GLAUCOMA DETECTION USING FUNDUS IMAGES THROUGH DEEP LEARNING

A Project Report submitted in the partial fulfillment of the

Requirements for the award of the degree

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

Submitted by

T.YUVANA	**(19471A05I5)**
HADASSA.M	**(19471A05E7)**
N.NIREEKSHANA	**(19471A05H0)**

Under the esteemed guidance of

Dr.S.V.N.Sreenivasu, M.Tech.,Ph.D

Professor.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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CERTIFICATE

This is to certify that the project that is entitled with the name "GLAUCOMA DETECTION USING FUNDUS IMAGES THROUGHDEEP LEARNING" **is a bonafide work done by the team T.YUVANA (19471A05I5), HADASSA.M (19471A05E7), N.NIREEKSHANA (19471A05H0)** in partial fulfillment of the requirements for the award of the degree of BACHELOR OF TECHNOLOGY in the Department of COMPUTER SCIENCE AND ENGINEERING **during 2022-2023.**

PROJECT GUIDE

Dr.S.V.N.Sreenivasu, M.Tech.,Ph.D
Professor

PROJECT CO-ORDINATOR

Dr. Sireesha .M, M.Tech., Ph.D
Asscociate Professor

HEAD OFTHE DEPARTMENT

Dr. S. N. TirumalaRao, M.Tech., Ph.D.,
Professor

EXTERNAL EXAMINER

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By:

T. YUVANA (19471A05I5)

HADASSA.M (19471A05E7)

N.NIREEKSHANA (19471A05H0)

ABSTRACT

Glaucoma is a group of related eye disorders that cause damage to the optic nerve that carries information from the eye to the brain which can get worse over time and lead to blindness. It is very important that glaucoma is detected as early as possible for proper treatment. In this project, we have proposed a Convolutional Neural Networks (CNN) system for the early detection of glaucoma. Initially, eye images are augmented to generate data for Deep learning.

The eye images are then pre-processed to remove noise and make the image suitable for further processing. The system is trained using the pre-processed images and when new input images are given to the system it classifies them as normal eye or glaucoma eye based on the features extracted during training.

Glaucoma is a progressive eye disease that causes vision loss and can lead to blindness if left untreated. Early detection and management of glaucoma are crucial to preventing irreversible damage to the optic nerve. In recent years, deep learning models such as Convolutional Neural Networks (CNN) have been utilized for automated glaucoma detection. CNNs are particularly suited for image analysis tasks, and glaucoma diagnosis typically involves the examination of retinal images. By training a CNN on large datasets of retinal images from both healthy and glaucomatous eyes, it can learn to accurately distinguish between the two and identify early signs of the disease.

Several studies have reported high accuracy rates for glaucoma detection using CNNs, with some achieving sensitivities and specificities exceeding those of human experts. Furthermore, automated detection using CNNs can be faster and more consistent than manual screening, potentially enabling earlier detection and intervention.

Overall, the use of CNNs for glaucoma detection shows great promise in improving the efficiency and accuracy of diagnosis, and ultimately, helping to prevent vision loss in affected individuals.

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M2: Build a passionate and a determined team of faculty with student centric teaching, imbibing experiential, innovative skills

M3: Imbibe lifelong learning skills, entrepreneurial skills and ethical values in students for addressing societal problems

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PEO4: Pursue higher studies and develop their career in software industry.

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2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meetthe specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9.Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Project Course Outcomes (CO'S):

CO425.1: Analyse the System of Examinations and identify the problem.

CO425.2: Identify and classify the requirements.

CO425.3: Review the Related Literature

CO425.4: Design and Modularize the project

CO425.5: Construct, Integrate, Test and Implement the Project.

CO425.6: Prepare the project Documentation and present the Report using appropriate method.

Course Outcomes – Program Outcomes mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C425.1		✓											✓		
C425.2	✓		✓		✓								✓		
C425.3				✓		✓	✓	✓					✓		
C425.4			✓			✓	✓	✓					✓	✓	
C425.5					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
C425.6									✓	✓	✓		✓	✓	

Course Outcomes – Program Outcome correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C425.1	2	3											2		
C425.2			2		3								2		
C425.3				2		2	3	3					2		
C425.4			2			1	1	2					3	2	
C425.5					3	3	3	2	3	2	2	1	3	2	1
C425.6									3	2	1		2	3	

Note: The values in the above table represent the level of correlation between CO's and PO's:

[1] Low level
[2] Medium level
[3] High level

Project mapping with various courses of Curriculum with Attained PO's:

Name of the course from which principles are applied in this project	**Description of the device**	**Attained PO**
C3.2.4, C3.2.5	Gathering the requirements and defining the problem, plan to develop a **Glaucoma detection using fundus images through deep learning.**	PO1, PO3
CC4.2.5	Each and every requirement is critically analyzed, the process model is identified and divided into **three modules**	PO2, PO3
CC4.2.5	Logical design is done by using the unified modelling language which involves individual team work	PO3, PO5, PO9
CC4.2.5	Each and every module is tested, integrated, and evaluated in our project	PO1, PO5
CC4.2.5	Documentation is done by all our four members in the form of a group	PO10
CC4.2.5	Each and every phase of the work in group is presented periodically	PO10, PO11
CC4.2.5	Implementation is done and the project will be handled by the **Glaucoma detection using fundus images through deep learning.**	PO4, PO7
CC4.2.8 CC4.2.	**The physical design includes software requirements like Windows & or higher Os and Python , streamlit , keras modules.**	PO5, PO6

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CHAPTER 1
INTRODUCTION

Glaucoma is often linked to a build-up of pressure inside the eyes. Glaucoma tends to run in families and one usually doesn't get it until later in life. The increased pressure in eyes, called intraocular pressure, can damage the optic nerve, which sends images to the brain. If the damage worsens, glaucoma can cause permanent vision loss or even total blindness within a few years. Most people with glaucoma have no early symptoms or pain. One must visit the eye doctor regularly so they can diagnose and treat glaucoma before one has long-term vision loss. If a person loses his vision, it can't be brought back. But, lowering eye pressure can help keep the sight that he has. Most people with glaucoma who follow their treatment plan and have regular eye exams are able to keep their vision. An optic disc and cup are present in all individuals but an abnormal size of the cup with respect to the optic disc is a characteristic of a glaucoma-infected eye.

Traditional methods of detecting glaucoma include an eye doctor analyzing the images and finding the abnormalities in them. This method is very time-consuming and not always accurate because the image contains noise and other factors which make it difficult for proper analysis. Also, if a machine is trained for analysis it becomes more accurate than human analysis.

Most of the literature works present mainly focus on optic cup and disk segmentation and some focus on Cup/Disk ratio. Through our analysis, we have found using the Convolutional Neural Network model to be better than other literature works proposed. Convolution Neural Networks are one of the most popular deep learning techniques for imageanalysis. In this technique, training data Convolution Neural Networks are one of the most popular deep learning techniques for image analysis. In this technique, training data feature learning and classification simultaneously. In deep learning algorithms, a model is formed using many layers which transform the given input data into an output.

1.1. MOTIVATION

The motivation behind choosing machine learning for glaucoma diagnosis and treatment among Indians is primarily due to the high prevalence of the disease in the country. India has one of the highest numbers of glaucoma cases in the world, and early detection and management of the disease are essential to prevent vision loss and blindness.

Machine learning, particularly deep learning models such as CNNs, have shown great promise in accurately diagnosing glaucoma from retinal images. This technology has the potential to improve the efficiency and accuracy of diagnosis, particularly in areas where access to trained healthcare professionals and resources may be limited.

1.2. PROBLEM DEFINITION

The aim is to design a computer-aided glaucoma detection system that detects glaucoma at an early stage from the fundus images of the human eye. The implementation is based on CNN.

1.3. OBJECTIVE

Traditional methods of detecting glaucoma include an eye doctor analyzing the images and finding the abnormalities in them. This method is very time-consuming and not always accurate because the image contains noise and other factors which make it difficult for proper analysis. So a machine trained for analysis becomes more accurate than human analysis. This project aimed to develop a CNN-based algorithm for glaucoma diagnosis in patients with glaucoma, The ultimate goal of glaucoma detection is to maintain vision and what is already lost cannot be restored. Some people are at higher risk for glaucoma than others.

1.4. LIMITATIONS

- A Convolutional Neural Network is significantly slower due to an operation such as amax pool.
- If the **CNN** has several layers then the training process takes a lot of time if the computer doesn't consist of a good GPU.
- A ConvNet requires a large Dataset to process and train the neural network.

1.5. ORGANIZATION OF DOCUMENTATION

In the introduction part, we describe the purpose of choosing the project, describe the problem definition, and the problem descript. The objectives and limitations of the project are also mentioned. These objectives are determined by studying the existing works being done.

The literature survey will help us to know about the existing models and be very useful in proposing new models. In the literature survey part, we mention the existing models and list theirs as disadvantageous them. This helps in proposing a new model that overcomes the disadvantages of the existing models and is used to give the best models.

Once the literature survey is done, we focus on the analysis part. This analysis part is used to describe the software requirements specifications such as user requirements, software requirements, and hardware requirements. Once the requirements are gathered, content diagrams, algorithms and flowcharts are specified. These algorithms and flow charts will be used mainly in the design phase.

In the design part, we make use of the content diagram, algorithms, and flowcharts to design the dataflow diagrams and the UML diagrams. With the help of these dataflows and UML diagrams, we can design the modules required for the implementation.

In the implementation part, all the designed modules are gathered together and implementation is done. The results obtained by implementing our project are exhibited in this phase.

To see whether the implementation is done correctly, testing and validation are done. In testing, we test the project in all scenarios. Validation of the project is also done by testing various aspects.

Finally, we conclude by summarizing our proposed system and also by specifying the future enhancements to be done to the proposed system.

CHAPTER 2

LITERATURE SURVEY

2.1. Introduction

Glaucoma is often linked to a build-up of pressure inside the eyes. Glaucoma tends to run in families and one usually doesn't get it until later in life. The increased pressure in the eyes, called intraocular pressure, can damage the optic nerve, which sends images to the brain. If the damage worsens, glaucoma can cause permanent vision loss or even total blindness within a few years. Most people with glaucoma have no early symptoms or pain. One must visit the eye doctor regularly so they can diagnose and treat glaucoma before one has long-term vision loss. If a person loses his vision, it can't be brought back. But, lowering eye pressure can help keep the sight that he has. Most people with glaucoma who follow their treatment plan and have regular eye exams are able to keep their vision. An optic disc and cup are present in all individuals but an abnormal size of the cup with respect to the optic disc is a characteristic of a glaucoma-infected eye.[1]

Traditional methods of detecting glaucoma include an eye doctor analyzing the images and finding the abnormalities in them.[3] This method is very time-consuming and not always accurate because the image contains noise and other factors which make it difficult for proper analysis. Also, if a machine is trained for analysis it becomes more accurate than human analysis.[2]

Most of the literature works present mainly focus on optic cup and disk segmentation and some focus on Cup/Disk ratio. Through our analysis, we have found using the Convolutional Neural Network model to be better than other literature works proposed. Convolution neural networks are one of the most popular deep learning techniques for image analysis. In this technique, training data Convolution neural networks are one of the most popular deep learning techniques for image analysis [6].In this technique, training data feature learning and classification simultaneously. In deep learning algorithms, a model is formed using many layers which transform the given input data into an output.

2.2 Existing system

A classification task usually involves separating data into training and testing sets. Each data into training and testing sets. Each value (i.e. the class labels) and several attributes (i.e. the features or observed variables).

The existing system used a support vector machine (SVM) classifier, a supervised learning model, for classifying normal eye fundus for glaucoma-affected eye fundus.[5] The goal of SVM is to produce a model (based on the training data) which predicts the target values of the test data given only the test data attributes. In that case, the input image matrices are modified and applying pre-processing techniques.

SVM is designed to separate a set of training images into two different classes, (x1, y1), (x2, y2), … (xn, yn) where xi in Rd, d-dimensional feature space, and yi in {-1, +1}, the class label, with i=1..n. SVM builds the optimal separating hyperplanes based on a kernel function (K). All images, of which the feature vector lies on one side of the hyperplane, belong to class -1 and the others belong to class +1. [6]

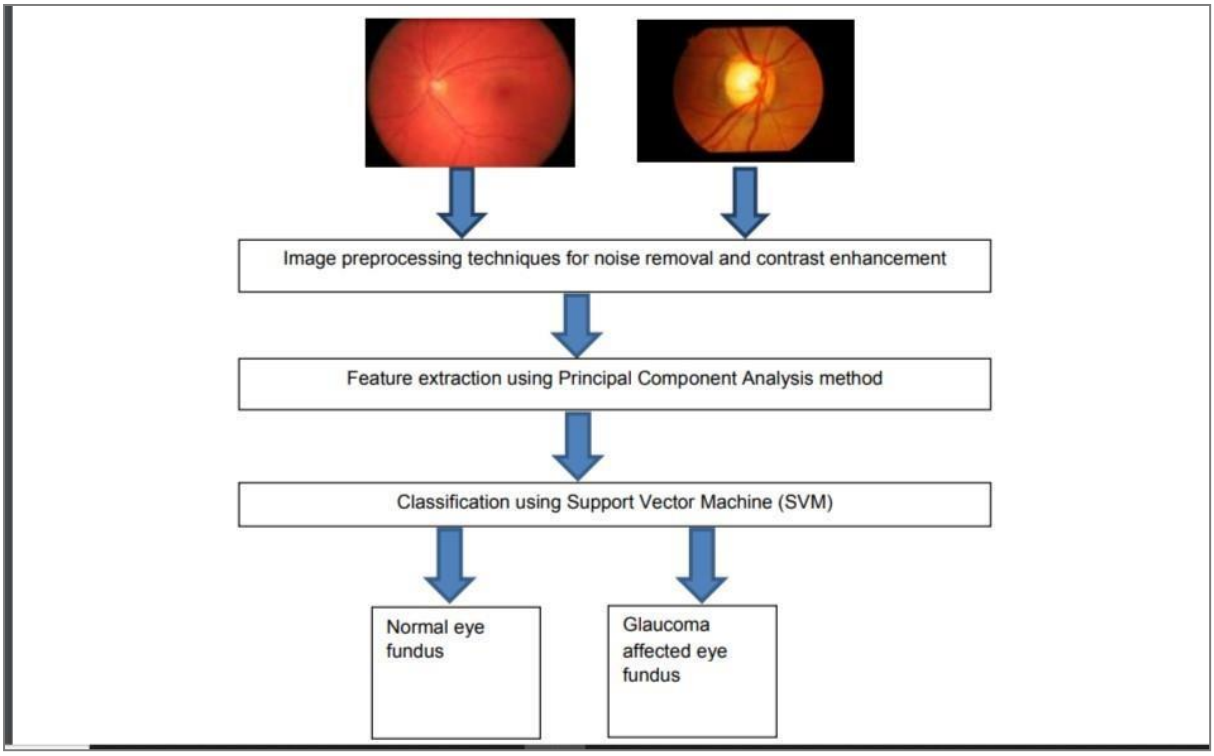

Fig 2.1 Existing system for Glaucoma detection

2.3 Disadvantages of the Existing system

- Long training time for large datasets.

- Difficult to understand and interpret the final model, variable weights, and individual impact.
- Since the final model is not so easy to see, we cannot do small calibrations to the model hence it's tough to incorporate our business logic.[8]
- The SVM hyperparameters are Cost -C and gamma. It is not that easy to finetune these hyper-parameters. It is hard to visualize their impact.

2.4 Proposed system

By considering the above existing system, a new system using CNN is proposed. Glaucoma detection from fundus images is implemented based on CNN. Initially, input images are collected from the user or dataset which is input to the data augmentation. The major problem which causes blurred non clarity images are rectified in pre-processing. Color space conversion, image restoration, and image enhancement are the stages in this process. These are composed of grey shades such as black being the weakest intensity and white being the strongest intensity [7]. Data augmentation is used to create new data with different orientations. It plays a vital role in the balance of 2 classes in glaucoma. The two classes are class 0(No glaucoma), and class 1(Glaucoma).

2.5 Summary

Taking the existing system into consideration, a new system using CNN is being proposed. To overcome the disadvantages of the existing system using SVM and a new system using CNN is proposed. CNN is the most efficient method used in medical analysis and an effective technique to detect the region of interest and also image classification.

CHAPTER 3

ANALYSIS

3.1 INTRODUCTION

System analysis is an important activity that takes place when we are building a new information system or changing existing ones. The analysis is used to gain an understanding of an existing system and what is required for it. At the conclusion of the analysis, there is a system description and a set of requirements for a new system. If there is no existing system, the analysis defines only the requirements.

System models are used to gain precision and to avoid the ambiguities often found in the natural language system analysis avoid ambiguity by using precise modeling constructors and process descriptors. They also assist to define precisely the requirements of analysis.

This phase is a detailed appraisal of the existing system. The appraisal includes finding how the system works and what it does. It also includes system problems and what the end-users required of any new or changed system. After this phase, the analyst should be familiar with both the detailed operation of the system terms and what is required of the new system.

From users, it is possible to find out the existing activities and to develop the user objectives and requirements. A system analyst must spend a lot of time talking to users and finding out they use the system, any problems they find with the system, and what they expect from it.

3.2. Software Requirement Specification

3.2.1. User Requirements

Input : Image path

Output : displays glaucoma or no glaucoma

3.2.2. Software Requirements

Operating System - Windows 7,8 and 10

Language - Python

IDE - Python 4.3.0

3.2.3. Hardware Requirements

RAM - 4 GB

Hard Disk - 260 GB

Processor - Intel Core i3

Input Device - Standard Keyboard and Mouse

Output Device - High-Resolution Monitor

3.3. Content Diagrams

Glaucoma detection from retinal images is implemented based on CNN. CNN is the most efficient method used in medical analysis and an effective technique to detect the region of interest and also image classification.

3.3.1 Module Description:

The three modules of the project are:

1. Image Pre-processing module
2. Feature Extraction module
3. Classification module

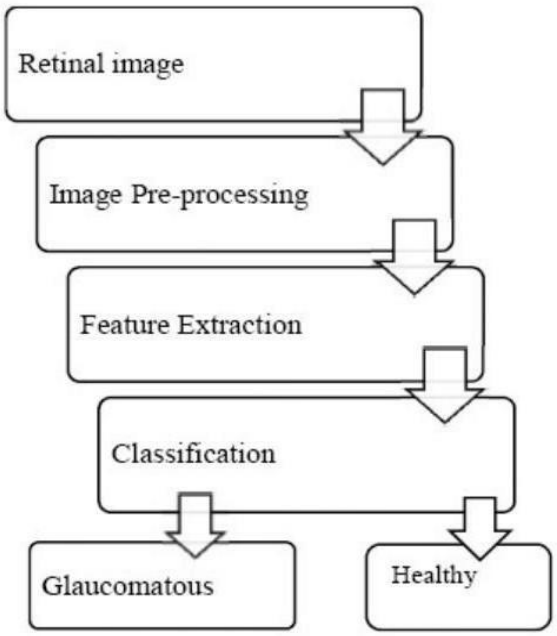

Fig. 3.3.1 Flow of Processing

- **Image Pre-processing:**

  Pre-processing defines the operations on images. The input and output are intensity images. These images are of the same kind as the original data capture. The intensity image is usually represented by a matrix of image function values such as brightness, and contrast. Pre-processing improves the image data that downscales the unwanted distortions and enhances the image features facilitating further processing. The removal of noise from the image, and reshaping and resizing of an image can be considered to be a part of the pre-processing phase.

- **Feature Extraction:**

  This is the most crucial phase of glaucoma detection. Feature extraction is a type of reducing the dimensions that efficiently represent the region of interest from an entire image vector. This approach is useful when image sizes are large and the feature representation is required to perform the image matching tasks and information retrieval. Detection of Region of Interest (ROI) comes under the feature extraction phase.

- **Classification:**

Image classification is the task of classifying the data into multiple classes from a spatial raster image. Image classification is done by analysing the properties of various features from the images and or organizing the data into different categories or classes. The fundus image taken is classified into two categories: healthy eye, and glaucomatous eye.

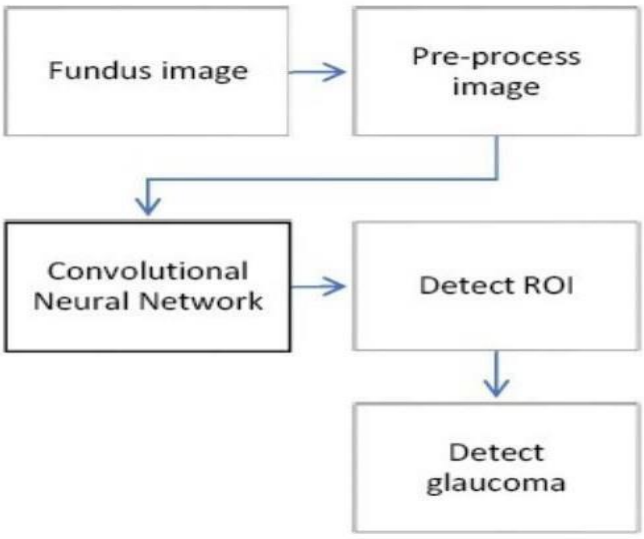

Fig 3.3.2 Classification of fundus image

3.4. Algorithm and flowchart

Algorithm for Glaucoma detection using Deep learning

Step1: Initially pass an image as input as an argument which is of any size

Step 2: we then use pre-processing to pre-process the image. In this, some techniques are used like data cleaning, transformation, data integrity, etc

Step 3: Next we use CNN model. This model is used to train and test, each input image will pass through a series of convolutional layers with filters pooling, and a fully convoluted layer applies the SoftMax function is used

Step4: Then it classifies the data according to the training data

Step5: Next we use decision in this we take condition as result[0][0] if the result is 1 then we get output as Glaucoma else we get output as Not Glaucoma

Flowchart:

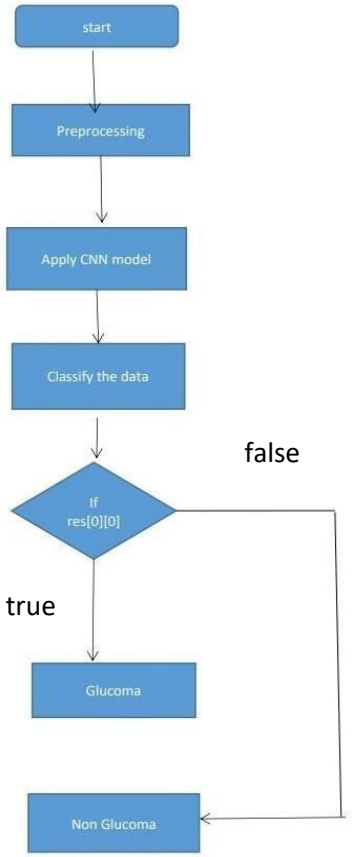

Fig 3.4 Flowchart of Glaucoma Detection

3.5 Summary

In this context, we specified the specifications that are essential to analyze the problem and give us the best solution. In this, we specified the software requirements, the content diagram of our project, and most importantly the algorithms and flowcharts of our work. All the content described in this section is very useful in designing our project.

CHAPTER 4

SYSTEM DESIGN

4.1 Introduction

In the design phase, the software requirements are transformed into the definition of software components and their interfaces, to establish the framework of the software. This is done by examining the system design description and building a physical model using recognized software engineering methods. The physical model describes the solution in concrete, implementation terms. The logical model produced in the requirement analysis phase is the structure of the problem and marks it manageable.

4.2 UML Diagrams

There are 8 UML diagrams they are

1. Class Diagrams
2. Use case Diagrams
3. Sequence Diagram
4. Collaboration Diagram
5. Activity Diagram
6. State Chart Diagram
7. Component Diagram
8. Deployment Diagram

They represent the functionality of the system from a user's point of view. They define the boundaries of the system.

4.2.1 Class Diagram

A class diagram is a static diagram. It represents the static view of an application. The class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application.

A class diagram describes the attributes and operations of a class and also the constraints imposed on the system. Class diagrams are widely used in the modeling of object-oriented

systems because they are the only UML diagrams, which can be mapped directly with object-oriented languages. The class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints. It is also known as a structural diagram.

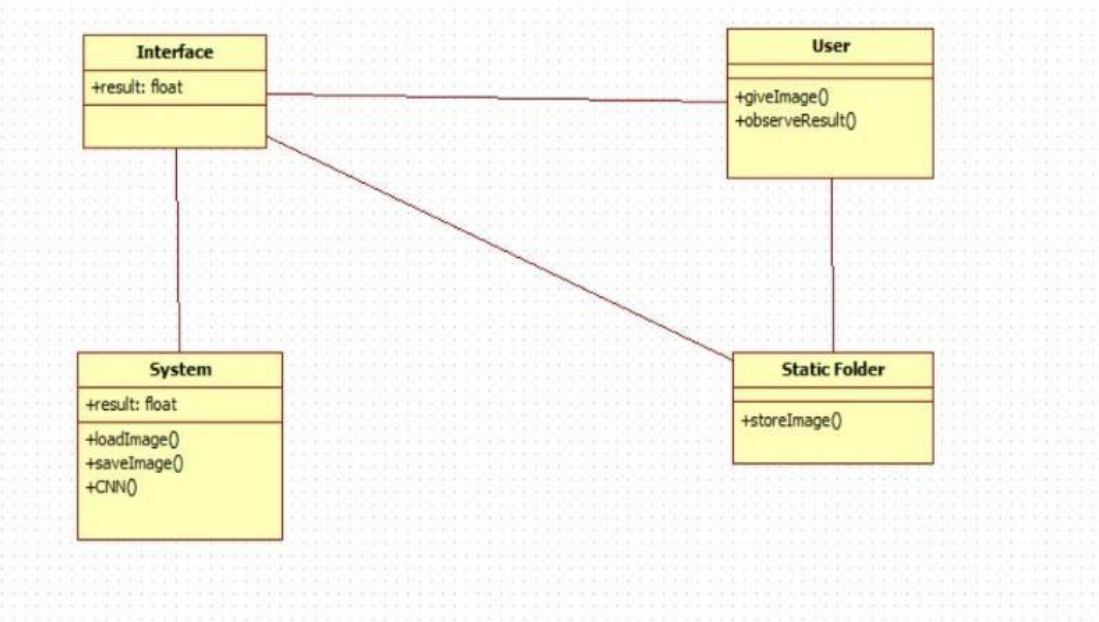

Fig 4.1 Class Diagram

4.2.2 Use Case Diagram

A use case diagram at its simplest is a representation of a user's interaction with the system and depicts the specifications of a use case. A use case diagram can portray the different types of users of a system and the various ways that they interact with the system. A use case is a methodology used in system analysis to identify, clarify and organize system requirements. Use case diagrams are employed in UML (Unified Modelling Language), a standard notation for the modelling of real-world objects and systems. Use case diagrams are very much important to explain the interaction between the system and the actor.

Use cases describe the functional requirements of a system from the end user's perspective, creating a goal-focused sequence of events that is easy for users and developers to follow. A complete use case will include one main or basic flow and various alternate flows. The alternate flow, also known as an extending use case, describes normal variations to the basic flow as well as unusual situations.

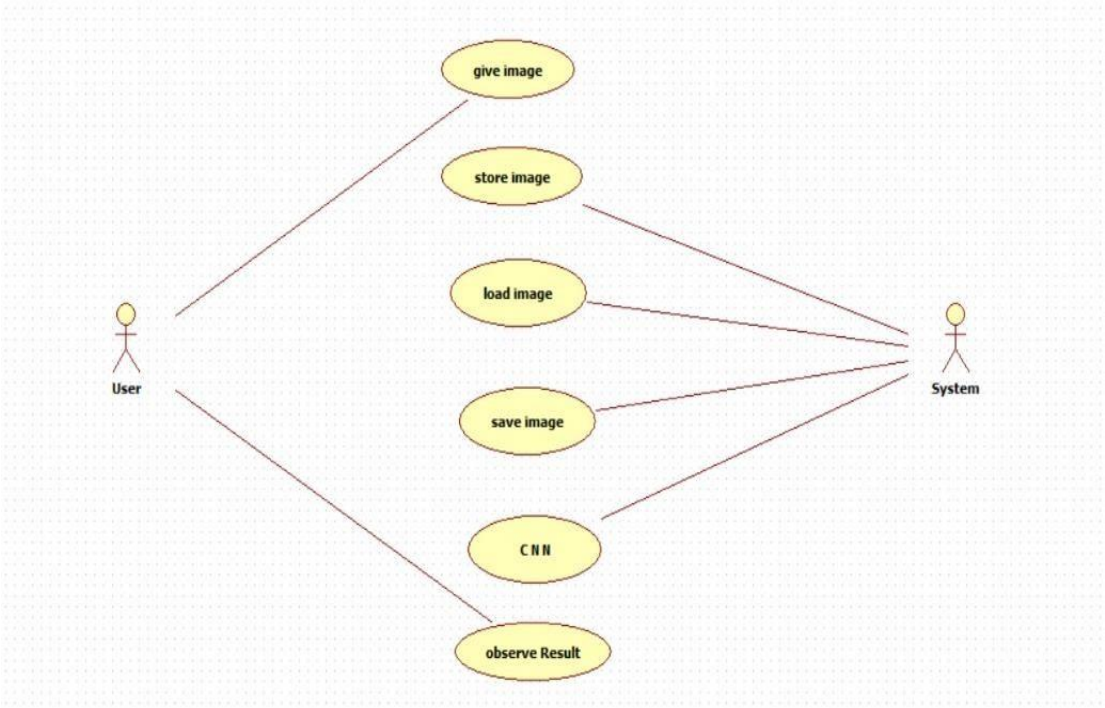

Fig 4.2 Use Case Diagram

4.2.3 Sequence Diagram

A sequence diagram is an interaction that shows how processes operate with one another and in what order. It is a construct of a message sequence chart. A sequence diagram shows object interactions arranged in n time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the logical view of the system under development. Sequence diagrams are sometimes called event diagrams, or event scenarios. A sequence diagram is structured in such a way that it represents a timeline that begins at the top and descends gradually to mark the sequence of interactions. Each object has a column and the messages exchanged between them are represented by arrows.

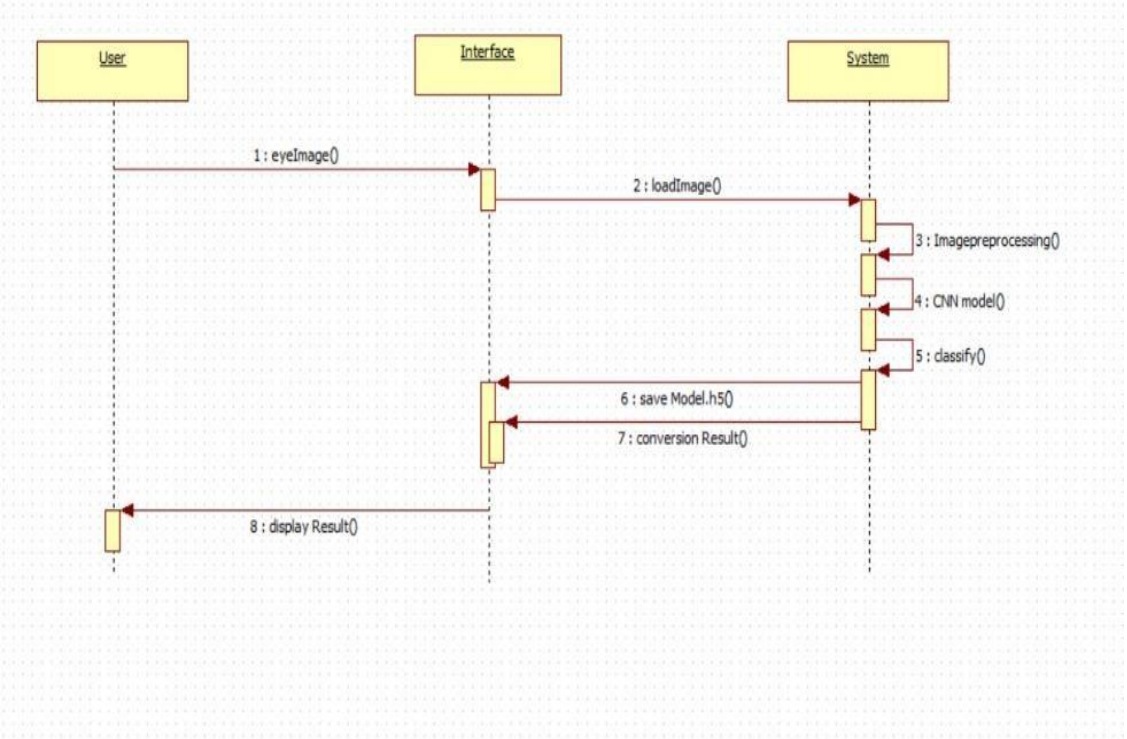

Figure 4.3 Sequence Diagram

4.2.4 Collaboration Diagram

A collaboration diagram, also known as a communication diagram, is an illustration of the relationships and interactions among software objects in the Unified Modeling Language (UML). These diagrams can be used to portray the dynamic behaviour of a particular use case and define the role of each object.

The collaboration diagram is used to show the relationship between the objects in a system. Both the sequence and the collaboration diagrams represent the same information but differently. Instead of showing the flow of messages, it depicts the architecture of the object residing in the system as it is based on object-oriented programming. An object consists of several features. Multiple objects present in the system are connected to each other. The collaboration diagram, which is also known as a communication diagram, is used to portray the object's architecture in the system.

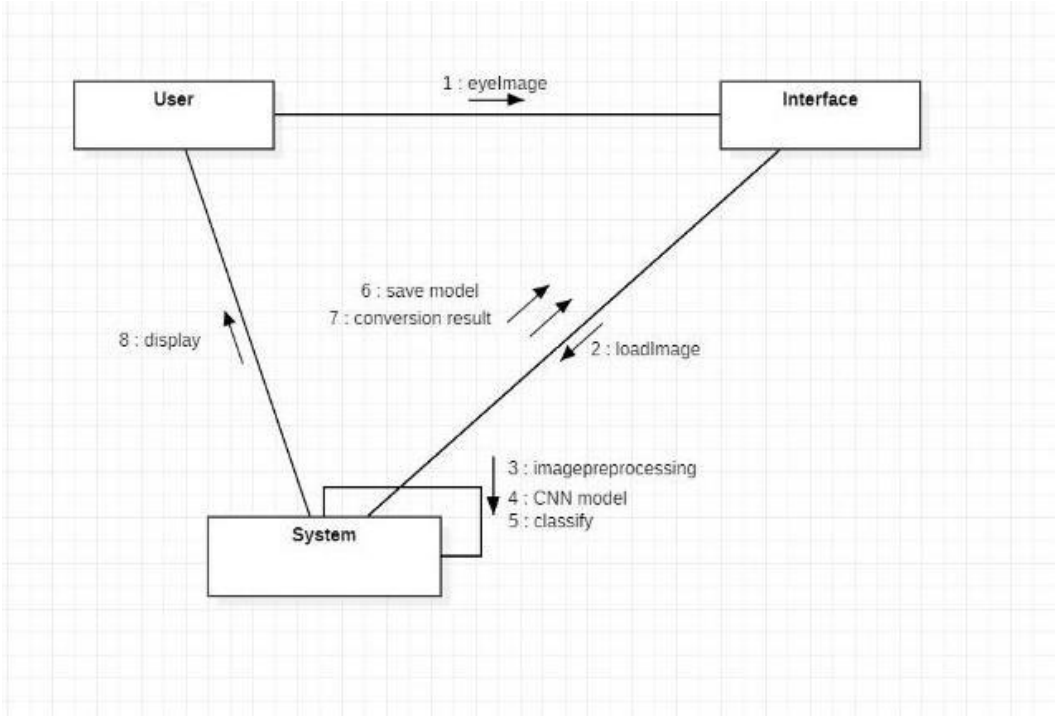

Fig 4.4 Collaboration Diagram

4.2.5 Activity Diagram

The activity diagram is another important diagram in UML to describe the dynamic aspects of the system. An activity diagram is basically a flow chart to represent the flow from one activity to another activity. The activity can be described as an operation of the system. The focus of activity modelling is the sequence and conditions for coordinating lower-level behaviours', rather than which classifiers own those behaviours. These are commonly called control flow and object flow models. The behaviour coordinated by these models can be initiated because other behaviours finish executing because objects and data become available, or because events occur external to the flow. The control flow is drawn from one operation to another. This flow can be sequential, branched, or concurrent. Activity diagrams deal with all types of flow control by using different elements such as fork, join, etc

Activity is a particular operation of the system. Activity diagrams are not only used for visualizing the dynamic nature of a system but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in the activity diagram is the message part.

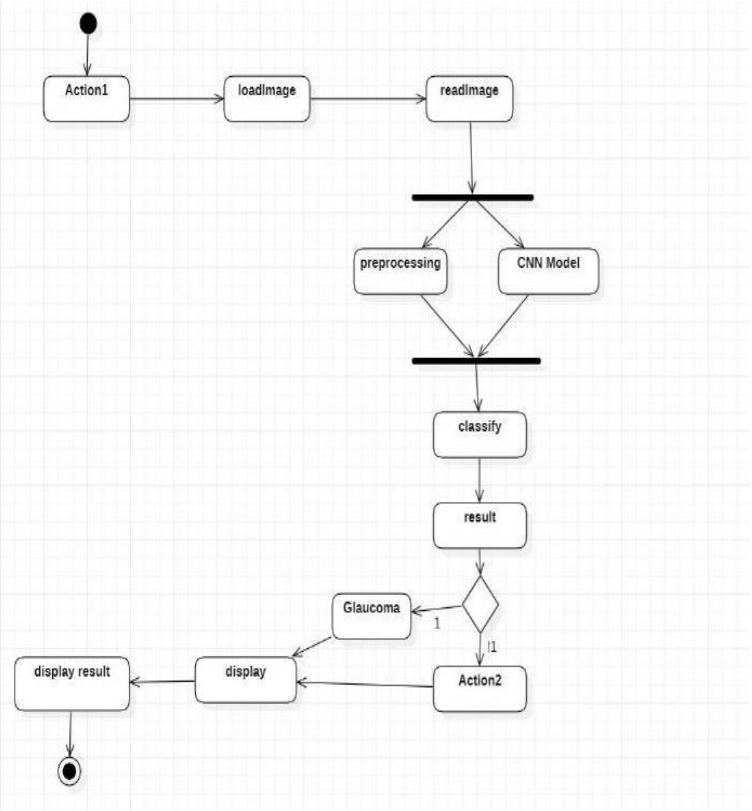

Fig 4.5 Activity Diagram

4.2.6 State Chart Diagram

A state chart diagram is one of the five UML diagrams used to model the dynamic nature of a system. They define different states of an object during its lifetime and these states are changed by the events. State chart diagrams are useful to model reactive systems.

A state chart diagram describes the flow of control from one state to another state. States are defined as a condition in which an object exists and it changes when some event is triggered. The most important purpose of the State chart diagram is to model the lifetime of an object from creation to termination.

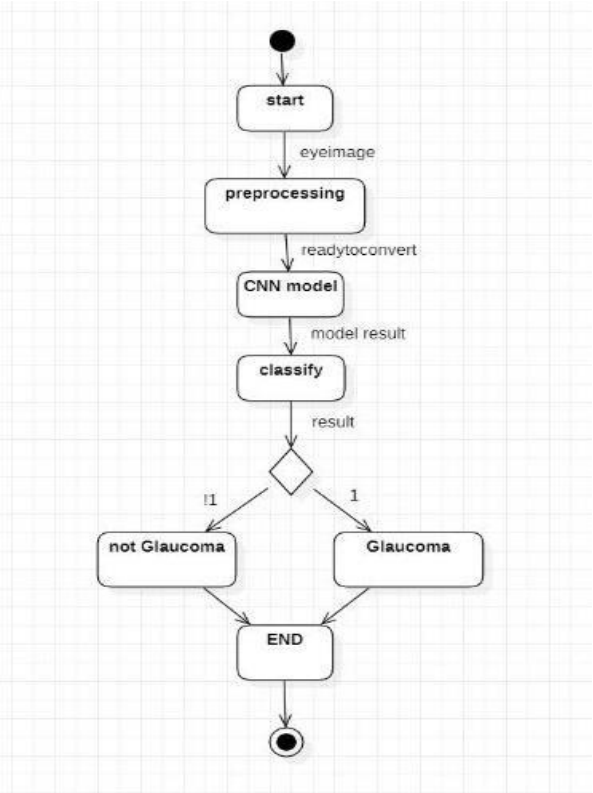

Figure 4.6 State Chart Diagram

4.2.7 Component Diagram

A component diagram, also known as a UML component diagram, describes the organization and wiring of the physical components in a system. In the first version of UML, components included in these diagrams were physical: documents, database table, files, and executables, all physical elements with a location. Component diagrams can also be described as a static implementation view of a system. Static implementation represents the organization of the components at a particular moment. A single component diagram cannot represent the entire system but a collection of diagrams is used to represent the whole.

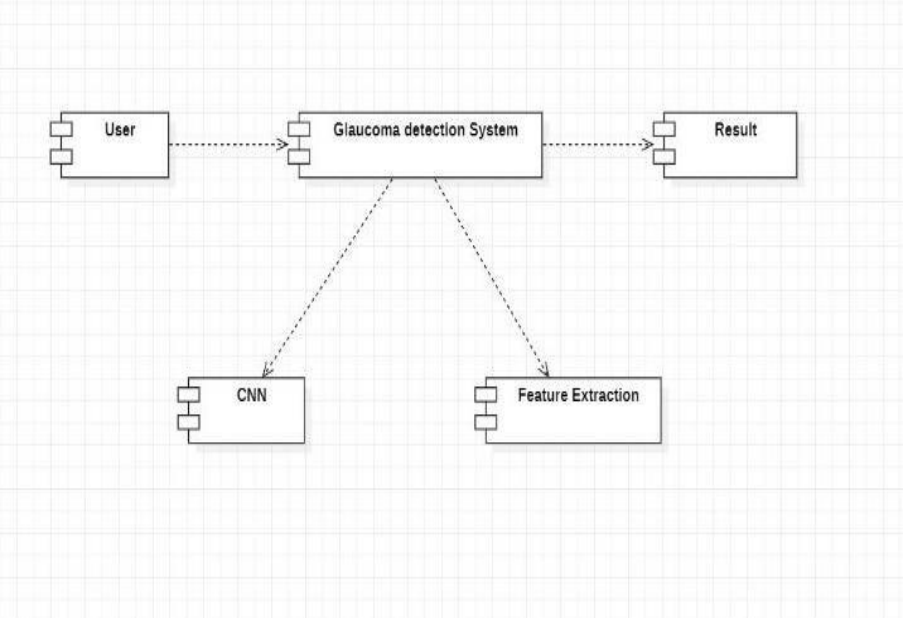

Figure 4.7 Component Diagram

4.2.8 Deployment Diagram

A UML deployment diagram is a diagram that shows the configuration of runtime processing nodes and the components that live on them. A deployment diagram is a kind of structure diagram used in modelling the physical aspects of an object-oriented system. deployment view of a system. Deployment diagrams are used for describing the hardware components, where software components are deployed. Component diagrams and deployment diagrams are closely related.

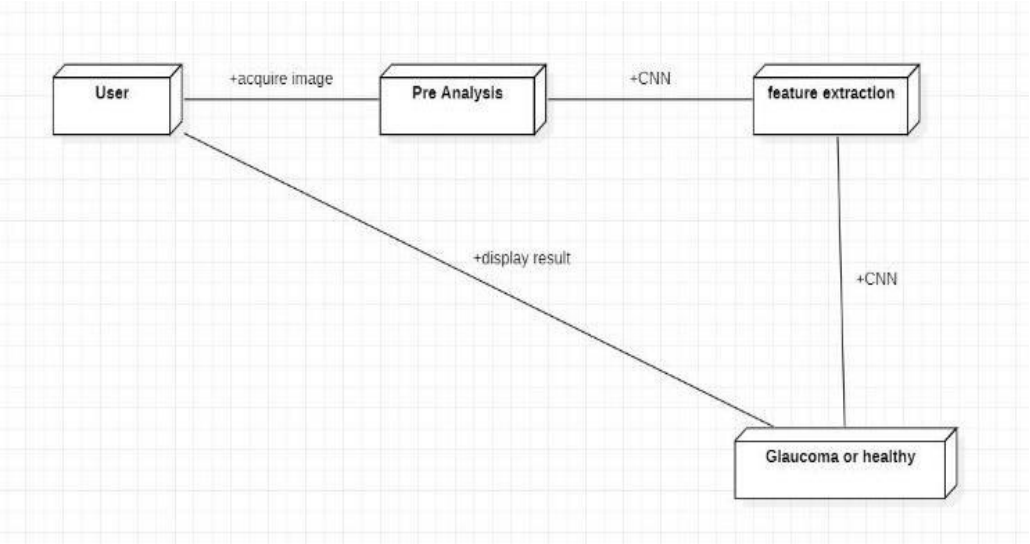

Figure 4.8 Deployment Diagram

CHAPTER 5

IMPLEMENTATIONS AND RESULTS

5.1. Introduction

Implementation is the stage of the project when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective. The implementation stage involves careful planning and investigation of the existing system and its constraints on the implementation and designing of methods to achieve changeover methods.

The goal of implementation is to put the new practices in place at selected implementation sites. Site-level Implementation Teams guide the implementation process, review data, make decisions, and provide feedback to the State Leadership Team, on successes and challenges.

5.1.1 Software Environment

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics.

5.1.2 The Python Programming Language

The following reasons make python a widely used professional language

- Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language.
- It was created by Guido van Rossum during 1985- 1990.
- Like Perl, Python source code is also available under the GNU General Public License (GPL).
- Python is a high-level, interpreted, interactive, and object-oriented scripting language. Python is designed to be highly readable.
- It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages.

5.1.3 Characteristics of Python

- It supports functional and structured programming methods as well as OOP.
- It can be used as a scripting language or can be compiled to byte code for building large applications.
- It provides very high-level dynamic data types and supports dynamic type checking.
- It supports automatic garbage collection.
- It can be easily integrated with C, C++, COM, ActiveX, CORBA, and Java.

5.1.4 Features of Python

There are many features in Python, some of which are discussed below –

1. **Easy to code:**

Python is a high-level programming language. Python is very easy to learn the language as compared to other languages like C, C#, Java script, Java, etc. It is very easy to code in python language and anybody can learn python basics in a few hours or days. It is also a developer-friendly language.

2. **Free and Open Source:**

Python language is freely available at the official website and you can download it from the given download link below click on the **Download Python** keyword.
Since it is open-source, this means that the source code is also available to the public.

So you can download it, use it as well as share it.

3. **Object-Oriented Language:**

One of the key features of python is Object-Oriented programming. Python supports object-oriented language and concepts of classes, object encapsulation, etc.

4. **GUI Programming Support:**

Graphical User interfaces can be made using a module such as PyQt5, PyQt4, python, or Tk in python.
PyQt5 is the most popular option for creating graphical apps with Python.

5. **High-Level Language:**

Python is a high-level language. When we write programs in python, we do not need to remember the system architecture, nor do we need to manage the memory.

6. Extensible feature:

Python is an **Extensible** language. We can write us some Python code into C or C++ language and also we can compile that code in C/C++ language.

7. Python is a Portable language:

Python language is also a portable language. For example, if we have python code for windows and if we want to run this code on other platforms such as Linux, Unix, and Mac then we do not need to change it, we can run this code on any platform.

8. Python is an Integrated language:

Python is also an Integrated language because we can easily integrated python with other languages like c, c++, etc.

9. Interpreted Language:

Python is an Interpreted Language because Python code is executed line by line at a time. like other languages C, C++, Java, etc. there is no need to compile python code which makes it easier to debug our code. The source code of python is converted into an immediate form called **bytecode**.

10. Large Standard Library

Python has a large standard library that provides a rich set of modules and functions so you do not have to write your own code for every single thing. There are many libraries present in python such as regular expressions, unit-testing, web browsers, etc.

11. Dynamically Typed Language:

Python is a dynamically-typed language. That means the type (for example- int, double, long, etc.) for a variable is decided at run time not in advance because of this feature we don't need to specify the type of variable.

5.2 Deep Learning

Deep learning is an Artificial intelligence (AI) function that imitates the workings of the human brain in processing data and creating patterns for use in decision-making. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of

learning unsupervised from data that is unstructured or unlabelled. Also known as deep neural learning or deep neural network.

Deep learning has evolved hand-in-hand with the digital era, which has brought about an explosion of data in all forms and from every region of the world. This data, known simply as big data, is drawn from sources like social media, internet search engines, e-commerce platforms, and online cinemas, among others. This enormous amount of data is readily accessible and can be shared through fintech applications like cloud computing. However, the data, which normally is unstructured, is so vast that it could take decades for humans to comprehend it and extract relevant information. Companies realize the incredible potential that can result from unravelling this wealth of information and are increasingly adapting to AI systems for automated support.

5.2.1 Deep Learning Model

5.2.1.1 Convolutional Neural Network

In the past few decades, Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks.

At the heart of AlexNet were Convolutional Neural Networks a special type of neural network that roughly imitates human vision. Over the years CNNs have become a very important part of many Computer Vision applications. So let's take a look at the workings of CNNs.

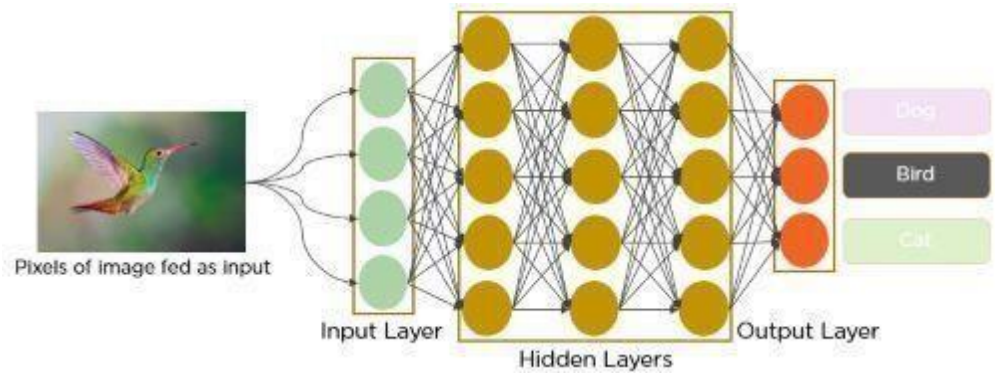

Fig 5.1 Example of CNN model

5.2.2 CNN Layers

There are three types of layers that make up the CNN which are the convolutional layers, pooling layers, and fully-connected (FC) layers. When these layers are stacked, a CNN architecture will be formed. In addition to these three layers, there are two more important parameters which are the dropout layer and the activation function which are defined below.

1. Convolutional Layer:

This layer is the first layer that is used to extract the various features from the input images. In this layer, the mathematical operation of convolution is performed between the input image and a filter of a particular size MxM. By sliding the filter over the input image, the dot product is taken between the filter and the parts of the input image with respect to the size of the filter (MxM). The output is termed as the Feature map which gives us information about the image such as the corners and edges. Later, this feature map is fed to other layers to learn several other features of the input image.

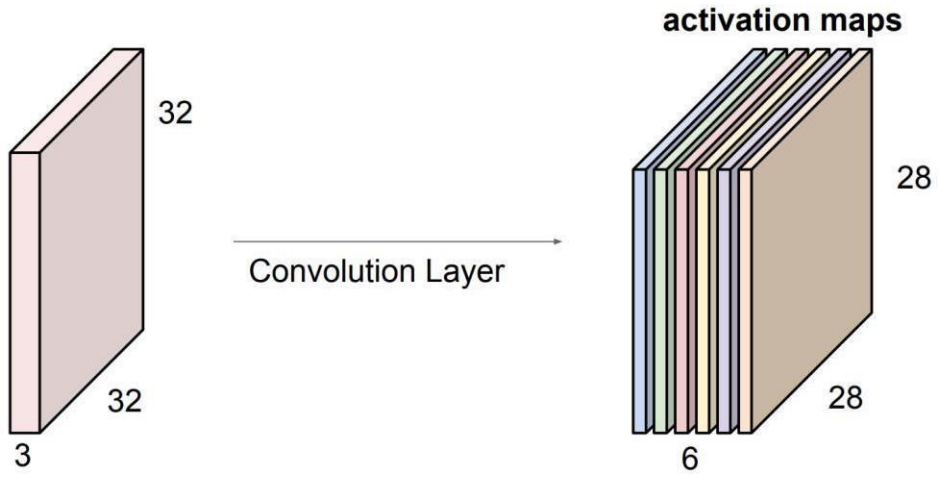

Fig 5.2 Convolution

2. Pooling Layer:

In most cases, a Convolutional Layer is followed by a Pooling Layer. The primary aim of this layer is to decrease the size of the convolved feature map to reduce computational costs. This is performed by decreasing the connections between layers and independently operating on each feature map. Depending upon the method used, there are several types of Pooling operations. In Max Pooling, the largest element is taken from the feature map. Average Pooling calculates the average of the elements in a predefined sized Image section. The total sum of the elements in the predefined section is computed in Sum

Pooling. The Pooling Layer usually serves as a bridge between the Convolutional Layer and the FC Layer

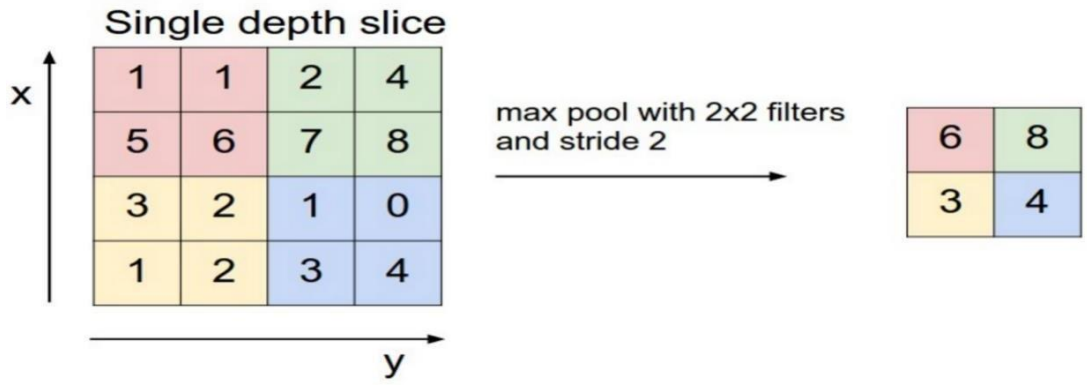

Fig 5.3 Max Pooling

3. Fully Connected Layer:

The fully Connected (FC) layer consists of the weights and biases along with the neurons and is used to connect the neurons between two different layers. These layers are usually placed before the output layer and form the last few layers of a CNN Architecture. In this, the input image from the previous layers is flattened and fed to the FC layer. The flattened vector then undergoes a few more FC layers where the mathematical functions operations usually take place. In this stage, the classification process begins to take place.

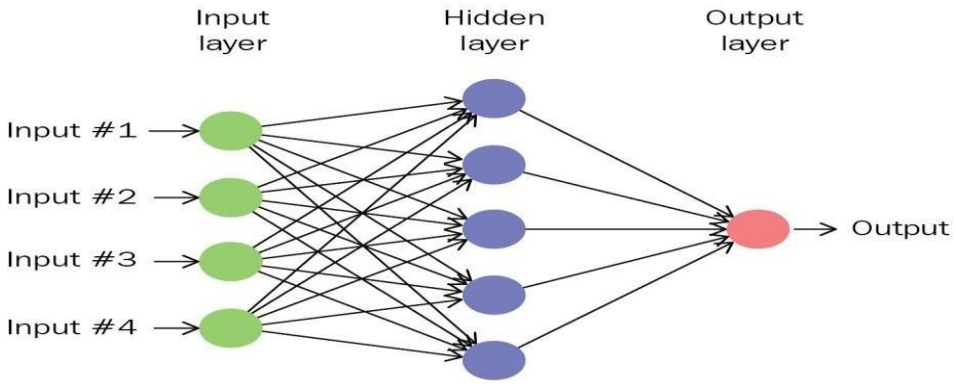

Fig 5.4: Fully Connected Layers

4. Dropout:

Usually, when all the features are connected to the FC layer, it can cause overfitting in the training dataset. Overfitting occurs when a particular model works so well on the training data causing a negative impact on the model's performance when used on new data. To overcome this problem, a dropout layer is utilized wherein a few neurons are dropped from the neural network during the training process resulting in a reduced size of the model. On passing a dropout of 0.3, 30% of the nodes are dropped out randomly from the neural network.

5. Activation Functions:

Finally, one of the most important parameters of the CNN model is the activation function. They are used to learn and approximate any kind of continuous and complex relationship between variables of the network. In simple words, it decides which information of the model should fire in the forward direction and which ones should not at the end of the network.

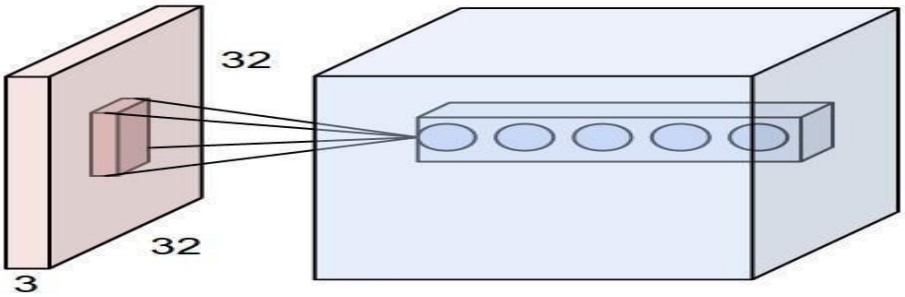

Fig. 5.5 Activation functions outlook

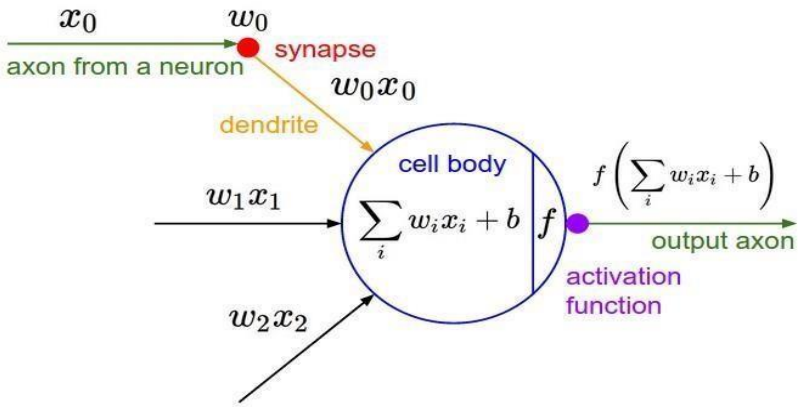

Fig 5.6 Activation Function

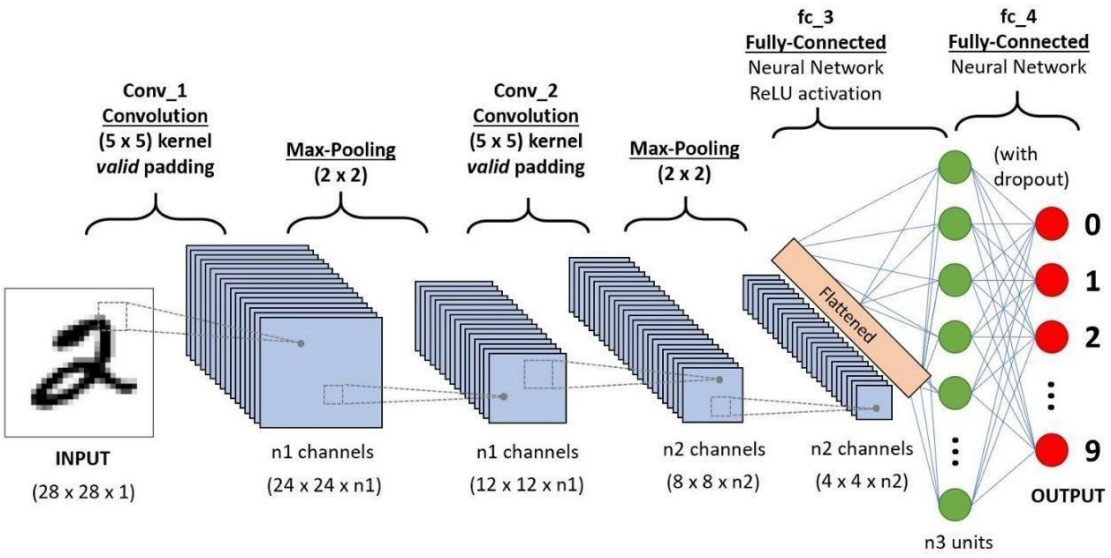

Fig 5.7 Overall Process of CNN

5.3 METHOD OF IMPLEMENTATION

Python GUI – Tkinter

Python offers multiple options for developing GUI (Graphical User Interface). Out of all the GUI methods, tkinter is the most commonly used method. It is a standard Python interface to the Tk GUI toolkit shipped with Python. Python with Tkinter is the fastest and easiest way to create GUI applications. Creating a GUI using Tkinter is an easy task.GUI is used for the epidemic analysis

Implementation Code Cnn.py

use of importing keras: We will be defining our deep learning neural network using Keras packages. We import the Sequential, Conv2D, Flattern, Dense, and Activation packages for defining the network architecture. We use the load_model package for saving and retrieving our model

ImageDataGenerator: ImageDataGenerator is a powerful tool that can be used for **image augmentation** and feeding these images into our model. The augmentation takes place in memory, and the generators make it very easy to set up training and testing data, without the need of manual labeling of the images

Classifier: It is used to classify the data

Use of importing CV2: OpenCV-Python is a library of Python bindings designed to solve computer vision problems. cv2. The read () method loads an image from the specified file. If the image cannot be read (because of the missing file, improper permissions, or unsupported or invalid format) then this method returns an empty matrix

Train.py :

```
import tensorflow as tf
from tensorflow. keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Activation, Flatten, Conv2D,
MaxPooling2D
from tensorflow. keras.layers import ZeroPadding2D
from tensorflow.keras.layers import BatchNormalization
from tensorflow.keras.preprocessing.image import ImageDataGenerator
model = Sequential()
model.add(Conv2D(64, (9, 9), input_shape=(100,100,3),padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, (5, 5), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(ZeroPadding2D((1, 1)))
model.add(Conv2D(256, (3, 3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(ZeroPadding2D((1, 1)))
model.add(Conv2D(512, (3, 3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Conv2D(512, (3, 3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
```

```
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dense(64))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(Dropout(0.5))
model.add(Dense(128))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(Dropout(0.5))
model.add(Dense(1))
model.add(BatchNormalization())
model.add(Activation('sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
train_datagen = ImageDataGenerator(rescale = 1./255,
 rotation_range=30,
  shear_range=0.2,
  zoom_range=[0.8, 1.2],
     horizontal_flip=True,
#  vertical_flip = True,
     fill_mode='nearest')
test_datagen = ImageDataGenerator(rescale = 1./255)
training_set=train_datagen.flow_from_directory('C:\\Users\\manik\\OneDrive\\Desktop\\glau
coma\\data\\train',
                                               target_size = (100, 100),
                                               batch_size = 64,
                                               class_mode = 'binary')

test_set=test_datagen.flow_from_directory('C:\\Users\\manik\\OneDrive\\Desktop\\glaucoma\
\data\\val',
                                          target_size = (100, 100),
                                          batch_size = 64,
                                          class_mode = 'binary')
my_callbacks = [
   # tf.keras.callbacks.EarlyStopping(patience=4, verbose=1),
```

```
    tf.keras.callbacks.ReduceLROnPlateau(factor=0.1, patience=3, min_lr=0.00001,
verbose=1),
    tf.keras.callbacks.ModelCheckpoint('my_model2.h5',
    verbose=1, save_best_only=True, save_weights_only=False)
    ]
model.fit(training_set, epochs=300, validation_data = test_set, callbacks=my_callbacks)
model.save('my_model2.h5')
```

TensorFlow:

TensorFlow is an open-source software library for machine learning and artificial intelligence developed by Google. It provides a comprehensive platform for building and deploying machine learning models, with support for a wide range of tasks, including image and speech recognition, natural language processing, and reinforcement learning. TensorFlow includes a variety of tools and libraries for training, evaluating, and deploying models, and it can run on multiple platforms, including desktop, server, and mobile devices.

App.py :

```
import os
from keras.models import load_model
from PIL import Image
from tensorflow.keras.preprocessing import image
import numpy as np
target_size = (100,100)
model=load_model('my_model2.h5')
print("model loaded")
def tempo(path):
    test_image = image.load_img(path, target_size = (100,100))
    test_image = image.img_to_array(test_image)
    test_image = np.expand_dims(test_image, axis = 0)
    result = model.predict(test_image)
    return result
pred=tempo("C:\\Users\\manik\\OneDrive\\Desktop\\glaucoma\\glu1.jpg")
if(pred > 0.5):
    print("Healthy")
```

```
else:
    print("Affected")
```

Streamlit :

Streamlit is an open-source app framework for Machine Learning and Data Science. It makes it easy to build and deploy interactive, web-based applications for exploration and communication of data insights. With a simple API and a lightweight design, Streamlit allows data scientists and machine learning engineers to create custom visualizations and animations, share interactive reports, and build custom tools and dashboards. Streamlit runs locally in the user's web browser and does not require any server setup or deployment, making it a popular choice for fast prototyping and building presentations for data-driven projects.

CHAPTER 6

OUTPUT SCREENS

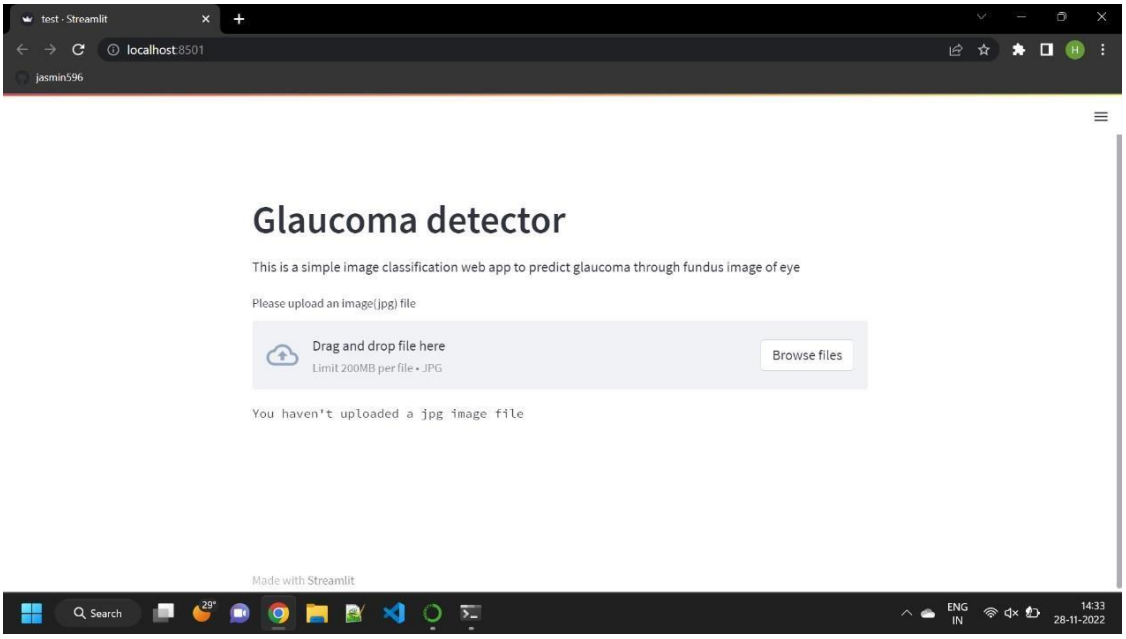

Fig 6.1: input image

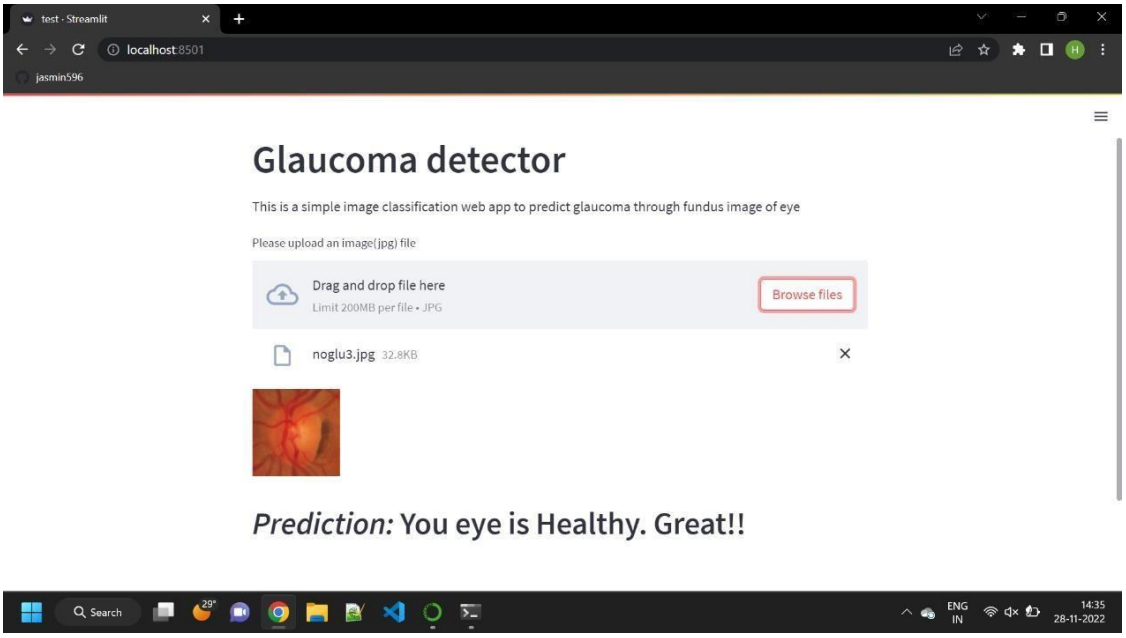

Fig 6.2: Not Glaucoma detected

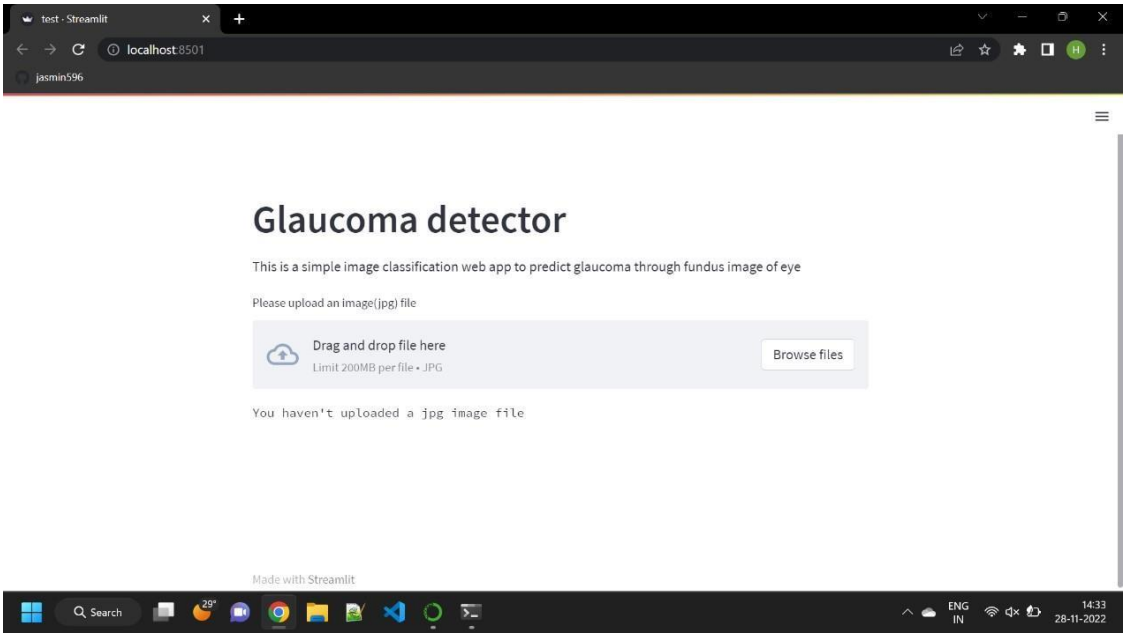

Fig 6.3: input image

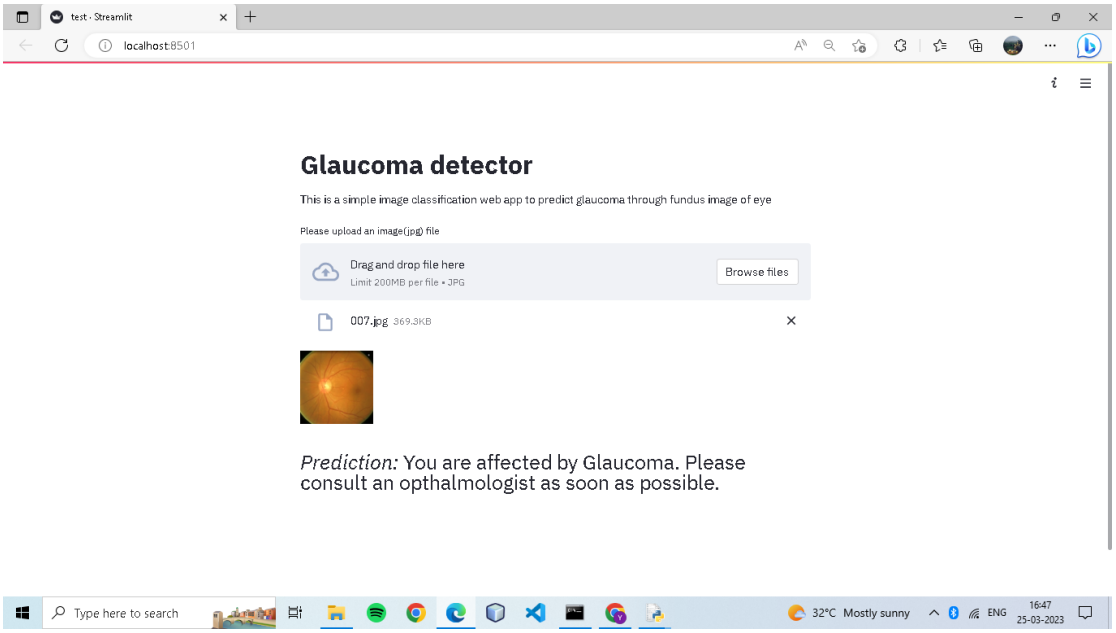

Fig 6.4: Glaucoma detected

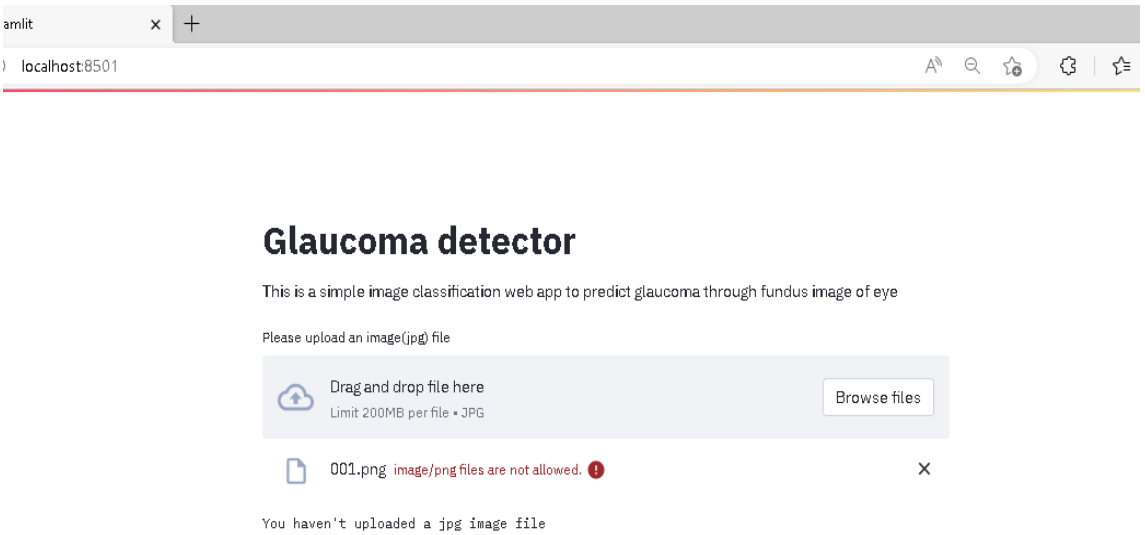

Fig 6.5: Unsupported file format

6.1. Summary

In this chapter, implementation of our process is done and the results are evaluated. The results obtained will be useful to apply testing. By testing we can know whether our project has met all the requirements that are specified before. The testing process is clearly dealt in the next phase.

CHAPTER 7

TESTING AND VALIDATION

7.1. Introduction

System Testing

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

TYPES OF TESTS

Unit Testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs.

All decision branches and internal code flow should be validated. It is the testing of individual software units of the application. It is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional Testing

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures : interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focussed on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

SYSTEM TESTING :

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

White Box Testing :

White Box Testing is a testing in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level

Black Box Testing :

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being testing. Black box tests, as most other kinds of

tests, must be written from a definitive source document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box. You cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

UNIT TESTING :

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach:

Field testing will be performed manually and functional tests will be written in detail.

Test objectives:

- All field entries must work properly
- Pages must be activated from the identified link.
- The entry screen, messages, and responses must not be delayed.

Features to be tested:

- Verify that the entries are in the correct format.
- No duplicate entries should be allowed.
- All links should take the user to the correct page.

INTEGRATION TESTING

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects. The task of the integration test is to check that components or software applications, e.g. components in a software system or-one step up-software applications at the company level-interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

ACCEPTANCE TESTING :

User Acceptance Testing is a critical phase of any project and requires significant participation by the user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

7.2 Design of Test Cases and Scenarios

TEST CASE-1

Description	Expected Result	Executed Result	Result
Choosing the input image which is in the form of .jpg, .jpeg or png	Glaucoma	Glaucoma	Pass

Table 6.1: Test case 1

TEST CASE-2

Description	Expected Result	Executed Result	Result
Choosing the input image which is in the form of .jpg, .jpeg or png	Non-Glaucoma	Glaucoma	fail

Table 6.2: Test case 2

TEST CASE-3

Description	Expected Result	Executed Result	Result
Choosing the input image which is in the form of .jpg, .jpeg or png	NonGlaucomaa	NonGlaucomaa	Pass

Table 6.3: Test case3

TEST CASE-4

Description	Expected Result	Executed Result	Result
Choosing the input image which is in the form of .jpg, .jpeg or png	Glaucoma	Non-Glaucoma	fail

Table 6.4: Test Case 4

Description	Expected Result	Executed Result	Result
Choosing the input image which is not in the form of .jpg .jpeg	Image/.png files are not allowed.	-	-

Table 6.5: Test Case 5

7.3. Validation

The following test cases are carried out to validate the implementation carried out. Validation is important in determining the system to compile with the requirements and perform functions for which it is intended and to meet the user requirements. Validation is done at the end of the development process and takes place after the verifications are completed.

7.4. Summary

In this context, testing and validation is done to the implementation of our project. In this, the design of test cases and scenarios specify the progress of our implemented code and help us to modify it to obtain the better results. Testing phase will help the user to verify whether all the requirements are met to obtain the desired output. The above mentioned test cases describe that the code implemented has met all the conditions and there are no problems and issues raised during the implementation.

CHAPTER 8

CONCLUSION

In this project, we have designed and implemented the project using Convolutional Neural Network. Our system will provide a better solution for detecting Glaucoma in the earlier phase in less time which will save the vision of many people. To implement this project we have used the Region of Interest (ROI) to take the only region of the image in which Glaucoma can be detected, also we have used Gaussian blur to remove no also we have used CNN methods to remove noise from image and then pre-processed image is given to CNN. Our system uses CNN to classify the model. This system gives 0.9 accuracy.

One of the leading causes of vision loss worldwide is glaucoma. 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.

CHAPTER 9

REFERENCES

[1] Diaz-Pinto, A., Morales, S., Naranjo, V., et al. CNNs for automatic glaucoma assessment using fundus images: an extensive validation. BioMed Eng OnLine 18, 29 (2019). https://doi.org/10.1186/s12938-019-0649-y

[2] Hafsah Ahmad, Abubakar Yamin, Aqsa Shakeel, Syed Omer Gillani, Umer Ansari 'Detection of Glaucoma Using Retinal Fundus Images' 978-14799-5132-1/14/$31.00 ©2014 IEEE.

[3] A. Budai, R. Bock, A. Maier, J. Hornegger, G. Michelson, "Robust Vessel Segmentation in Fundus Images", International Journal of Biomedical Imaging, vol. 2013, Article ID 154860, 11 pages, 2013. https://doi.org/10.1155/2013/154860

[4] Aukif Yousuf Wani, Preeti Sondhi, "Glaucoma Detection Using Support Vector Machine Algorithm", International Journal of Science and Research (IJSR), Volume 10 Issue 3, March 2021, pp.376379, https://www.ijsr.net/get_abstract.php?paper_id=SR2122609 2410

[5] D. W. K. Wong et al., "Level-set based automatic cup-todisc ratio determination using retinal fundus images in ARGALI," 2008 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Vancouver, BC, Canada, 2008, pp. 2266-2269, doi: 10.1109/IEMBS.2008.4649648.

[6] G. D. Joshi, J. Sivaswamy and S. R. Krishnadas, "Optic Disk and Cup Segmentation From Monocular Color Retinal Images for Glaucoma Assessment," in IEEE Transactions on Medical Imaging, vol. 30, no. 6, pp. 1192-1205, June 2011, doi: 10.1109/TMI.2011.2106509.

[7] F. Yin et al., "Automated segmentation of optic disc and optic cup in fundus images for glaucoma diagnosis," 2012 25th IEEE International Symposium on Computer-Based Medical Systems (CBMS), Rome, Italy, 2012, pp. 1-6, doi: 10.1109/CBMS.2012.6266344.

[8] J. Cheng et al., "Superpixel Classification Based Optic Disc and Optic Cup Segmentation for Glaucoma Screening," in IEEE Transactions on Medical Imaging, vol. 32, no. 6, pp. 1019-1032, June 2013, doi: 10.1109/TMI.2013.2247770…

[9] AtheesanS. and YashotharaS. ” Automatic glaucoma discovery by using funduscopic images, 2016 International Conference on Wireless Dispatches, Signal Processing and Networking(WiSPNET) “, Chennai, India, 2016,pp. 813- 817, doi10.1109/ WiSPNET.2016.7566246.

[10] Lecun,Y.(1989). conception and network design strategies. InR. Pfeifer,Z. Schreter,F. Fogelman, &L. Steels(Eds.), Connectionism in perspective Elsevier https//doi.org/10.1186/s12938-019-0649-y

[11] Zilly J, Buhmann JM, MahapatraD. Glaucoma discovery using entropy slice and ensemble literacy for automatic optical mug and slice segmentation. Comput Med Imaging Graph. 2017 Jan; 5528- 41. doi10.1016/j.compmedimag.2016.07.012. Epub 2016 Aug 23. PMID 27590198.

[12]N.M. Dipu,S.A. Shohan andK. M. A Salam," Brain Excrescence Discovery Using colorful Deep literacy Algorithms," 2021 International Conference on Science & Contemporary Technologies(ICSCT), Dhaka, Bangladesh, 2021,pp. 1- 6, doi10.1109/ ICSCT53883.2021.9642649.

[13]A.-M. Ştefan,E.-A. Paraschiv,S. Ovreiu andE. Ovreiu," A Review of Glaucoma Discovery from Digital Fundus Images using Machine Learning ways," 2020 International Conference one-Health and Bioengineering(EHB), Iasi, Romania, 2020,pp. 1- 4, doi10.1109/ EHB50910.2020.9280218.

[14] Li T, Bo W, Hu C, Kang H, Liu H, Wang K, FuH. Applications of deep literacy in fundus images A review. Med Image Anal. 2021 Apr; 69101971. doi10.1016/j.media.2021.101971. Epub 2021 Jan 20. PMID 33524824.

[15] Akshat Tulsani, Preetham Kumar, Sumaiya Pathan, Automated segmentation of optical slice and optical mug for glaucoma assessment using bettered UNET armature, Biocybernetics and Biomedical Engineering, Volume 41, Issue,2021, Pages 819- 832, ISSN 0208- 5216, https//doi.org/10.1016/j.bbe.2021.05.011

GLAUCOMA DETECTION USING FUNDUS IMAGES THROUGH DEEP LEARNING

Yuvana Tagore [1] , Mekala Hadassa[2] , Nandigam Nireekshana[3] , Dr.S.V.N.Sreenivasu[4]

[1, 2, 3]Student, Department of CSE, Narasaraopeta Engineering College, Narasaraopeta, Guntur (D.T) A.P, India

[4]Professor, Department of CSE, Narasaraopeta Engineering College, Narasaraopeta, Guntur (D.T) A.P, India

tyuvana070@gmail.com , prabhavathi1705@gmail.com , nireekshana.nandigam@gmail.com , drsvnsrinivasu@gmail.com

***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.

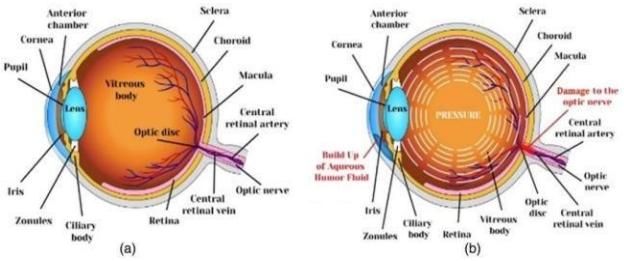

Fig 1: Internal Structure of the eye.

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.

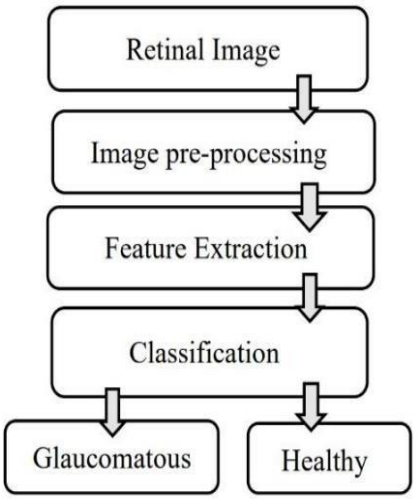

Fig 2. The process of the project

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.

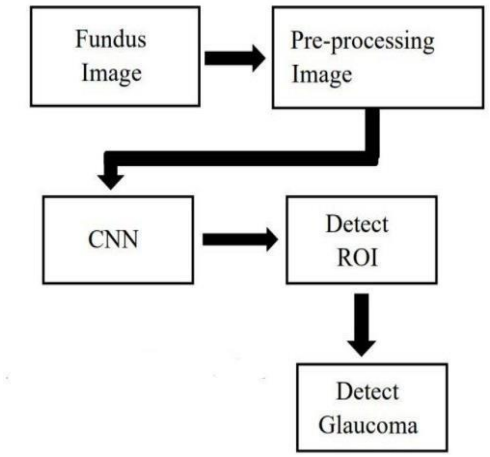

Fig 3. Image Classification

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.

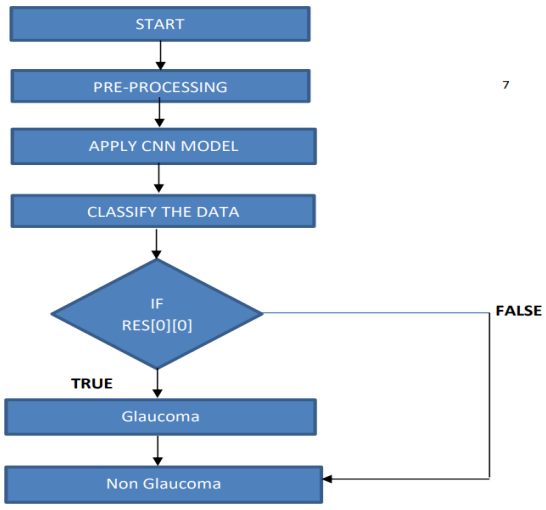

Fig 4. Flowchart

IV RESULTS

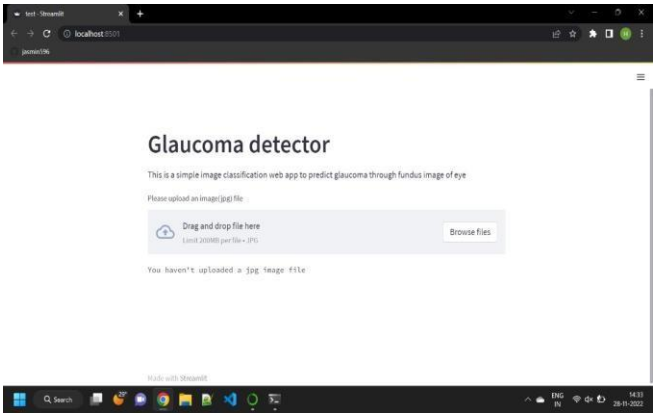

Fig 5. Input Image

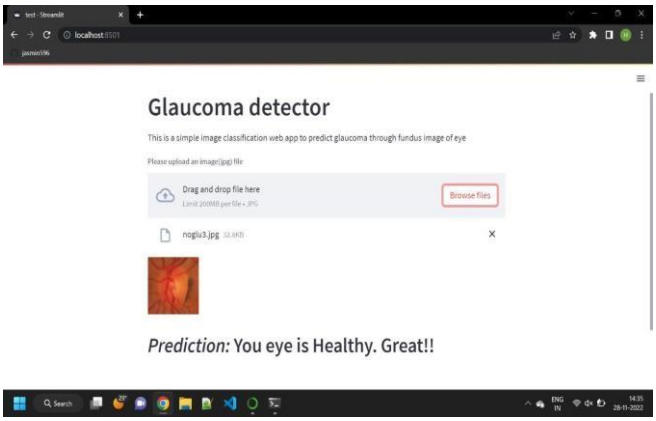

Fig 6. Healthy eye

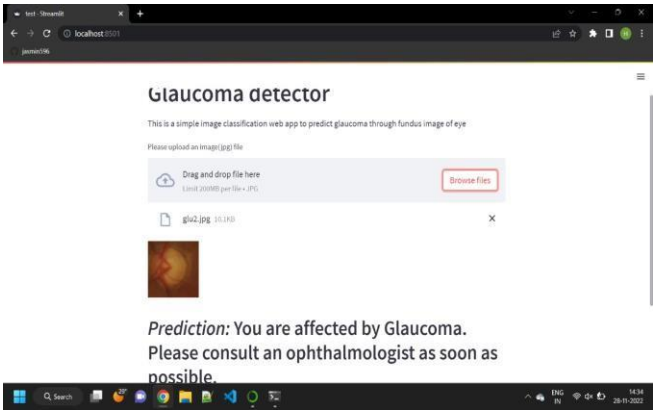

Fig 7. Glaucoma Detected

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

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VI REFERENCES

[1]A. Navea, A. Diaz-Pinto, S. Morales, J. M. Mossi, V. Naranjo, and T. Köhler. a thorough evaluation of CNNs for glaucoma identifying using images of the fundus. biomedical engineering online. 2019 Dec;18:1-9.

[2] J. Wen, M. Hassan, N. Nasrullah, S. Sun, and S. Hayat, as well as M. Mateen. Analyses of datasets, methods, and evaluation metrics for the automatic diagnosis of diabetic retinopathy. IEEE Access.

[3] Breiman L. Baggage predictors. Machine learning. 1996 Aug;24:123–40.

[4] Images of the retinal fundus are used in Jia X, Yin F, Li H, Wong TY, Wong DW, Liu J, Lim JH, and ARGALI's level-set-based automatic pint glass ratio computation. On August 20 of that year, the IEEE Engineering in Health and Biology Society held its 30th Annual World Congress. (pp. 2266-2269). IEEE.

[5] Joshi GD, Sivaswamy J, and Krishnadas SR. Using binocular colour retinal images, the optic disc and cup are segmented to assess glaucoma. The IEEE Journal of Medical Imaging, May 2, 2011, 30(6):1192-205.

[6] Automated glaucoma diagnosis employing segmentation of the retinal image and optic cups in fundus photographs was developed by Yin, F., J. Liu, D. Wong, N. M. Tan, C. Cheung, M. Baskaran, T. Aung, and T. Y. Wong. The 25th annual international conference on computer-based health systems (CBMS) was held by the IEEE on June 20, 2012. (pp. 1-6). IEEE.

[7] Wong TY, Wong DW, Tan NM, Tao D, Cheng CY, and Aung. Yin F, Cheng J, Liu J, Xu Y, and Yin F. Super pixel classification is used to separate the optic disc from the optic cup for glaucoma screening. 2013 Feb 18;32(6):1019-32 in the Journal of a IEEE on Diagnostic Imaging.

[8] MD, S. Khilariwal, and R. Verma. An antenna with a notch design for 5 GHz high-speed LAN. The 23rd annual world convention on networking, signal processing, and wireless communications is called Wisp NET 2016. (pp. 999- 1002). IEEE.

[9] Sampling techniques and clustering techniques for automatic segmentation of the optic disc and cups are used to identify glaucoma. Medical images and images on computer. 2017 Jan 1;55:28-41. Zilly J, Buhmann JM, Mahapatra D

[10] Kang, Liu, Wang, Fu, Kang, Bo W, and Hu C. Review of fundus image deep learning applications. Medical image analysis, 2021 April 1;69:101971.

[11] International Congress on Communicating and Processing Signal (ICCSP), Chennai, India, 2020, pp. 0628–0631, Glaucoma Detection Using Retinal Fundus Images V. Sekhar, J. Sidharth, S. Gautham, and G. Gopakumar, along with R. Krishnan.

[12] Rueda J., Villamizar J., Carrillo J., Bautista L., and Sanchez M. Glaucoma can be identified using images of the fundus of the eye. At the STSIVA XXII Conference on Imaging, Data Processing, and Synthetic Vision on April 24, 2019 (pp. 1-4). IEEE.

[13] Deep learning, computational intelligence, and image processing approaches are used by A. Pandey, P. Patre, and J. Minj to diagnose glaucoma. On October 7, 2020, the Fourth World I-SMAC Workshop (IoT in Social, Mobile, Analytics, and Cloud) will be held. (pp. 1-7). IEEE

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Organized by Department of Computer Science and Engineering in Association with CSI

Certificate of Presentation

This is to Certify that Dr.S.V.N.Sreenivasu , Narsaraopeta Engineering College has presented the paper title GLAUCOMA DETECTION USING FUNDUS IMAGES THROUGH DEEP LEARNING in the International Conference on Artificial Intelligence and Its Emerging Areas-2K23 [NEC-ICAIEA-2K23], Organized by Department of Computer Science and Engineeringin Association with CSI on 17th and 18th March 2023 at Narasaraopeta Engineering College, Narasaraopet, A.P., India.

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