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Recent Approaches for Automatic Cataract Detection Analysis Using Image Processing

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Abstract – In the current medical domain, the contribution of image processing technique is more prominent. It provides more advanced functionality for several medical diagnoses. In such environment, retinal image analysis and pathology detection have more challenging tasks. To develop a best solution to detect eye cataract and other eye diseases, there is a necessity to study the available techniques of digital image processing suitable for the retinal image processing. This survey gives an overview of the clinical evaluation image processing techniques with its merits and demerits. The survey includes several automated eye disease detection techniques, which are proposed recently.

Index Terms – Digital Image Processing, Eye Cataract, Retinal Disease Diagnosis, Neural Network, SVM.

1. INTRODUCTION

Digital image processing (DIP) techniques are the promising approach, which process an image and produces certain outputs according to the user's code. Using image processing techniques one can perform image enhancement, segmentation, analysis and diagnosis etc. medical image processing is the process of analyzing medical images such as brain scan images, skin images for skin disease detection, retinal images, Computer Tomography (CT) images to detect and diagnose diseases and abnormalities in the part of the body. This survey concentrated on the retinal image analysis for automatically detecting eye diseases using DIP. The sample retinal images are given in fig 1.0.

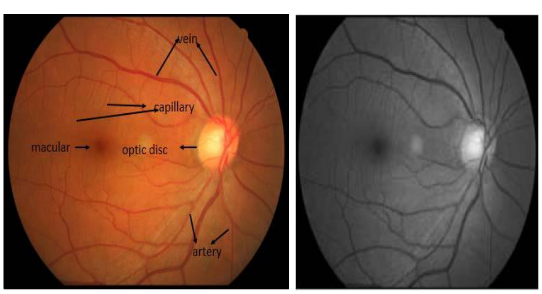

Fig 1.0 retinal images in color and gray scale mode

Eye Cataract : The retina mainly contains three sections, which are optic disc, macular and blood vessel shown in Fig.1.0. Every section from the retinal images is represented below, first the Optic disc is the huge circular part in the middle of the retina, and this associated with brain nerves. This reveals the state of the brain and human body. Macular falls at the center of the eye and it shown in fig 1.0, this is high in lutein and this will appear in the yellow color. Finally the blood vessels are segmented into vein and artery and it joins at the optic disc. The difference between artery and vein can be seen by its appearance, that is the vein are more dark and strong and the artery are the thin lines and lighter than veins.

2. EYE CATARACT DETECTION AND ANALYSIS TECHNIQUES-LITERATURE REVIEW

The retinal image analysis and disease diagnosis is carried out by several authors; this survey gives the technique and method used in the existing system. Automated detection of pathology of retinal images using digital image analysis offers huge potential benefits. In the research analysis, it offers the possible technique to examine a large number of medical images with time and cost reductions at the time of analysis. This also offers more unbiased measurements than the existing image analysis techniques.

The medical image analysis also includes the potential to perform large numbers of automated detection of health conditions. This includes several medical features and this will be used at the time of testing user input images. Image analysis approaches are designed to measure key aspects of fungus images and identify diseases from images and compare images with similar in features using statistical neural network learning modules. The greatest emphasis in automated diagnosis has unsurprisingly been given to the detection of accurate and automatic cataract and retinal diseases.

In paper [1], authors Basant Kumar proposed and evaluated an algorithm to automatically detect the cataracts from color images. Currently, methods available for cataract detection are based on the use of either fundus camera or DSLR camera; both are very expensive. The key intention behind this work is to develop an inexpensive robust and convenient algorithm which in conjugation with suitable devices will be able to diagnose the presence of cataract from the true color images of eye. An algorithm is proposed for Cataract Screening based on texture features: uniformity, intensity and standard deviation. These features are initially estimated and mapped with diagnostic opinion by the eye expert to define the basic threshold of screening system later tested on real subjects in eye clinic. They presented a diagnostic and texture information based automated algorithm for detection of cataract. Experiments were performed on true color images obtained from low resolute images. It was observed that inclusion of standard deviation parameter together with mean intensity and uniformity features added robustness to the decision made by algorithm which was validated by the ophthalmologist. Proposed method gave very good results with close to 98% accuracy. The authors guided some ideas for the further development, which includes fine tuning of the threshold parameters for cataract detection by considering large number of patients and ophthalmologists. Intelligent computing such as SVM or machine learning can be used for improved results. The algorithms can be extended for predicting severity information in terms of cataract Grading.

Cataract is one of the most prevalent causes of blindness in the industrialized world, accounting for more than 50% of blindness. This paper [2]aims to research the execution and productivity by utilizing Deep Convolution Neural Network (DCNN) to recognize and graduate cataract consequently, it likewise picture a portion of the element maps at pool5 layer with their high-arrange experimental semantic importance, giving a clarification to the element portrayal extricated by DCNN. The proposed DCNN classification framework is cross approved on various number of populace based clinical retinal fundus images gathered from healing center, up to 5620 images.

There are two conclusions proposed in this paper: The first is, the obstruction of nearby uneven brightening and the impression of eyes were overwhelmed by utilizing the retinal fundus images after G-filter, which makes a huge commitment to DCNN classification. The second one is, with the expansion of the measure of accessible examples, the DCNN classification exactnesses are expanding, and the change scope of correctness's are more steady. The best exactness, the strategy accomplished, is 93.52% and 86.69% in cataract location and evaluating assignments independently. It is shown in this paper the DCNN classifier beats cutting edge in the execution. Proposed strategy in this paper with Deep Convolution Neural Network(DCNN) is fit for accomplishing record softening outcomes up the testing cataract recognition and reviewing undertakings utilizing absolutely directed learning.

The methods surpass state-of-the-art in both accuracy and time efficiency. The interference of local uneven illumination and the reflection of eyes were overcome by using the retinal fundus images after G-filter, which makes a significant contribution to DCNN classification. Through DCNN, discriminative features that characterize high-level information are extracted effectively and automatically, rather than artificially. Furthermore, the feature extraction and classifier were combined together, which demonstrates a higher level of intelligence. This approach has been confirmed to have great practical significance in early cataract screening and diagnosis, and has great potential to be applied in other eye diseases.

In paper [3], authors discussed the cataract detection techniques. Furthermore, authors expressed as, cataract is one of the predominant reasons for visual debilitation around the world. It causes an obscured and foggy vision which can prompt fractional or finish loss of visual perception. A protein layer is produced step by step and the focal point ends up plainly shady over a drawn out stretch of time which lessens vision and prompts visual deficiency. Early treatment can decrease the challenges looked by cataract patients and turn away visual debilitation. Individuals living in immature nations and rustic territories can't get compelling treatment in time because of shortage of eye mind administrations and assets. Moreover, the current techniques for cataract determination are modern and costly. Considering the above situation, chopping down the cost and streamlining the procedure of cataract determination is critical.

The objective of this paper [3] is to contemplate, examine and advanced diverse cataract location strategies and systems. This paper classifies various techniques stated and implemented until now based on three basic steps: 1) Pre-processing, 2) Feature extraction, 3) Classifier construction. Identification and grading of cataract disease is done with the help of automatic cataract detection using advanced portable methods and devices. Several newly designed systems implement a check on cataract efficiency by comparing pre cataract and post cataract images. This paper studied and put forth several approaches of automatic cataract detection. Slit lamp imaging method is mostly used which is expensive and less accurate. It can only detect and grade a specific class of cataract. The fundus image based cataract system is also studied. Its efficient but not portable and consumes time. Hence there is a need of a system which has an efficient algorithm and also is portable that is used in smart-phones by remote people with minimum amount of detection time.

In paper [4], Amit Asish Bhadra authors proposed novel approach uses OpenCV library as the tool to implement the algorithm. An attempt is made to recognize cataract and conjunctivitis based on pattern recognition combined with BGR color property and is tested for multiple normal and diseased eye images. The proposed approach consider the features of an optical eye image such as the big ring area, small ring area of the lens, the eye ellipse and the intensity of the affected area for the computation. It takes the image of an eye as input and tells us if it is normal or has any diseases. The proposed method to diagnose the mentioned eye diseases is based on the effective computation approach and promises great results. The algorithm has the potential to ease the strain on optometrists and ultimately the society. The result indicates an average accuracy of 92% over an image dataset of 100 images for cataracts and 83% for conjunctivitis. Accuracy can further be increased by collecting extra dataset images for larger scale trials. The accuracy depends on several factors such as image quality, eye positioning and scanning at some angle. The algorithm can be enhanced to detect some other eye diseases. The work is carried mainly for automatic cataract retinal image classification through IT technology.

This paper [5] proposes and evaluates an algorithm to automatically detect the cataracts from color images in adult human subjects. Presently, techniques available for cataract detection are based on the use of either funds camera or Digital Single-Lens Reflex (DSLR) camera; both are very expensive. The main motive behind this work is to develop an inexpensive, robust and convenient algorithm which in conjugation with suitable devices will be able to diagnose the presence of cataract from the true color images of an eye. An algorithm is proposed for cataract screening based on texture features. These features include uniformity feature intensity and standard deviation calculations. These features are first computed and mapped with diagnostic opinion by the eye expert to define the basic threshold of screening system and later tested on real subjects in an eye clinic. Finally, a tele-ophthamology model using the proposed system has been suggested, which confirms the telemedicine application of the proposed system. This paper presented a texture information based automated algorithm for detection of cataracts from a digital eye image of adult human subjects.

Examinations were performed on true color images got from an ease smaller computerized camera. It was watched that incorporation of standard deviation parameter together with mean power and consistency highlights added vigor to the choice made by the calculation which was approved by the ophthalmologist. The proposed strategy gave exceptionally reassuring outcomes with near 98% precision however this should have been additionally tried on bigger dataset for more exact location of a mellow or a beginning period cataract. The proposed calculation recognizes nearness of cataract by perusing surface data from round understudy of grown-up human subjects. It isn't tried on kid subjects, likewise it can't identify cataract in the tyke subjects with those torment from coloboma, i.e., the youngster subjects who have non round students. A GUI has been made in MATLAB for adding effortlessness to the operation of proposed framework and system engineering has been proposed for its execution in telemedicine application. Future work incorporates adjusting of the edge parameters for cataract recognition by considering an extensive number of patients and relating ophthalmologists' choices. Keen figuring techniques, for example, SVM or machine learning can be utilized for enhanced outcomes. Efforts are being made to remove the flash spot of the camera during preprocessing and evaluate its effect. The algorithm can further be extended for predicting severity information in terms of cataract grading. Different wireless networks will be evaluated for the required quality of service parameter requirements at different layers for the proposed tele-ophthalmology architecture.

In the paper [6], authors proposed a system to automatically learn features for ranking the severity of nuclear cataracts from slit lamp images. The authors developed local filters and then that will be clustered of image patches from lenses within the same grading class. The learned filters are fed into a convolution neural network followed by a set of recursive neural networks to further extract higher-order features. With these features, support vector regression (SVM) is applied to determine the cataract grade.The proposed system is validated on a large population-based dataset of 5378 images, where it outperforms the state-of-the-art by yielding with respect to clinical grading a mean absolute error of 0:304, a 70:7% exact integral The proposed method is useful for assisting and improving clinical management of the disease in the context of large-population screening and has the potential to be applied to other eye diseases. The proposed method for nuclear cataract grading based on automatic feature learning. Trouble in finding the correct highlights has been a restricting component in examine on programmed cataract evaluating, and this work brings another approach that specifically tends to this issue in a precise and general way, rather than falling back on heuristic handpicked highlights. Through profound learning, discriminative highlights that Characterize abnormal state semantic data are adequately separated. This approach can possibly be connected to other eye ailments. Highlights separated through this kind of profound learning methodology may conceivably prompt enhanced execution in these cases

In this work [7] image processing techniques are used 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 image such as Big Ring Area (BRA), Small Ring Area (SRA), Edge Pixel Count (EPC) and Object Perimeter are extracted. The features are statistically analyzed and found to be significant for the automatic classification. The same features are then used in the automatic classifier such as Support Vector Machines (SVM) for the automatic classification. The results are found to be clinically significant with 94% sensitivity and 93.75% specificity. The classification rate is nearly 90%. As a summary, this paper has discussed the performances of SVM classifier as diagnostic tools to aid physicians in the detection of cataract even at the early stages. These classifiers are also suitable for diagnosing the effectiveness of cataract operations using the post-cataract images. However, these tools generally do not yield results with 100% accuracy. The accuracy of these tools depend on several factors such as the size and quality of the training set, the rigor of the training imparted, and parameters chosen to represent the input.

In the paper [8], authors proposed a convenient and cost-effective auxiliary diagnosis system. The main objective is to develop a fundus image analysis based automatic classification and grading system for all types of cataracts. Initially preprocessing is done for the fundus image, followed by feature extraction in spatial and transform domain, classification and grading. The fundus image is classified as non cataract and cataract image using SVM classifier. The cataract image is graded as mild and sev ere cataract using RBF Network. MATLAB tool is used to implement the work. Various grade of cataract images are tested by the proposed method and the performance been compared and analyzed. Cataract identification and classification for different types of cataracts has been successfully implemented. Two methods, one in spatial domain and one in wavelet domain have been combined effectively. It is found to be effective from the simulation analysis, that it shows 90% sensitivity and 93.33% specificity which is higher than the other existing techniques. SVM and RBFN classifiers shows two classifications, 'normal' and 'cataract' and the grading as 'mild' and 'severe'. It is worthwhile to be generalized and adapted to be used for solving other medical diagnosis problems with similar situations. The future work can be done to improve the system to identify more eye disorders with one algorithm and to use multi-class classifiers such as neural networks and neuro-fuzzy classifiers to classify those diseases.

Considering the fact that retinal image is one of the most important medical references that help to diagnose the cataract, this paper [9] proposed to use a neural network classifier for automatic cataract detection based on the classification of retinal images. The classifier building procedure includes three parts: preprocessing, feature extraction, and classifier construction. In the pre-processing part, an improved Top-bottom hat transformation is proposed to enhance the contrast between the foreground and the object, and a trilateral filter is used to decrease the noise in the image. According to the analysis of preprocessed image, the luminance and texture message of the image are extracted as classification features. The classifier is constructed by back propagation (BP) neural network which has two layers. Based on the clearness degree of the retinal image, the patients' cataracts are classified into normal, mild, medium or severe ones. The initial evaluation results illustrate the effectiveness of the proposed approach, which has great potential to improve diagnosis efficiency of the ophthalmologist and reduce the physical and economic burden of the patients and society.

A neural network classifier is proposed to automatically classify the severity of cataract. It is based on the clearness degree of the retinal image. The classifier consists of preprocessing, feature extraction and classification three parts. An improved Top-bottom hat transformation and trilateral filter are used to improve the quality of the image. The features are extracted from luminance and texture. The classifier is a two layer BP neural network. Through the classifier, the patients' cataracts are classified into normal, mild, medium or severe ones. It has great potential to improve the efficiency of the ophthalmologist and help to reduce the physical and economic burden of the patients and society as well. In the future, this will continue the research with the emphasis on extracting the features of blood vessel in retinal image, and reduces the time in pre-processing. Furthermore, running the classification in larger trials will be explored.

In this paper [10], the enhanced texture feature is proposed based on the graders' expertise of cataract and the characteristics of the retro-illumination lens images. The statistics of the enhanced texture feature is used to train the linear discriminate analysis to detect the cataract. The accuracy of 84:8% is achieved on a clinical database that contains 4545 pairs of images. It demonstrates that the proposed method is promising for mass screening and as the preprocessing step for computer-aided grading. In this paper, this proposed a new method to classify the cataract lens from the non-cataract lens. Based on the graders' expertise on the cortical and PSC cataracts and the observation of the database, an enhanced texture analysis method is proposed. The statistics of the enhanced texture information is used as the features and an LDA is trained to classify the database. The result shows that the proposed method is useful for mass screening.

The table 1.0 shows the existing cataract detection techniques along with the accuracy, merits and demerits. From the survey a list of suggestions are made for further work.

- The cataract images from color image using effective image processing techniques can be developed. The accurate distinction of veins and artery can also consider for the pathology detection.
- Many authors suggested the multi class SVM algorithms and neural network concepts can be improved for further study. So the algorithms can be enhanced with the high accuracy rate and ability to predict the condition in terms of mild, sever, and extreme disease levels.
- Effective retinal analysis for other type of eye diseases can also detected in future studies.

3. COMPARATIVE STUDY

From the above literature, the accuracy of every technique is compared and plotted in fig 2.0. the chart shows the techniques in [1][5] yielded better accuracy when comparing with the others.

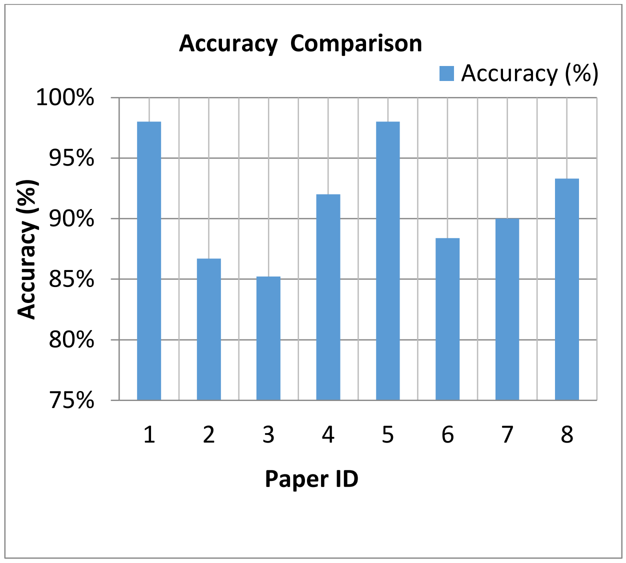

Fig 2.0 Accuracy comparison chart

Table 1.0 Comparison Table of Cataract Detection Techniques

Paper ID	Algorithm	Purpose	Accuracy (%)	Advantages	Disadvantages
1	Robust And Efficient Automated Cataract Detection Algorithm	Detect cataract from color images	98%	Suitable for true color images	Machine learning algorithms can be used. Severity prediction not done.
2	Deep Convolution Neural Network (DCNN)	Detect and grad cataract automatically	86.69%	high-level information are extracted effectively and automatically	Completely supervised learning, so need more training data
3	Automatic cataract detection using advanced portable methods and devices	Analyzed and developed cataract detection technique	85.23%	Efficient	Expensive and less accurate, not portable. can only detect and grade a specific class of cataract
4	OpenCV library	diagnose the mentioned eye diseases is based on the effective computation approach	92%	Automatic retinal image classification. Have the ability to detect different images	Need high quality images as input

5	cataract screening based algorithm with texture features	automatically detect the cataracts from color images in adult human	98%	inexpensive, robust and convenient	In effective preprocessing
6	Convolution neural network	nuclear cataract grading based on automatic feature learning	88.4%	high-level semantic information are effectively extracted	Accuracy is low
7	SVM classifier	used to detect the features in the three classes of optical eye images such as normal, cataract and post-cataract images	90%	suitable for diagnosing the effectiveness of cataract operations using the post-cataract images	size and quality of the training set should be high
8	SVM classifier	cataract image is graded as mild and severe cataract using RBF Network	93.3%	Used for solving other medical diagnosis problems with similar situations.	Further improvement needed to detect other problems
9	Back propagation (BP) neural network	automatic cataract detection based on the classification of retinal imagess	89.56%	The features are extracted from luminance and texture	Not Suitable for large datasets
10	enhanced texture analysis method	Detect cataract and the characteristics of the retro-illumination lens images	84.8%	Improves the detection ratio.	Need more feature training

4. CONCLUSION

This survey presented an analysis on various cataract detection techniques of cataract. It was observed that inclusion several features for cataract detection can improve the detection accuracy. With the help of digital image processing techniques and tools, the eye disease diagnosis process became easier and effective. The literature shows the use of SVM and NN can improve the detection ration in the color and gray scale retinal images. The texture based method gave very good results with close to 98% accuracy.

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