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Detection of Glaucoma Disease from Optical Images Using Image Processing and Machine Learning Techniques

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Abstract-*Glaucoma is the retinal disorder which is leading cause for blindness. Glaucoma is classified into two types namely open angle glaucoma and closed angle glaucoma. Earlier detection of glaucoma will prevent the vision loss. The retinal fundus images of the databases are taken for the glaucoma detection. To detect the abnormality, preprocessing methods such as filtering, green channel extraction and CLAHE are applied and proposed classifiers will take these images and formation of the presence/ absence of glaucoma by calculating the CDR value in the respected image. The accuracy of the proposed classifier is compared with the techniques which includes hybrid methods and Soft computing techniques for morphological based image classification.*
Keywords: *Glaucoma Disease, Cup Disk Ration (CDR), CLAHE, Soft Computing Classifiers.*

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I. Introduction

The human eye is the organ which gives us the sense of sight. The eye allows us to see and interpret the shapes, colors and dimensions of objects in the world by processing the light they reflect or emit. Retina places a major role in the human vision system. The retina gets affected by diseases called glaucoma which is leading cause for blindness. Open angle is said to be wide and open angle between iris and cornea. It is a normal form of glaucoma and lead to slow clogging in the eye and can be easilycured. And the symptoms are said to be easily identified. This type of glaucoma is commonly widespread affecting disease, mainly for old aged people. Angle closure or closed angle glaucoma is a very rare case and highly dangerous which leads to sudden blindness. Main cause of this type of glaucoma is said to be rise in Intraocular. Pressure and blockage occurred in retina affected person has a closed or narrow angle between the iris and cornea.

Blood vessels extraction is very important as many eye diseases are recognized by inspecting the blood vessels. Since the eye is the only organ in the body that you can visualize the blood vessels which reflects the health status of body organs. The blood vessels in the fundus image should be segmented and analysed the disease affecting the eye called glaucoma.

II. Literature Survey

Priyanka Verma[3] proposed a technique called simple linear iterative clustering algorithm (SLIC) is used to segment optic disk to identify whether the given image is glaucomatous or not. Preeti, Jyotik Pruthi [4] proposed a technique to segment the CDR. Here ratio determines the glaucoma level in the patients and classification is done for deciding whether condition of eye is normal or glaucomatous. Manish. M. Kawde and V.K. Bairagi [5] proposed a method to detect CDR and blood vessel extraction. 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. In [7] detection of glaucoma using Higher Order Spectra (HOS) and Discrete Wavelet Transform (DWT) features extracted and fed to SVM classifier with kernel function of polynomial order 2. In [8] energy signatures obtained from 2-D discrete wavelet transform, used for feature ranking and feature selection. Support vector machine, random forest, sequential minimal optimization and naive bayes classification strategies are used. In [9] open angle glaucoma classification using wavelet transform, hitherto which are more sensitive to multifocal electro retinogram signals based on the characterization of global flash MFERG signals. Two markers obtained were used for the classification 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]. 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]. 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]. The multi thresholding segmentation is a process of segmenting the region of interest by assigning multiple thresholds to different grey level values

[13]. Segmentation of Optic Nerve Head using Warping and random sample consensus (RANSAC) where an imaginary circle is created with approximate radius and the ROI is extracted using some smoothing techniques is described in [14]. Segmentation of Colour Fundus Images using morphological gradient can be used [15].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.

The strategy used in [17] includes building up a glaucoma screening system utilizing super pixel arrangement on optic circle and optic glass. A computerized glaucoma grouping framework proposed in [18] which that doesn't relies upon the division estimations. In this strategy, picture based highlights have been given which are utilized to identify the glaucoma.

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

The glaucoma detection methodology basically contains 4 steps, first we need to take the preprocessing of input image, then the task of segmentation will be performed to extract the region of interest, in third step two features will be extracted cup radius and disk radius. Then finally identification of disease on the basis of cup disk ratio by using machine learning techniques. These steps can be shown in figure below:

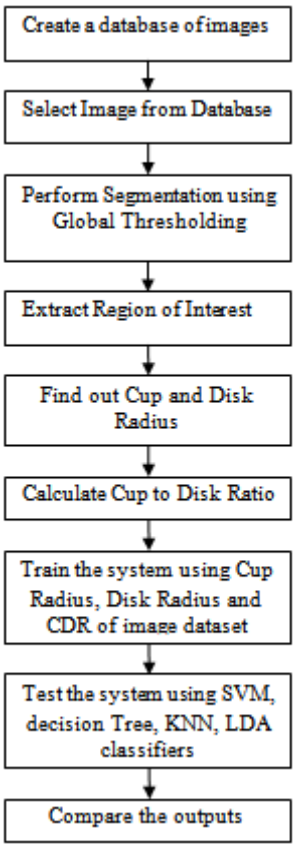


Figure1: Flowchart of Methodology

A. Image Dataset

For database creation we are using online available dataset of glaucoma disease, by merging images from various datasets , we create a dataset of 510 image , in which 320 images are of glaucoma disease and 190 images are of healthy persons.

B. Segmentation

The segmentation task done by using global thresholding technique and ROI is selected from various results got after changing the threshold limit from global thresholding using following algorithm

Step 1: Divide the image in n×n parts.

Step2: Calculate the average intensity values of each block

Step3: now select this average value as threshold value T.

Step4: All the intensities above T will set as a fore ground object and all intensities less than T will treat as back ground object

C. Region of Interest (ROI):

Region of interest can we find out after segmentation of image this region of interest is highlighted by small circle finally this two region of interest are used for of detection of cup disc ratio.

D. Cup Disk Ratio:

This Cup disc ratio place a very important role in detection of glaucoma disease if this come this ratio is very high then it shows that there is a chance of glaucoma disease at the same time if Cup disc ratio is very low then it shows that there is a no chance of glaucoma disease.

E. Feature Extraction and Training:

First feature extraction we are using CDR and RDR as the extracted features of image in this way we can make a matrix of all the features extracted from our image database which will be helpful for us to train the machine learning model using this pictures and perform the task of classification.

Table 1: Features Extraction

S.No.	CDR	RDR	Glaucoma
1	0.4436	0.6394	1
2	0.3123	1.1061	1
3	0.3290	1.0336	1
4	0.4289	0.6213	1
5	0.8152	0.1159	3
6	0.8262	0.1069	3
7	0.6516	0.2736	3
8	0.4342	0.6978	1
9	0.5683	0.3905	2
10	0.5565	0.4012	2
11	0.5756	0.4312	2
12	0.6667	0.2564	3
13	0.1692	2.4811	1
14	0.7932	0.1232	3
15	0.7634	0.1566	3

Here, 1 shows no glaucoma, 2 shows there is a middle level chance of glaucoma, 3 shows high chance of glaucoma(presence glaucoma disease), we have performed the test on randomaly selected 100 person's feature dataset for classification.

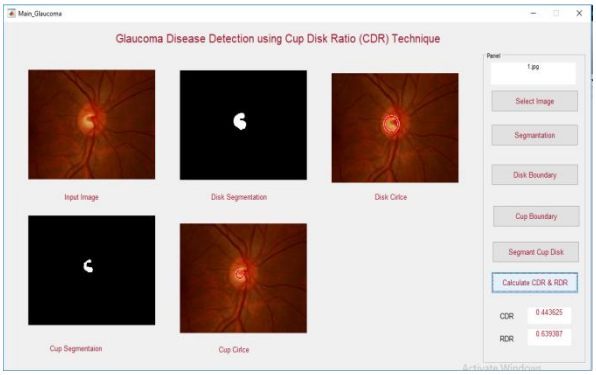
F. Classification:

The task of classification we are using various famous classifiers life support vector machine linear discriminate analyzer decision tree etc. This classifier performs well in various classification problems. here, because we are just doing the the identification of glaucoma disease show our data set belongs to three categories, first category contains the features of patient who are not suffering from glaucoma disease second category contains the features of persons who are at the middle of the risk of having glaucoma disease and third category contains the features of patients who have a very high chances of glaucoma disease.

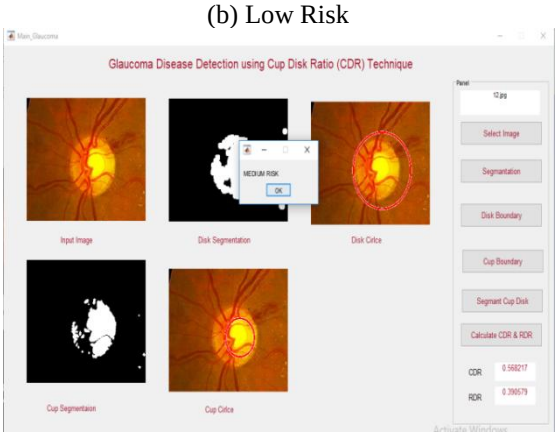
So we have a multi class problem that's why we are using only that classifier we can perform well for multiclass classification

IV. Result Analysis

(a) High Risk



(b) Low Risk

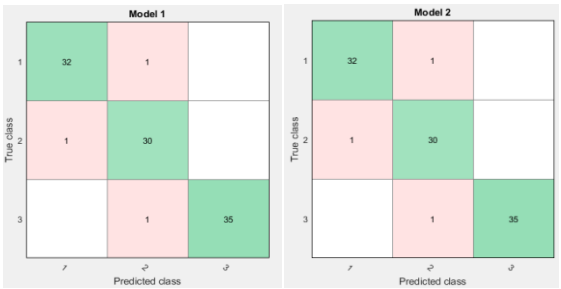


(c) Medium Risk

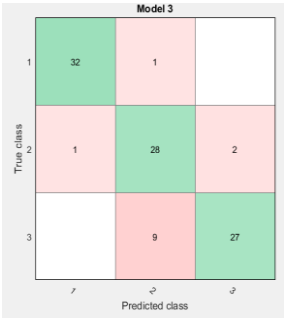
Figure2: (a) high risk of glaucoma, (b) no risk of glaucoma and (c)medium chances of glaucoma

Here, figure (a) shows the high risk of glaucoma, (b) shows the no risk of glaucoma and (c) shows the medium chances of glaucoma disease.

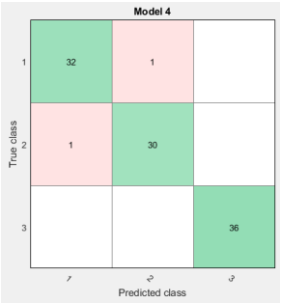
After classification we observe following classification result in the from of confusion matrix.



(a) Decision Tree (b) SVM



(c)LDA



(d)KNN

Finally, accuracy of classifiers can be calculated as:
Accuracy (in percent) = (Sum of diagonal allocations/ Total allocations in matrix)* 100
Accuracy of SVM= (32+30+35)/100 = 0.97 * 100 = 97 %
Accuracy of Decision Tree = (30+32+35)/100 = 0.97 *100 = 97%
Accuracy of LDA = (32+28+27)/100 = 87/100 = 0.87 * 100 = 87%
Accuracy of KNN= (30+32+36)/100= 0.98*100=98%

V. Conclusion

Early detection of glaucoma disease may save several eyes. So, it is very important to detect such disease at early stage with high accuracy. Although this disease can treated with very easily at early stage, but it becomes very risky if not cure timely. In such cases involvement of computer always helps the doctors in detection of such disease with more accuracy. Here, we have analyzed some machine learning techniques for classification of dataset of 100 persons which are belongs to 3 different classes, we found that KNN is one of the more accurate classifiers for detection of such disease because we got the accuracy of 98% for KNN.

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