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An Automated Detection and Classification of Cataract and Glaucoma Using RCNN

Alida E T[1], Dr. K. Anusudha[2]
[1]*M Tech, Electronics and Communication Engineering, Dept. of Electronics Engineering,Pondicherry University, Pondicherry, India*
[2]*Assistant Professor, Dept. of Electronics Engineering, Pondicherry University, Pondicherry, India*

Abstract: ***one of the human's deterioration is visual impairment. Cataract and Glaucoma are the most prevailing cause blindness in the world. Early detection and treatment is the best way to prevent the blindness. Currently grading is done by human graders, it is found to be time taking and grading is usually subjective. Computer aided analysis can help human graders. An automated cataract and glaucoma detection and classification approach is proposed in this paper, to grade more objectively. Region based convolution neural network (RCNN) is used to classification process. The percentage of accuracy of classification obtained for cataract and glaucoma is 98.9% and 97.8% respectively. The method is especially suitable for cataract and glaucoma screening in the underdeveloped areas or areas which are in shortage of ophthalmic resources. It can also improve the accessibility of ophthalmic medical treatment.***

Keywords: RCNN (Region based Convolutional neural network), Adaptive Histogram Equalization (ADE), Fundus images.

I. INTRODUCTION

Medical images are a particular and significant type of non-text information. Medical images play an important role in diagnosing diseases in remote and distant areas and regions. Interests in medical image processing have increased significantly over the past decades. Especially, the methods based on neural networks (NNs) have attracted more attention. Neural networks are well known for their good performance in classification and function approximation, and have been used with success in medical image processing over the past years. RCNN is an object detection model that uses high-capacity CNNs to bottom-up region proposals in order to localize and segment objects. It uses selective search to identify a number of bounding-box object regions and then extracts features from each region for classification. Cataract is one of the most common diseases that are experienced by human beings when they grow old. Cataract means clouding of lens, starts to decrease the vision which prevents entering the light into the lens of our eyes [1]. The main symptoms that this disease shows up are blurry vision, faded colors, trouble while seeing in bright light, etc. Now the detection of disease is a tedious task. In this disease clumps or chums of protein or a brown-yellowish pigment gets deposited on the lens cause in the reduction of transmission of light through the eyes to the retina shown in Fig.1a. The early symptoms of cataract can be improved from the wearing of sunglasses. Else using surgery to remove the cloud is the only effective treatment. Glaucoma is another one of the critical diseases that may also lead to blind the vision of the person. The troublesome disease in which damages the optic nerve of eyes. If treatment is get late, the person can blind. Normally glaucoma detects when there is an increase in the fluid in the front of eye shown in Fig.1b. When that extra fluid is increased, the pressure in your eye is also getting increased. Accordingly, the size of the optic disc and optic cup is increased as a result diameter also increased [2]. Which is degrades the vision over time which is responsible for loss vision of 66.8 million people in all over the world.



(a) (b)

Figure1: (a) Cataract eye, (b) Glaucoma eye

People in less developed areas still do not receive timely treatment because of poor eye care services, lack of professional ophthalmologists, and high treatment costs. Thus, reducing the cost by simplifying the process of early diagnosis of cataract and glaucoma is one of the easy ways to improve eye care services in underdeveloped areas.

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II. LITERATURE SURVEY

E. Deepika, Dr. S. Maheswari, Mr. S. K. Logesh [1], Cataract is the major cause of blindness in the world and the most prevalent ocular disease. This process cannot be reversed, but a healthy lifestyle may slow the progression. This method has been proposed to diagnosis of cataract using statistical features and its severity has been classified using K-means classifier. The earlier diagnosis of cataract which are arranged as pre processing method namely Adaptive Histogram Equalization is used in diagnosis process. Thresholding technique is used for feature extraction. The automatic K-means classifier is classifies normal, mild and severe.

Shwetali M. Nikam and Dr. C. Y. Patil [2], Glaucoma is nothing but the multi factorial neurodegenerative disease, which is degrades the vision. The image processing step is introduced to enhance the contrast of fundus image and convert that image into gray scale image. Further image processing is done for the localization of the boundary of cup and disc. After that compare the images with black image then get the segmented disc. Again compare that image with the black image then get the optic cup boundary. The segmentation is used to detect the boundary of the optic disc and optic cup. Here, main motto is glaucoma detection by CDR and disc and cup detection using MATLAB GUI. In this concentrate on direct linear method for CDR finding. The combine approach for detection is segmentation, ellipse fitting on boundary, CDR for finding ratio is proposed.

Yue Zhou, Guoqi Li, and Huiqi Li [3], Accurate and convenient cataract detection and cataract severity evaluation will improve the situation. Automatic cataract detection and grading methods are proposed in this. With prior knowledge, the improved Haar features and visible structure features are combined as features, and multilayer perceptron with discrete state transition (DST-MLP) or exponential DST (EDST-MLP) are designed as classifiers. Without prior knowledge, residual neural networks with DST (DST-ResNet) or EDST (EDST-ResNet) are proposed. Whether with prior knowledge or not, proposed DST and EDST strategy can prevent over fitting and reduce storage memory during network training and implementation, and neural networks with these strategies achieve state-of-the-art accuracy in cataract detection and grading.

Juan Carillo, Lola Boutista, Jorge Villamizar, Juan Rueda, Mary Sanchez and Daniela Rueda [4], Glaucoma is one of the leading cause of irreversible blindness in people over 40 year old. A computational tool for automatic glaucoma detection from fundus images of the eye, a novel method for cup segmentation. CDR ratio is used the measurement.

Neha Naik, Namrata Deshmukh [12], Cataract is a clouding of the lens of the eye and occurs frequently in older age groups. In proposed system, diagnosis will be obtained using image processing and mining techniques on fundus image. Feature extraction using DCT. K-NN classification algorithm will be used to classify the image in a specific class.

Kavita Choudhary et al [18], this paper, aim of detection of glaucoma at early stages using cross-validation algorithm. Authors analyzed symptoms prevailing in persons & computed & generalized those symptoms to reach conclusive evidence. It was found that measures such as blood pressure, Age, Sugar level, & myopia were combined for various datasets are related to changes of a person suffering from glaucoma. Authors in their study have done an analysis of glaucoma disease by Classification method such as cross-validation algorithm & split validation algorithm. The outcome reveals that patients who have high blood pressure, high sugar level, myopia & with the family history of this disease can suffer from glaucoma. It is also observed that the patients with age more than 50 have higher chances of glaucoma.

III. EXISTING WORK

The existing work is proposed to diagnosis of cataract using statistical features and its severity has been classified using K-means classifier. The entire process is earlier diagnosis of cataract which is arranged as: preprocessing, Feature extraction and classification, the blockdiagram of existing model shown in Fig 3.1.

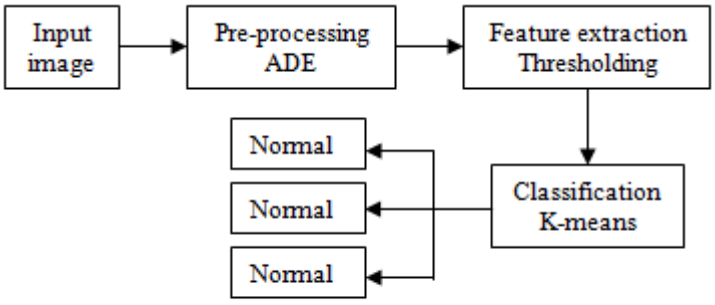


Figure.3.1: Existing model

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Preprocessing is performed to obtain noise free and enhanced image in gray scale, which can be used to detect features. Adaptive histogram equalization is used here to enhance the contrast and to avoid amplifying the noise which is present in the image. Thresholding technique is used to extract the features. The features are contrast, correlation, energy and homogeneity. In classification K-means is used, is a type of unsupervised machine learning that groups data on the basis of similarities and it is classified as normal, mild and severe. In K-means classification, provide the model with features and then it "learns" the associations on its own. The grouping is done by minimizing the sum of the distances between each object and the group or cluster centroid. The output of the all process is shown Fig. 3.2 in a single GUI window using Matlab.

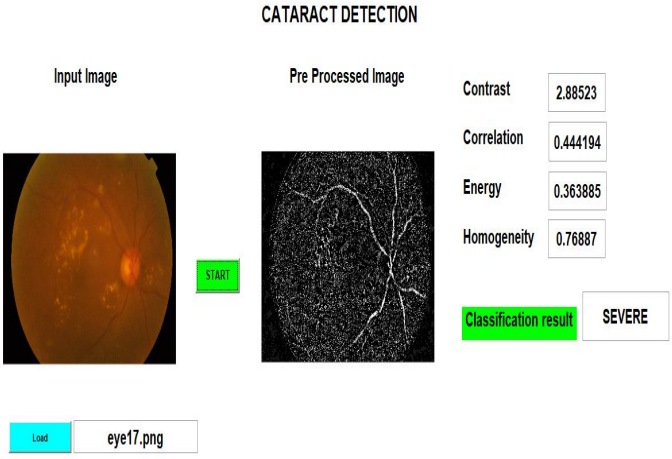


Fig. 3.2**:** Output of existing work

TABLE -1: Table of features

Contrast	***Correlation***	***Energy***	***Homogeneity***
1.7943	0.5084	0.4082	0.8465
1.8364	0.5208	0.401	0.842
1.5211	0.5619	0.6166	0.8847
1.618	0.5483	0.6313	0.8867
1.4765	0.5941	0.5986	0.8823
1.694	0.4802	0.4068	0.8591
1.4323	0.6023	0.5877	0.8722
1.9183	0.5372	0.5844	0.8664
1.2717	0.639	0.5915	0.8757
1.4312	0.6273	0.5888	0.8739

Confusion matrix is used to determine the accuracy of the existing work, which is shown in Fig. 3.3. The average accuracy of the tested images using K-means classiifier is 85%.

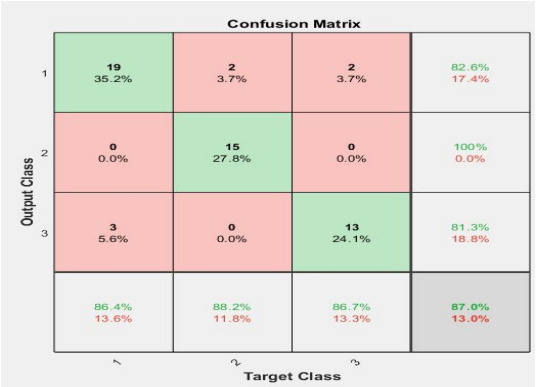


Fig. 3.3 Confusion matrix

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IV. PROPOSED WORK

In this section, introduce the proposed work structure in detail. In the existing work detect the cataract of the eyes. Here an automatic cataract and glaucoma disease detection and classification method is proposed. This system automatically detects the cataract and glaucoma effected region and shows the input image which is effected or not and belongs to which category, that is which severity level they are, normal, mild, moderate, and severe. The evaluation is done by using the Region Based Convolutional Neural Networks (R-CNN).

The proposed system detects by using three phases: Preprocessing, Feature extraction, and Classification. The input images are fundus images. It is high quality images to use the preprocessing phase. The Cataract and glaucoma detection and classification of a random image is according to the previously trained data. This work can improve the accuracy and it will reduce the misdiagnosis rate and difficulties of the doctor's examination. The proposed work is shown in Fig. 4.

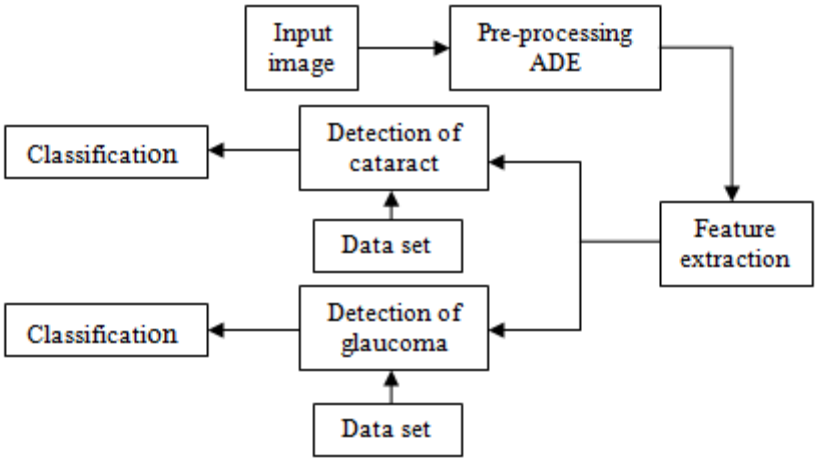


Fig 4.1: Proposed work blockdiagram

A. *Preprocessing*

Preprocessing is performed to obtain noise free and enhanced image, which is used to detect the features. The poor quality images can not ensure adequate level of success in the automated detection. In this work took high quality images. The preprocessing stage first resizes the image and color image is converted in to grayscale. Then adaptive histogram equalization is applying, which is adjusting the contrast without effect the quality of the image and avoid amplifying noise which is present in image.

B. *Feature extraction*

Feature extraction is a part of the dimensionality reduction process, in which, an initial set of the raw data is divided and reduced to more manageable groups. The most important characteristic of these large data sets is that they have a large number of variables. These variables require a lot of computing resources to process them. So Feature extraction helps to get the best feature from those big data sets by select and combine variables into features, thus effectively reducing the amount of data. Thresholding technique is used to determine the features. Mean, standard deviation, entropy, RMS value, kurtosis, contrast, correlation, entropy, energy, and homogeneity are calculated through this technique.

C. *Classification*

It is a process of categorizing a given set of data into class. It can be performed on both structured and unstructured data. The process starts with predicting the class of given image. The Region based Convolutional neural network (RCNN) is a class of deep learning neural networks. They're most commonly used to analyze visual imagery and are frequently working behind the scenes in image classification. In this method the cataracts and glaucoma is classified as: normal, mild, medium, severe. The cataract classification lens of the eye is considered and glaucoma classification disk and cup segmentation is considered. The optic cup region and optic disc region and boundaries are determined earlier, after that using the cup-to-disc ration which is nothing but the clinical indicator of glaucoma detection.

CDR= Cup diameter / Disc diameter (1)

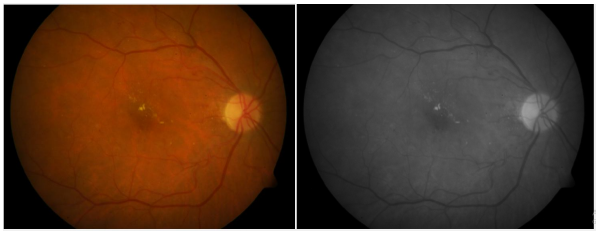
The equation (1) is used to calculate CDR. When the ratio of cup-to-disc is more than 0.3, and then we can say that patient have the glaucoma disease. Normal eye has the CDR is less than 0.3.

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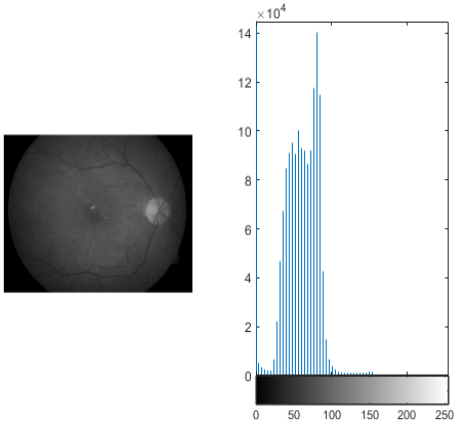
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V. RESULT

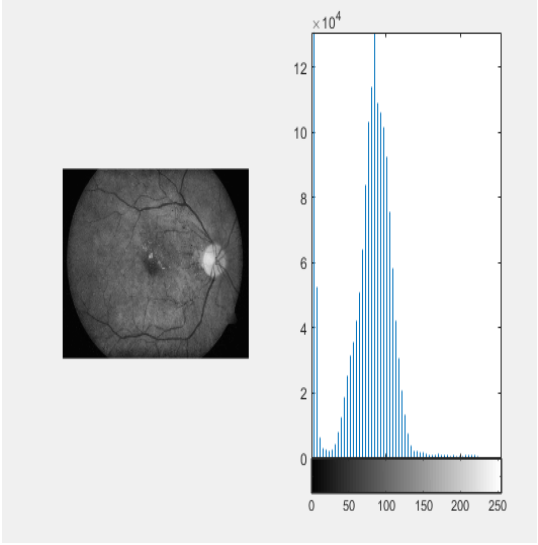
The Fig. 5.1 showed preprocessing stages and histogram of the grayscale image and contrast adjusted image. Cataracts are classified as to the severity level, Fig. 5.2 shown GUI window of the work, the cataract is present and it is in mild stage.



(a) (b)



(c)



(d)

Fig. 5.1: (a) original image (b) grayscale image
(c) Histogram of grayscale image
(d) Histogram of contrast adjusted image

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A. Detection of Cataract

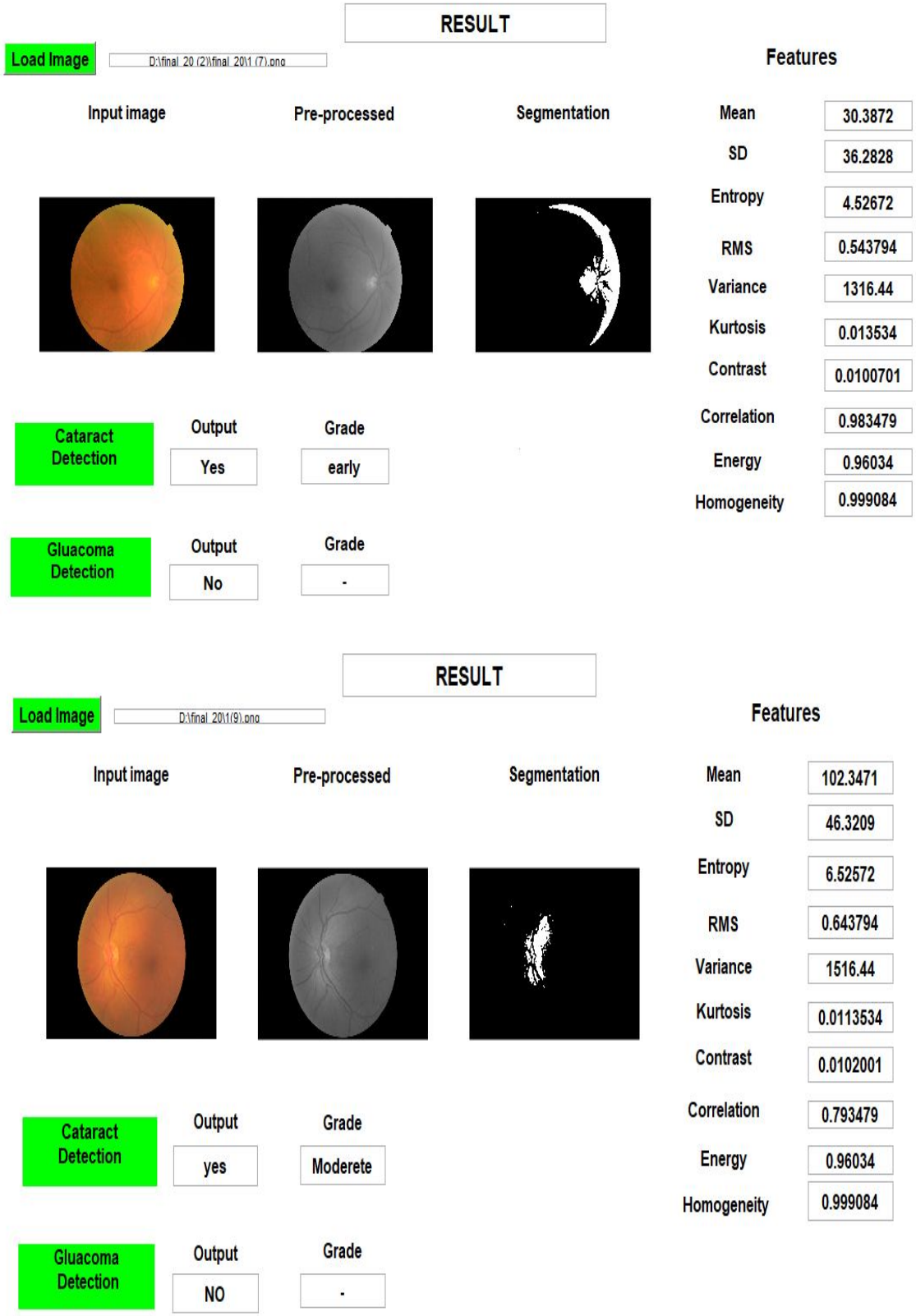


Fig. 5.2 Cataract detected

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B. Glaucoma detection

Glaucoma is classified according to the CDR ratio, the Fig. 5.3 is indicates the disk segmented image and cup image.

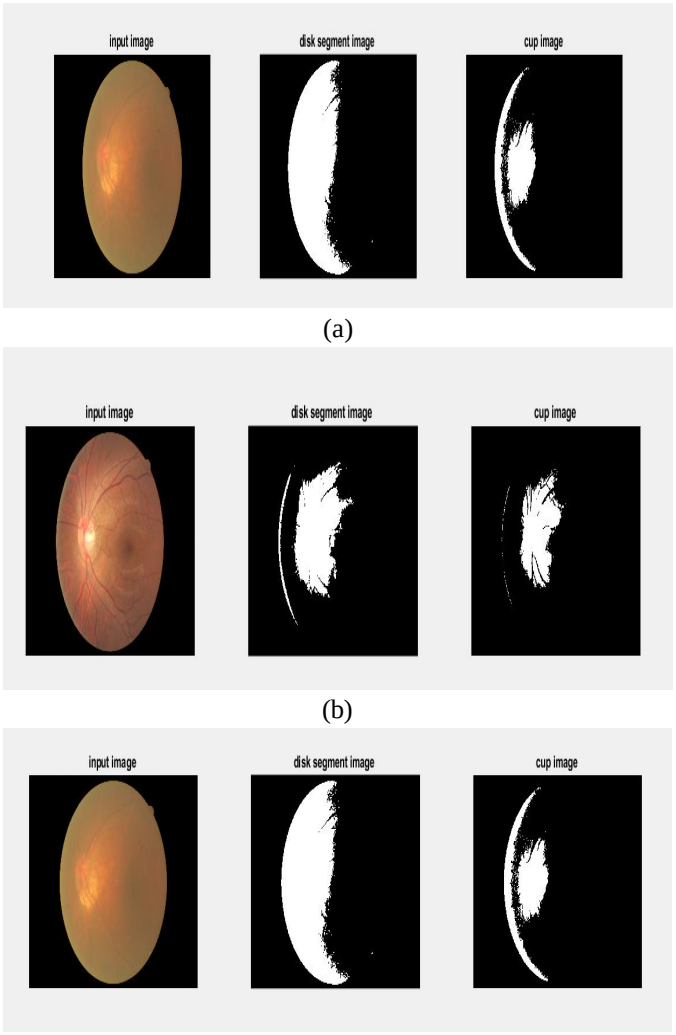


Fig. 5.3: Input image, disk segmented image and cup image

The glaucoma is detected and classified, in the Fig. 5.4 is shown the output GUI window of the work.

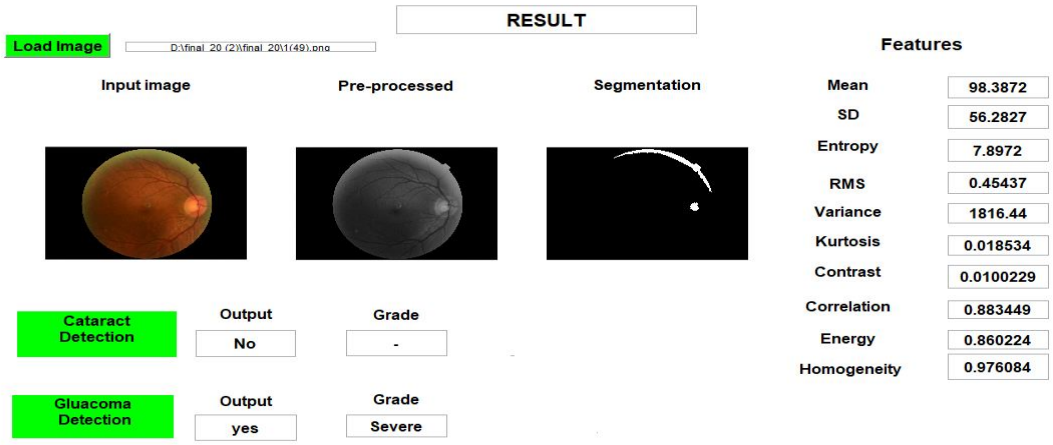


Fig. 5.4: Glaucoma detected

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C. Confusion Matrix

It is a technique for summarizing the performance of a classification algorithm. Classification accuracy alone can be misleading if having an unequal number of observations in each class or if having more than two classes in the dataset. It is used to visualize important predictive analytics like specificity, accuracy, and precision. Confusion matrices Fig. 5.5 is used to determine sensitivity, specificity, precision, and accuracy. This matrix is useful because they give direct comparisons of values like True Positives, False Positives, True Negatives and False Negatives.

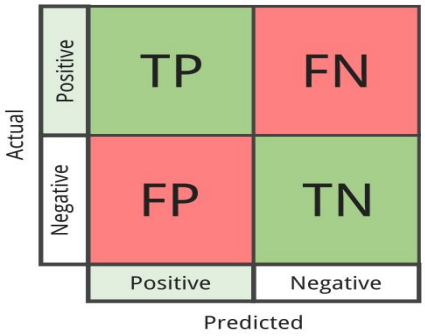


Fig. 5.5: 2x2 confusion matrix

Sensitivity= TP / (TP+FN)
Specificity= TN / (TN+FP)
Accuracy= TP+TN / TP+TN+FP+FN
Precision= TP /(TP+FP)
Error rate= (FP+FN)/ (TP+TN+FP+FN)
Where, TP-True Positive
TN-True Negative
FP-False Positive
FN-False Negative

Table-2: Confusion matrix values

Disease	Accuracy	Sensitivity	Specificity	Precision	Error rate
Cataract	98.931%	0.9829	0.9643	0.994	0.0207
Glaucoma	97.86%	0.9766	0.9565	0.982	0.0323

D. PSNR

The term peak signal-to-noise ratio (PSNR) is an expression for the ratio between the maximum possible value (power) of a signal and the power of distorting noise that affects the quality of its representation. In this work psnr is 32dB.

VI. CONCLUSION

An efficient technique to detect the Cataract and Glaucoma is proposed in this work. The early detection of Cataract and Glaucoma is necessary for the proper diagnosis. Various works are going in the field of Cataract and Glaucoma detection in separately, in this work, both are detected and classified. This work is based on three stages: Preprocessing, Feature extraction and Classification. Compared to the other classifiers Region based Convolutional Neural Network (RCNN) gives better accuracy of 98.9% in cataract and 97.8% accuracy in glaucoma detection and classification tasks. This is designed to diminish the workload of human experts. Due to advancement in technology, it is getting better and better to obtain eye imaging using fundus images with high resolution. It can solve the problems regarding manual grading and are promising for future clinical diagnosis.

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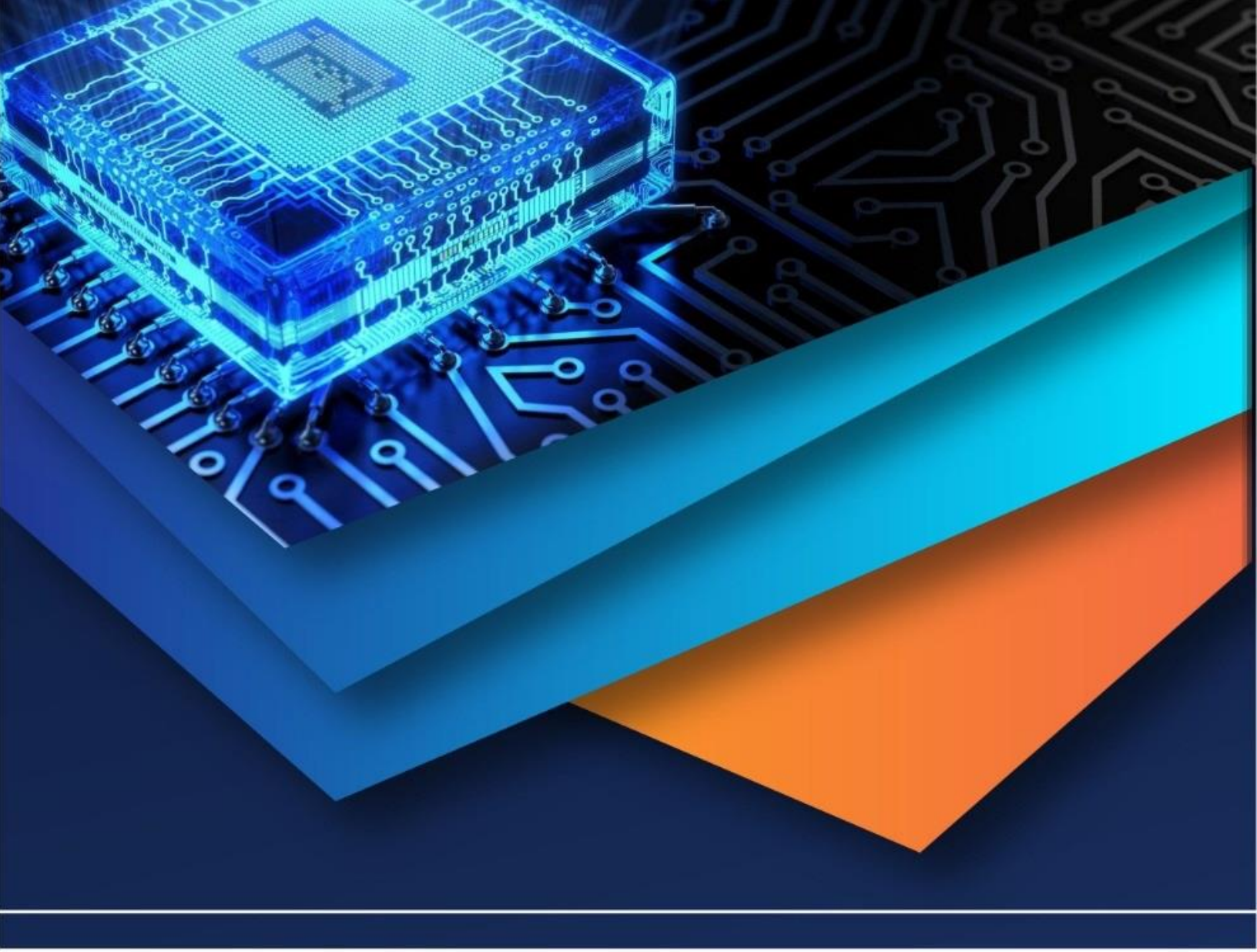
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