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Research Article

Automated Glaucoma Detection using Machine Learning Approaches

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Abstract

One among the most common reasons for people surviving with eye disorders or visual impairment around the globe is glaucoma. It is one of the prime roots that is leading to irrevocable blindness in our world today. Manual examination of illness by medical practitioners today do not guarantee precision. Therefore early detection of such flaw in eye is a rising need today and this can be aided by automation of glaucoma detection. Input images used in this proposed work are extracted from DRIVE database that comprises of both images belonging to glaucoma group (abnormal) and normal images. These images Pre-processed by first converting them to RGB (to know which channel among R,G,B can give the highest contrast). Binarization of an image is performed to obtain a BW (black and white) image followed by dilation which is a morphological operation that uses a structuring element to look into the shape and expanding the input image by filling holes and making it more visible. Optic disc (starting of optic nerve) and optic cup (depression in nerve centre) which are terms of interest for glaucoma detection are made clearer. CCL is applied to find ROI which is the optic cup part of the disc here. For feature extraction, cup to disc and rim to disc ratios are extracted. A classifier is built using SVM that gave an overall accuracy of 88% for GLCM and 97% for CDR..

Keywords: Ocular pressure, Optic nerve, SVM, Cup to disc ration , dilation ,morphology, region of interest, connected component labelling, GLCM.

1. Introduction

Glaucoma is an eye chaos that is caused due to the pressure built within the ocular space of an eye which later injures the optical nerve as shown in Fig.1. Ganglia cells within the eye are irritated causing irreparable damage to the eye which is eventually termed as vision impairment. During the initial stages of the disease, symptoms hardly appear but causes unforeseen harm and loss of Eye-sight as the illness progress. Section 2 gives information on literature survey done of glaucoma detection and related works. Section 3 gives information on proposed methodology. Section 4 shows results and section 5 gives conclusion and future scope.

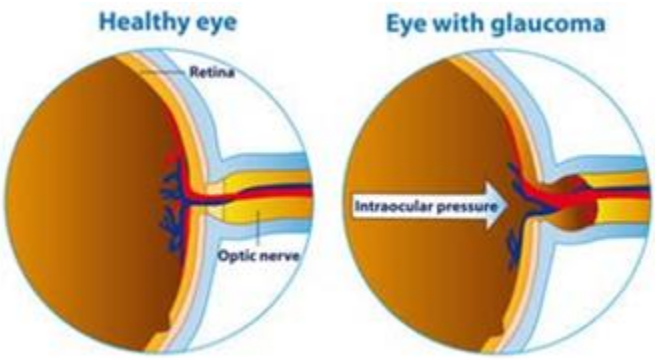

Fig.1 Normal and Glaucoma affected eye

2. Literature Survey

There are tremendous amount of experimental studies conducted for the detection of glaucoma. Few of them are presented here. Guerre.A, Martinez-del-Ricon published a work in 2014 wherein CDR and neuro-retinal (RIM) features of optical nerve were extracted. Post segmentation, SVM classifier with linear kernel is implemented for glaucoma detection [1].U.Rajendra, Acharya (2015) presented a work in which about 510 images were used. Mean, kurtosis, variance etc features along with Shannon, kapoor entropies from Gabor coefficients are extracted. PCA is applied. Different ranking methods are assessed for accuracy where 93.10% is given by t-test ranking method [2]. Ayush Agarwal, Shradha Gulia in their work of 2015, proposed a system in which glaucoma is detected using adaptive threshold based method to segment optic disc, cup. CDR, RDR are calculated. Furthermore SVM is used for classification which gave an accuracy of 90% [3]. Madhusudan Mishra, S.R Nirmala (2011) compared the various image segmentation techniques on fundus images. Region growing segmentation outperformed the other two techniques of multi thresholding and active contours [4]. Sumayya pathan and Preetham Kumar, in their work (2018) presented their proposed work considering fundus image database of 124 retinal images for glaucoma detection. Median/Laplacian filtering, GLCM (for color and texture features) and SVM method is used that resulted an accuracy of 92% [5].

3. Proposed Methodology

Image acquisition:

Input images used in proposed work are derived from DRIVE image database which comprises of 148 images in total. 80 images belonging to glaucoma class and the rest 68 are normal images. The study for automated glaucoma detection proposed here is pictorially depicted in the following Fig.2.

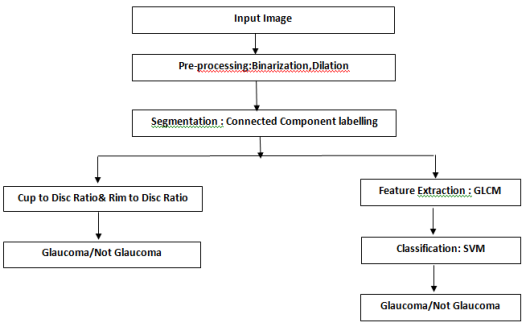

Fig.2 Proposed system architecture

Pre-processing:

Pre-processing goes in three steps. Firstly, the input image is converted to RGB for better channel visualization. Secondly, binarization is done to convert the image into a BW (black and white) image using Otsu method is done. Lastly, dilation is done to fill in the voids of the previous image and it also performs image expansion by adding objects to boundaries.

Segmentation:

Connected component labelling is used for segmentation. Here thresholding of an image is done firstly wherein few connected components are formed like optical disc, outliers and other features. ROI is the one having highest number of pixels (optic cup region of the disc here).

Feature Extraction:

Post CCL, ROI's centroid along with major and minor axes are computed. Length or distance between optic disc and cup are calculated. Here major and minor axes are the longest and the shortest diameter of the image acquired in the last step. CDR, neuro retinal RDR and GLCM statistics are extracted as features (contrast, energy, skewness, correlation, homogeneity, standard deviation, kurtosis).

Classification:

Features obtained in the previous module are used to build a classification model using SVM that analyzes those features and finds a hyperplane that maximizes margin. An example image is given in Fig.3. Dataset used in this proposed work is bifurcated as 70:30 ratio wherein 70% is utilized for training and 30% is utilized for testing. This implies 104 images were trained and the resulting SVM model was tested on 44 images.

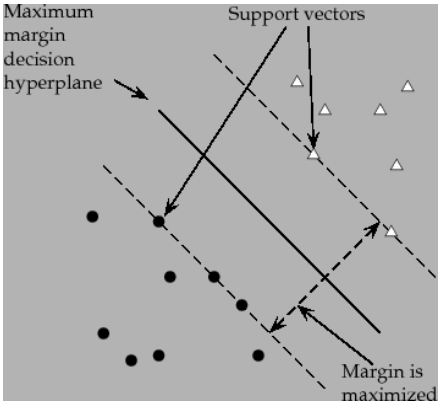

Fig.3 Principle of SVM

4. Results

The input image as in Fig.4. From the image dataset is considered. Pre-processing is done by applying RGB conversion (resulted green channel image is shown in Fig. 5), Binarization (as in Fig. 6) followed by dilation. The disc image and cup image samples are shown in Fig. 7 and Fig. 8. Fig.9 gives the subplot of all the images. CDR (cup to disc ratio) feature extraction along with SVM gives an overall accuracy of 97% and GLCM with SVM showed an accuracy of 88%. All the other performance measures are presented in Table 1.

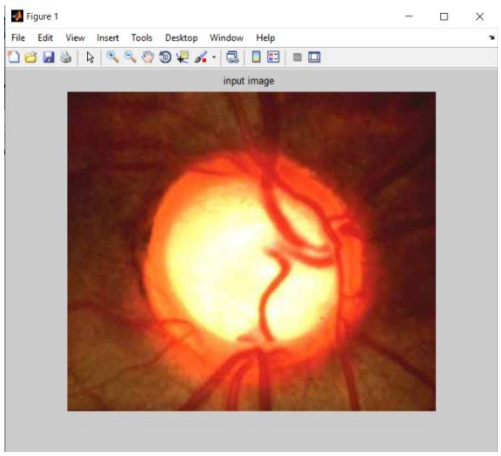

Fig.4 Input image

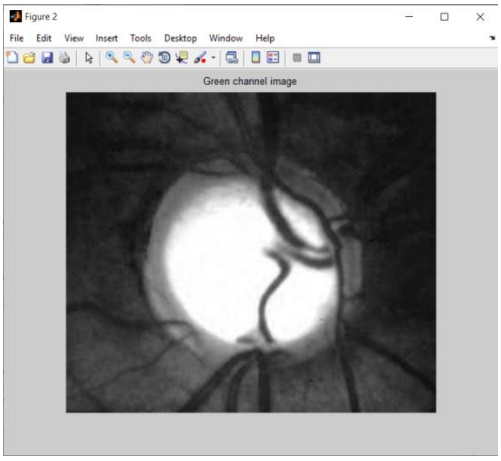

Fig.5 Green channel image

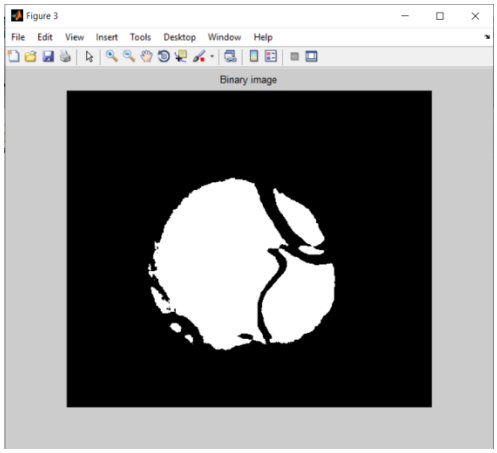

Fig.6 Binary image

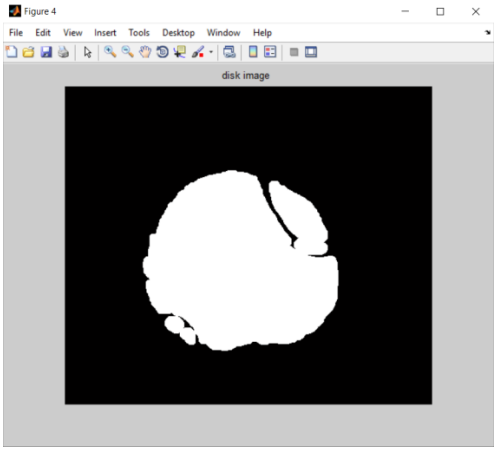

Fig.7 Disk image

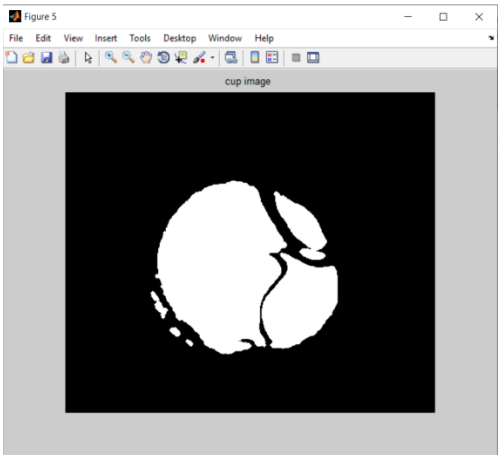

Fig. 8 Cup image

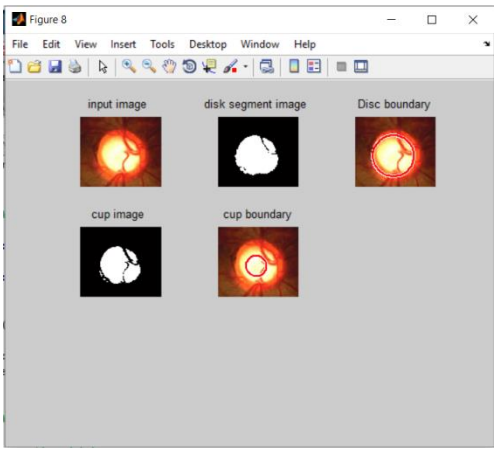

Fig. 9 Subplot of all images

Table.1 Performance measures for CDR and GLCM with SVM

Feature Extraction	Precision	Recall	Specificity	Error rate	Accuracy
CDR	97	82	97.5	2.7	97
GLCM	85	88	89	12.1	88

5. Conclusion And Future Scope

By the entire experimental study made here, the proposed work reached a conclusion that CDR features with SVM outperformed GLCM features. Accuracy post classification is found to be better in terms of CDR features unlike GLCM features. The proposed work presented here can be extended to future medical systems for detection of diseases other than glaucoma like illness affecting retina leading to hypertensive retinopathy, macular dema, degeneration that mainly consider age as a factor of cause.

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