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Automated Cataract Diagnosis

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Abstract: ***Cataracts are the cause of half of blindness and 33% of visual impairment worldwide. It causes blurred and foggy vision. A Protein layer will develop gradually in the eyes and the lens become cloudy over a long time period. By timely detection, it is possible to prevent cataract surgery in the initial stage of it. There are various Automatic Cataract detection and classification methods available today. All the Cataract detection and classification systems have 3 basic steps: Preprocessing, Feature extraction and Classification. In this paper some of the recent methods are discussed and analyzed. In the proposed methodology, the texture features are extracted using 2-D discrete wavelet transforms. The image features obtained from five different wavelet filters db3, sym3 and (Bior 3.3, Bior 3.5, Bior 3.7) are used to classify the images The z-score normalization is applied on features before classification. The features are then used in the automatic classifier such as SVM for the automatic classification***

Keywords: Daubechies-db3, Symlet-sym3, Biorthogonal-Bo3.3, bior3.5, bior 3.7, support vector machine-SVM

1. Introduction

The Human eyes are an organ which reacts to light and pressure. A cataract is a clouding of the lens in the eye that affects vision. Most cataracts are related to aging and are very common in older people. The lens lies behind the iris and the pupil. It works much like a camera lens. It focuses light onto the retina at the back of the eye, where an image is recorded. The lens is made of mostly water and protein. The protein is arranged in a precise way that keeps the lens clear and lets light pass through it. But as we age, some of the protein may clump together and start to cloud a small area of the lens. This is a cataract. Over time, the cataract may grow larger and cloud more of the lens, making it harder to see. Aging and exposure to sunlight can cause cataracts. Changes in your eyes are often a normal part of aging. But the changes do not always lead to cataract. Cataracts can also happen after an eye injury, as a result of eye disease, after you use certain medicines, or as a result of health problems such as diabetes. Sometimes children are born with cataracts. Signs and symptoms of cataracts include: Clouded, blurred or dim vision, Increasing difficulty with vision at night, Sensitivity to light and glare, Need for brighter light for reading and other activities etc. Poor vision caused by cataracts may also result in an increased risk of falling and depression. Cataracts are the cause of half of blindness and 33% of visual impairment worldwide. Early treatment and prevention of cataract have been detected. Certain measures can be taken to slow their progression, such as by wearing antiglare sunglasses. When the cataracts have progressed enough to. seriously impair the vision and affects daily life, the cataract surgery is necessary. Cataract surgery is simple and relatively painless procedure to regain vision. Cataract surgery is very successful in restoring vision. During surgery, the surgeon will remove the clouded lens, and in most cases replace it with a clear, plastic intraocular lens (IOL). For cataract detection and grading, there are four main kinds of checking methods at present. The first one is light focus method; The second one is iris image projection, the third one is slit lamp illumination, The last one is ophthalmoscopic transillumination. However, manual assessment can be subjective, time-consuming and costly. Therefore, from the social and economic points of view, it is very consistent to achieve automatic cataract detection. It was clear to us that we should focus on eye care because it is an area where we can make a real difference to people's lives across the world. A new technology based on Fundus images has been put forward, on which works are done rarely, but produce possible better result in low cost. Nowadays Cataract is a very common disease among aged people. So the health authorities and social welfare associations are conducting Cataract detection camps. As this is intended for common rural people and the camps are very crowded, the system can be used for mass screening which is very help full for the people to reduce the waiting time. An automatic Cataract detection and classification system is necessary for detecting the types of Cataracts using image processing technology.

2. Overview

For cataract detection and classification systems uses slit lamp, retro-illumination, Fundus images. Silt lamp images are normally used for the classification Normal, Cataract and post Cataract and to grade the Nuclear Cataract. Retroillumination images are used to grade Cortical and PSC Cataract. Finally the new technology based on fundus images classifies the optical images based on severity and is graded to four classes: Normal, Mild, Moderate and Severe as is defined in figure 1 Cataract identification and classification system consist of basic three steps:- Preprocessing, Feature Extraction, Classifier construction as shown in Figure 2. In pre-processing step all the unwanted information are removed and this makes the image suitable for further steps. In feature extraction, the important features are extracted. Depending upon these features the classification is done. The features should be extracted from all the images and we will get different result for each class. For these two steps, different image processing techniques are used. The final step is classification. According to the features extracted, the classifier classifies the images into different classes. For that different artificial intelligence and neural network techniques are used. These are the three common steps mainly used in all the papers of Cataract detection and classification.

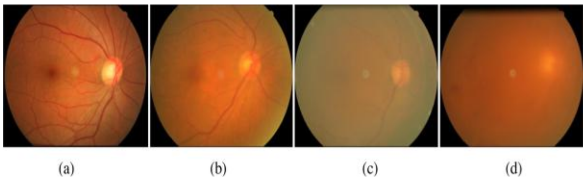

Figure 1: Fundus images of non-cataract and cataract in different grading a) non cataract b) mild c) moderate d) severe

3. Literature Survey

In [1], automated classification of normal, cataract and post-cataract optical eye images using SVM classifier is implemented. In this work author uses image processing techniques to detect the features in the three classes of optical eye images such as normal, cataract and post-cataract images. The features of the optical eye images such as big ring area (BRA), small ring area (SRA), edge pixel count (EPC) and object perimeter are extracted. These features are statistically analysed and found to be significant for the automatic classification. Based on these features SVM classifier is used to classify the optical images

In [2], a system for detection of the cataract and to test for the efficacy of the postcataract surgery using optical images is proposed using AI techniques. Image processing and fuzzy K-means clustering algorithm is applied on the raw optical images detect the features. Then the back propagation algorithm is used for the classification.

In [3] cataract is detected and graded using deep convolution neural network, the RGB image is converted to green channel inorder to get clear image and to reduce the amount of data by 2/3 by extracting the single channel of the image. In [4] investigate the discriminatory potential of wavelet features obtained from the daubechies (db3), symlets (sym3), and biorthogonal (bio3.3, bio3.5, and bio3.7) wavelet filters. Propose a novel technique to extract energy signatures obtained using 2-D discrete wavelet transform, and subject these signatures to different feature ranking and feature selection strategies and classify using SVM, sequential minimal optimization, random forest, and naive Bayes

4. Methodology

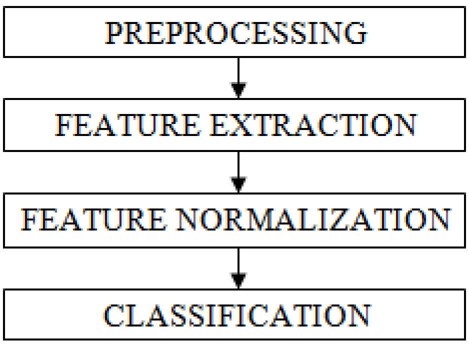

Figure 2: Flow chart

a) Image Preprocessing

The database contains variety of color fundus images of people having of different size and resolution. In image preprocessing, all the images in database arranged in same dimension by resizing and the original fundus images are converted from RGB color space to the green channel. From the figure 3 it is clear that the green channel is the most clear one. The RGB color model is composed of red, green and blue. In general, each pixel of the RGB image is represented by 24-bit data, the three primary colors each accounts for 8-bit, every primary colors can show 256 different concentrations of hue. Thus it can reduce the amount of data by 2/3 by extracting the single channel of the image, as well as achieving the effective compression of the data and greatly reducing the processing time of data

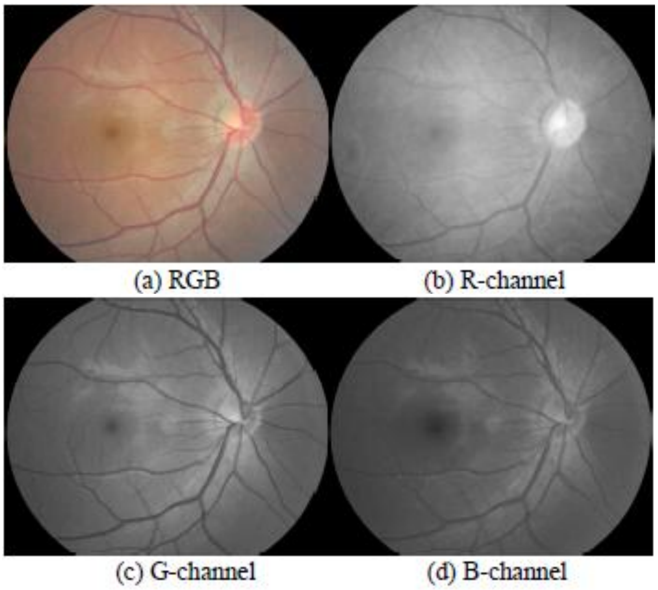

Figure 3: Channel conversion

b) Discrete wavelet transform

Extracting appropriate features from fundus image, which can represent different cataract degrees, plays an important role in automatic classification and grading system. The non-cataract fundus image shows clear optic structure details, such as vessels and macular. On the contract, those cataract fundus images appear less optic structure details. For this reason, an intuitive approach to select features sensitive to different grading of cataract, is to use the localized features related to the high frequency components, such as the details related to edges or sudden small peaks. These details are usually hard to be recognized and quantitatively assessed in space domain but obvious in frequency domain. According to such considerations, in this paper, discrete wavelet transform (DWT) used for the analyses of localized features in signals are investigated for cataract feature extraction.

The DWT captures both the spatial and frequency information of a signal. DWT analyses the image by decomposing it into a coarse approximation via low-pass filtering and into detail information via high-pass filtering. Image is decomposed) into four sub band namely approximate component (LL Band), horizontal component (LH Band), vertical component (HL Band) and diagonal component (HH Band) as shown in figure3. Image is applied to row wise and column wise filtering by Low Pass Filter (L. P. F.) and High Pass Filter (H. P. F.) as shown in the following figure4.

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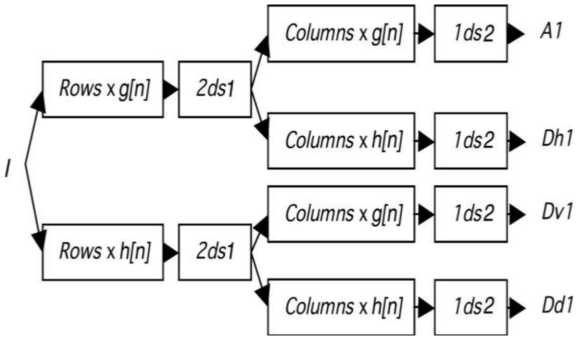

Figure 4: 2D-DWT decomposition

As is evident from Fig.4, the first level of decomposition results in four coefficient matrices, namely, A1, Dh1, Dv1, and Dd1. Since the number of elements in these matrices is high, and since we only need a single number as a representative feature, we employed averaging methods to determine such single valued features. The definitions of the three features that were determined using the DWT coefficients are in order. Equations (1) and (2) determine the averages of the corresponding intensity values, whereas (3) is an averaging of the energy of the intensity values.

$$\text{Average } Dh1 = \frac{1}{p \times q} \sum_{x=\{p\}} \sum_{y=\{q\}} |Dh1(x,y)|$$

$$\text{Average } Dv1 = \frac{1}{p \times q} \sum_{x=\{p\}} \sum_{y=\{q\}} |Dv1(x,y)|$$

$$\text{Energy} = \frac{1}{p^2 \times q^2} \sum_{x=\{p\}} \sum_{y=\{q\}} (Dv1(x,y))^2$$

In this paper, we quantitatively examine the effectiveness of different wavelet filters on a set of fundus eye images by employing the standard 2-D-DWT. We propose to use three well-known wavelet filters, the daubechies (db3), the symlets (sym3), and the biorthogonal (bio3.3, bio3.5, and bio3.7) filters. We calculate the averages of the detailed horizontal and vertical coefficients and wavelet energy signature from the detailed vertical coefficients. We subject the extracted features to a feature normalization schemes to determine the best combination of features to maximize interclass similarity and aid in the convergence of classifiers, such as the support vector machine (SVM).

c) Feature Normalization

To compare the set of features, it is essential to normalize the feature. We have adapted the z-score normalization scheme where data of 1 features are normalized with zero mean and unit variance. Computation of mean (M) and standard deviation (std) of feature vector are given

$$y_{\text{new}} = \frac{y_{\text{old}} - \text{mean}}{\text{std}}$$

Where yold is the original value, ynew is the new value, and the mean and std are the mean and standard deviation of the original data range, respectively.

d) Classification

After the detection of features, the normal and abnormal images are separated by using the SVM classifier. Amongst the abnormal images, the SVM classifier can classify whether an image is moderately or severely affected. It is a supervised learning model which has associated learning algorithms that analyse data and recognize patterns used for classifications. It can discriminate the input data to decide which of two classes it belongs to. Basically SVM is a linear classifier but in general the feature vectors belonging to two different classes are not linearly separable. To handle this issue kernel trick is used which employs a kernel function to project the feature vectors to higher dimensional space where they become linearly separable. Different kernel functions like RBF and polynomial are in common use

5. Result and Discussion

The experimental results obtained from feature extraction and classifications are briefly described in this section. Totally 24 images are used for evaluation among which 8 are normal and 16 are cataract images. Sensitivity, specificity, and accuracy are the 3 evaluation metrics are used to analyse the performance of the system. The evaluation metrics are calculated by using true positive, true negative, false negative and false positive values

Sensitivity: The probability of abnormal images classified as abnormal is given by sensitivity. It also defined as the proportion of true positives are correctly detected by the system

Specificity: Specificity gives the probability of normal images being classified as normal. Which can also be defined as the proportion of true negatives are correctly detected.

Accuracy: Accuracy defines how well the system gives correct results

Total images	24
True Positive (TP)	14
True Negative (TN)	8
False Negative (FN)	0
False Positive (FP)	2
Accuracy	91.67
Specificity	100
Sensitivity	87.50

6. Conclusion

A computer-aided auxiliary diagnosis system for Cataract classification and grading from fundus image is presented. It is helpful for improving the screening test of cataract in underdeveloped areas without sufficient healthcare resources, so that the cataract patients in these areas can timely know their cataract conditions and obtain treatment suggestions from doctors. Based on the extracted features using DWT, the SVM classifiers are used to classify the input images into normal or abnormal. The abnormality is also further classified as mild moderate and severe to assess the severity of the disease. The features extracted using DWT gives a classification accuracy of 91.67%. The proposed system is simple to use, computational complexity is less and cost effective

References

[1] M. Jagadish Nayak, "*Automated Classification of Normal, Cataract and Post cataract Optical Eye Images Using SVM Classifier*", Proceedings of the World Congress on Engineering and Computer Science 2013 Vol I WCECS 2013, 23-25 October, 2013, San Francisco, USA

[2] Huiqi Li1, Joo Hwee Lim1, Jiang Liu1, Damon Wing Kee Wong1 Ngan Meng Tan1, Shijian Lu1, Zhuo Zhang1 tien in Wong2; "*Computerized Systems for Cataract Grading*", Institute for Infocomm Research, A*STAR (Agency for Science, Technology and Research) Singapore and Singapore Eye Research Institute, Singapore

[3] Sumeet Dua, Senior Member, IEEE, U. Rajendra Acharya, Pradeep Chowriappa, Member, IEEE, and S. Vinitha Sree" *Wavelet-Based Energy Features for Glaucomatous Image Classification*" IEEE Transactions on information technology in biomedicine, vol.16, No.1, January 2012.

[4] Linglin Zhang, Jianqiang Li, i Zhang, Jijiang Yang "*Automatic Cataract Detection And Grading Using Deep Convolutional Neural Network*", 2017.

[5] Xinting Gao, Huiqi Li, Joo Hwee Lim Tien Yin Wong, "*Computer-Aided Cataract Detection Using Enhanced Texture Features on Retro-Illumination Lens Images*" 61in18th IEEE International Conference on Image Processing, 2011.

[6] Yanwu Xu, Xinting Gao1, Stephen Lin, Damon Wing Kee Wong, Jiang Liu, Dong Xu, Ching-Yu Cheng, Carol Y Cheung, and Tien Yin Wong, "*Automatic Grading of Nuclear Cataracts from Slit-Lamp Lens Images Using Group Sparsity Regression*", in Institute for Infocomm Research, Agency for Science, Technology and Research, Singapore 2 Microsoft Research Asia.

[7] Rajendra Udyavara Acharya, Wenwei Yu, Kuanyi Zhu, Jagadish Nayak, Teik-Cheng Lim, and Joey Yiptong Chan, "*Identification of Cataract and Post-cataract Surgery Optical Images Using Artificial Intelligence Techniques*", in Springer Science + Business Media, LLC, 2009.

[8] Y. N. Fuadah, A. W. Setiawan, T. L. R. Mengko, "*Performing High Accuracy of The System for Cataract Detection Using Statistical Texture Analysis and K-Nearest Neighbour*", 2015 IEEE International Conference on Imaging Systems and Techniques Proceedings.

[9] M. Yang, J. Yang, Q. Zhang, Y. Niu, and J. Li, "*Classification of Retinal Image for Automatic Cataract Detection*, " 2013 IEEE 15th International Conference on e-Health Networking, Applications and Services.

[10] Haralick R M, Shanmugam K, & Dinstein I H; "*Textural Features for Image Classification*", IEEE Transactions on Systems, Man and Cybernetics, Vol.6, pp.610-621, Year 1973.

[11] D. Allen and A. Vasavada *"Cataract and surgery for cataract*, " British Medical Journal, vol.333, No.7559, 2006.

[12] U. R. Acharya, S. Dua, X. Du, V. S. Sree, and C. K. Chua, "*Automated diagnosis of glaucoma using texture and higher order spectra features*, " IEEE Trans. Inf. Technol. Biomed., vol.15, no.3, pp.449–455, May2011

[13] The IEEE website. [Online]. Available: http: //www.ieee. org/