IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-12, Dec 2018 E-ISSN: 2347-2693

Medical Diagnosis System for Glaucoma Diseases Detection Based On Retinal Images Using Data Mining Techniques

G.Pary[1*], M. Aramudhan[2], N.Thirumoorthy[3]

[1]Manonmaniam Sundaranar University, Tirunelveli, India
[2]Dept. of Information Technology, Perunthalaivar Kamarajar Institute of Engineering and Technology, Nedungadu, India
[3]MCE, Mahindra college of Engineering, Salem

[*]*Corresponding Author:paryvallal@yahoo.com*

Available online at: www.ijcseonline.org

Accepted: 09/Dec/2018, Published: 31/Dec/2018

Abstract- The main objective of this research paper is to present an analysis of different types of data mining techniques for the detection of glaucoma. It is one of the serious eye diseases. The Glaucoma affects the optic nerve in retina. In which the retinal ganglion cells are in dead condition and this leads to permanent loss of vision. So the early detection of glaucoma is needed to prevent the patients from diseases. The Manual analysis of retinal images is fairly time-consuming and accuracy depends on the expertise of the professionals. By the proposed Medical diagnosis system mass screening is possible to help the doctor for take proper treatment.

***Keywords*:** SVM classifier, glaucoma, K-means, PCA, Fundus images.

I. INTRODUCTION

The word glaucoma has been emanated from the Greek word, this means "clouded or blue- green hue," one who is with a swollen cornea or rapidly developing cataract, both of this may be reason for increasing pressure in the intraocular. If the eye is in increased pressure this damages the optic nerve. The optic nerve will transmit images to the brain, and the glaucoma will not be visible in the early stage. If this damage persists for a long time, it may lead to loss of vision. And will be very painful. Sometimes, the person cannot know whether they have affected by glaucoma or not. If the pressure is above the normal value in the retinal image then the circulation of flood will be in the anterior part of the eye this may lead to the abnormal condition. This kind of blood circulation is called aqueous humor. Sometime the flow of blood will be out of the eye through mesh channel. These channel fluids set up the glaucoma. For the glaucoma the reason cannot be identified, but the appearance of the retinal image will be normal. If the blood will not properly flow through the channel there may be some problem to the eye just like injury to the eye, severe infection, blood vessels obstruction in the eye, sometime the conditions may lead to eye surgery to rectify this problems. This kind of problem may happen to many people in the world. So the early detection process is important for identifying the glaucoma. There are different types of glaucoma. They are Normal Tension Glaucoma, Ocular Hypertension, Primary Angle Closure Glaucoma, Secondary Glaucoma, Congenital Glaucoma, Primary Open Angle Glaucoma Acute Glaucoma, Pigmentary Glaucoma, and Exfoliation and Trauma- Related from this two major type of glaucoma and their symptoms are identified by analyzing the retinal image condition. This proposed system may help to the doctor to detect the disease and diagnosis to give the proper treatment to the patients and also by this system mass screening possible. In future this technique is going to be implemented in supermarket and ATM. the people may know there disease condition from this places as a printed copy.

II. TYPES OF GLAUCOMA

Open angle glaucoma

The Open-angle glaucoma means there is angle in which the iris meets the cornea is as wind and open. It is otherwise called primary or chronic glaucoma. The Open-angle glaucoma is the most common type of wide-angle glaucoma. This type of glaucoma develops slowly with respect to time and there will be no pain. The vision may begin to decrease and if not treated the resulting lead to blindness. The structure of the eye will appears normal but the fluid of the eye will no flow correctly in the drainage canal are called the tabular mesh network that is shown below in the figure.1

Figure.1 Open-angle glaucoma

Angle-Closure Glaucoma

This is also called acute glaucoma or narrow-angle glaucoma in this a result of the angle between the iris and cornea is closed. This is happening when the iris bulges forward to narrow or block the drainage angle and also there will not be any fluid circulation in the eye. In this the symptoms and damage that are usually very noticeable in eye of certain people those who are having the age of above forty, children, and adult. Then the treatment can give to them.

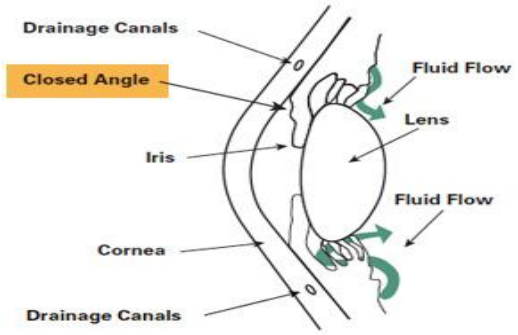

Figure 2. Angle-Closure Glaucoma

Symptoms of Glaucoma

The symptoms of the glaucoma are loss of vision peripheral .this some time may not be known until the disease identified, this is called a sneak thief of vision. In some other time the intraocular pressure may be increased condition this can lead severity of disease .the vision may be blurred, and halos may be seen around bright lights. And also this include a head ache, vomiting. Reduced vision, redness, pain and the eye looks hazy for child.

III. GLAUCOMA DETECTION

The manual Diagnosis of glaucoma disease is very difficult to detect from retinal images for mass screening. This is time consuming process and the also treatment is varying with respect to the eye professional for different type of glaucoma eye disease .some time the delay of treatment may lead to risk for the eye. So the new system of medical diagnosis used to detect and diagnosis of disease based on retinal images by using various data mining techniques such as k-mean, support vector machine, PCA, have been used for glaucoma prediction.

Diagnosis process of Glaucoma Detection

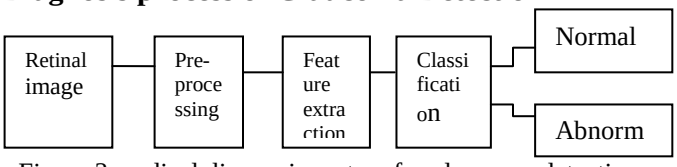

Figure 3.medical diagnosis system for glaucoma detection process

The above system .the First step the retinal fundus images are taken for the detection process by using digital image capturing devices. In the second step pre-processing is per- formed for equalization of irregularities in the images. The Pre-processing involves for the segmentation of the blood vessels and in painting them to gain a vessel-free image. the third step of Feature extraction involves simplifying the amount of resources required to describe a large data set accurately and also the Pixel intensity values, textures, FFT coefficients, and histogram models are the methods used in feature extraction. A feature extract the certain data that can be used for classification of diseases .the forth step Classification performs to analysis the properties of an image. According to the analysis which is obtained, the dataset has been divided as normal eye or glaucomatous

In the Glaucoma Detection process. The ratio of the C/D represents the depression condition in the optic disc. Some time the neural tissue may be absent when compared with overall optic disc size. A larger C/D ratio indicates that the patient has a greater risk of glaucoma. Here there some steps are used to determine the CDR. For this diagnosis process the STARE dataset has been taken with around 400 images with this normal and abnormal are available.

IV. METHODOLOGIES USED

ROI determination The small portion of the image is Region of Interest (ROI) extracted in which some necessary operations have been performed. The binary mask is created to define the ROI as a binary image this has the same size as the image which is to be processed. In the mask image if the pixel is that is going to be set to and remaining of the pixel set to. To extract the optic disc and cup the ROI around the optic disc has been traced out as it occupies less than the pixel in the retinal fundus image. The ROI reduces the computational cost and also improves the accuracy of the segmentation.

Optic Disc segmentation

The optic disc and optic cup segmentation eliminate the drawback of the conventional optic nerve head (ONH) analyzing method. With the help of The Structured Analysis of Retina (STARE) data set images various techniques are used for segmentation.

Optic cup segmentation

The optic cup's edge identification is more difficult when compare with optic disc. Because of the blurred image the blood vessels pass across the optic cup. After preprocessing this kind of image to enhance, the blood vessels were extracted and in painting. Then the optic cup was segmented.

Methodologies used to enhance the optic cup to disc ratio

Optic disc smoothing

The Optic disc smoothing is one of the necessary processes to remove the Noise in ROI image. The vessel holes leaves by vessel elimination. This is processed by median filter and closing operation. The Median filter fills the holes with the Pixel value of their neighbors and also applied by Creating 3 ×3 windows and convolved on each image. In closing operation the element of disc structure with radius 3 is worked and successfully fills up the holes leaved by Median filter. Finally the optic disc smoothing is done by Applying average filter. The Average filter sets the pixel value both in the background and optic disc area uniformly.

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Ellipse optimization for optic disc and cup

The optic disc and cub boundary is smoothened by an ellipse fitting algorithm. the optic disc and cup boundary based on a least square fitting algorithm which assumes the best-fit curve. This has a minimal sum of deviations squared from a given data point this allows the fitting of ellipse on a certain data point of particular region of interest. The condition of glaucoma is predicted by CDR value. If the CDR value greater then

The risk of glaucoma has been predicted by CDR value; if a CDR greater than 0.5 this indicates high glaucoma. The enhancement of the CDR ratio may be used for identify the glaucoma.

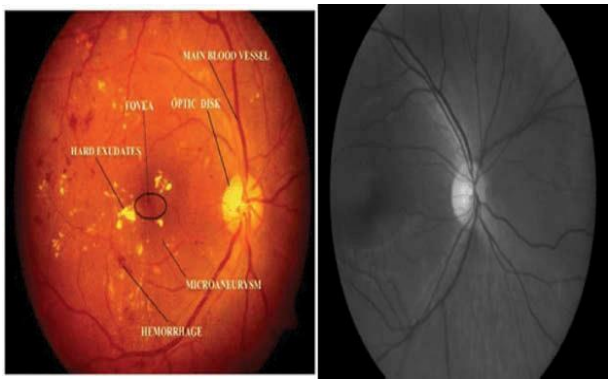

Figure 4. Retinal fundus image and binary image

Glaucoma Detection Using PCA and Bayes classifier

The principal component analysis (PCA) is one of the techniques used for data reduction and to de-correlate the data. The PCA uses two applications in the image processing. First One is it reducing three components in color image have been reduced to one component this containing a major part of the information. And second, it calculates the eigenvectors corresponding to the largest Eigen value for determining the features of an object in an image. So the PCA has been used for the location of the optic disc in retinal fundus images. Here the Two strategies for retinal fundus image analysis has been proposed; one is the bottom-up approach in this the optic disc is identified by the largest pixels having a highest gray level image and second is top-down processing, used to locate the optic disc automatically. These two methods have been used for determining the candidate regions by bottom-up processing and PCA approach is used to find the exact location of the optic disc.

The Bayes classier is technique. It is best one when the dimension of the input is so high. This discriminates or classified the objects in an image by considering their respective prior probabilities in an image. The proposed glaucoma detection process in shown in this research paper includes the following steps: retinal images from data set used for preprocessing, calculating the Eigen vector form training images. Use testing images to disc space. Glaucoma is distinguished by Bayes Classifier using Gaussian model. By using PCA with Bayes classifier .the normal and abnormal is classified. This success rate has been given in the below table.

TABLE 1: Result of glaucoma detection process

Input retinal image	Glaucoma	Non glaucoma	Total images	Success rate
Clinical glaucoma	100	30	130	76.9%
Clinical non glaucoma	34	140	174	80.4%

Detection Using CDR and ISNT Ratio

The retina having the ganglion cells everywhere. The retina and their fibers converge on the optic nerve head. The fiber's layer gets thicker just at their nerve head. The fibers pile up and dive into the opening. This nerve head is called the disc, this is filled with fibers, and the leftover space in the middle of the nerve head is called a cup. Just by Comparing the size of the cup to the size of the whole disc is a cup to disc ratio (CDR). Because of increasing in intraocular pressure, the cup size rises, and increases the CDR. For a normal optic disc, the CDR is reckoned to be less than 0.5, and also in the of glaucoma it is greater than 0.5. The increase in cup size also affects the neuron-retinal rim (NRR). The NRR is the one of the region that is in between the edge of the optic disc and the optic cup. At the time of glaucoma detection, the ratio

of the area covered by NRR in the nasal and the temporal region becomes thick, as compared to the area covered by NRR and also by this inferior and superior region. A method for ONH segmentation and its verification is based on morphological operations has been proposed in this paper. In this proposed system STARE used in this 196images has been applied; a specificity of 90%, a sensitivity of 95%, and an accuracy of 94% have been achieved.

Detection of glaucoma: to detect the glaucoma by using extraction of two features has been done by a mean threshold morphological method to calculate CDR and NNR ratio is ISNT quadrants. The CDR evaluation has been done by using the optic disc and cup. To evaluate the NRR ratio, the NRR also it used and CDR is calculated as given below.

CDR= (cup area/Disc area)*2;

Extraction of neurons retinal rim To extract NRR here an AND operation has been applied in the resultant images of a cup and disc, and also the mask's size is applied to measure the ratio of the area covered by the neuroretinal rim in ISNT quadrants. The mask is rotated 90 degrees each time to determine the ratio separately in ISNT quadrants.

V. PERFORMANCE MEASURES FOR ACCURACY

Accuracy is given as

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}*100;$$

To find accuracy of classification is performed by using sensitivity, specificity, positive prediction value(PPV),Negative prediction value(NNV), are given below by using four possible function .true positive (TP), false positive (FP),true negative(TN),and false negative(FN) the sensitivity measure value is proportion of actual positive stage glaucoma that is correctly identified .on the other side the specificity measures the proportion of negative stage recognized correctly .by the higher sensitivity and specificity the best medical diagnosis system is possible.

Sensitivity=TP/ (TP+FN)
Specificity=TN/(FP+TN)
PPV=TP/(TP+FP)
NPV=TN/(TN+FN)

TABLE 2.This performance has given as a table

Classifier	performance
Number of training images	137
Number of testing images	59
TN	18
TP	37
FP	2
FN	2
SENSITIVITY	95%
SPECIFICIT	90%
ACCURACY	94%
PPV	0.95
NPV	0.9

Glaucoma detection without segmentation

Analyzing the different type of features such as pixel intensities, spectral features, Textures and various parameters of the histogram model all the classifications are performed. Three different kind of classifiers are used .they are naïve Bayes classifier, support vector machine and k-nearest neighbor .by this method feature of retinal images have been analyzed and integrated to detect the glaucoma. This system has 200 real images for two stage classification with SVM.

Table 2.Different methodologies used to for diagnosis of glaucoma

VI. CONCLUSION

In this diagnosis system I have used many techniques to detect the glaucoma. This is a dangerous disease. It may lead to blindness. To avoid this kind of risk able disease the early detection mechanism supports the doctor to detect and diagnosis. This is very less expensive and time consuming method. The PCA and SVM is the best for classifier.

ACKNOWLEDGMNT

I convey my thanks to my guide for given all kind of help regarding this diagnosis system.

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Authors Profile

Mr.G.Pary. phd research scholar from manonmaniam sundaranar university tirunelvel, abhisekapatti,tamilnadu,india.i am doing research in computer science and engineering decipline. And also I have published more than 7 papers in various topic.

Mr.M. Aramudhan associate professor and Head, Department of Information Technology and engineering, Perunthalaivar Kamarajar Institute of Engineering and Technology (pkiet), Nedungadu, karaikal, Pondichery.He is a member of various computer society . He has published more than 35 research papers in reputed international journals including and conferences. His research work focuses on Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining, and Computational Intelligence based education. He has more than 15 years of teaching experience and Research Experience.

Mr. N.Thirumoorthy, Associate professor MCE, Mahindra college of Engineering, Salem,
Tamil Nadu, He has published more than 7 research papers in reputed international journals including and conferences and his research network Security, Cloud Security and Privacy, He has more than 10 years of teaching experience..

