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Diagnosing Chronic Glaucoma Using Watershed and Convolutional Neural Network

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Abstract: Glaucoma is a disease that relates to the vision of human eye,Glaucoma is a disease that affects the human eye's vision. This sickness is regarded as an irreversible condition that causes eyesight degeneration. One of the most common causes of lifelong blindness is glaucoma in persons over the age of 40. Because of its trade-off between portability, size, and cost, fundus imaging is the most often utilised screening tool for glaucoma detection. Fundus imaging is a two-dimensional (2D) depiction of the three-dimensional (3D), semitransparent retinal tissues projected on to the imaging plane using reflected light. The idea plane that depicts the physical display screen through which a user perceives a virtual 3D scene is referred to as the "image plane". The bulk of current algorithms for autonomous glaucoma assessment using fundus images rely on handcrafted segmentation-based features, which are influenced by the segmentation method used and the retrieved features. Convolutional neural networks (CNNs) are known for, among other things, their ability to learn highly discriminative features from raw pixel intensities. This work describes a computational technique for detecting glaucoma automatically. The major goal is to use a "image processing technique" to diagnose glaucoma using a fundus image as input. It trains datasets using a convolutional neural network (CNN). The Watershed algorithm is used for segmentation and is the most widely used technique in image processing. The following image processing processes are performed: region of interest, morphological procedures, and segmentation. This technique can be used to determine whether or not a person has Glaucoma.
Keywords: Recommender system, item-based collaborative filtering, Natural Language Processing, Deep learning.

I. INTRODUCTION

Glaucoma is that the second greatest reason for blindness, in line with the planet Health Organization. It affected 60 million people in 2010, and it's expected to affect 70.6 million people by 2020. Glaucoma is one among the silent robbers of sight. As a result, early detection of glaucoma is critical for preventing irreversible eye damage. Glaucoma may be a visual condition that causes permanent blindness in older people.

As a result, early detection of this irreversible glaucoma illness is extremely important. (i) glaucoma, (ii) angle closure glaucoma, (iii) normal tension glaucoma, and (iv) congenital glaucoma are the four sorts of glaucoma. Increased pressure (IOP) and/or lack of blood flow to the optic tract cause this silent disease. IOP measurement, on the opposite hand, has been proven to be neither specific nor sensitive enough to be a decent glaucoma diagnostic, as visual disorder can occur without an increase in IOP. The blind spot is made when ganglion cell axons leave the attention through the second cranial nerve head.

The point will be visually divided into two zones during a fundus image: a bright and central zone termed the calyculus, and a peripheral section called the neuro-retinal rim. While the blind spot (OD) and cup are present all told people, an abnormally large cup in reference to the blind spot could be a glaucomatous eye's feature. As a result, many techniques to caliculus and optic disk segmentation for glaucoma diagnosis in colour fundus pictures are devised.

Moreover, before performing the glaucoma diagnosis, there are important factors that ought to be checked, like tonometry, ophthalmoscopy, perimetry, gonioscopy, and pachymetry. Then, the diagnosis of the glaucoma is performed supported the medical history of the patient's pressure level (IOP), field of regard loss tests, and physical evaluation of cranial nerve head (ONH) via ophthalmoscopy.

The testing of glaucoma is conducted through digital fundus camera, optical coherence tomograph (OCT), IOP measurement, ONH evaluation, retinal fibre layer (RNFL), and sight view defect. Glaucoma is that the causal agent affects the cranial nerve of the eye, it causes blindness. The majority of individuals do not develop signs of vision loss until the disease has progressed to an advanced stage. According to Mohammadi and Jayaraman, a minimum of half of glaucoma patients in affluent countries experience no symptoms of the condition, with the situation expected to worsen in poorer countries

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II. LITERATURE SURVEY

The literature survey structured with existing technologies, history of watershed algorithm, convolutional neural network and survey of different other models which is related to glaucoma detection. Glaucoma could be a disease where the eye’s optic tract is broken, it's one in every of the leading causes of blindness. it's a bunch of disorders characterized by an abnormally high intra ocular pressure (IOP), force per unit area (IOP) is that the fluid pressure inside the attention. IOP is set using tonometry method which is employed by eye care professionals. pressure, can damage your second cranial nerve, which sends images to your brain. If the damage worsens, glaucoma can cause permanent vision loss or maybe total blindness within some years Sometimes, experts don’t know what causes this blockage. But it may be inherited, meaning it’s passed from parents to children, Less-common causes of glaucoma include a blunt or chemical injury to your eye, severe hordeolum, blocked blood vessels inside your eye, and inflammatory conditions. Blood vessels extraction is extremely important as many eye diseases are recognized by inspecting the blood vessels. Since the attention is that the only organ within the body that you just can visualize the blood vessels which reflects the health status of body organs. The blood vessels within the fundus image should be segmented and analysed the disease affecting the attention called glaucoma. Open angle is claimed to be wide and open angle between iris and cornea. it's a traditional kind of glaucoma and result in slow clogging within the eye and may be easily cured. and therefore the symptoms are said to be easily identified. this sort of glaucoma is often widespread affecting disease, mainly for old aged people. Angle closure or closed angle glaucoma may be a very rare case and highly dangerous which results in sudden blindness. Main explanation for this sort of glaucoma is claimed to be rise in Intraocular. Earlier detection of glaucoma is important to stop irreversible damage to the vision The aim is to produce an approach to detect whether the person has glaucoma or not. the target is to develop an application for the detection of glaucoma using the Convolutional neural network and watershed algorithm. Keras is employed, it's a deep learning application programming interface (API) written in python runs on top of machine learning platform tensorflow

Martins, José, Cardoso, Jaime S, Soares, Filipe [1] ,In there paper proposes an interpretable computeraided diagnosis (CAD) pipeline that is capable of diagnosing Glaucoma using fundus images and run offline in mobile devices. Several public datasets of fundus images were merged and used to build Convolutional Neural Networks (CNNs) that perform segmentation and classification tasks. These networks are then used to build a pipeline for Glaucoma assessment that outputs a Glaucoma confidence level and also provides several morphological features and segmentations of relevant structures, resulting in an interpretable Glaucoma diagnosis. The results demonstrate the potential that this method can have in the contribution to an early Glaucoma diagnosis. The proposed approach achieved similar or slightly better metrics than the current computer-aided diagnosis (CAD) systems for Glaucoma assessment while running on more restricted devices.

This pipeline can, therefore, be used to construct accurate and affordable computer aided diagnosis (CAD) Maheshwari, Shishir, Kanhangad, Vivek, Pachori, Ram Bilas, Bhandary, Sulatha V, Acharya, U Rajendra [2] In this paper, they present a bit-plane slicing (BPS) and local binary pattern (LBP)based novel approach for glaucoma diagnosis. Firstly, we separates the red (R), green (G), and blue (B) channels from the input color fundus image and splits the channels into bit planes. Secondly, we extract LBP based statistical features from each of the bit planes of the individual channels.

Thirdly, these features from the individual channels are fed separately to three different support vector machines (SVMs) for classification. Finally, the decisions from the individual support vector machines (SVMs) are fused at the decision level to classify the input fundus image into normal or glaucoma class. R. Zhao, W. Liao, B. Zou, Z. Chen, and S. Li [3] They present a brand new Weakly-Supervised Multi-Task Learning (WSMTL) strategy for reliable evidence recognition, point segmentation, and automatic glaucoma diagnosis during this work. Only weak-label data with binary diagnostic labels (normal/glaucoma) is employed within the WSMTL approach for training, whereas pixel-level segmentation mask and diagnosis are obtained for testing. To capture multi-scale discriminative representation of fundus structure, the WSMTL is formed of a skip and densely connected CNN. a well-designed pyramid integration structure for generating a high-resolution evidence map for evidence identification, with pixels with greater values representing increased confidence to point irregularities 11 A fully-connected discriminator for automated glaucoma diagnosis, as well as a limited clustering branch for optic disc segmentation. Our suggested WSMTL successfully and simultaneously performs evidence identification, point segmentation (89 percent TP Dice), and accurate glaucoma diagnosis, according to experimental data (92 percent AUC).

As a result, our WSMTL[7] has a high potential for glaucoma clinical assessment. Baidaa Al-Bander, W. Al-Nuaimy, M. Al-Taee, Yalin Zheng[4], Yalin Zheng[4], Yalin Zheng[4], Yalin Zheng[4], Yalin Zheng[4], Yalin Zhe The feasibility of employing a deep learning method to construct an automatic feature learning methodology for detecting glaucoma in coloured retinal fundus images is investigated during this study.

A totally automated system powered by a convolutional neural network (CNN) is employed to tell apart between normal and glaucomatous patterns for diagnostic purposes. S.M. Nikam and C.Y. Patil [5]in this paper, Threshold type segmentation method is employed during this system for localizing the point and eyecup. Another edge detection and ellipse fitting algorithm are used. The proposed system for optic disk and eyecup localization and CDR calculation is MATLAB GUI software. The astronomical structures found through single point distribution model of the image with points on each structure. the price function combines both global and native cues in to search out the right position of the model points. the worldwide terms of the price function within the image operate through vascular patterns of orientation and width.

S. Nawaldgi [6] during this paper, Segmented blind spot and cup by c-mean clustering and superpixel algorithm.. the rise in pressure on the attention nerve causes glaucoma resulting in loss of vision. Detection of this Glaucoma could be a very difficult task and Current tests using pressure level (IOP) testing aren't sensitive enough for population-based glaucoma screening. during this paper, glaucoma screening is treated by point and cup segmentation. Spatially Weighted Fuzzy C-Mean(SWFCM) clustering method is employed to segment the optic disk, and Superpixel algorithm is employed to segment the calyculus The CDR for glaucoma screening is then computed using the segmented blind spot and cup. The second nervus head is additionally referred to as the purpose. For glaucoma identification, blind spot and cup segmentation of fundus images are examined.

T.R. Ganeshbabu and colleagues [8] c-mean clustering and also the super pixel technique were wont to segment the blind spot and cup. If not discovered and treated early enough, glaucoma is one among the key causes of blindness. Glaucoma could be a vision loss condition induced by a rise effective per unit area on the eye nerve. Detecting this kind of glaucoma is also difficult, and current pressure (IOP) assays don't appear to be sensitive enough for population-based glaucoma screening. Glaucoma screening is addressed during this article using point and cup segmentation. The blind spot is segmented using the Spatially Weighted Fuzzy C-Mean (SWFCM) clustering approach, while the caliculus is segmented using the Superpixel algorithm. The CDR for glaucoma screening is then computed using the segmented point and cup. The blind spot is another name for the nerve head. Glaucoma is detected by fundus image segmentation of the point and cup.

Ganesh Babu TR, Shenbaga Devi S, Venkatesh R [9] Ganesh Babu TR, Shenbaga Devi S, Venkatesh R employing a digital fundus image and an optical coherence tomography (OCT) image, this research proposes a unique approach for detecting glaucoma. The cup to disc ratio (CDR) and, as a result, the inferior superior nasal temporal (ISNT) ratio, which were determined from fundus images, are discussed within the first part. The aforesaid features were utilised to classify the standard and glaucoma condition using back propagation neural network (BPN) and Support Vector Machine (SVM) classifiers. within the second a part of the article, the OCT image was accustomed extract features like CDR and two unique features, cup depth and retinal thickness.

These properties were assessed using the BPN and SVM classifiers. U. Rajendra Acharya and colleagues [10] Glaucoma causes the fluid pressure inside the attention to extend, causing damage to the optic nerve and eventually blindness. Optical coherence tomography examines the fiber for any nerve structure damage. a mixture of texture, feature, and fundus picture is employed to detect glaucoma. The identification of glaucoma is proposed during this study utilising a mixture of upper order spectral characteristics and texturing. However, support vector machines and therefore the nave Bayesian technique are accustomed improve supervised classification.

This study by S.Kavitha et al [11] provides a computer-aided decision support system for automated glaucoma detection in monocular fundus pictures. Glaucoma is diagnosed by measuring the size, shape, and location of the Optic Cup and Neuroretinal Rim using fundus pictures. Because the cup is intertwined with the blood vessels, detecting an optic cup is difficult. To distinguish between the Optic cup to disc boundary, a new colour model technique based on pallor in fundus pictures using K- means clustering is applied. The approach is distinguished by the identification of the optic cup region first, followed by the erasure of blood vessels.

To better characterise pathological subjects, textural features are extracted in addition to shape-based features[12]. The Adaptive Neuro-Fuzzy inference system uses the optimal set of features selected by the Genetic algorithm to classify images into normal, suspect, and pathological categories. The approach was tested on 550 photos, which included both normal and glaucomatous images.

In terms of classification accuracy and convergence time, the suggested approach is compared to Neural Network and SVM Classifier SumeetDua et al [13] Glaucoma is detected using energy signatures and textures features obtained from 2-D discrete wavelet transform. They measured the effectiveness of the resultant ranked and selected subsets of features with a support vector machine, sequential minimal optimization, random forest, and naive Bayes classification strategies.

They observed an accuracy of around 93% using tenfold cross -validations Boren Li, Mao Pan, and Zixing Wu [14] provided a way for reducing over segmentation in watershed segmentation employing both pre- and post-processing. In pre-processing, they used more prior information and in post-processing, they merged redundant minimal regions.

The watershed transform produces a gradient image from the initial image within the first stage, but it also introduces the feel gradient. A gray-level co-occurrence matrix are often accustomed extract the feel gradient. the ultimate gradient image is made by fusing the 2 gradient images.

We apply the merging region technique to get rid of small regions after the initial segmentation findings. Xiaoyan Zhang, Lichao Chen, Lihu Pan, and LizhiXiong [16] introduced a watershed technique for image segmentation supported independent component analysis (ICA).

For its properties, ICA is a picture filtering method. ICA is capable of effectively removing noise while maintaining a smooth visual texture. Image segmentation will be accomplished by using an independent component analysis algorithm to get rid of waveband redundancy and extract image signal components from the source signal. The results revealed that this method can effectively process image segmentation and reliably identify features.

ZhonglinXia ,Danfeng Hu and Xueyan Hu [17] has presented watershed algorithm is introduced supported image processing technology for the contamination of insulator. This algorithm is also accustomed obtain the size of contamination area of the insulator, and follow the following steps.

Firstly segment the insulator image with watershed algorithm, that the region growing algorithm is used to process the segmented image, which can guarantee the segmentation effectiveness and reduce . the amount of segmented sections increases the insulating image's segmentation outcomes.

Orlando et al. [18] did a beautiful job of demonstrating how two different CNNs, OverFeat and VGG-S, might be used as feature extractors. Tey also looked into how the performance of these networks changes when the fundus pictures are subjected to contrast-limited adaptive histogram equalisation (CLAHE) and vessel elimination.

Abbas [19] created and implemented a Glaucoma-Deep system as part of his research. This method uses an unsupervised CNN architecture to extract features from fundus images automatically. After that, it selects the foremost discriminative characteristics employing a deep-belief network (DBN) model.

Qaisar Abbas tests his method using four datasets, three of which are public and also the fourth is private. Yann LeCun was the first to form convolutional neural networks (CNNs), which are biologically inspired variations of multilayer perceptrons. they need been employed in computer vision and AI since then. However, it wasn't until the ImageNet competition in 2012 that their significance was recognised.

The foremost goal is to use a subset of the ImageNet dataset to estimate the content of natural photographs for the aim of automatic annotation [13]. GPUs, rectifiers like ReLU, data augmentation approaches, and novel regularisation techniques like Dropout all contributed to their success.

III. PROPOSED SYSTEM

The main goal is to use image processing techniques to diagnose glaucoma utilising a fundus image as an input. There are two metrics involved: 1)The cup-to-disc ratio (CDR) is calculated by dividing the vertical cup height by the vertical disc height. 2)The ratio of the world of vessels on the inferior-superior side to the realm of blood vessels on the nasal-temporal side. To diagnose glaucoma, thickness of the retinal fibre layer is measured using a retinal fundus scan (RNFL). Ophthalmologists employ it as one of the most common non-invasive procedures.

Its key advantage is that photographs of both healthy and sick retinas may be taken fast. It's also portable and easy to use for any health care provider, making it ideal for screening programmes for those without access to health care. The thickness of the RNFL is calculated by dividing the nervus opticus' size(named disc) by the size of the excavation created within the nervus opticus as a result of increased ocular pressure (named cup).

The Cup-to-Disc Ratio is the name given to this variable (CDR). This work describes a computational technique for detecting glaucoma automatically. The major goal is to use a "image processing technique" to diagnose glaucoma using a fundus image as input. It trains datasets using a convolutional neural network (CNN).

The Watershed algorithm is used for segmentation and is the most widely used technique in image processing. The following image processing processes are performed: region of interest, morphological procedures, and segmentation. This technique can be used to determine whether or not a person has Glaucoma.

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IV. FLOW DIAGRAM OF A PROPOSED SYSTEM

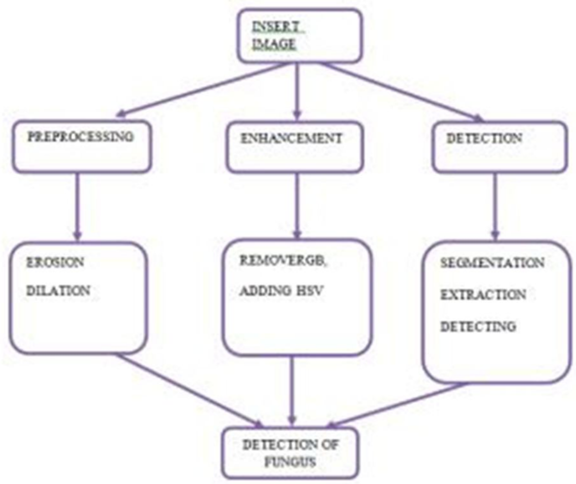

Fig 4.1 Flow Diagram of A Proposed System

V. METHODOLOGY

- *Project Function:* The function of the project are as follows: 1. Take the fundus image of an eye as input 2. Perform image processing steps like ROI, Watershed, Morphological and Segmentation. 3. Using CNN algorithm for dataset training. 4. To predict whether the person has glaucoma or not. There are two user classes of this product as follows: i. Patient (User): The image of an eye is taken from the patient to check whether he has glaucoma or not. The given fundus image is then processed further. ii. Diagnostic: The eye image is taken as input then it undergoes testing process. The testing process contains ROI, Watershed, Morphological, Segmentation and finally based on these process the prediction is made whether the patient has glaucoma or not**.**

A. System Features

1) *Preview:* The preview will show the selected eye image which has to be taken as input.
2) *Region of Interest (ROI):* A Region Of Interest (ROI) could be a a part of a picture that you simply wish to filter or manipulate. a neighborhood Of Interest (ROI) is built employing a binary mask, which is that the same size because the fundus picture we would like to edit but with pixels that outline the ROI set to 1 and every one other pixels set to 0. The ROI defines the borders of an object under examination in computer vision and optical and optical character recognition. Symbolic labels are accustomed describe the content of a ROI during a succinct manner in numerous applications.
3) *Watershed:* Watershed is a well-known algorithm for image segmentation. We start with a user-defined marker when using the watershed method. These markers can be manually defined using point-and-click, or they can be heuristically defined using thresholding and/or morphological processes. The watershed method treats pixels in our input image termed topography based on these markers.
4) *Morphological:* Image components that are important in the representation and description of region form are extracted using morphological techniques. Morphological operations are a set of basic tasks that are depending on the geometry of the image. It's usually done with binary images. It requires two data sources, one of which is the input image and the other of which is the structuring component. Morphological operators take two inputs: an image and a structural component, which are subsequently combined using set operators. The items in the input image are processed based on the structuring component's encoded properties of the image's shape. Morphological consists of erode and dilate.

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5) *Segmentation:* Segmentation is the process of dividing an image into a set of pixel sections that are represented by a mask or a labelled picture. You can process only the key segments of an image instead of the complete image by separating it into segments. Looking for abrupt discontinuities in pixel values, which show edges that define a region, is a frequent strategy. Toggle the image between black and white and grayscale. Applying thresholding to the image is a good idea. Find the contours of the image (edges). Using the largest contour, make a mask. To eliminate the backdrop, use the mask on the original image.
6) *Prediction:* In prediction process the given eye image has to undergo the preprocessing and segmentation. After that the dialogue box will appear showing the prediction whether the person has glaucoma or not. This project uses Anaconda to run Python libraries such as Keras, numpy, matplotlib, and tkinter. Python is a free open-source programming language that anybody can use. We used Visual Studio Code Notebook, which is an open source cross-platform integrated development environment, and Anaconda Powershell for the front end. Operational feasibility is a measure of how well a proposed system solves the problems. This project takes fundus image of an eye as input. The input image undergo ROI, Watershed, Morphological and Segmentation.
7) *User Interface:* This Interface for the system is used to select the fundus image as input and perform various operations on it. The result of the prediction is shown in a dialogue box.

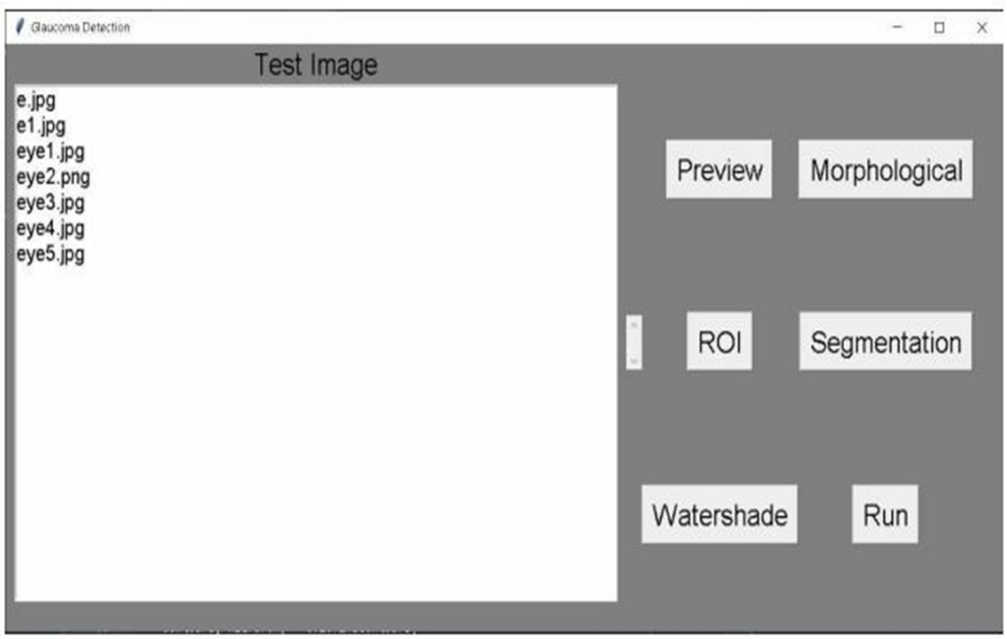

Fig 3.7: User Interface Of The Console

VI. IMPLEMENTATION

A. *Algorithm*

- Step 1: Choose an trained image from the dataset through the GUI.
- Step 2: Preview the image to check the selection.
- Step 3: Through ROI(Region of interest) algorithm, choose the region to filter out and perform further operations on it.
- Step 4: Perform Watershed Algorithm to segment the image into markers and this treats the pixels in the image.
- Step 5: Perform Morphological operations on the image to extract components .
  - Step 5.1: Erosion Algorithm is performed to Erode the boundaries of the object in the image and Shrinks the object.
  - Step 5.2: Dilation algorithm increases the size of the object without including noise.
- Step 6: Segmentation Algorithm divides the image into multiple segments based on characteristics of pixels. Line foreground/background, colour, shape.
- Step 7: On running the algorithms ,all the preprocessing and prediction processes are triggered.
- Step 8: Dialogue box showing Glaucoma or no Glaucoma.

1) *Watershed Algorithm:* The Image is taken as an input and using the maximum and the minimum filter, the image is enhanced. Using the multi-scale, linear filter which is based on the Hessian and the Gaussian matrix, the image is checked for the edge intensity and the boundary intensity. Morphological operations are performed on these images for minimum external region and the segmentation is performed for markers are the pixels from the image. This algorithm extracts the glaucoma prone region, distance transform method is used Now we need to somehow separate these two touching objects and create a border between them, to create a border as far as possible from the centers of the overlapping objects we will use a method that works on rounded objects and it is called a distance transform. It is an operator that generally takes binary images as inputs and pixel intensities of the points inside the foreground regions are replaced by their distance to the nearest pixel with zero intensity. To apply distance transform in OpenCV we can use the function cv2.distanceTransform(). It consists of the following parameters:

a) *Src:* input image.
b) *dst:* output image.
c) *Distance Type:* A variable that represents the type of distance transformation
d) *Mask Size :* A variable representing the mask size.

Marked based watershed segmentation with k-mean algorithm apply the Watershed algorithm on more complex image with multiple overlapping. Step one is to convert the image into grayscale and to apply the threshold function cv2.threshold() to separate pixels into foreground and the background areas.

gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
ret, thresh_img = cv2.threshold(gray, 120, 255, cv2.THRESH_BINARY)
cv2_imshow(thresh_img)

To remove some noise from an image, we use the morphological function .This function can be used for several morphological operations so we need to add a parameter to specify which one we want to use. Since we want to remove small black holes inside the object we will use opening operation that is erosion followed by dilation ,to suppress larger noise areas more iterations need to be done.

# Noise removal kernel = np.ones((3),np.uint8)
opening_img = cv2.morphologyEx(thresh,cv2.MORPH_OPEN, kernel, iterations = 9) cv2_imshow(opening_img) the shapes of some objects are a little distorted as we don't want to affect the overall shapes of the objects apply closing operation (dilation followed by erosion).

# Noise removal
closing_img = cv2.morphologyEx(thresh,cv2.MORPH_CLOSE, kernel, iterations = 4) cv2_imshow(closing_img)

2) *Convolutional neural network (CNN):* Initializing a new model, the training is performed on the entire training set and checked for validation loss equal to the training set. If yes, the model is considered to be underfitting and model complexity is increased to reduce the regularization. If no, the validation loss is checked for being lower than the training model. If yes, the model is considered to be overfitting and the model complexity is decreased. If no, check is performed if the error is rising, thus evaluation on the test set is performed to obtain accuracy and the model is considered complete. Convolution neural networks (CNNs) are a type of deep learning method that uses convolution layers to extract feature maps from images using various numbers of kernels. Then there are the pooling layers, which bring these dimensions down. Again, there are two types of pooling layers: maximum pooling and average pooling layers.

Syntax
Fromkeras.layers import Input,conv2D,maxpooling2D,GlobalAveragepooling2D.
Fromkeras.layers import batchNormalization, activation, Dropout,Flatten,Dense

Training and validation of data is done.

- Convolutional Layer: This layer employs 36 5x5 filters activated by Rectified Linear Units (ReLU).
- Pooling Layer: Uses a 2x2 filter and a stride of 2 to produce maximum pooling.

Important modules to employ when building a CNN include:

- Conv2d () : Assign the number of filters, filter kernel size, padding, and activation function to a two-dimensional convolutional layer.
- Max pooling2d () : Using the max-pooling technique, create a two-dimensional pooling layer.
- Dense () : Using the hidden layers and units, create a dense layer.

Command to initiate the train and test generators with data Augumentation

```
seq = iaa.Sequential
([ iaa.GaussianBlur(sigma=(0 , 1.0))
 iaa.Sharpen(alpha=1, lightness=0)
 iaa.CoarseDropout(p=0.1, size_percent=0.15)
```

3) *Morphology:* The input image is checked for the pixels of the boundaries and those boundaries are removed, which is the erosion od the eye and the smaller object in the image is dilated and the pixels are enlarged to get a clear view of the region.

Commands for morphological operations

```
thresh_img = cv2.erode(thresh_img, None, iterations=2)
 cv2.imshow('erode',thresh_img)
thresh_img = cv2.dilate(thresh_img, None, iterations=3)
cv2.imshow('dilate',thresh_img)
```

4) *Region of Interest:* Region of interest (R.O.I) algorithms takes the image as input and checks for the optic disc segmentation, optic cup segmentation. It then calculates the blood vessels in the particular areas and classification based on blood vessel count is performed to categorize the eye images for presence of glaucoma.

Command which shows region of interest ROI():

```
img = cv2.imread('test/%s' % (spath)) roi = autoroi(img)
cv2.imshow("Region of Interest", roi)
```

5) *Segmentation:* Segmentation of the image is performed by taking the input as the image and segmenting the images into a number of images based the characteristics of pixels in the case of the foreground, background, colour and shape of eye.

Commands Used

```
OpticDisc and Optic Cup img = cv2.imread('test/%s' % (spath)) gray_image = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
res,thresh_img=cv2.threshold(gray_image,127,255,cv2.THRESH_BINARY_INV)
 thresh_img = cv2.erode(thresh_img, None, iterations=2)
thresh_img = cv2.dilate(thresh_img, None, iterations=3)
 contours, hierarchy = cv2.findContours(thresh_img,cv2.RETR_TREE,cv2.CHAIN_APPROX_NONE)
```

6) *Detection:* The measurements were taken on a collection of fundus images of both healthy and unhealthy eyes, with the ophthalmologists estimating the CDR for each image. The results of our algorithm were compared to those of the reference estimates. where the comparisons between the doctor's estimation, the output of the algorithm of ratios, and the output of the algorithm of proportions of regions are shown.

VII. RESULTS AND DISCUSSIONS

The results of proposed system is predicting whether the person is having glaucoma or not.

1) In the fist step we select the trained image ,this images undergoes further operations in diagnosing glaucoma

Test case id	Test cases	Preconditions	Input test data	Expected result	Actual result	Pass/ Fail
1	Taking image as an input	Searching for test images	Selecting an image	Preview of image is obtained	Preview of image is obtained	Pass

Table 5.1 : preview of image

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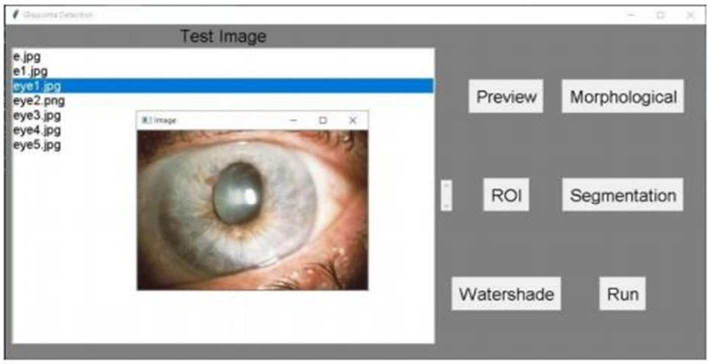
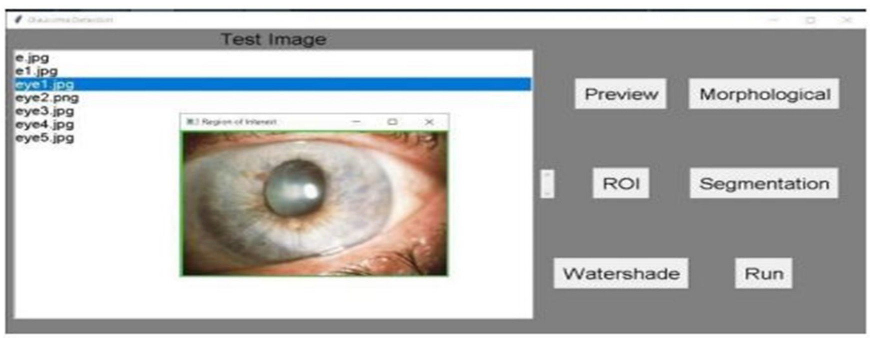


Fig 5.1: Preview of input image

2) The region of interest selected from the trained images

2	Region Of Interest	Binarization of image	Selected image given as input	Obtaining ROI in the input image	ROI is obtained	Pass

Table 5.2: Region of interest



3) Watershed Algorithm is Applied

3	Watershed	Execution of Watershed algorithm	Giving the ROI image as input	Obtaining the gradient image	Obtaining the gradient watershed image	Pass

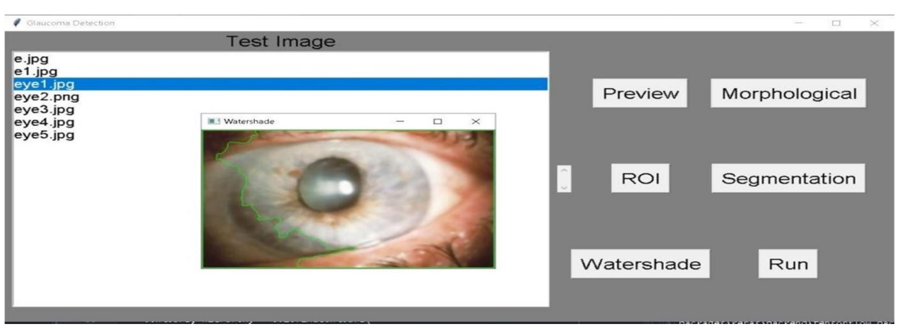


Figure 6.3: Watershed image

4) Morphological Operations are Done

4	Morphological	Erosion and Dilation	Watershed processed image as input	Erode and dilate image is obtained	Erode and dilate image is obtained	Pass

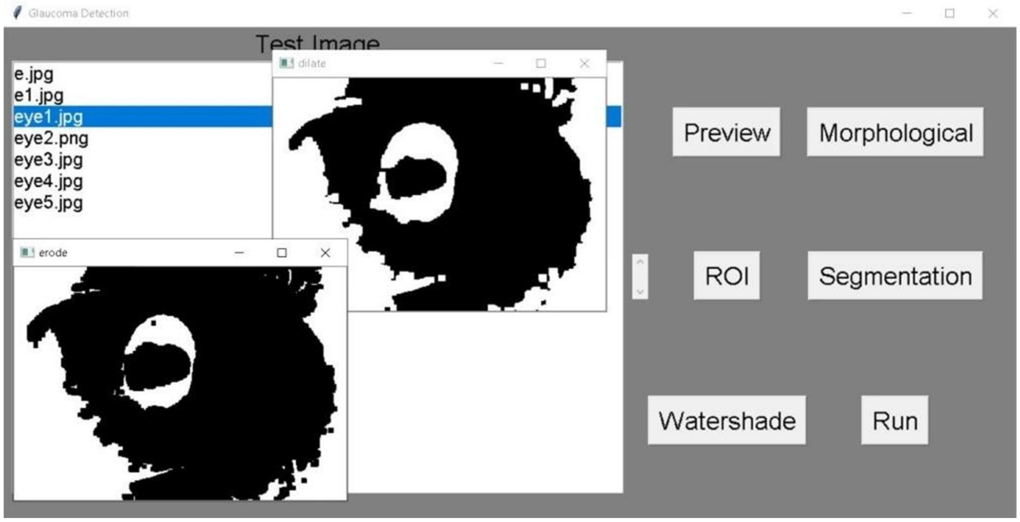


Figure 6.4: Erosion and Dilation

5) Segmentation is done to above obtained image.

5	Segmentation	Segmentation of given image	Taking previously obtained image as input	Segmented image is obtained	Segmented image is obtained	Pass

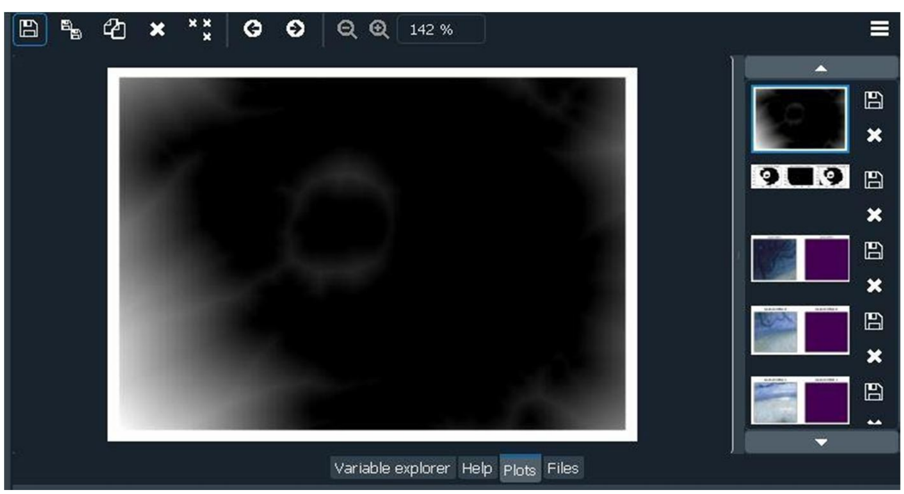


Figure 6.5: Segmentation

6) Prediction shows the required output

6	Prediction	Comparing the output with datasets	Taking previously obtained image as Input	Prediction of glaucoma	Prediction of glaucoma	Pass

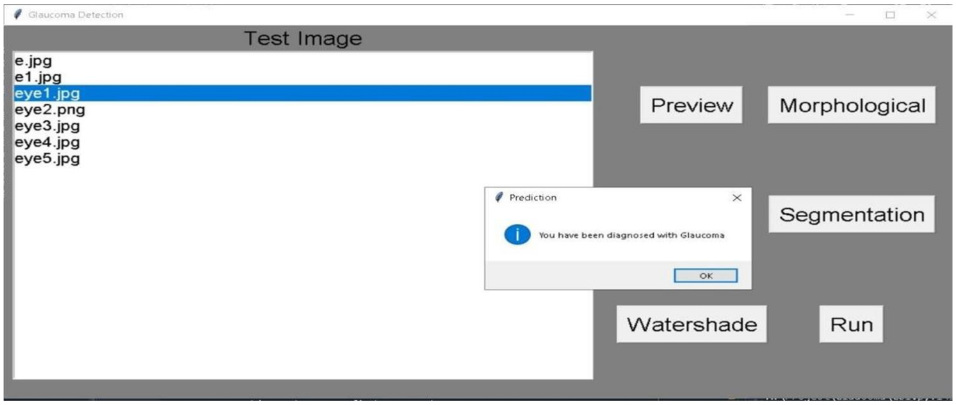


Figure 6.6: Prediction

The above output image shows whether the given eye image has glaucoma or not. To obtain the result the eye image has to undergo the preprocessing and segmentation process.

VIII. CONCLUSION

Because the existence of a cup in the disc is a strong predictor of glaucoma, in this paper,a method for detecting glaucoma was presented here by correctly recognising the cup's location. The disc segmentation in this proposed system was done using thresholding, the vessel segmentation was done using edge detection, and the cup segmentation was done using the vessel and cup intensities.

IX. ACKNOWLEDGEMENT

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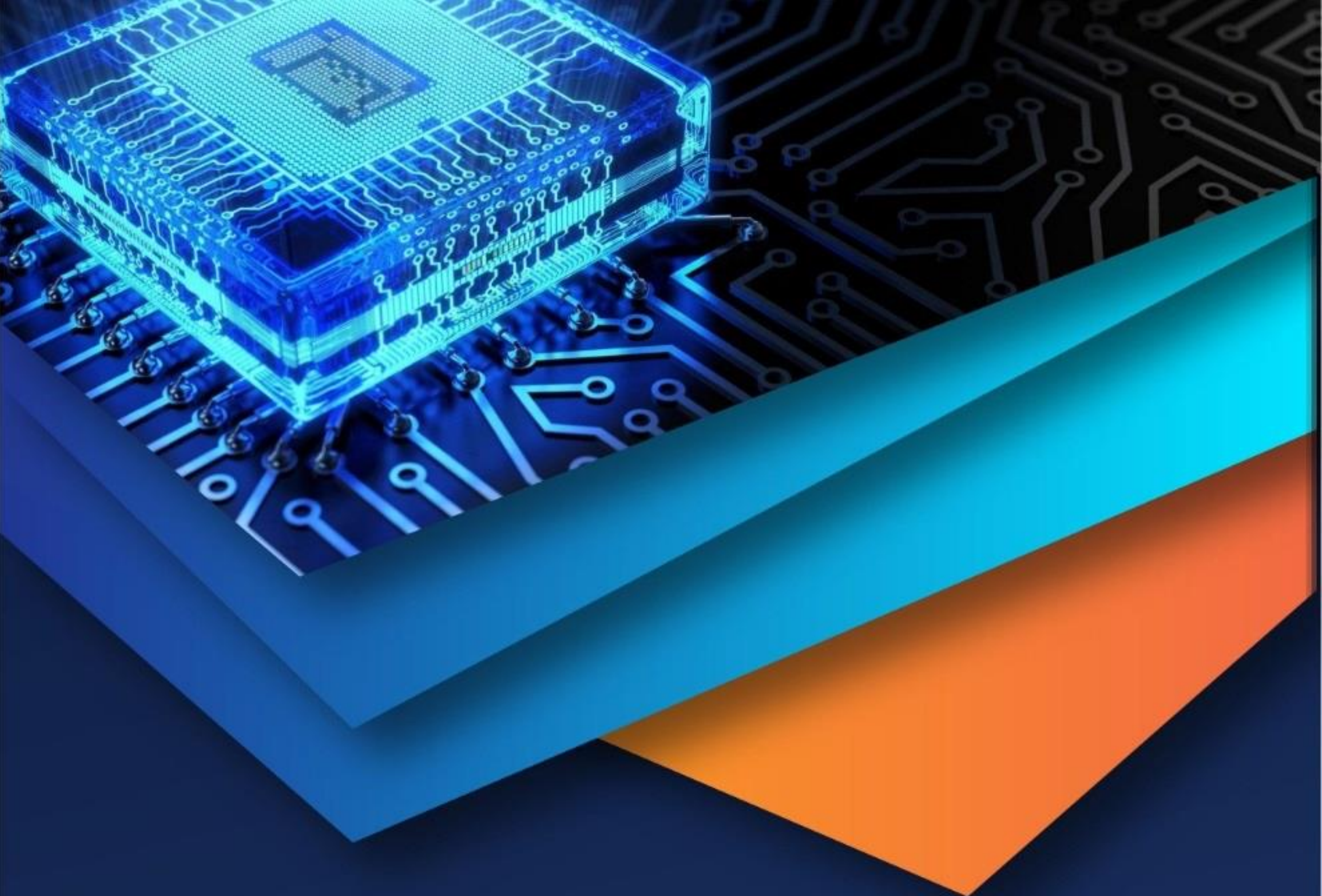

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