GLAUCOMA DETECTION USING FUNDUS IMAGES THROUGH DEEP LEARNING

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***Abstract*: A chronic eye condition called glaucoma has a deleterious effect on the optical nerve, which links the brain and eye to transmit visual information. Early detection is essential for stopping the condition's progression. Glaucoma is one of the most prevalent eye conditions, and it's important to catch it early because it can cause blindness and neurological issues. In this study, a CNN system is proposed for the early detection of glaucoma. The system utilizes enlarged images of the eyes as input data for the deep learning method. The eye image undergoes pre-processing to eliminate any noise and prepare them for further analysis. The suggested system classifies new eye images as either having normal pupils or being impacted by glaucoma based on the features it learned during training.**

Keywords: Glaucoma, CNN, Deep Learning, pre-processed, Fundus Images

I. INTRODUCTION

Glaucoma, One of the leading causes of blindness worldwide is glaucoma, a long term neurodegenerative eye disease. According to the WHO, average 65 million people around the world are affected by glaucoma[1].Given that the primary symptom of glaucoma, the loss of optic nerve fibers, may be asymptomatic, early diagnosis and treatment are crucial in preventing vision loss. This loss is caused by increased intracranial pressure or decreased blood flow into the optic nerve[2][2]. Visual data is transmitted via the optic nerve from the brain to the eye. Pathologically high intraocular pressure, which can suddenly rise to 60-70 mmHg, is a symptom of glaucoma. Prolonged pressure of less than 25-30 mmHg can result 2 in visual loss High pressure in glaucoma is caused by increased reluctance to fluid expulsion into the drainage system of the eye. The fluids generated within the eye and the ones that are released are in equilibrium in healthy eyes[3]. A common method used in ophthalmology to examine the human eye is taking a photo of the eye's fundus using a fundus camera. The medical professional takes the picture through the pupil to capture the eye's background. The photos are then analysed, which can take several hours on a computer, but the results are not always accurate[3][3]. Diagnosing glaucoma at home is a challenging task that requires determination and patience.

We employed a supervised learning method classifier to distinguish between a healthy eye fundus and one affected by glaucoma. SVM aims to build a model, based on training and test data, which predicts the key features of the test data. SVM is a popular supervised learning technique used for classification or regression problems.

For classification issues, the SVM algorithm is a popular choice in machine learning. Its purpose is to create a boundary line or decision point that can divide high-dimensional spaces into classes, making it easier to categorize new data points in the future.

This boundary line is referred to as a hyperplane[4]. The objective is to automatically detect the abnormalities and conditions with the least amount of error. However, when used with SVM algorithms for images obtained with fast rising spatial resolution, conventional image processing methods that were created and tested on low-resolution images have limits.

A new set of methods must be devised for this purpose. Because Convolutional Neural Networks (CNNs) can handle high-resolution images with minimal processing expense, we use them. CNNs are one kind of neural network that is frequently employed for image recognition applications.

The network's convolutional layer lowers the high dimensionality of the images while retaining crucial data[1]. Another similar model that extracts features through convolutional filters is the Convolutional Neural Network (CNN). In large datasets, CNNs have become the preferred method for efficient and accurate image classification.

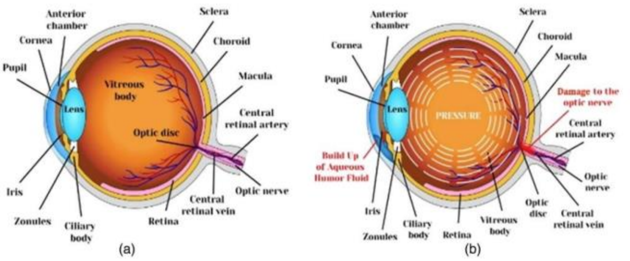

Fig 1: Internal Structure of the eye.

II. LITERATURE SURVEY

The primary indication of the glaucoma is the loss of retinal cells and astrocytes. This can be investigated by measuring the length of the eye cup about the eye disc and the thickness of a neuro-retinal rim. In the literature, there are many studies using fundus images that have primarily focused on measuring the size of the retinal ganglion cell head[5]. proposed a system to measure the Cup-to-Disc Ratio (CDR) using position-set methods and optic cup masks. They tested their system on 104 images and aimed to achieve a difference of less than 0.2 CDR points from the root truth. The optic cup was identified by Joshi et al[6].using an anatomical method based just on the curvature of the blood vessels just at the cup boundary. With the use of a container shape and a circular Hough transform, they achieved a CDR error of 0.12 to 0.10 in locating the eye cup. In a different study, Yin et al.[7], with average Cor relation measures of 0.92 and 0.81, using the Circular Wavelet transform to segment the optic disc or cup in 325 pictures. Cheng and co. [1] offered an alternative way that measures the CDR using super pixels to segment the retinal image and cup. They tested their system on 650 images and obtained average Jaccard scores of 0.800 and 0.822 across two datasets. Liu et al. also presented a study incorporating additional patient-specific and genetic information [2].

The loss of eye nerve fibres and astrocytes is a main symptom of glaucoma. By measuring the length of the eye cup in relation to the eye2 disc and the viscosity of the neuroretina rim, this loss can be examined. Numerous studies have primarily used fundus images to measure the optic nerve head literature.

Various techniques have been proposed for computing the Cup-to-Disc Ratio (CDR), including using position-set methods, anatomical verification, and Circular Hough transform. Researchers have tested these methods on various datasets and obtained different results. The use of additional information, such as case-specific and genetic data, has been suggested to improve the performance of glaucoma screening.

However, the large variability in manual grading among experts remains a challenge. Therefore, researchers have focused on developing new data-driven algorithms, such as convolution neural networks (CNNs), to automate the process. A data-driven system was proposed in a study that utilized "Eigen images" and a Support Vector Machine (SVM) to highlight and categorize features. The system achieved a competitive AUC of 0.88 when tested on 575 mislabelled photos from the Erlangen Glaucoma Registry, but cannot be compared to other methods due to the private nature of the photos.

“Convolutional Neural Networks (CNNs), first created by YannLeCun,[10] are multi-layer perceptions with naturalistic influences that have been widely used in artificial intelligence and computer vision. Until 2012, their potential was largely unnoticed until they dominated the ImageNet competition. The usage of GPUs, training algorithm like ReLU, data preprocessing methods, and regularization methods like Dropout were all credited with the success of CNNs. The capacity of CNN designs to extract discriminative characteristics at many levels of abstraction is their primary strength [9].

III. PROPOSED SYSTEM

Convolutional neural networks are used in the suggested novel system. Glaucoma can be identified by the method using fundus images. The original images are collected from a dataset or source and subjected to data augmentation.

Pre-processing is performed to addressing issue of blurry or unclear images, which includes color space conversion, image reconstruction, and image enhancement.

These steps utilize grayscale tones, where white represents the highest intensity and black is the lowest. Rotation, zoom in, and zoom-out techniques are used to create new data with different exposures. This is crucial for achieving a balance between the two classes of glaucoma.

Methodology Overview:

The three modules of the project are:

- A Image Pre-processing.
- A Feature Extraction.
- A classification module.

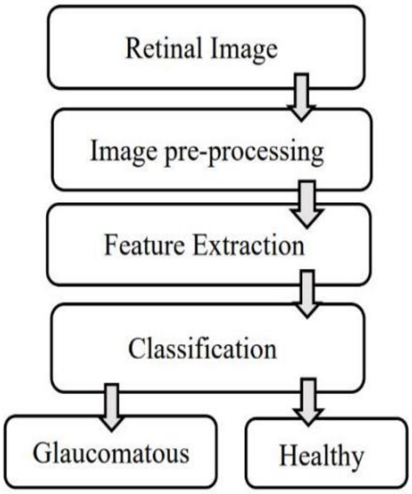

Fig 2. The process of the project

Image Pre-processing:

Image pre-processing sets the standard for production processes. Both the input and the context in filmland are intense, leading to distinct films. Usually, a matrix that includes metrics for image quality such as brilliance and discrepancy is utilized to reflect the intensity of the image.

Pre-processing enhances the visual elements, simplifying subsequent steps and enhancing image data to minimize undesirable distortions. This stage can involve tasks like removing noise from the image, resizing, and making modifications

Feature Extraction:

The initial important step in identifying eye issues is to pinpoint the area of concern. One way to accomplish this is through a technique called "point of interest," which quickly highlights the specific area of interest within a vector representation of the entire image.

This approach is beneficial when precise point representation and large image sizes are necessary for image matching tasks and data retrieval. The designation of a Region of Interest is essentially the point of interest (ROI).

Classification:

The process of categorizing a word into various categories using an abstract confirmation image is referred to as "image categorization." This involves evaluating the different options from the images and organizing the information into new groups or categories.

Once this has been completed, the image categorization is considered finished. The structured image is divided into two categories: eyes that are healthy eyes with glaucoma.

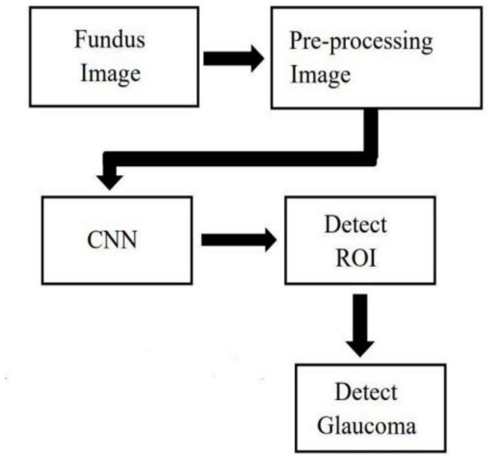

Fig 3. Image Classification

Algorithm :

Step 1: As an initial argument, pass an image of any size as input.
Step 2: To reprocess the image, pre-processing is also used. This employs various techniques, including data cleansing, metamorphosis, data integrity, etc.

Step 3:Next, we employ the CNN model. Each input image will be processed via several convolutional layers.

(It is done using pollutants pooling in the current model, which is used to generate both training and test sets of data.)

Step 4: The data is also sorted based on the training set.

Step 5: Making decisions comes next. In this instance, we consider the condition to be a result(0)(0), and if the result is 1, we also receive the affair as glaucoma; otherwise, we obtain the affair as Not Glaucoma.

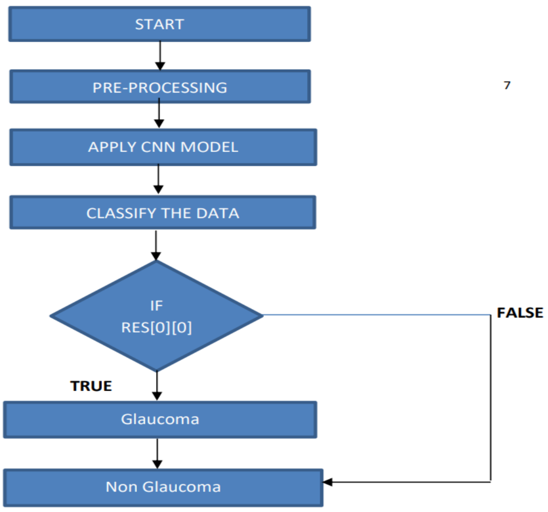

Fig 4. Flowchart

IV RESULTS

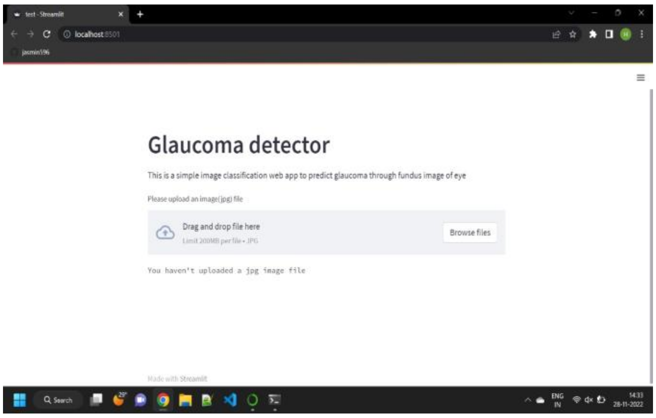

Fig 5. Input Image

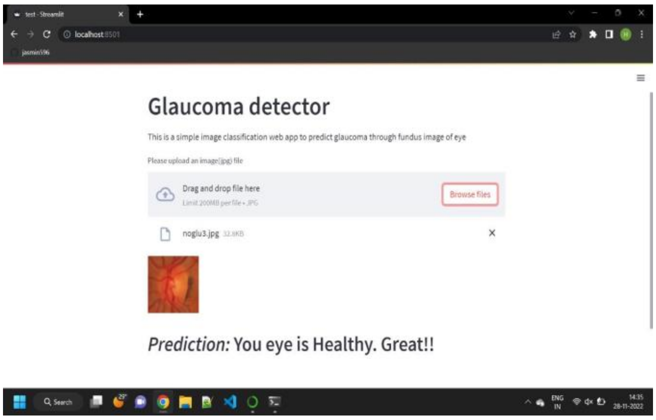

Fig 6. Healthy eye

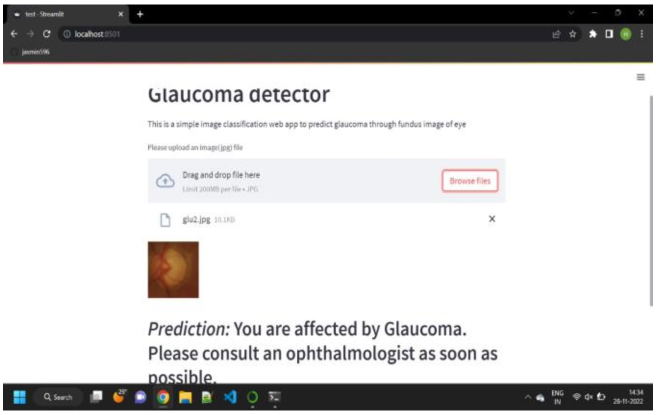

Fig 7. Glaucoma Detected

V CONCLUSION

Glaucoma is one of the main reasons for eyesight loss in the globe. The developed CNN model can correctly categorize photos of the fundus (not glaucoma). The key advantage of this model is that it considers the entire image rather than just the affected area and combines filtered data to lessen the need for complex feature generation and deliver accurate results. This lessens confusion and emphasizes the qualities that distinguish people with normal eyes from those with glaucoma. Future research can employ our effective technique to identify glaucoma in its early stages, allowing doctors to suggest early treatment.

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