ISSN (ONLINE) : 2395-695X
ISSN (PRINT) : 2395-695X
Available online at www.ijarbest.com

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 6, September 2015

Screening Glaucoma – A Survey

J.Maria Jeya Sujitha[1], R.Chinnakanan Ajith[2], B.Aarathy[3]

PG Scholar, Department of Computer science and engineering, VV College of Engineering, India[1]

PG Scholar, Department of Computer science and engineering, VV College of Engineering, India[2]

Assistant professor, Department of Computer science and engineering, VV College of Engineering, India[3]

***Abstract*—Glaucoma is a silent theft of sight. It is a neurodegenerative disease and is considered as one of the most common reasons of blindness, here it is describing a group of eye disorders that result in optic nerve damage, often associated with increased fluid pressure in the eye (intraocular pressure) (IOP). There is a small space in the front of the eye called the "anterior chamber". Clear liquid flows in-and-out of the anterior chamber; this fluid nourishes and bathes nearby tissues. If a patient has glaucoma, the fluid does not drain properly - it drains too slowly - out of the eye. This leads to fluid build-up, and pressure inside the eye rises. Unless this pressure is brought down and controlled, the optic nerve and other parts of the eye may become damaged. Once nerve damage and visual loss occur, it is permanent. Most people are unaware about the disease until it reach risky. Early detection and treatment are the keys to preventing optic nerve damage and vision loss from glaucoma. To detect the glaucoma in the earlier stage is the risk factor for a low cost; since advanced technologies want to be used to detect the glaucoma. The main idea behind this paper is to describe a system which is mainly based on image processing and classification techniques for screening of glaucoma by comparing and measuring different parameters of fundus images of glaucoma patients and normal patients.**

***Index Terms*— Glaucoma screening, Cup to Disc Ratio(CDR), ISNT, ASM, Sparse Dissimilarity Constraint Coding, Fundus Image, ONH, IOP.**

I. Introduction

Glaucoma is a disease of the major nerve of vision, called the optic nerve. The optic nerve receives light-generated nerve impulses from the retina and transmits these to the brain, where we recognize those electrical signals as vision. Due to the abnormal growth of the blood vessels in the eye the vision blocked, so that permanent vision loss is occurred. Glaucoma is characterized by a particular pattern of progressive damage to the optic nerve that generally begins with a subtle loss of side vision (peripheral vision). If glaucoma is not diagnosed and treated, it can progress to loss of central vision and blindness. Diabetes patients are severely affected by this disease, and also the premature babies are also have this complex. There are many different types of glaucoma. Most, however, can be classified as either open-angle glaucoma, which are usually conditions of long duration (chronic), or angle-closure (closed angle) glaucoma, which include conditions occurring both suddenly (acute) and over a long period of time (chronic). The glaucoma is usually affect both eyes, but the disease can progress more rapidly in one eye than in the other. Involvement of just one eye occurs only when the glaucoma is brought on by factors such as a prior injury, inflammation, or the use of steroids only in that eye.

Open-angle glaucoma Primary chronic open-angle glaucoma (COAG) is by far the most common type of glaucoma. Moreover, its frequency increases greatly with age. This increase occurs because the drainage mechanism gradually may become clogged with aging, even though the drainage angle is open. As a consequence, the aqueous fluid does not drain from the eye properly. The pressure within the eye, therefore, builds up painlessly and without symptoms. Angle-closure glaucoma an attack of acute angle-closure glaucoma may be associated with severe eye pain and headache, a red (inflamed) eye, nausea, vomiting, and blurry vision.

As the disease progress it causes of losing the vision and the patients may suffer from tunnel vision (being only able to see centrally). Therefore early detection of this disease is essential to prevent the permanent blindness. In this study, we are trying to do a review the available techniques. Each of the techniques has some advantages as well as disadvantages. Based on this study, we can determine which technique can be applied in which scenario to obtain the optimal result

II. Review the Techniques for Glaucoma Screening

Jun Cheng et al., [1] had devised a new method for screening glaucoma. Here in this techniques contain 4 methodologies. In this first step is the optic disc segmentation, the segmentation is done by super pixel classification, this method give the better accuracy than the ASM, elliptical hough transform and best-fitted ellipse. After that Blood vessel is removed by morphological closing operators then uneven-illumination correction is carried out. The second step is reconstruction; the reconstructed is done by using a novel Sparse Dissimilarityconstrained Coding (SDC) approach. Third step is the calculating Dissimilarity Score. Final step is the CDR assessment. By CDR estimation the early stage of the glaucoma is accurately screened.

G. D. Joshi et al., [2] adopted an automatic method for segment optic disc and cup boundary for glaucoma identification. First is the optic disc segmentation using the region-based active contour model, to improve the segmentation on the range of OD instance. Second is the optic cup segmentation by r-bend information. By OD parametrisation, a efficient estimation for glaucoma assessment.

R. Bock et al., [3] proposed an automated glaucoma detection. By obtained Glaucoma Risk Index (GRI) reached a classification accuracy of 80% in a two class problem (control vs. glaucomatous eyes) taking a gold standard diagnosis by ophthalmologists as a basis. The AUC was 88% with a sensitivity of 73% at a specificity of 85% in detecting glaucoma.

G. D. Joshi et al., [4] had identified new technology for detecting glaucoma. Firstly optic disc boundary is detected by using region-based statistics. Here a unified deformable contour approach for OD and cup boundary detected. This method uses a clustering-based classification of contour points and customized contour evolution step integrated in original snake formulation. Optic cup is segmented by color information and the structural properties of cup region to get the object boundary. Under segmentation occurs more in advanced stages of glaucoma marked by a gradual transition between the cup and disc. The density of vessels is maximum in the inferior and superior regions and hence identifying the correct vessel's bend to correct the cup boundary is challenging. A solution is to use 3D depth information. After finishing all these the Cup to Disc Ratio is calculated to detect glaucoma accurately.

J. Cheng et al., [5] proposed super-pixel classification-based approach for screening glaucoma by including features from super-pixel level, which significantly improves the disc and cup detection. Here the optic disc is segmented by self- assessment reliability score is computed to evaluate the quality of optic disc. Super-pixel classification have both pixel classification based method and deformable model base method. In this minimum bounding box of the disc is used for cup segmentation the best fitted Ellipse method is carried out.

Y. Xu et al.,[6] adopted new technology for finding the glaucoma. Here the first step is the optic disc localization by reconstruction-based method. Secondly optic disc segmentation by Active Shape Model (ASM).The segmented disc is normalized by standardized circle with radius, to remove the influence illumination variation among images. Here in this locating cup in 0.1s more than ten times faster than the methods like Pixel-based, window-based, and super-pixels. By the influence of the codebook the images are tested. The method achieves an AUC value of 0.86, a sensitivity of 73.9% at a specificity of 85% and somewhat good for glaucoma detection.

Inoue et al., [7] developed a glaucoma screening technique using super pixel classification on optic disc and optic cup segmentation. In optic disc segmentation, histograms were utilized to classify each super pixel as disc or non-disc. The quality of the automated optic disc segmentation is calculated using a self-assessment reliability score. For optic cup segmentation, along with the histograms, the location information is also included to boost up the performance. In this proposed segmentation approach a database of 650 images was used with optic disc and optic cup boundaries which had been manually marked by professionals. The results showed an overlapping error of 9.5% and 24.1% in disc and cup segmentation, respectively. Lastly the cup to disc ratio for glaucoma screening was computed.

Bock et al., [8] developed an automated glaucoma classification system that does not at all depend on the segmentation measurements. They had taken a purely data-driven approach which is very useful in large-scale screening. This algorithm undertakes a standard pattern recognition approach with a 2-stage classification step. In this study, various image-based features were analyzed and integrated to capture glaucomatous structures. There are certain disease independent variations such as size differences, illumination in homogeneities and vessel structures which are removed in the preprocessing phase. This system got 86% success rate on a data set of 200 real images of healthy and glaucomatous eyes.

Cheng et al., [9] proposed a new technique for glaucoma detection based on RetCam. In this study, for glaucoma detection RetCam is used which is an imaging modality that captures the image of irridocorneal angle. The manual grading and analysis of the RetCam image is quite a time consuming process. In this study, they developed an intelligent system for analysis of iridocorneal angle images, which can distinguish between open angle glaucoma and closed angle glaucoma automatically.

Deshmukh et al., [10] devised a method for glaucoma screening. Here the optic disc and optic cup is segmented by region based method by the region of interest as the size of the optic disc and ROI is selected and to initiate an active contour evaluation and morphological operations are processed to taken out for accurate segmentation of both optic disc and optic cup. Cup to Disc Ratio is calculated, it indicated the risk of the glaucoma. By use of this region based segmentation produce a better estimation of CDR for both high risk and low risk retinal images. These promising results suggest use of region based active contour model in automatic detection of glaucoma in mass screening.

C. A. Lupascu et al., [11] proposed AdaBoost classifier for segmenting blood vessel it is a method for automated vessel segmentation in retinal images by classifying pixels as vessel or nonvessel, so first thing is vessel tracking by using the kalman filter, select a set of reliable seed points on the vessel network, and follow (track) the vessels starting from the seeds (an idea akin to classical region growing). Test set from DRIVE database is 0.9561 and the accuracy is 0.9597, while the sensitivity is 67.28 and the specificity is 98.74.

Liu et al., [12] had design automated glaucoma detection technique through medical imaging informatics (AGLAIA-MII) that takes into consideration everything starting from patient personal data, patient's genome information for screening and medical retinal fundus image. The AGLAIA-MII architecture uses information from multiple sources, including subjects' personal data, imaging information from retinal fundus image, and patients' genome information. Features from each data source will be extracted automatically. Subsequently, these features will be passed to a multiple kernel learning (MKL) framework to generate a final diagnosis outcome. AGLAIA-MII achieved an area under curve value of 0.866, which is much better than 0.551, 0.722 and 0.810 obtained from the individual personal data, image and genome information components, respectively. This methodology had shown a substantial improvement over the previous glaucoma detection techniques depending on intraocular pressure.

Grau et al., [13] developed a new segmentation algorithm, depending on the expectation-maximization. This algorithm used an anisotropic Markov random field (MRF). In this study, structure tensor had been used to characterize the predominant structure direction as well as spatial coherence at each point. This algorithm had been tested on an artificial validation dataset that is similar to ONH datasets. It has shown significant improvement over an isotropic MRF. This algorithm provides an accurate, spatially consistent segmentation of this structure.

Choudhary et al., [14] exposed a method for glaucoma detection by calculating CDR and ISNT rule analysis, which facilitates early diagnosis of glaucoma. Extraction of Optic Disc and Cup then CDR Calculation, Extraction of Neuroretinal Rim and ISNT calculation. After that artificial neuron network (ANN) is a computational model based on the structure and functions of biological neural networks. Feed Forward Back Propagation Neural Network Algorithm is used and initialize the weight and calculate the activation level. Here by this 96.7%. of accuracy and good performance of large scale clinical evaluation.

Lalonde M. et al., [15] "Fast and Robust Optic Disc Detection Using Pyramidal Decomposition and Hausdorff-Based Template Matching". The two approaches are tested against a database of 40 images of various visual quality and retinal pigmentation, as well as of normal and small pupils. This approach can also to investigate possible generalizations of this approach for the detection of non rigid shapes.

Lowell J. et al., [16] had introduced a method for segmenting Optic Nerve Head. Here in this an algorithm for the localization and segmentation of the optic nerve head boundary in low-resolution images the algorithm is evaluated against a randomly selected database of 100 images from a diabetic screening program.

Tan M.N. et al., [17] devised "Mixture Model-based Approach for Optic Cup Segmentation". They propose an approach for optic cup segmentation based on Gaussian mixture models. Here in this the determination of the contour of the cup area, due to the difficulties to determine an accurate optic cup boundary.This segmentation method should helpful to detect the glaucoma

Noor M.N et al., [18] introduced a method for Optic Cup and Disc Color Channel MultiThresholding Segmentation. First to segment the optic cup and optic disc using MultiThresholding Segmentation and extracted feature such as cup to disc ratio .Detecting CDR measurement process is complex due to the unclearly defined color texture between the optic disc and optic cup.

Kavitha D et.al., [19] "Automatic Detection of Optic Disc and Exudates in Retinal Images" .A fast reliable and efficient method for detecting the optic disc and exudates in the retinal funds images .The method has been tested on normal, abnormal retinal images. The Accuracy, Sensitivity(S) and Predictive Value (P) are also presented and found this algorithm promising results. This method can be used for determining classification and severity of the eye diseases after locating the macula is pending.

Sanchez T.J.A et al., [20] devised Optic Disc Detection and Segmentation of Retinal Images Using an Evolution Strategy on GPU . In which the optic disc detection and segmentation approach based on evolution strategy .The major limitation related to this fact is the absence of standardization of technical characteristics for retinal image acquisition.

Pruthi et al., [21] developed an automated glaucoma detection system having six different stages. The system is comprised of six different stages: Preprocessing, Region of Interest (ROI) Extraction, Feature Extraction stage, Calculation of CDR, Classification and Performance analysis stage. The system takes as input a fundus image. In the preprocessing stage, illumination correction and blood vessel removal takes place. After the analysis of entire image, a small square having 360 X 360 pixels is taken around the brightest region is denoted as ROI. Feature extraction is done from the images. In this method the features are extracted from optic disc and optic cup. The diameter of cup and optic disc is used for calculating Cup to disc ratio. It is extracted from the segmented optic disc and cup. The classifiers namely SVM, Back Propagation Neural Network, ANFIS are used to differentiate between normal and abnormal cases of glaucoma. ANFIS, SVM and Back Propagation had achieved accuracy of 97.77%, 98.12% and 97.35% respectively

Vermeer et al., [22] presented a model for detecting the change in images. These images were collected by scanning laser polarimetry, for tracking the glaucomatous progression. This methodology depends on image set of 23 healthy eyes and includes colored noise, incomplete cornea and masking is done by the retinal blood vessels. There are two more methodologies for tracking progression by taking up one or two follow-up visits into the account. Then they are tested on these simulated images. Both of these methods are depending on Student's t-tests, anisotropic filtering and morphological operations. The images simulated by this technique are visually pleasing and also show statistical properties to the real images. This results in optimizing the detection methods. The results reveal that tracking the progression depending on two follow-up visits marks a great improvement in sensitivity without affecting the specificity adversely.

Acharya et al., [23] adopted an automated glaucoma detection system by combining the texture and higher order spectra (HOS) features obtained from fundus images. Naive Bayesian, Support vector machine, random-forest classifiers and sequential minimal optimization are used to perform supervised classification. After z-score normalization and feature selection, the results reveal that the texture and HOS

ISSN (ONLINE) : 2395-695X
ISSN (PRINT) : 2395-695X
Available online at www.ijarbest.com

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 6, September 2015

based features. When these features are combined with a random-forest classifier it performs much better than the other classifiers. This method correctly diagnoses the glaucoma images with 91% accuracy.

L´aszl´o G. Ny´ul et al., [24] devised a novel automated glaucoma classification technique, depending on image features from fundus photographs. In this study, data-driven technique does not need any manual assistance. The system does not depend on explicit structure segmentation and measurements. First of all size differences, non uniform illumination and blood vessels are eliminated from the images. They then extracted the high dimensional feature vectors. Finally compression is done using PCA and the combination before classification with SVMs takes place. The Glaucoma Risk Index (GRI) produced by the proposed system with a 2-stage SVM classification scheme achieved 86% success rate. This is comparable to the performance of medical experts in detecting glaucomatous eyes from such images. Since GRI is computed automatically from fundus images acquired by an inexpensive and widely available camera it is suggested that the system could be used in glaucoma mass screenings

III. Conclusion

In this review paper it shows many method and works related to Glaucoma screening. Glaucoma is the leading eye disorder leads to permanent vision loss. Many people are unaware about the disease. So screening glaucoma is important and to develop some inexpensive method to screen glaucoma at the early stage.These techniques are more helpful for the ophthalmologists and people who are unaware about the glaucoma disese. There have been several works done earlier in this field. In future, we need to develop more accurate, robust as well as affordable automated techniques for glaucoma detection so that the benefits are passed on the poorest of poor people. Once glaucoma is correctly diagnosed then they can take proper medicine or undergo surgery in a timely manner to avoid total blindness.

References

[1] Jun Cheng et al., "Sparse Dissimilarity-Constrained Coding for Glaucoma Screening" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 62, NO. 5, MAY 2015.

[2] G. D. Joshi et al., "Optic disk and cup segmentation from monocular color retinal images for glaucoma assessment," IEEE Trans. Med. Imag., vol. 30, no. 6, pp. 1192–1205, Jun. 2011.

[3] R. Bock et al., "Glaucoma risk index: Automated glaucoma detection from color fundus images," Med. Image Anal., vol. 14, pp. 471–481, 2010.

[4] G. D. Joshi et al., "Optic disk and cup boundary detection using regional information," in Proc. IEEE Int. Symp. Biomed. Imag., 2010, pp. 948–951.

[5] J. Cheng et al., "Superpixel classification based optic disc and optic cup segmentation for glaucoma screening," IEEE Trans. Med. Imag., vol. 32, no. 6, pp. 1019–1032, Jun. 2013.

[6] Y. Xu et al., "Efficient reconstruction-based optic cup localization for glaucoma screening," Proc. Med. Image Comput. Comput.-Assisted Intervention, 2013, vol. 8151, pp. 445–452.

[7] Inoue, Kenji Yanashima, Kazushige Magatani, Takuro Kurihara, Naoto, "Development Of A Simple Diagnostic Method For The Glaucoma Using Ocular Fundus Pictures", in the Proceedings of the 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference Shanghai, China, September 1-4, 2005

[8] R¨udiger Bock, J¨org Meier, Georg Michelson, L´aszl´o G. Ny´ul, and Joachim Hornegger, "Classifying Glaucoma with Image-Based Features from Fundus Photographs", DAGM 2007, LNCS 4713, pp. 355–364, 2007. Springer-Verlag Berlin Heidelberg 2007.

[9] Jun Cheng, Jiang Liu, Beng Hai Lee, "Closed Angle Glaucoma Detection in RetCam Images", IEEE Proceedings of the 32nd Annual International Conference, Sep 2004, pp 4096-4099.

[10] Padmasinh M. Deshmukh et al., "Segmentation of Retinal Images for Glaucoma Detection" International Journal of Engineering Research & Technology (IJERT) Vol. 4 Issue 06, June-2015.

[11] C. A. Lupascu et al., "FABC: Retinal vessel segmentation using adaboost," IEEE Trans. Inf. Technol. Biomed., vol. 14, no. 5, pp. 1267–1274, Sep. 2010.

[12] Jiang Liu, Zhuo Zhang, Damon Wing Kee Wong, Yanwu Xu, Fengshou Yin, Jun Cheng, Ngan Meng Tan, Chee Keong Kwoh, Dong Xu, Yih Chung Tham, Tin Aung, Tien Yin Wong: J Am Med Inform Assoc 2013;0:1–7.

[13] Vicente Grau, J. Crawford Downs, and Claude F. Burgoyne, "Segmentation Of Trabeculated Structures Using An Anisotropic Markov Random Field: Application To The Study Of The Optic Nerve Head In Glaucoma", IEEE Transactions on Medical Imaging, Vol. 25, No. 3, March 2006. Pg.: 245.

[14] Choudhary et al., "ANN Glaucoma Detection using Cup-to-Disk Ratio and Neuroretinal Rim" International Journal of Computer ApplicationsInternational Journal of Computer Applications" International Journal of Computer Applications Volume 111 – No 11, February 2015.

[15] Lalonde M. and Beaulieu M." Fast and Robust Optic Disc Detection Using Pyramidal Decomposition and Hausdorff-Based Template Matching" IEEE Transactions on Medical Imaging, vol. 20, no. 11, November 2001.

[16] Lowell J and, Andrew Hunter" Optic Nerve Head Segmentation" IEEE Transactions on Medical Imaging, vol. 23, no. 2, February 2004.

[17] Tan M.M and, Wong D.W.K" Mixture Model-based Approach for Optic Cup Segmentation" 32nd Annual International Conference of the IEEE embs Buenos Aires, Argentina, August 31 - September 4, 2010.

[18] Noor M.N Khalid" Optic Cup and Disc Color Channel Multithresholding Segmentation" 2013 IEEE International Conference on Control System, Computing and Engineering, 29 Nov. - 1 Dec. 2013, Penang, Malaysia.

[19] Kavitha D. S" Automatic Detection of Optic Disc and Exudates in Retinal Images" 0•7803-8840•2/051$2000 ©20D5 IEEE

[20] German Sanchez Torres and John Alexander Taborda" Optic Disk Detection and Segmentation of Retinal Images Using an Evolution Strategy on GPU" 978-1-4799-1121-9/13/$31.00 ©2013 IEEE

[21] Jyotika Pruthi, Dr.Saurabh Mukherjee: "Computer Based Early Diagnosis of Glaucoma in Biomedical Data Using Image Processing and Automated Early Nerve Fiber Layer Defects Detection using Feature Extraction in Retinal Colored Stereo Fundus Images", International Journal of Scientific & Engineering Research, Volume 4, Issue 4, April-2013

[22] Koen A. Vermeer, Frans M. Vos, Barrick Lo,"Modeling of Scanning Laser Polarimetry Images of the Human Retina for Progression Detection of Glaucoma", IEEE Transactions On Medical Imaging, May 2006, pp. 517-528

[23] U. Rajendra Acharya, Sumeet Dua, Xian Du, "Automated Diagnosis of Glaucoma Using Texture and Higher Order Spectra Features", IEEE Transactions On Information Technology In Biomedicine, May 2011, pp 449-455

[24] L´aszl´o G. Ny´ul: "Retinal image analysis for automated glaucoma risk evaluation". MIPPR 2009: Medical Imaging, Parallel Processing of Images, and Optimization Techniques. Proc. of SPIE Vol. 7497