Retinal Health Diagnosis using Image Processing

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Abstract - Vision is most important aspect of human beings. The occurrence of ocular diseases is increasing and diseases like glaucoma, diabetic retinopathy and age-related macular degeneration are the leading causes of blindness. However identifying these diseases is time consuming. So the use of an automatic Computer aided diagnosis system reduce the time taken for analysis it will also reduce error which is occurred during subjective analysis in this work we propose one such method for detection of glaucoma. We had taken 45 normal and 40 abnormal fundus images. In this work the most efficient method for detecting glaucoma is Propose. In order to classify glaucoma Rim to Disc Ratio is considered. Adaptive image thresholding technique is used to segment disc and optic cup. Neuro retinal Rim is obtained from segmented optic disc and optic cup which is used for evaluating Rim disc ratio in order to detect glaucoma. SVM classifier is used to classify the images as Glaucomatic or healthy. After testing on 20 fundus images our proposed method gives result with an accuracy of 90%, sensitivity 98% and specificity 80%

Keywords: fundus image, glaucoma, rim to disk ratio, Adaptive image thresholding, optic disk and optic cup, Neuro retinal rim, SVM classifier

1. Introduction

Glaucoma is an ocular disorder which leads to permanent blindness in humans beings. It especially occur in aged humans beings. As the order is irreversible it is important to detect in it's early stages. Techniques used by Ophthalmologist are time consuming so in this paper we proposed a technique for detecting glaucoma in low time with the higher accuracy.

2. Proposed Method for Glaucoma Detection

2.1 Pre Processing and filtering

The proposed method for the detection of glaucoma employs, RGB fundus image is used as an input. It is filtered using a noising filter. It removes noise.

In order to detect glaucoma, the most important region of interest is the optic disk. Therefore, instead of processing on the whole retinal image, we focus on region around optic disk and extracted it[3]. This ROI is a minor image which helps in faster processing and automated screening of glaucoma. The Block diagram of proposed method is described in Fig 1

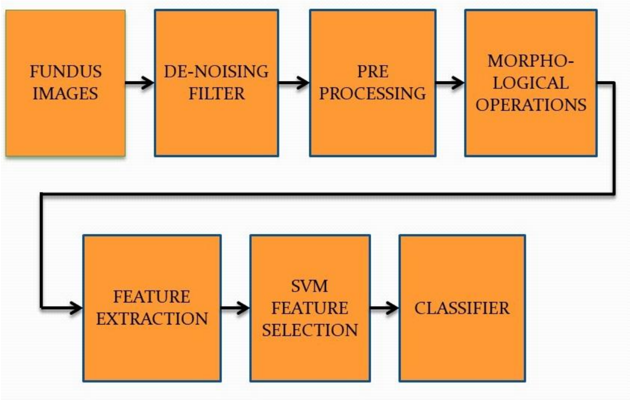


Fig.1: Block Diagram for Glaucoma Detection

2.1.1 Region of Interest

In order to extract ROI first we compute centre of the optic disc. A window of dimension r*column is created. Where r is radius of optic disc. Then the window is passed through the image spatially for all rows and obtaining the Maxima we find row of the centre of the optic disc. Another window of dimension r*r is created. Window is passed through the all columns of detected row. Hence the coordinates of centre of optic Cup is obtained

2.2 Morphological operations

To decompose an image in visually homogeneous regions we use a simple and efficient technique of SLIC. It is based on a spatially localised version of K means clustering initially we divide image into grid. The size of the grid is step region. To initialise a corresponding K means we used the centre of each grid tile. Finally segmented image yielded by refining the K means centre and clusters.

2.3 Feature Extraction

2.3.1 Optic Disc Segmentation

The extracted ROI image consist of three channels that is red green and blue. To detect optic disc red channel is used. We preferred red channel because optic disc appear to be the brightest and blood vessels are also suppressed in this channel. Hence it is easier and accurate to segment optic disc in red channel of input image. Adaptive thresholding technique is used to segment the optic disc.

2.3.2 Optic Cup segmentation

Optic Cup is segmented using Green channel of ROI image. Statistical features such as mean standard deviation of Green channel is calculated.

Mean and standard deviation is calculated by using following formulas

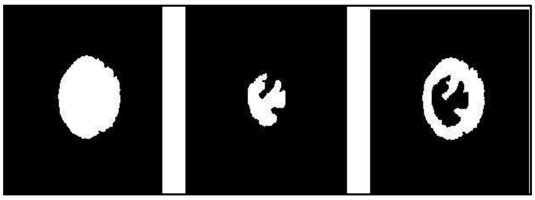
$X=1/N\ xi$……………………….(1)

$\sigma^2 = 1/N\ (xi - X)^2$.........(2)

Standard deviation is defined as the square root of variance. Optic cup and optic disc is segmented by determining the Threshold level of histogram of each image. From the statistical patterns of histogram we know that mean is Central tendency and the standard deviation is the dispersion from that Central value.

2.3.3 Neuro retinal Rim

Neuro retinal rim is the region located between the edge of optic disk and optic cup. After segmenting of optic disk Fig 2.3.3(a) and optic cup Fig 2.3.3(b), Neuro Retinal Rim is obtained by subtracting optic cup from optic disk. Neuro Retinal Rim is shown in Fig 2.3.3(c).



(a) (b) (c)

Fig.2.3.3: (a) Segmented optic disk image (b) Segmented optic cup image (c) Neuro Retinal Rim image

The change in appearance of this area helps in identifying damage to the disk due to glaucoma. Thickness of the rim is an important parameter to detect whether the fundus image is glaucomatic or not [17][18]. The healthy optic disk is thicker in inferior portion than in superior of the image. In a glaucomatic eye, optic cup increases in its area vertically reducing the thickness of the rim in infero - temporal disk sectors. Consequently rim-disk ratio for infero-temporal region of the rim can be evaluated to determine glaucoma.[2]

2.4 Classification

Classification of images as glaucomatic or healthy can be done based on two parameters 1.Cup to disc ratio and 2.Rim to disc ratio

2. 4.1 Cup to Disc Ratio

Cup disc ratio is the first parameter we use to detect glaucoma. CDR is defined as ratio of total segmented cup area to segmented disc area.

CDR = Optic Cup Area/Optic Disc Area**…..(3)**

Cup area and disc area are obtained by summing all the white pixels in segmented cup and disc. Then CDR is calculated if this value is greater than 0.3 then the fundus image is considered as glaucomatic else it is healthy

2.4.2 Rim to Disc Ratio RDR

CDR itself is not sufficient to detect whether the eyes glaucomatic or not. Sometimes patient is diagnosed inappropriately due to large optic cup in presence of large optic disc and has healthy Rim tissue. Therefore neuro retinal rim tissue plays vital role in detection of glaucoma.

RDR is calculated

RDR= Rim area in infero-temporal region/ Disk **Area…….. (4)**

RDR is less than or equal to 0.4 then the fundus image is considered to be normal glaucomatic else healthy. After calculating these parameters we use these parameters to train SVM classifier to detect glaucoma.

2.5. SVM Classifier

The Support Vector Machine (SVM) is a popular data classification technique, which was proposed by Vapnik and his group at AT&T BELL Laboratories. Generally speaking, the SVM is a supervised learning method that can analyze data and recognize patterns. It has been widely used in human face recognition, handwriting recognition, and vehicle license the recognition and can outperform other competing methods in most cases.

The main concept of the SVM is to construct a hyper-plane or a set of hyper-planes in a high or infinite dimensional space, and use them to classify the data. Among the possible hyper-planes, SVMs select the one where the distance of the hyper-plane from the closest data point is as large as possible. The distance between this data point and the hyper-plane is known as the margin.

Figure.2.5.1 shows the geometric interpretation of the SVM, the figure on the left presents a large margin whereas the image on the right displays a small margin. As a result, the hyper-plane on the left is more desirable than the one on the right for the purposes of classification.

SVM classifier is trained with previously calculated parameters of CDR RDR. SVM classifier will bifurcate the diseased pixel and normal pixel based on the previously calculated parameters. Based on that we can detect weather the person is affected with glaucoma or not.

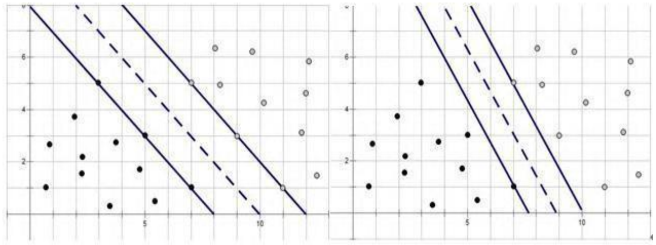


Fig. 2.5.1 Geometric interpretation of SVM

3. Results

The algorithm has been applied to retinal images of normal and glaucomatic eyes from open source data base as well as data from local hospital database the statistical results of all these cases are shown in Table3.1. Accuracy Specificity and Sensitivity results during testing are given in Table 3.2.

Table3.1. Accuracy Specificity Sensitivity results

Classifier	Accuracy	Specificity	Sensitivity
SVM	93%	80%	98%
Random Tree	89%	75%	95%

Table 3.1 statistical results of all cases

S. No	Region	Area (Pixels)	RDR	Exp. Result
1	Rim	6210	0.7261	Abnormal
	Optic disk	8552		
2	Rim	7213	0.7456	Abnormal
	Optic disk	9673		
3	Rim	3672	0.3888	Normal
	Optic disk	9540		
4	Rim	2424	0.2864	Normal
	Optic disk	8461		
5	Rim	2327	0.2272	Normal
	Optic disk	10240		
6	Rim	5720	0.4412	Moderate
	Optic disk	12964		
7	Rim	3950	0.3285	Normal
	Optic disk	12022		
8	Rim	3951	0.4930	Moderate
	Optic disk	9508		
9	Rim	5692	0.5766	Abnormal
	Optic disk	9871		
10	Rim	6421	0.7153	Abnormal
	Optic disk	8976		

4. Conclusions

An efficient method for detecting glaucoma is proposed in this project. In order to detect whether the input images is glaucomatic or healthy ocular parameters are calculated. Adaptive image thresholding technique is used to segment optic disc and optic cup which makes the proposed method independent of image quality. Neuro retinal Rim is obtained from segmented optic disc and optic Cup which is used to evaluate disc ratio in Infero temporal regions which helps in screening glaucoma. SVM classifier is used to classify fundus images as glaucomatic or healthy. As we are using SVM we get classification more accurately compared to previous random tree because in random tree we assign value of one for diseased pixel and 0 for normal pixel. But SVM classifier will bifurcate the diseased pixel and normal pixel based on the values obtained from ocular parameters calculated previously to train the SVM classifier. As we are using SVM we get classification more accurately compared to previous random tree. When tested on a large data set of 20 fundus images, the proposed method gives promising results over 90% accuracy, 98% sensitivity and 80% specificity.

Future work may involve extracting more parameters in fundus image which reflects glaucoma symptoms such as disk hemorrhage, focal notching, peripappilary atrophy, ISNT ratio, etc. Study of these factors requires deep processing of fundus image. Extending these parameters to the proposed work can make the system more automatic and reliable giving greater accuracy.

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