Simulation of Novel Technique for Glaucoma Detection using Retinal Fundus Images

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Abstract— Glaucoma is a progressive eye disease and is called “Silent Theif of Sight”. Currently, glaucoma assessment is manually performed by trained ophthalmologists limiting its potential for population based glaucoma screening. Thus there is a need for an efficient automatic glaucoma assessment technique. In this paper we propose a novel technique for the detection of glaucoma using retinal fundus images which mainly affects the optic disc by increasing the cup size. The simulation is done using MATLAB tool.

Key words: AWGN, DVB-T, OFDM, PAPR, QAM, Rayleigh, Rician, SNR

I. INTRODUCTION

The recent rapid advances in medical imaging and automated image analysis allow us to make significant advances in our understanding of life and disease processes, and our ability to deliver quality healthcare. Fundus eye image processing is now a core field of research for diagnosis of various eye disorders. Glaucoma assessment is one of the applications of fundus image processing. Glaucoma is a chronic and irreversible neurodegenerative disease in which the nerve that connects the eye to the brain is progressively damaged. Progression of the disease leads to loss of vision, which occurs gradually over a long period of time[1]. Unawareness about the disease until it reaches the advanced stage is a major problem as it cannot be cured. According to World Health Organization, glaucoma is the leading cause of blindness that contributes to approximately 5.2 million cases of blindness and will increase to 11.2 million people by 2020[2] . So detecting the disease in time is critical and population based glaucoma assessment is very relevant to save the vision of millions. Glaucoma assessment performed by trained ophthalmologists limits its potential for population based glaucoma screening. There comes the need for an efficient automatic glaucoma assessment technique. The main ocular indicators of glaucoma are Optic CDR, RDR, ISNT rule, ISNT ratio, PPA, Notching etc. There are some nonocular factors like age, race, family history etc which determine the risk of glaucoma. Research is being done to fully automate the glaucoma assessment. The digital fundus image of a normal eyes and glaucomatic eyes are illustrated in Fig. 1.

Fig. 1: shows the digital fundus image of a normal eyes and glaucomatic eyes. L to R: Normal Disc (CDR<0.5), Glaucoma tic Disc (CDR>0.5)

II. LITERATURE REVIEW

J Cheng et al, (2013) [2] proposed a superpixel classification based disc and cup segmentations for glaucoma screening. C.B. Anusorn et al, (2013) [3] proposed a method to calculate the CDR automatically from fundus images. To automatically extract the disc, two methods making use of edge detection and variational level set are proposed and cup segmentation is evaluated using color component analysis and threshold level set method. K. Narasimhan et al, (2012) [4] proposed a semi automated method for glaucoma detection using CDR and ISNT ratio of a fundus image. O.Sheeba et.al (2014)[5] proposed automatic detection using artificial neural network. In the proposed method neural network is trained to recognize the parameters for the detection of different stages of the disease. The neuron model has been developed using feed forward back propagation network.

As the cup size increases it also influences the Neuroretinal Rim (NRR). NRR is the region located between the edge of the optic disc and the optic cup. In the presence of glaucoma, area ratio covered by NRR in nasal and temporal region becomes thick as compared to area covered by NRR in inferior and superior region [6].

Many studies have been performed to ameliorate computer based decision support algorithms for early detection of glaucoma through extraction of optic cup and disc to determine CDR. A method for ONH segmentation and its verification, based on morphological operations, Hough transform, and an anchored active contour model is proposed in [7]. A new approach to automatically segment the optic disc and exudates is suggested in [8].

The techniques include use of the green component of the image followed by preprocessing and then morphological opening, minima imposition, extended maxima operator, and watershed transformation. Extraction of optic disc automatically through region of interest (ROI) and component analysis method for cup detection is proposed in [9].

Morphological techniques to extract optic disc and cup to figure out pathological process of glaucoma are used in [10]. The proposed method was applied on 61 images with a specificity of 80% and sensitivity of 100% was achieved. 95% accuracy has been achieved by implementing K-means clustering to extract the optic disc and optic cup region in [11] Hill Climbing Algorithm was used for the extraction of optic disc whereas Fuzzy C-Mean clustering for optic Cup extraction in [12] with accuracy of 90%. OpenCV programming tools for Classification of glaucoma are proposed in [13]. The novel approach used K-Means Clustering for the extraction of optic disc and cup with Sensitivity of 90%.

III. Proposed Work

In this work we have proposed performance analysis of simulation of glaucoma detection using fundus images. The novel method uses Morphological techniques to extractions of two features in order to calculate CDR and NRR ratio in ISNT quadrants. Optic disc and cup is required for CDR evaluation and to find NRR ratio NRR itself is required. The developed methods were tested on three different databases.

A. Image Preprocessing

In this step the green plane is extracted from original image for extraction of optic cup, which provides enhanced contrast for optic cup. The original image is then converted to HSV plane. After analysis of a number of images, it has been concluded that optic disc has a better contrast in V plane extract from HSV image.

B. Optic Disc and Cup Extraction

In this step Evaluation of CDR is calculated by extracting optic cup and optic disc. Green plane is extracted from original image for extraction of optic cup and then converted to gray scale image. Optic cup having the brighter contrast with respect 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 transition in cup color by which boundary of cup is not much clear. Therefore, mean of this image is calculated using software and on the basis of this mean a threshold value for linearization is defined. This mean value was around 0.4 to 0.57 for majority 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. Boundaries of optic cup in resultant image are then smoothen with help of Gaussian filter. The area of optic cup is calculated by counting no of white pixels. Now for optic disc Value plane is extracted from HSV image. The V plane is then converted to gray scale image. After that find mean value of gray scale image and then convert it to binary image. By setting threshold to 1500 unwanted objects are removed except optic disc in the resultant image. Now the resultant image is subjected to Gaussian filtering for smoothing the boundaries of image. Edges of both optic disc and optic cup in resultant image are found by applying canny filter.

$$CDR = \left(\frac{CA}{DA}\right) \times 2 \qquad (1)$$

CA means Cup area and DA means Disc area

C. Neuroretinal Rim Extraction

Neuroretinal Rim extraction is one of the feature to detect glaucoma. Ratio of area covered by inferior to superior is thinner as compared to ratio of area covered by nasal to temporal region in glaucoma. In order to extract NRR, AND operation is applied on both resultant images of cup and disc. A mask of size 256x256 is applied on extracted NRR image to measure the ratio of area covered by neuroretinal rim in ISNT quadrants and Mask is rotated 90 degrees each time to determine ratio separately in ISNT quadrants. Fig.7 shows the mask and its rotated versions. Finally for ISNT ratio area covered by white pixels are counted.

D. Classification

In this step Glaucoma Classification has been done with above mentioned two extracted features. CDR is greater than 0.5 in Retinal fundus image with presence of glaucoma and it also violates the ISNT rules. CDR is less than 0.5 for normal healthy retinal fundus image and obeys the above mentioned ISNT rule. If there is contradiction between both features then disc is considered to be alleged.

IV. Results & Discussions

The inputs are collected from different sources. Images used in the simulation are the standard retinal fundus images which are popular with the image processing community. The fundus eye image represents the interior surface of the eye and is used as the input for processing. A sample input image is shown in Fig 2. The fundus image processing involves preprocessing and feature extraction. The four feature extraction processes are optic disc segmentation, optic cup segmentation, optic rim segmentation and blood vessel extraction.

Fig. 2: Shows Input Image

The RGB retinal fundus images are obtained from different sources including DMED dataset, FAU data library and MESSIDOR data set. Four color retinal fundus images are considered for performing simulation using MATLAB. All classification results could have a misclassification rate and on any occasion can either generate false result to identify an abnormality, or it may also classify an abnormality which is not present.

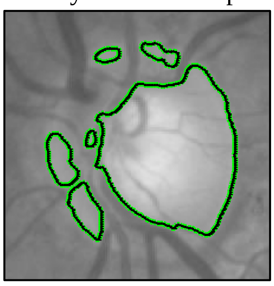

Fig. 3: Shows 400 iterations

Fig. 4: Shows contour image

- Top: Marks-(a) Superior (b) Temporal (c) Inferior (d) Nasal
- Bottom: ISNT marks multiplied with NRR

Usually misclassification rate is described by the correct and false positive and correct and false negative parameters as follows:

$$Accuracy = \left(\frac{Cp + Cn}{Cp + Cn + Fp + Fn}\right) X\ 100 \qquad (2)$$

Here Cp represents True Positive, Cn represents True Negative, Fp represents False Positive and Fn represents False Negative.

The effectiveness of proposed system is computed by comparing the results with provisional diagnosis by Ophthalmologist.

Fig. 5: Shows image with extracted pixels

Fig. 6: Shows Compliment of detected cup.

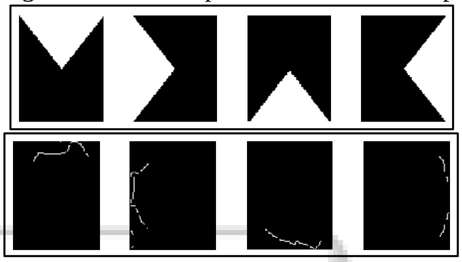

Fig. 7: Shows ISNT Quadrants

The comparison has been made with conventional method and proposed method for glaucoma identification system in Table I and shown graphically in Fig.8. The existing model shows lower accuracy rate in than our proposed technique for classification purpose. Fig.8 shows the comparison between proposed method and existing method.

	Classifier Type	True Positive	False Positive	Accuracy
Case I	Proposed Method	316	219	100
Case I	Existing Method	292	270	95.6
Case II	Proposed Method	380	214	101
Case II	Existing Method	355	204	95.2

Table 1: Performance Evaluation Result

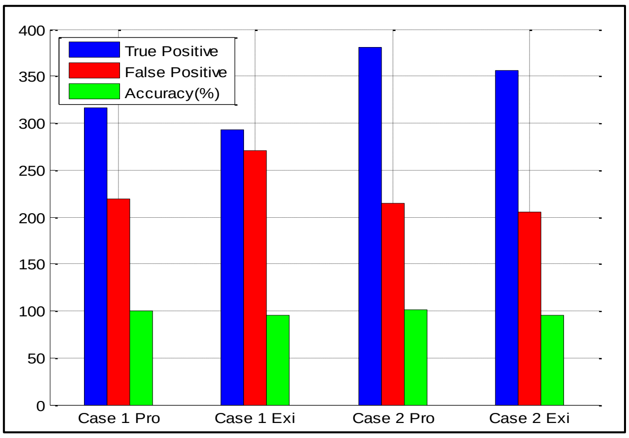

Fig. 8: Performance Evaluation Chart

V. CONCLUSION

In this paper, we have simulated a novel technique to identify glaucoma. Four color retinal fundus images are considered for performing simulation using MATLAB. The accuracy achieved by proposed method is 99.7%.

REFERENCES

[1] Guyton and Hall "Textbook of Medical Physiology".
[2] J. Cheng, J. Liu, Y. Xu, F. Yin, D.W. K. Wong,N. M. Tan, D. Tao, C.Y. Cheng, T. Aung, and T. Y. Wong, "Superpixel Classification Based Optic Disc and Optic Cup Segmentation for Glaucoma Screening," IEEE Transactions on Medical Imaging., vol.32, no. 6, pp.1019-1032, June. 2013.
[3] C. B.Anusorn, W. Kongprawechnon, T.Kondo, S. Sintuwong and K. Tungpimolrut, "Image Processing Techniques for Glaucoma Detection Using the Cup to Disc Ratio," Thammasat International Journal of Science and Technology. , vol.18, no.1, pp.22-33,Jan-March. 2013.
[4] K. Narasimhan , K. Vijayarekha, K. A. JogiNarayana, P. SivaPrasad and V. SathishKumar, "Glaucoma Detection From Fundus Image Using Opencv," Research Journal of Applied Sciences, Engg & Technology, pp. 5459- 5463, Dec. 2012.
[5] O.Sheeba, J.George, P.K.Rajin, T.Nisha, G.Sherin "Glaucoma Detection using Artificial Neural Network" IACSIT International Journal of Engineering and Technology, vol.6,no.2, April 2014
[6] S.Kavitha, S.Karthikeyan, Dr.K.Duraiswamy "Neuroretinal Rim Quantification in retinal images to detect glaucoma" IJCSNS, Vol 10, No.6, June 2010,
[7] R.Chrastek a, M. Wolf a, K. Donath, "Automated segmentation of the optic nerve head for diagnosis of glaucoma", Journal of Medical Image Analysis in Elsevier, Functional Imaging and Modeling of the Heart, August 2005, pp 297-314.
[8] Ahmed Wasif Reza & C. Eswaran & Subhas Hati, "Automatic Tracing of Optic Disc and Exudates from Color Fundus Images Using Fixed and Variable Thresholds", Journal of Medical Systems, Feb 2009, pp 73 -80.
[9] S.Kavitha, S.Karthikeyan, Dr.K.Duraiswamy, "Early Detection of Glaucoma in Retinal Images Using Cup to Disc Ratio", IEEE Second International conference on Computing, Communication and Networking Technologies, 2010, pp 1-5.
[10] J. Nayak & R. Acharya U, P. S. Bhat, N.Shetty, T-C. Lim, "Automated Diagnosis of Glaucoma Using Digital Fundus images", vol33, pp. 337–346, July 2008.
[11] K. Narasimhan, Dr. K.Vijayarekha, "An efficient automated system for glaucoma detection using fundus image", Journal of theoretical and applied information technology, vol. 33 no.1. 15th November 2011.
[12] T. R. Ganesh Babu, S. Shenbagadevi, "Automatic Detection of Glaucoma Using Fundus Image", European Journal of Scientific Research ISSN 1450-216X Vol.59 No.1 2011, pp.22-32.
[13] K. Narasimhan,K. Vijayarekha, K. A. JogiNarayana, P.SivaPrasad and V.Satish Kumar,"Glaucoma Detection From Fundus Image Using Opencv" ,Research Journal

of Applied Sciences, Engineering and Technology 2012.
[14] A. Aquino, M. E. G. Arias and D. Marin "Detecting the Optic Disc Boundary in Digital Fundus Images Using Morphological, Edge Detection, and Feature Extraction Techniques" IEEE Transactions On Medical Imaging, pp.0-8 2010.