Hybrid Feature Extraction in Retinal Fundus Images used in Glaucoma Detection

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Abstract— Glaucoma is caused due to unawareness in people which can be resulted in to the blindness. For patients affected by this, mass screening can be the best curable solution which can help to extend symptom-free life. Using hybrid feature extraction from digital fundus images, we propose a novel low cost automated glaucoma diagnosis system. Higher order spectra (HOS) and discrete wavelet transform (DWT) features are used for automated identification of normal glaucoma classes. Vector machine (SVM) classifier with linear, radial basis function (RBF) and polynomial order 1, 2, 3 are the extracted features fed to support in order to select the best kernel for automated decision making. Our results shows that the combination of HOS and DWT features in feature extraction performs better than the other feature extraction and correctly identifies the glaucoma images with an accuracy of more than 92.48%. System proposed by us is having clinically significance features and this system can be adopted for detecting glaucoma with accurate results.

Key words: Glaucoma, Hybrid Feature Extraction, Retinal Fundus Images, SVM Classifiers

I. INTRODUCTION

Glaucoma is caused by increased intraocular pressure (IOP) due to the malfunction of the drainage structure of the eyes. Glaucoma is an eye disease in which the optic nerve is damaged in a characteristic pattern. Glaucoma is the second leading disease worldwide, which may cause blindness and results into neuron degeneration of the optic nerve. It may be possible that the people having high eye pressure they never have damage and damage developed to the people having relatively low eye pressure, and that causes glaucoma. Untreated glaucoma can result to vision loss and permanent damage of the optic nerve, which over time can resulted into the blindness. It is estimated that within next 5 years, approximately 11.1 million people from all over the world will suffer from glaucoma which will cause bilateral blindness. In India, it is calculated that approximately more than 11.2 million people from age group above 40, suffer from glaucoma and it is believed that these figure can restricted with effective detection and treatment options. Basically computational analysis techniques for retinal images are used for the assessment of eye images.

There are several papers regarding each sub area of my dissertation area. There are summery regarding papers, books and e-materials which I have studied during my literature survey period. At the end, definition of my dissertation work is shown as conclusion from this survey. In order to identify these diseases at a preliminary stage by differentiating a normal and glaucoma affected retinal images, for that we have proposed a novel approach, to extract the energy signatures from provided dataset using which two dimensional discrete cosine transform and subject them to classification process. The texture features are obtained using three different wavelet filters and the selected features are subjected to two different classifiers to obtain higher accuracy level of differentiation.

Fig. 1: Normal And Glaucoma Eyes[12]

Many computational techniques are available automated clinical decision support systems (CDSS) in ophthalmology, such as CASNET/glaucoma is designed to create effective decision support systems for the identification of disease pathology in human eyes. These CDSS have used glaucoma as a predominant case study for decades by extracting structural, contextual or textual features from retinal images. For reducing the variability, that may be arrived due to different tracking progression of structural characteristics in the eyes by the clinicians.

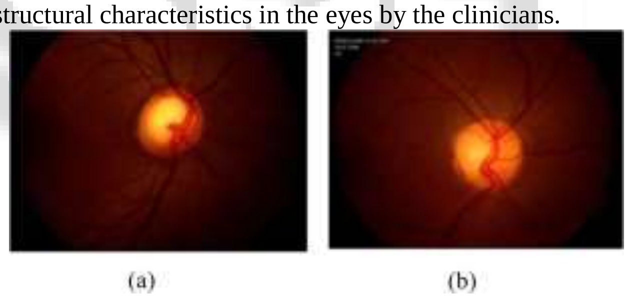

Fig. 2: Typical fundus images (a) Normal. (b) Glaucoma[12]

Proper orthogonal decomposition (POD) is another technique that uses structural features to identify glaucomatous progression. Pixel level information like location or region specific and the texture features is known as the spatial variation of pixel intensity. Glaucomatous image classification can also be done using texture features and higher order spectra (HOS) features. With the use of textural features, these are not cover to specific locations on the image which results in to low accuracy and still its difficult challenge to generate features to retrieve generalized structural and textural features from retinal images. By using Higher Spectra order, the accuracy to determine the glaucoma disease is low. The Combination of random-forest classifier with Z-score normalization and feature selection method with low accuracy. So using a better classifier and better features we can improve the accuracy and also using more retinal fundus images of normal and glaucoma can enhance the percentage of correct diagnosis.

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II. MATERIAL USED

The digital retinal images were collected from the Doctor Library, India. We have used 70 fundus images: 35 normal and 35 open-angle glaucoma images from 20-to-70-year-old subjects. The doctors in the Ophthalmology Department of the hospital the images are certified by the doctors in the Ophthalmology Department of the hospital of quality and their usability of the images. The consisting of senior doctors in the ethics committee of college, approved the images for this research purpose. All the images were taken with a resolution of 720 × 1080 pixels and stored in JPEG format. The fundus camera along with a microscope and light source were used to acquire the retinal images to diagnose diabetes retinopathy, glaucoma, etc. Fig. 2(a) and (b) shows the typical normal and glaucoma fundus images, respectively.

III. IMAGE PROCESSING

The pre-processing step consists of image contrast improvement using histogram equalization and radon transform was performed for HOS feature extraction. Histogram Equalization method is for the usable data of the image is corresponded by close contrast values, which is generally increasing the contrast of the images. On the histogram, the intensities of the pixels can be allotted nicely through this type of adjustment. The histogram equalization usually used to gain a higher contrast form areas of lower local contrast. Histogram equalization carried out this by effectively spreading the most frequent intensity values of the pixel. This is more often used for enhancing the fundus image contrast and images converted in RGB to Gray scale,

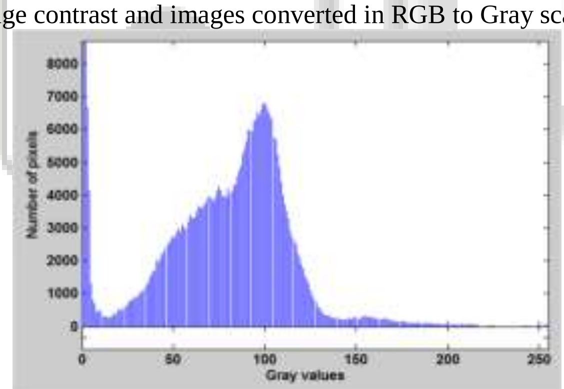

Fig. 3: Histogram equalizer[10]

Image change or palette change are the two basic ways for implementation and thinking of histogram equalization. The operation can be expressed as P(M(I)) where I is the original image[10], where P is a palette and M is histogram equalization mapping operation. If we define a new palette as P'=P(M) and leave image I unchanged then histogram equalization is implemented as palette change. The implementation is by image change if image data is modified to I'=M(I) and palette P remains unchanged. In most cases, palette change, preserves the original data so it is better than Image change. *Radon Transform* is having minimal computational requirements to perform many useful features, have ability to differentiate objects with proper mathematical properties, but accordingly to human perception, these features of Radon transforms, devoid physical meaning.

For creation of an image from cross sectional scans of object, that is associated with scattering data in computed tomography, radon transform is widely used. Radon transform transforms, lines into domain of line parameters within 2D images, every line will give a sign to reflect to the corresponding line parameters that are positioned. Hence, lines, are going to transforming in points to the Radon domain in the original image.

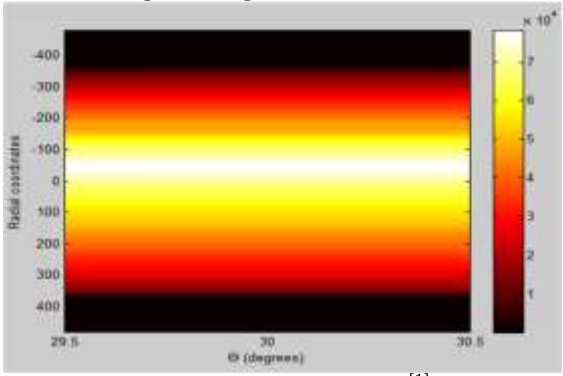

Fig. 4: Redon Transform [1]

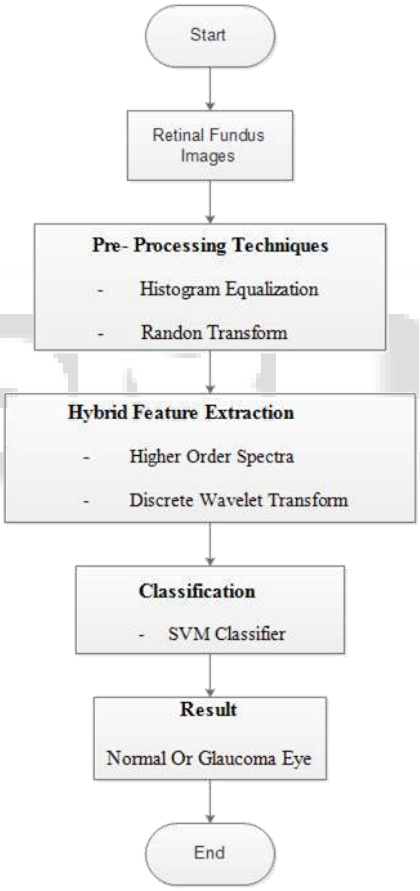

Fig. 5: Flowchart of Proposed System

IV. FEATURE EXTRACTION

A. Higher Order Spectra

In this, we have used the third order spectra which is generally called as “bispectrum”, for that we have to derived the bispectral phase entropy (P_h) of the bispectrum, entropy 1 (P_1), entropy 2 (P_2), and entropy 3 (P_3). These entropies are related to the spectral entropy. The Higher Oder Spectra is a nonlinear method in which measured elusive changes in image pixels. The Higher order spectra is used higher order derivation which is starts with second order statistics which

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evaluate both mean and variance, the mean and variance of the spectra is define by the below equations

$$m_{\Delta} - E\{A\} \; and$$
$$\sigma_A{}^2 - E\{(A - m_{\Delta})^2\}$$

If A is a time discrete signal, the second order moment autocorrelation function is:

$$m_{\Delta}{}^2(i) - E\{(A(n) \times A(n+1)\}$$

Higher order spectra are generally used for shape recognition in many eye diseases. It is used in different kinds of eye diseases to identify. HOS is a nonlinear method which captures different changes in image pixels. The third order statistic of higher order, which is generally used to deterministic and random signals called "bispectrum", was used in this work.

$$B(f_{1\,,}\, f_2) = E\{A(f_1)A(f_2)A^*(f_1 + f_2)\}$$

Where,

A*(f)* is the Fourier is transform of the signal a(nT) and $E\{.\}$ is define as the average over random signal realizations.

B. DWT based Energy Features

In order to extract the energy signatures, The Discrete Wavelet Transform is commonly used to extract the energy signatures by using the three different filters which is having a name as Daubechies, Symlets and Biorthogonal. We will use the filter namely high-pass filters and low-pass filters. The average and energy calculation resulting of the image in feature extraction obtained by wavelet coefficient using the above filters. Wavelets are decomposes data into different frequency components and use the mathematical functions. Continuous wavelet transforms (CWT) and Discrete Wavelet Transform (DWT) is generally used for Multiresolution analysis. The wavelet analysis separates a signal in the coarsest scale with hierarchy of scales starting; on the other side The Fourier transform separates a signal into a spectrum of frequencies. The DWT transform of a 2D signal is generated by sending the signals through a sequence of down-sampling high-pass filters and low-pass filters.

V. CLASSIFIER

The support vector machine (SVM), which is based on statistical learning theory invented by Vapnik in 1995 and Cherkassky and mulier in 1998. SVM is a universal constructive learning procedure. Classification with Support Vector Machines (SVM) has recently been explored by two groups for the task of brain tumor segmentation and represent a more appealing approach than ANN models for the task of binary classification since they have more robust (theoretical and empirical) generalization properties, achieve a globally optimal solution, and also allow the modeling of nonlinear dependencies in the features.

1) Data Setup: In our dataset, it contains three classes, each data having N samples. The data is in 2D plot original data.
2) SVM with linear kernel (-t 0): Here, in this we want to find the best parameter.
3) Value C using two-fold cross validation technique with 1/2 data to training set and the other 1/2 data to testing set.
4) In third step, we train the whole data again using C parameter value after finding the best parameter value for C.
5) In fourth step, plot support vectors.
6) In fifth step, plot decision area using support vectors.

Input vectors to a higher dimensional vector space are mapped by Support Vector Machine (SVM), where an optimal hyper plane is developed. Only one hyper plane, which maximizes the distance between the nearest data vectors of each category and itself from the many other hyper planes available. The hyper plane known as the optimal separating hyper plane which maximizes the margin. The maximize margin is known as the sum of distances of the hyper plane to the closest vectors of each category.

Expression for hyper plane:

$$\mathrm{w} \times \mathrm{x} + \mathrm{b} = 0$$

Where,

x is given as Set of training vectors, w is the vectors perpendicular to the separating hyper plane and b is offset parameter which allows the increase of the margin.

And the margin between two hyper plans can be given by:

Margin is d1+d2

Where,

d1 is the margin between hyper plan and training support vectors and d2 is the margin between hyper plan and testing support vectors. When a linear function of data is not a decision function and, rather than fitting non-linear curves to the vector space for separating data, when a non-linear transformation data maps to the input space, we have to use Kernel function. The classification task is good to scale high dimensional data relatively well, tradeoff between classification error and complexity of classifier can be controlled explicitly.

VI. RESULT

As we shows the graph of existing system and our proposed system which is in figure6 and figure7, the values of normal and glaucoma eyes in the proposed system is less value compared to existing system which is shown in both HOS and DWT features of proposed system. For correct diagnosis the result of glaucoma we need the less values of normal eyes and glaucoma eyes images which are nearer to p-value. In our proposed system we obtain the values of normal and glaucoma at each of every parameter in both HOS and DWT features are less and nearer to p-value.

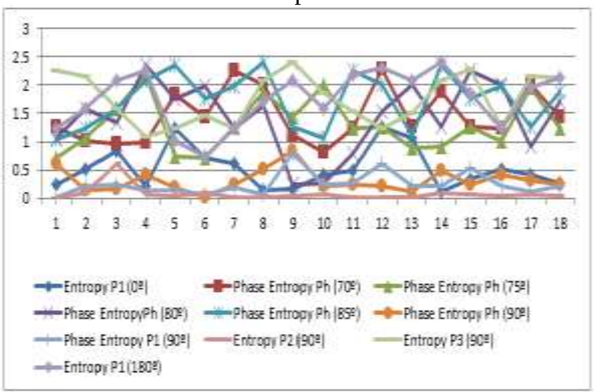

Fig. 6: Data distribution of various HOS features for a variety of images in Proposed System

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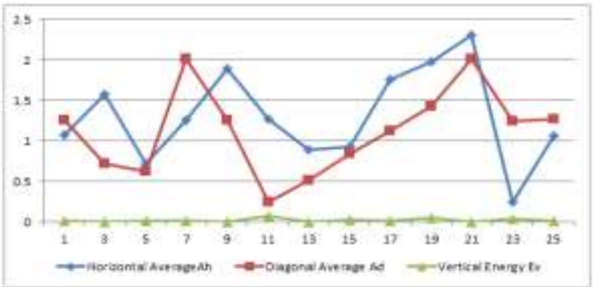

Fig. 7: Data distribution of various DWT features for a variety of images in Proposed System

VII. CONCLUSION

The present illustrates various methods and techniques used for Glaucoma Detection. Glaucoma represents pathology of multifactorial etiologic, so set up an objective alteration in the various diagnostic tests that represents the principal element for the performance of a certain diagnosis of glaucoma. We illustrate the demerits of this methods and technique. To overcome this demerits and apply a new technique and methods to improve the diagnosis of glaucoma detection result such as Hybrid Feature Extraction and SVM Classifier to improve the diagnosis of glaucoma detection. We obtain the high accuracy to diagnosis the glaucoma with the specificity and sensitivity parameters. The accuracy of the classification can be improved using more data as training images also choose the better features and better classifiers for the improving accuracy of the system. The percentage of correct diagnosis is further improved by using the more diverse digital fundus images of normal and glaucoma eye.

REFERENCES

[1] Dua S., Xian Du, Vinitha Sree S., "Automated Diagnosis of Glaucoma Using Texture and Higher Order Spectra Features", IEEE Computer Society, 24 February 2011, Page(s):449 – 455, ISSN :1089-7771
[2] Choudhary K., Wadhwa S.,"Glaucoma Detection Using Cross Validation Algorithm", IEEE, 8-9 Feb. 2014, Page(s):478 – 482, ISSN:2357-0028
[3] Khan S.A., Yasin U.U., Ul Haq I., "Detection of glaucoma using retinal fundus images", IEEE, 23-25 Oct. 2013, Page(s):1 – 5, ISSN: 978-1-4799-1466-1
[4] Blalasubramanian M., Bowd C., Weinreb R.N., "Glaucoma progression detection using variational expectation maximization algorithm", IEEE, 7-11 April 2013, Page(s):876 – 879, ISSN :1945-7928
[5] Hoover A., Goldbaum M.," Locating the optic nerve in a retinal image using the fuzzy convergence of the blood vessels", IEEE Engineering in Medicine and Biology Society, Aug. 2003, Page(s):951 – 958, ISSN :0278-0062
[6] Sanchez CI, Hornero R, Lopez MI, Poza J.," Retinal Image Analysis To Detect And Quantify Lesions Associated With Diabetic Retinopathy", IEEE Eng Med Biol Soc., 2004, Page(s):1624-7, ISSN:1254-2865
[7] Abramoff, M.D., Niemeijer M., Viergever M.A., "Ridge-based vessel segmentation in color images of the retina", IEEE Engineering yin Medicine and Biology Society, April 2004, Page(s):501 – 509, ISSN :0278-0062
[8] N. Annu, Judith Justin., "Automated Classification of Glaucoma Images by Wavelet Energy Features", International Journal of Engineering and Technology (IJET), Vol 5, No 2, Apr-May 2013, Page(s):386-390, ISSN:1716
[9] Giribabu kande, p. Venkata subbaiah, T. satya Savithti, "Feature Extraction in Digital Fundus Images", Journal of medical and biological engineering, Page(s):122-130, 2 January 2009, ISSN: 1856-2006
[10] Gonzalez, Woods, And. Eddins, Digital Image Processing Using MATLAB 2nd Ed., 2009
[11] K.P. Soman, R. Loganathan, V. Ajay, Machine Learning With SVM And Other Kernel Methods, PHI Learning Pvt. Ltd., 02-Feb-2009
[12] Normal And Glaucoma Eyes http://www.doctor2020vision.com/eye-library(2nd November, 2014, 4:38 PM)

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