithms are trained & tuned using transfer learning. It is found that 'GoogLeNet' model is better than 'ResNet-50' for detecting of both early & advanced glaucoma in eye of patient.

Ramin Daneshvar et. al [10] analysed that baseline OCT measures predict VF progression in patients with suspicious or established glaucoma & also authors compared performance with semi quantitative optic disc measures.It is observed that baseline pRNFL & macular OCT parameters can be used for checking risk of glaucoma progression in future. People abnormal OCT findings require better care to prevent progression of functional damage.

Guangzhou An et. al [11] presented a model for the detection of the glaucoma within the patients by making the use of the open angle for the glaucoma that is based on the 3-D data color images. The CNN architecture is provided by various fundus pictures as input. After getting output form every CNN model the outputs have been combined. And we used random forest method for the classification of the fundus pictures. This classification is done with the healthy and glaucoma infected eyes. At the end result obtained for the AUC is of .96.

Juan Carrillo et. al [12] The authors have provided the glaucoma detection method as the glaucoma is the irreversible cure of eyes. They have provided a too for computing the glaucoma symptoms in eyes. They have used this tool for the detection and the detection is observed by the sizes of the cup and the disc. Also, they have used the fundus images for the evaluation.

Tehmina Khalil et al [13] have presented an overview of the glaucoma detection and they have stated that the most of the detection schemes for glaucoma uses the fundus images. They stated that the detection of the glaucoma can be done in an efficient manner by making the use of the Optical Coherance Tomography. By using the OCT, the detection can be done at early stage is concluded by them.

Namita Sengar et al [14] have stated that the image processing for the glaucoma detection can be done by using the fundus images. They have presented a deciding parameter for the detection of the glaucoma. The work proposed by them performed wel and an accuracy of 93.57% has been achieved by their presented mechanism.

III. PROPOSED APPROACH

The presented approach works in six layers. The four layers are the convolutional layers and the last two layers are connected fully. The output obtained from the very last layer is given to the classifier for the detection of the glaucoma disease.

Convolutional layers: This are used as the feature learners at small scale that are taken in random manner from any image. Any feature that is present

in the image at any point of location will be calculated by using it with the detector that detects the features and the image that is present at that location itself. Response Normalization layer: This layer works in following with the 1st and 2nd layer of convolution in the presented architecture. For a neural network to calculate the output f(x)= tanh(x), here x is the input. Overlapped pooling layers: This layer for the CNN architecture gets the overall statistics for a particular region inside the given image. Here we have used the max pooling layer.

CNN based classification for glaucoma

3.1 Region of Interest (ROI) Extraction:

Here in our presented CNNto get input we will use the ROI of the image that forms a short image as an input. The ROI provided will take very small time for the processing in comparison with the disc or cup. To get the proper ROI will make the execution very faster and the detection of the glaucoma will be much faster and the performance will be improved. We used here the ARGALI approach in which they divided the image of fundus in to grids and the ROI will be detected where the optic nerve is detected as per the same of any user or patient. So here we will use this algorithm for the ROI detection.

In ARGALI method the used preprocessing for the removal of the bright fringe, which will help in getting the center for the trimming circle and the radius of the trim. The obtained ROI will be fix to 256*256 resolution. At the end for all the pixels of disc image the mean value is subtracted from the ever y pixel for the removal of the illumination in the images.

3.2 Dropout and Data Augmentation

Dropout: We have implemented dropout in two stages of the fully connected layers as presented in our approach. The Dropout will set 0 for every value of neuron which is having value of .5. When the dropping of the neurons is done in the CNN then they will not take part in the passing forward and will not be a part of the back propagation. While performing the experiment the multiplication for all the outputs of the neurons by .5 is done.

Data Augmentation: The over fitting suffering will be seen if the data augmentation is not done in the model. DA will generate translations for the images and the reflections that are horizontal. For the training period 224*224 patch is done for random values with the inclusion of the 256* 256 images, and train the network for this patches that are extracted. In testing five 224*224 patches are obtained from CNN which include four corner and one centre. The horizontal reflections are also obtained for these five patches. The average of this predictions that is given by the network soft max layer for these 10 patches is taken.

IV. EXPERIMENTS PERFORMED

We experimented our model of two datasets that are ORIGA and SCES which is having the images of glaucoma fundus.

1. Criteria for the Evaluation

The area under curve () AUC is utilized of the receiver operation characteristics (ROC) curve for the evaluation of the glaucoma detecting performance of the model. The curve between the sensitive TPR and the specificity TNR is plotted as the ROC and is defined as:

$$TPR = \frac{TP}{TP + FN}, \quad TNR = \frac{TN}{TN + FP}$$

2. Setup for the Experiment:

The ORIGA dataset consists of clinical glaucoma diagnoses, and having 168 glaucoma and 482 images of normal fundus. The dataset of the SCES is having 46 images for glaucoma and 1676 images for the fundus.

V. RESULT EVALUATION

For the validation of our proposed approach using the CNN for the detection of the glaucoma accuracy, we compared the given modelto the state-of-the-art reconstruction-based method. The training dataset we provided will consists 90 images out of 600 images and the left image are used in the testing of the results. And in the SCES dataset the same training set as of ORIGA is used and the and the overall images in SCES is used for the testing. The obtained AUC for the proposed method is .0822 for the ORIGA dataset and for the SCES it is having the value of .882. and for the comparison that we used the state-of-the-art mechanism give the value of the AUC as .809 for ORIGA and .859 for the SCES dataset.

Table1. The values of AUC for proposed and earlier methods.

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Dataset used	State of Art Method	Proposed CNN method
ORIGA Dataset	.809	.822
SCES Dataset	.859	.882

The graphical representation is shown below for the obtained values of the AUC:

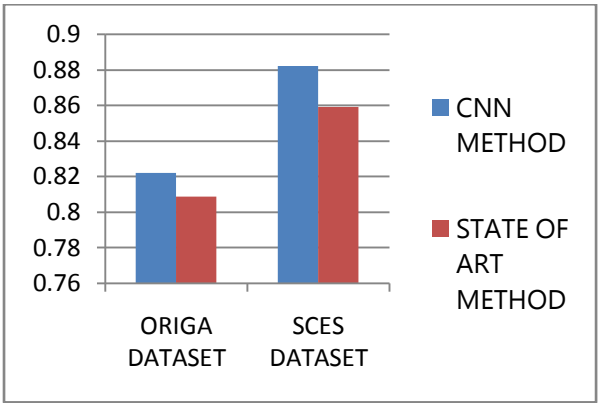

Figure 2. Graph for the Obtained Values.

The results are providing satisfaction in the results obtained. The detection capability of the proposed system seems higher than other methods.

VI. CONCLUSION

The glaucoma is one of the major concerns for the human eye. The vision of the eye can be lost is the glaucoma symptoms are seen in human eye. The glaucoma is a major defect that may result in blindness if pre stage detection is not done. So, to detect this disease we have proposed a mechanism that uses the deep learning CNN for the analysis. The proposed mechanism is based on the six-layer architecture and the CNN will classify the patterns observed for the glaucoma detection in the patient's eye images. The dataset we used here are two datasets that are ORIGA and the SCES dataset. The proposed method worked very well and the results obtained are satisfactory. The AUC values are carried out from our experiment. The values are obtained for both the datasets and compared with the existing state of the art algorithm. The obtained value is .882 and .822 for the SCES and the ORIGA dataset respectively. The proposed method can be used for the glaucoma detection.

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