Identification of Glaucoma Using Convolutional Neural Network

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Abstract -*Glaucoma is a chronic eye disease that damages the eyes optic nerve. The eye produces a fluid called aqueous humor which is secreted by the ciliary body. It is a condition in which the fluid pressure within the eye rises, if left untreated the patient may loss vision or even become blind. Glaucoma cannot be cured but you can keep the condition under control. It is an inherited disorder which affects the people over fourth years of age. In this paper, we have extracted the features from the retinal fundus images using convolutional neural network (CNN). The neuro retinal rim usually follows the normal pattern called ISNT rule where inferior is broader than the superior broader than the nasal broader than the temporal. The alteration of this pattern is a sign of glaucoma. Another non-invasive technique is to calculate the CDR ratio (cup to disc) both horizontally and vertically via optic disc and cup segmentation. This novel technique is implemented on large data set with the accuracy, sensitivity, specificity.*

Key Words: Glaucoma, Cup to Disc Ratio (CDR), ISNT, Fundus Images.

1.INTRODUCTION

Glaucoma is an eye disease of the major nerve of a vision, called the optic nerve and it is often associated with elevated intraocular pressure, in which damage to optic nerve is continuous over a long period of time and leads to loss of vision. Glaucoma is a disease of the eye in which fluid pressure within the eye rises if left unprocessed the patient may lose eyesight, and even grow into blind. The disease generally influences both eyes, although one may have more severe signs and symptoms than the other.

Glaucoma cannot be cured, but its development can be slowed down by medicament. Therefore, detecting glaucoma in time is critical to preserve the vision. Since glaucoma continue with few signs or symptoms and the vision loss from glaucoma is irreversible, screening of people at high risk for the disease is vital. There are two types of glaucoma

(i) **Open-angle glaucoma:** The approach to the eye's drainage canals are clear, but a blockage develops within the canal, trapping fluid and causing an increase in pressure in the eye. Eyesight loss is usually slow and gradual

(ii) **Angle-closure glaucoma:** The entrance to the canal is either too narrow or is closed completely. pressure can rise very quickly. The known tests to detect Glaucoma are Tonometry (inner eye pressure), Ophthalmoscopy (shape and color of the optic nerve) & Perimetry (complete field of eyesight).

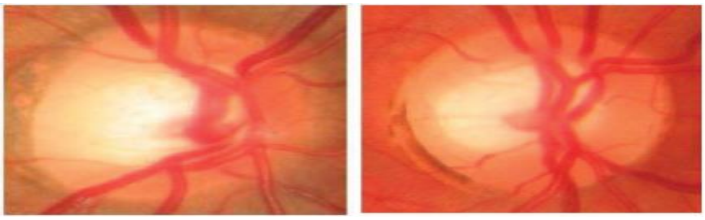


Fig-1: L to R: Normal Disc (CDR<0.5), Glaucoma tic Disc (CDR>0.5)

1.1 RETINAL IMAGE DATABASE

RGB retinal fundus images are acquired from different sources. Experiments were performed on 20 fundus images having variable size but all were in RGB color space. Websites for data sets indication that images were taken using fundus camera and fixed light conditions.

1.2 PROPOSED METHODOLOGY

To discover glaucoma, extractions of two features are involved by Mean Threshold Morphological method in order to compute CDR and NRR ratio in ISNT quadrants. Optic disc and cup are involved for CDR assessment and to find NRR ratio NRR itself is required.

A. Image Preprocessing After performing the top-hat transformation, the aim is to extract the micro calcification cluster part. For that segmentation algorithm is applied on the image.

B. Extraction of Optic Disc and Cup

Analysis of CDR is primary thing for glaucoma discovering, which is computed by extracting optic cup and optic disc. From native image green plane is fetching for extraction of optic cup and then converted to gray scale image. Optic cup having the brighter contrast with esteem to others in image, the gray scale image is then converted to binary image.

Threshold value for the extraction of cup varies because there is gradual change in cup color by which boundary of cup is not much clear. Therefore, mean of this image is computed using software and on the basis of this mean a threshold value for linearization is explained. This mean value was around 0.4 to 0.57 for most images in our case. Due to presence of blood vessels there are gaps in image, these gaps are filled by morphological operations such as dilation and then erosion is applied with same structuring element on image. The area of optic cup is computed by counting no of white pixels. Now for optic disc Value plane is fetched from HSV image. The V plane is then transformed to gray scale image. After that find mean value of gray scale image and then change it to binary image. By setting threshold to 1500 unwanted objects are detach except optic disc in the resultant image. The area of cup is now divided by area of disc to find CDR. Edges of both optic disc and optic cup in resultant image are found by applying canny filter.

CDR Calculation

The area is calculated by counting the number of white pixels after that, the area of cup is divided by the area of disc to calculate CDR.

$$CDR = \frac{Cup\ Area}{Disk\ Area}$$

Coextractions of Neuroretina Rim

Another feature to detect glaucoma is extraction of NRR. Ratio of area covered by inferior to superior is thinner as compared to ratio of area covered by nasal to temporal region in glaucoma. The optic disc and optic cup are already extracted now in order to extract NRR AND operation is applied on both resultant images of cup and disc. On extracted NRR image a mask of size 256x256 is applied to measure the ratio of area covered by neuroretina rim in ISNT quadrants. Mask is rotated 90 degrees each time to determine ratio separately in ISNT quadrants. Fig.5 shows the mask and its rotated versions. Finally, for ISNT ratio area covered by white pixels are counted.

D. Classification

Classification of glaucoma has been done using the above mentioned two fetched features. Retinal fundus image with presence of glaucoma have CDR greater than 0.5 and it also violates the ISNT regulation. For normal healthy retinal fundus image has CDR less than 0.5 and obeys the above declared ISNT rule. If there is negation between both features then disc is considered to be alleged.

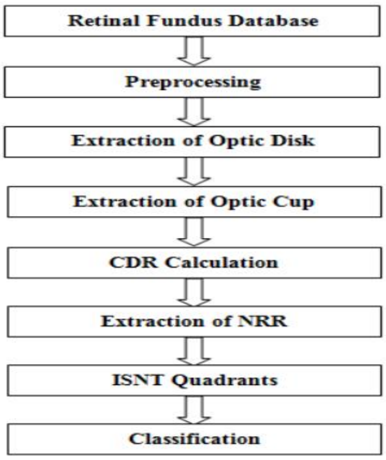


Fig-2: Flowchart

2. EXPERIMENTAL RESULTS

Neural Network Algorithm:

Backpropagation is a common method of training artificial neural networks used in conjunction with an optimization method such as gradient descent. It is a generalization of the delta rule to multi-layered feed forward networks. The method calculates the gradient of a loss function with respects to all the eights in the network. A loss function or cost function is a function that maps an event or values of one or more variables on to a real number intuitively representing some "cost" associated with the event. The gradient is fed to the optimization method which in turn uses it to update the weights, in an attempt to minimize the loss function.

Step 1: -Weight Initialization1--- Set all weights and Node threshold to some mall random values.

Step 2: - Calculation of activation: **-**

1. Input Unit: The Activation Level of the input unit is determined by the instances presented to the Network.

2.Hidden unit and Output unit: The Activation Level OJ of Hidden unit and Output Unit are determined by:

OJ = F [∑ w ji*Oi – θ j]

Where **w ji -** weight from input Oi to unit j,

θ j - Node threshold at unit j

F - Activation Function.

Step 3: - Weight Training:

a. Start at output unit and work backward to the hidden layer recursively adjust the weight by

$$w_{ji}(t+1) = w_{ji}(t) + \Delta w_{ji}$$

b. The weight change is computed by

$$\Delta w_{ji} = \eta \delta_j O_i$$

Where η = learning rate,

δ_j = error gradient

The error gradient is given as follows at Output Unit

$$\Delta_j = O_j (1 - O_j)(k_j - O_j)$$

And for Hidden Unit

$$\Delta_j = O_j (1 - O_j) \sum \delta_k w_{kj}$$

Where **T j** = Target Value,

O j = Actual Output Value,

Δ k = Error Gradient at unit k to which a connection point at unit j.

Step 4: - Repeat Iterations until convergence.

We determined the accuracy of the inferior > superior > nasal > temporal (ISNT) neuroretina rim area rule and its variants in adult Asian populations, and evaluated whether disc area impacts its performance characteristics..

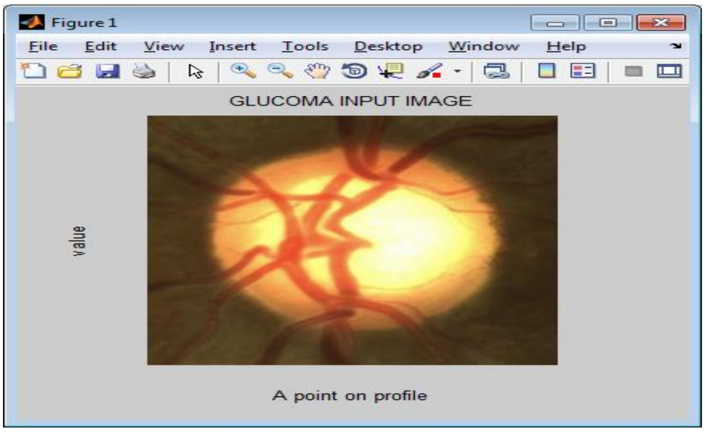


Fig-3: Input Image

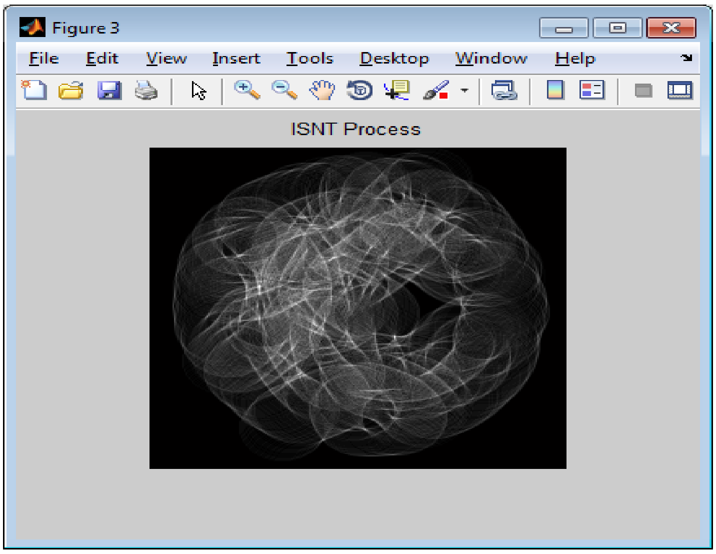
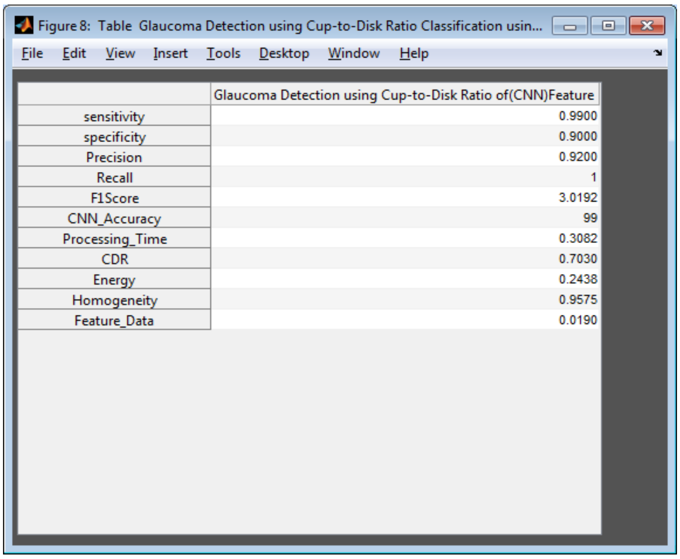


Fig- 4: ISNT Process



	Glaucoma Detection using Cup-to-Disk Ratio of(CNN)Feature
sensitivity	0.9900
specificity	0.9000
Precision	0.9200
Recall	1
F1Score	3.0192
CNN_Accuracy	99
Processing_Time	0.3082
CDR	0.7030
Energy	0.2438
Homogeneity	0.9575
Feature_Data	0.0190

Fig-5: Result

3. CONCLUSIONS

This project is implemented using GLCM Based CNN classification based optic disc and cup segmentations for glaucoma screening. This project is executed and assessed for Glaucoma observation in patients using multimodalities including simple linear iterative clustering (SLIC) algorithm, K-Means clustering, and Gabor wavelet transformation of the color fundus camera image to obtain accurate boundary delineation. Using structural features like GLCM the ratio value exceeds 0.3 shall be recommended for further analysis of a patient to the ophthalmologist. This shall help in patients worldwide by secured further vision deterioration through timely medical intervention. The accuracy of the proposed method is much better than the IOP measurement, abnormal visual field and previous GLCM based CNN Classification methods Glaucoma detection.

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