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"Glaucoma Detection and Classification: A Review"

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Abstract- Digital image processing techniques enable ophthalmologists to detect and treat several eye diseases like diabetic retinopathy and glaucoma. Glaucoma is an eye problem that affects the retina and weakens the nerve cells that assist in visual recognition. Glaucoma, the most common cause of blindness is the disease of the optic nerve of the eye and can lead to ultimate blindness if not treated at an early stage. Raised intraocular pressure, increase in cup to disk ratio and visual field test are some of the measures for such a disease. This paper presents a succinct of different types of image processing methods employed for the detection of Glaucoma The main objective of this project is to find an automated tool to detect glaucoma at an early stage and to classify this disease based on its severity and damage of the optic fibre. In this paper different existing methods are reviewed and their performance are evaluated so that it can help the researchers in their work.

Keywords: Glaucoma, Cup-Disc Ratio, Image Processing, Glaucoma Stages

I. INTRODUCTION

Glaucoma is the unending eye infection which alludes to the essential driver of visual deficiency overall [1]. The word glaucoma radiates from old Greek word, signifying 'blurred or blue-green tint', apparently which portrays an individual with an enlarged cornea or who is quickly building up a waterfall, the two of which might be affected by constant (long haul) increment in the intraocular weight of the eye. Glaucoma is a class of ailments in which the optic nerve is vandalized prompting irreversible loss of vision. As a rule, this harm is because of monstrous increment of weight inside the eye.On the off chance that this harm left untreated, may prompt absolute visual impairment. In this manner, the early recognition of glaucoma [2] is fundamental. The principal indication of glaucoma is frequently the loss of side vision, which may not see as the sickness drags out [3]. This is the reason glaucoma is frequently called the "sneak cheat of vision" [4].

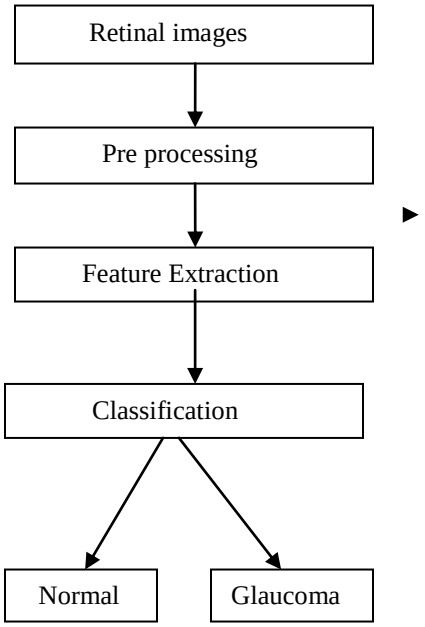
A. There are two primary sorts of Glaucoma:

a) Open edge glaucoma: This is the most well-known kind of glaucoma, likewise called wide-edge glaucoma. It happens because of incomplete blockage of waste trench in which weight increments gradually as liquid does not deplete appropriately as appeared in. Indications emerge from fringe loss of vision and may not see until focal vision is influenced. There is no noticeable variation from the norm of the trabecular meshwork [3].

b) Angle-conclusion glaucoma: It is likewise called intense glaucoma caused because of unexpected and complete blockage of watery seepage appeared in . The weight rises quickly prompting loss of vision rapidly. It is created because of restricted waste point, meager and saggy iris.

B. Glaucoma Detection Process

For glaucoma identification, first, retinal pictures are gotten utilizing computerized catch gadgets for picture content. At that point pre-preparing is performed for adjusting the anomalies on the pictures. In pre-preparing, veins are sectioned and in painted to pick up a without vessel picture. At that point, Feature extraction is performed to lessen the measurements viably to speak to the intrigued parts of a picture as a succinct element vector for depicting the expansive informational collection absolutely. Pixel force esteems, surfaces, FFT coefficients and Histogram show are the strategies utilized in highlight extraction. Picture Classification is performed which investigation the numerical properties of a picture and sorts out the information. Contingent upon the outcomes acquired, the arrangement of information is separated into discrete classes' for example ordinary eye or glaucomatous eye. The general glaucoma discovery process [5] is represented in Flowchart 1



Flowchart 1: Glaucoma detection process

The remaining part of paper is organised as follows:
Chapter 2 contains the literature review of recent methods used for detection of glaucoma disease then chapter 3 focuses on different methods which have been applied for the detection of above disease. Chapter 4 contains the analysis of results obtained by different researchers and finally last chapter concludes the results and focuses on the gaps found in whole survey.

II. LITERATURE SURVEY

Jonas et al. Presented their work in which Jonas et al. Recommended that the crumbling of the retinal [16] color epithelial layer, photograph receptors and fundamental choriocapillaries in the area encompassing the ONH. Weinreb et. al. Presented their work in which Clarified the Open-edge implies that the edge where the iris meets the cornea is as wide and open as it ought to be open-edge glaucoma [6] and furthermore called as essential or perpetual glaucoma. Kevin Noronha et al. proposes distinctive procedures to remove principle highlights of retinal fundus pictures, for example, optic plate, fovea and veins. The creator finds the most splendid piece of the fundus and applies Hough change to decide the optic plate and its inside.[11]. Reus & Lemij Proposed that CDR can be used to compare Glaucoma patients with normal subjects, and it is an key measurement for the diagnosis of Glaucoma [10]. Xu et al. - proposes a novel procedure that changes unique snake strategy. This procedure is utilized to extricate the limit of glass and plate.[12]

Sekhar S et al. Improved the method by utilizing numerical morphology to relate the shade rectification on the retinal picture [19].Cheng et al.- . [20] proposed superpixel classification methods to segment the optic disc and cup. Hafsah Ahmad et al proposed a technique for early detection of glaucoma using CDR and ratio of NRR in ISNT quadrants. The technique is implemented on 80 images and 97.5% accuracy is achieved in 0.8141 seconds. L. [21] Sobia et al. proposed a method in which anisotropic filtering is performed. Disc is extracted using 3 techniques i.e. edge detection method, optimal thresholding method and manual threshold analysis. M. [22] . Anindita et al. proposed a review paper which consisted of all possible features that can be extracted from the retinal image and can be used as a parameter to detect glaucoma disease [23].

III. METHODOLOGY

A .Enhancement of Optic Cup to Disk Ratio
The optic glass to circle proportion is one of the standard physiological qualities which is utilized for identification of glaucoma. The C/D proportion speaks to the gloom in the optic circle in which neural tissue is missing and contrasted and in general optic plate estimate. A bigger C/D proportion has more serious danger of glaucoma.

B. Glaucoma Detection Using Pca And Bayes Classifier
Central Component Analysis (PCA) is the procedure which is utilized for information decrease and to decorrelate the data[8].two application has been finished by pca in picture processing, first the three segment in a shading picture has been diminished to one segment containing a noteworthy piece of information, second ascertaining the eigen esteem vectors relating to biggest eigen incentive to decide the element of an article in a picture. Consequently by this procedure PCA has been utilized for area of optic plate in retinal fundus pictures investigation has been proposed, one is base up methodology in which optic circle is distinguished by biggest pixel having most astounding dark dimension picture and second top down methodology preparing to find the optick circle automatically.these two methodologies have been utilized for deciding the applicant locales and pca approach is utilized to discover definite area of optic plate.
Bayes classifier technique is based on bayes theorem.It classify the object in an image by considering their respective prior probabilities in an image.The proposed glaucoma classification process include retinal image processing, calculating eigen vectors from training image,projecting the testing images to “disk space” and distinguishing glaucoma with bayes classifier based on gaussian model.[8]

C. Location utilizing CDR and ISNT Proportion
It is to take note of that ganglion cells are dissipated everywhere throughout the retina, their filaments meet on the optic nerve head and layers of strands get thicker exactly

at their nerve head and heaped up and plunge into the opening. The nerve head is called as plate loaded up with filaments, and the left over space amidst nerve head is called container appeared in fig. 4 and 5. Contrasting the extent of container with the measure of entire circle is Cup to Disk Ratio (CDR) [9 and 10]. Because of increment in intra visual weight, the CDR increments because of ascend in container estimate. The CDR is figured to be under 0.5 for typical optic circle yet for strange optic plate, it surpasses 0.5.The increment in glass estimate additionally influences the Neuro-retinal Rim (NRR). NRR is the region situated between the edge of the optic circle and the optic glass [3]. In the event that glaucoma exists, proportion of region shrouded by NRR in nasal and worldly district turns out to be thick contrasted with the region canvassed in sub-par and predominant area. This strategy utilizes ONH [10] division, in view of morphological tasks, Hough change, and moored dynamic form.

D. A Novel Robotized Glaucoma Discovery

The proposed framework manages the pictures acquired from Stratus Anterior Segment Optical Coherence Tomography (AS-OCT). OCT [13] is a non-contact, noninvasive imaging procedure that uncovers layers of retina by looking impedance examples of reflected laser light. AS-OCT creates in-vivo, cross-sectional sweeps of tissue to break down cornea, foremost chamber point, focal point and iris. AS-OCT is favored since it produces quality pictures, catches at rapid rate and furthermore has ability of deciding profundity of outside body. To recognize irregular pictures from ordinary pictures, a Fuzzy min-max neural system dependent on Data-Core (DCFMN) has been utilized. It has a solid vigor and has high precision in arrangement. DCFMN has two sorts of neurons: characterizing neurons (CNs) and covering neurons (OLNs). CNs used to order the examples of information. OLNs handles a wide range of covered hyper boxes. The enrollment capacity of OLNs manages relative position of information in hyper boxes. The execution of this strategy is fantastic and characterization rate of 97% has been accomplished [13]. The mean deviation was - 0.67 ± 0.62 dB in typical and 5.87 ± 6.48 dB in glaucoma gathering. Utilizing non-obtrusive imaging strategy OCT and with the assistance of Fuzzy neural system dependent on DCFMN, glaucoma has been distinguished [13].

E. Computerized glaucoma identification framework having six unique stages

The framework [7] includes Pre-handling, Region of Interest (ROI) Extraction, Feature Extraction organize, Calculation of CDR, Classification and Performance investigation arrange. The framework accepts contribution as fundus picture. In the pre-handling stage, light adjustment and vein expulsion has been performed. After investigation of the whole picture, a little square having 360 X 360 pixels taken around the most brilliant area meant as ROI. Highlights have been removed from optic circle and optic glass and CDR is determined. The exactness of classifiers specifically SVM, Back Propagation Neural Network, ANFIS acquired are 98.12%, 97.35% and 97.77% [14]. From over six phases and by appropriate classifier, one may get great exactness in glaucoma location.

F. Utilizing z-score standardization procedure

Another technique created as a robotized glaucoma discovery framework by consolidating the surface and higher request spectra (HOS) [15] highlights acquired from fundus pictures. Gullible Bayesian, Support vector machine, irregular timberland classifiers and successive insignificant improvement has been utilized to play out the characterization. After z-score standardization and highlight choice, the outcome gives the surface and HOS based highlights. At the point when these highlights are joined with an irregular woodland classifier it performed much superior to different classifiers. This strategy has determined the pictures of glaucoma to have exactness of 91% utilizing HOS method and with the assistance of arbitrary timberland classifiers.

G. Glaucoma Screening System utilizing Super Pixel Grouping

This strategy [17] includes building up a glaucoma screening system utilizing super pixel arrangement on optic circle and optic glass division. In this technique, every optic circle picture has first over sectioned into super pixels at that point, from every super pixel, mean forces, focus encompass areas and highlights of the area has been extricated so as to characterize whether it is a glass or non-container. In optic plate division, histogram has been utilized to separate every super pixel as circle or non-circle. A database comprises of 650 pictures were utilized with limits of optic plate and optic glass. It demonstrated an over-lapping mistake of 9.5% and 24% in optic plate and optic glass.

H. Glaucoma Detection without division

A computerized glaucoma grouping framework [18] that doesn't relies upon the division estimations. In this strategy, picture based highlights have been given which are utilized to identify the glaucoma. This depends on assessment of information and not on diagram of optic circle and dissecting diverse kinds of highlights, for example, pixel forces, unearthly highlights, surfaces and parameters of histogram show. Three unique classifiers has been utilized which are gullible bayes classifier, k-closest neighbor and Support Vector Machine (SVM). This calculation adopted a standard example acknowledgment strategy. In this technique, highlights of pictures have been dissected and incorporates to catch structures of glaucoma. In preprocessing stage, varieties of size contrasts, brightening in homogeneities and structures of vessel has been expelled. This framework has 86% achievement rate of 200 genuine pictures for two phase arrangement with SVM.

I. Veins division

The vein division thusly gives a technique to the recognition of Glaucoma .The retinal veins are normally alluded to; corridors and veins. At that point supply route and focal vein regularly show up close to one another in the nasal side of the optical circle focus. Veins are more clear in the green segment. Data about the structure of the veins can group the seriousness of the ailment and may likewise fill in as a kind of perspective amid task. Furthermore, two procedures have been utilized for the identification of veins in picture. One is the identification of edges; and the other is checking that requires from the earlier information of the situation from the picture. Data about veins can be utilized in evaluating illness seriousness or as a major aspect of procedure of robotized conclusion of ailments with visual indications. Here the glaucoma is identified by methods for ISNT (Inferior, Superior, Nasal, Temporal) proportion.

IV. RESULT ANALYSIS

Table1: comparison of existing methods

Reference	Method Used	Accuracy
[18]	Glaucoma Detection without division	86%
[8]	PCA	75-80%
[9] & [10]	CDR & ISNT	90-95%
[13]	OCT	97%
[7] & [14]	ROI Extraction	98.12%, 97.35% 97.77%
[15]	Consolidating the surface and (HOS)	91%
[18]	Without Segmentation, SVM	86%

Table 1 contains the results obtained by different researchers on applying different methods for detection of glaucoma disease , we can observed here that results are varying between 75 to 97.7% so there is a scope for new researcher to increase the accuracy of classification up to 2 %

Also we can observed that some experimental results shows good accuracy without using any soft computing technique, so in near future soft computing techniques may apply to increase the accuracy.

V. CONCLUSION

Through this survey paper we have considered distinctive systems which were engaged with recognizing glaucoma. Glaucoma is one of the significant ailment which is adding to greater part of visual deficiency around the world. With the assistance of these systems, we have to build up some more affordable mechanized method so as to recognize glaucoma illness precisely. These systems would be useful for less created nations where there is a lack of ophthalmologists. In future, exact identification with less cost adequacy, it might be valuable to the destitute individuals. When glaucoma is effectively analyzed there is a likelihood of keeping away from absolute visual deficiency. After Various flow inquires about is being done for recognition of Glaucoma, we can see utilizing ROI extraction technique give more exactness than different strategies. Here, we can conclude that results are varying between 75 to 97.7% so there is a scope for new researcher to increase the accuracy of classification up to 2 % by cascading existing classifiers or by applying new classifiers.

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