VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JNANA SANGAMA", BELAGAVI-590018

A PROJECT REPORT ON

"DETECTION OF GLAUCOMA USING RETINAL FUNDUS"

Submitted for the fulfillment of the requirements of the award of the degree of

Bachelor of Engineering

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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CERTIFICATE

This is to certify that the project work entitled **"DETECTION OF GLAUCOMA USING RETINAL FUNDUS"** is a bonafide work carried out by **KUMARSWAMY B P (1GG20EC408), NAWAZ PASHA J A (1GG20EC415), SUHAS S (1GG20EC421)** and **ABHISHEK GOWDA K S (1GG20EC428)** in partial fulfillment for the award of degree Bachelor of Engineering in Electronics and Communication Engineering of Visvesvaraya technological university, Belgaum during the academic year 2022-2023s. The Project has been approved as it satisfies the academic requirements with respect to the seminar work prescribed for the B.E degree.

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DECLARATION BY THE STUDENT

We hereby declare that the entire work of the project titled **"DETECTION OF GLAUCOMA USING RETINAL FUNDUS"** embodied in this project report has been carried out by **KUMARSWAMY B P (1GG20EC408), NAWAZ PASHA J A (1GG20EC415), SUHAS S (1GG20EC421), and ABHISHEK GOWDA K S (1GG20EC428)** during the 8th semester of Bachelor of Engineering degree at Government Engineering College, Ramanagara under the esteemed guidance of **Sumithra C V** (Assistant Professor, Dept. of ECE) affiliated to Visvesvaraya Technological University, Belagavi.The work embodied in this dissertation work is original and it has not been submitted in part or full for any other degree in any University.

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CHAPTER 1

INTRODUCTION

Glaucoma is a primary cause of permanent blindness. It is a disease in which the intraocular pressure (IOP) becomes pathologically high, sometimes rising severely to 60-70 mm Hg. Pressures greater than 25-30 mm Hg can cause vision loss when sustained for a long time. In most cases of glaucoma, the abnormally high pressure results from increased resistance to fluid outflow through eye's drainage system. In normal healthy eyes there is a balance between fluids produced within eye and one that outflow. This balance keeps Inter Ocular Pressure (IOP) within the eye constant but in case of glaucoma, this balance is not maintained which in turn causes an increase in IOP, consequently damaging the optic nerve. Because of increase in IOP, the cup size begins to rise which accordingly increases the CDR. For normal d sic the CDR is considered to beless than 0.5 but in case of glaucoma, it is greater than 0.5. As the cup size increases it also influences the Neuroretinal Rim (NRR). NRR is the region located between the edge of the optic disc and the optic cup. In the presence of glaucoma, area ratio covered by NRR in nasal and temporal region becomes thick as compared to area covered by NRR in inferior and superior region. The digital fundus image of a normal eyes and glaucoma tic eyes are illustrated. Machine learning is the idea of using algorithms to find patterns and/or make predictions based on a collection of data. There are various algorithms available, each with its own set of benefits and drawbacks, as well as levels of complexity. These algorithms are easily accessible and available across a variety of programming tools (including R and Python) with varying levels of coding requirements. They can do away with the need for comprehensive coding instructions specific to your application in favor of more general instructions.

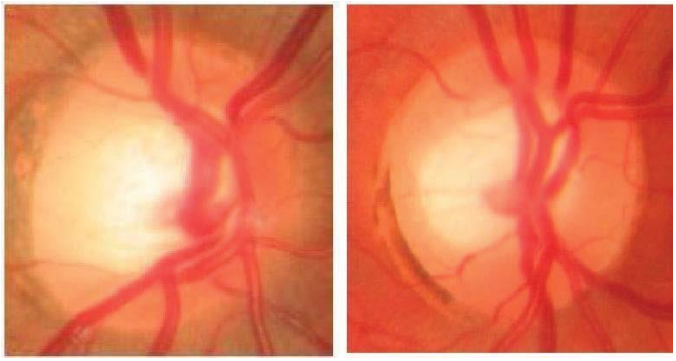


Fig. 1.1 : L to R: Normal Disc (CDR<0.5), Glaucomatic Disc (CDR>0.5)

A new approach to automatically segment the optic disc and exudates is suggested. The techniques include use of the green component of the image followed by pre-processing and then morphological opening.

1.1 AIM

Many studies have been performed to ameliorate computer based decision support algorithms for early detection of glaucoma through extraction of optic cup and disc to determine CDR. A method for ONH segmentation and its verification, based on morphological operations.

1.2 MOTIVATION

Glaucoma is the main source of visual impairment among African Americans and Hispanics in the U.S. The very expanding request of this ailment wind up hazardous from everywhere throughout the world. The factor of this infection like high Myopia, Diabetes, Eye Surgery and hypertension turn into a reason for dejection. Utilization of corticosteroids (for `instance, eye drops, pills, inhalers, and creams) Prescription eye drops could cut African Americans' danger of getting glaucoma into equal parts. In excess of 3 million Americans are living with glaucoma, and 2.7 million of whom-matured 40 and more established are influenced by its most regular frame, open-edge glaucoma. Get the certainties about glaucoma. We will assemble a framework which can recognize this malady in beginning times.

1.3 OBJECTIVE

The objectives are important to achieve the goal. The main objectives of this project are:

1) The objective of the proposed autonomous system is to develop a complete decision support system for early glaucoma detection.

2) Analysis, design, implementation, and testing of novel algorithms for a complete decision support system for early glaucoma detection with powerful feature selection strategies.

3) Performing extensive experiments to evaluate the performance of the proposed glaucoma detection system on real datasets and comparisons with existing state of the art techniques for performance assessment

4) Easy to access for all the peoples of the world.

5) Disease can be cured in early stages.

6) Disease can be cured more accurately and efficient.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

A literature review or native review is a type of review article. A literature review as a scholarly paper which includes the current knowledge including substantives findings as well the radical and methodologies contributions to a particular topic. Literature reviews are secondary sources and do not report new or original experimental work most often associated with academic-oriented literature such reviews are found in academic journals. And are not be confused with book reviews that may also appear in the same publication. literature reviews are basis for research in nearly every academic field. A narrow-scope literature review may be included as part of peer reviewed journal article presenting new research serving to situate the current study with in the body of the reveling literature and do provide context for the rider in such case the review usually proceeds the methodology and results sections of the work producing a literature may also be part of graduate and post-graduate student work including in the preparation of this is desertion, or a journal article literature reviews are also common in a research proposal or prospectus (the document that is approved before a student formally begins adissection or these.

2.2 EXISTING SYSTEM

Many image processing, computer vision and machine learning techniques and tools are being used to excel in this research field and come up with more accurate results that might help in more accurate and early glaucoma diagnosis. Some state of art methodologies are being discussed in the upcoming section. An Optic disc localization algorithm (Geetha Ramani and Dhanapackiam 2018) implement template matching technique to locate optic disc center.

Template was created by averaging the images in the database. Green plane was processed further using some morphological operations to detect the Optic disc. In 2014, a disc localization algorithm (Akhade et al. 2018) performed principal component analysis (PCA). Most significant principal component was further processed to remove vessels using morphological operations. Circular Hough transformation was applied to detect the circular body from the resultant fundus image. Tan et al. (2015) used Gaussian Mixture Models (GMM) to extract cup region from fundus images. Resulting cup region has good boundary results in temporal region, while cup extraction algorithm in ARGALI performs well in nasal region, thus a hybrid cup extraction was done by fusion of both ARGALI detected boundary and proposed algorithm detected boundary. Algorithm was tested on 71 images and 14 % error reduction was observed. Cup detection algorithm based on vessel kinking was proposed in Damon et al. (2017). Algorithm proceeds with detecting vessels by classifying some patches of interest by using features like mean and standard deviation of a fused image formed after computing wavelets of edges of green red component and gradient of green component. Vessel kink detection was completed by localizing maximum curvature of the detected vessels.

2.3 SURVEY PAPERS

From [1]. This paper proposes image processing technique for the early detection of glaucoma. Glaucoma is one of the major causes which cause blindness but it was hard to diagnose it in early stages. In this paper glaucoma is classified by extracting two features using retinal fundus images. (i) Cup to Disc Ratio (CDR). (ii) Ratio of Neuroretinal Rim in inferior, superior, temporal and nasal quadrants i.e.

(ISNT quadrants) to check whether it obeys or violates the ISNT rule. The novel technique is implemented on 50 retinal images and an accuracy of 94% is achieved taking an average computational time of 1.42 seconds. In this paper, we designed and implemented an algorithm to identify glaucoma. The novel method uses Morphological techniques to extract two major features for detection of Glaucoma. First of all, all praise to Almighty ALLAH who gave us the capability to go through this research work with our full dedication and commitment. We would also like to express our great appreciation to the team of Armed Forces of Institute of

Ophthalmology for their valuable guidance and suggestion during planning and implementation of this research work."

From [2]. The vascular tree observed in a retinal fundus image can provide clues for Glaucoma diseases. Its analysis requires the identification of vessel bifurcations and crossovers Methods .We use a set of trainable key point detectors that we call Combination of Shifted Filter or morphological filer responses to automatically detect vascular bifurcations in segmented retinal images. We configure a set of filters that are selective for a number of prototype bifurcations and demonstrate that such filters can be effectively used to detect bifurcations that are similar to the prototypical ones. The automatic configuration of such a filter selects given channels of a bank of Gabor filters and determines certain blur and shift parameters

From [3]. Reliable glaucoma detection in digital fundus images is still an open issue in biomedical image processing. The detection of glaucoma in retinal fundus image is essential for preventing from the vision loss. Glaucoma is an irretrievable chronic eye disease which leads to blindness that caused due to the damage of optic nerves Particularly there is no effective method for detection of glaucoma in current status. We have referred various research papers issued by different researchers in the international journals and conferences. All these papers are described the basic ideas and concepts which we are implementing through our paper. We have present literature survey of some papers about the detection of glaucoma in 2D fundus retinal images with using several techniques.

From [4]. Computational techniques are highly used in medical image analysis to aid the medical professionals. Glaucoma is a sight threatening retinal disease that needs attention at its early stages, though it does not reveal any symptoms. Glaucoma is identified usually through cup to disc ratio and ISNT rule. Optic disc segmentation methodology attains an average accuracy of 99.33%. Glaucoma detection accuracy reaches a maximum of 96.42%.General Terms:- Medical image analysis, Image Processing,

From [5]. Retinal nerve fiber layer (RNFL), optic cup and optic disc are most important parts of human eye. The thickness of retinal nerve fiber layer and optic cup to disc ratio are used to diagnose the Glaucoma eye disease. The proposed work provides an automatic technique to estimate the RNFL thickness using statistical region merging algorithm and vertical

cup to disc ratio using edge detection approach and a variation level-set approach to diagnose the Glaucoma through Optical Coherence Tomography (OCT) eye images and fundus images, which are captured from the OCT device and fundus camera respectively.

From [6]. Glaucoma is a disease in which the optic nerve of the eye gets destroyed. As a result, it causes vision loss loss. Most vision loss cases due to Glaucoma are preventable if the disease treatment is started in early stages. Most of times peripheral vision can be damaged earlier than an individual's central vision by Glaucoma because it does not show any sign and symptoms. The existing procedures to detect Glaucoma are time consuming and uncertain at the clinic Bhupendra Singh Kirar, Dheeraj Kumar Agrawal proposed hybrid and concatenation approach to increase the accuracy for measuring features of images. DWT decomposes images into approximate and detail coefficients and EWT decomposes images into its sub band images.

From[7]. Glaucoma is the medical condition which can result in blindness and vision loss. In Glaucoma, optic nerve which connects the eye to brain, is damaged which leads to progressive, irreversible vision loss. This disease does not cause any symptoms in early stages. Due to this people don't realize about the Glaucoma. Glaucoma is a common cause of eye blindness in India and abroad. Majority of people still don't know that they have Glaucomathe optic cup and the optic disc is segmented by image processing technique in MATLAB TOOL. Color retinal imagesare used as input.

From[8]. "Content-based image analysis and computer vision techniques are used in various healthcare systems to detect the diseases. The abnormalities in a human eye are detected through fundus images captured through a fundus camera. Among eye diseases, glaucoma is considered as the second leading case that can result in neuro degeneration illness.

Sl. No	Authors	Year	Keywords	Classification	Accuracy
1	Fauzia Khan and Shoaib A Khan	2013	Glaucoma,GLCM matrix, Wavelet,Rando Forest.	Normal Suspected Glaucoma	94%
2	Divya Rekha, and A. Murugan	2015	CAD Systems, FundusImage, Glaucoma, Iridocorneal Angle,Optic Disc.	Cup to Disk RatioAnalysis ISNT Rule Analysis	71%
3	D.Vijayasekr M.E.SE .Dhivya M.E.S.And dhanalakshmi M.E.,	2016	Glaucoma, Retina, Random Forest. CAD Systems,	Medical image analysis, Image Processing, DataMining	86.82 %
4	R.GeethaRamani, Phd Lakshmi B. And Sugirtharani S	2017	Glaucoma, Retina, Fundus Image, Opticdisc	Maximum voting,hybrid classification K-Means, Wavelet and Histogram based	96.42 %
5	Chandrappa S, Santhrupthi B M,Suman B R, Sahana S M,	2018	Retinal nerve fiberlayer(RNFL), OpticalCoherence Tomography(OCT), Vertical cup to disc ratio(VCDR)	Proposed work presentstechniques for segmentation ofretinal nerve fiber from OCT images	Avrage
6	Nerkar Vipul Balkrishna, Nandkishor C. Patil, KuteYogesh Ramesh,	2019	Glaucoma,GLCM matrix , Wavelet, Supervised Machine	algorithms to instantaneously detect and classifyhealthy and Glaucoma eye	90.05 %
7	Amit Kumar Mourya , BarkatAli , Asraf Ali	2020	color retinal images,segmentation, Neuroretinal Rim, opticdisk, optic cup	Blood vessels, houghtransform.	96.46 %

2.3 Table : Literature Comparisons

2.4 PROPOSED SYSTEM

Glaucoma is an ocular condition whose progression leads to permanent blindness. Glaucoma is a chronic disease whose progression can only be stopped if detected accurately at an early stage. Proposed algorithm provides an automated glaucoma detection computer aided system that enables the ophthalmologists in early diagnosis of glaucoma patients with high accuracy. Algorithm takes a pre-processed fundus image and extracts optic cup and optic disc followed by CDR calculation. Intensity and textural features are extracted from the image to train and test the classifier. Result from glaucoma detection using CDR and features are combined to classify the image as glaucoma, non-glaucoma or suspect. In colored retinal fundus images, Optic disc appears to be the brightest part having light orange or pink color and is deemed to be Region of Interest (ROI). The ROI from all images (dataset) is cropped using intensity values and then resized to 256×256. The green plane is extracted from original image for extraction of optic cup, which provides enhanced contrast for optic cup The original image was then converted to HSV p lane. It was concluded after analysis of a number of images, that optic disc has a glaucomais an ocular condition whose progression leads to permanent blindness. Glaucoma is a chronic disease whose progression can only be stopped if detected accurately at an early stage. Proposed algorithm provides an automated glaucoma detection computer aided system that enables the ophthalmologists in early diagnosis of glaucoma patients with high accuracy. Algorithm takes a preprocessed fundus image and extracts optic cup and optic disc followed by CDR calculation. Intensity and textural features are extracted from the image to train and test the classifier. Result from glaucoma detection using CDR and features are combined to classify the image as glaucoma, non-glaucoma or suspect.

2.5 ABOUT LANGUAGE

2.5.1 PYTHON

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports module and package, which encourages program modularity and code reuse.

The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed. Often, programmers fall in love with Python because of the increased productivity it provides. Since there is no compilation step, the edit-test-debug cycle is incredibly fast. Debugging Pythonprograms is easy: a bug or bad input will never cause a segmentation fault. Instead, when the interpreter discovers an error, it raises an exception. When the program doesn't catch the exception, the interpreter prints a stack trace. A source level debugger allows inspection of local and global variables, evaluation of arbitrary expressions, setting breakpoints, stepping through the code a line at a time, and so on. The debugger is written in Python itself, testifying to Python's introspective power. On the other hand, often the quickest way to debug a program is toadd a few print statements to the source: the fast edit-test-debug cycle makes this simpleapproach very effective.

2.5.2 MACHINE LEARNING

Machine learning is a branch of artificial intelligence (AI) focused on building applications that learn from data and improve their accuracy over time without being programmed to do so.In data science, an algorithm is a sequence of statistical processing steps. In machine learning, algorithms are 'trained' to find patterns and features in massive amounts of data in order to make decisions and predictions based on new data. The better the algorithm, the more accurate the decisions and predictions will become as it processes more data. Today, examples of machine learning are all around us. Digital assistants search the web and play music in response to our voice commands. Websites recommend products and movies and songs based on what we bought, watched, or listened to before. Robots vacuum our floors while we do . . . something better with our time. Spam detectors stop unwanted emails from reaching our inboxes. Medical image analysis systems help doctors spot tumors they might have missed. And the first self-driving cars are hitting the road. We can expect more. As big data keeps getting bigger, as computing becomesmore powerful and affordable, and as data scientists 0keep developing more capable algorithms, machine learning will drive greater and greater efficiency in our personal and work lives. How machine learning works There are four basic steps for building a machine learning application (or model). These are typically performed by data scientists working closely with the business professionals for whom the model is being developed.

CHAPTER 3

SOFTWARE REQUIREMENT SPECIFICATION

3.1 INTRODUCTION

A software requirements specification (SRS) is a description of a software system to be developed. It lays out functional and nonfunctional requirements, and may include a set of use cases that describe user interactions that the software must provide. In order to fully understand ones project, it is very important that they come up with an SRS listing out their requirements, how are they going to meet it and how will they complete the project. SRSalso functions as a blueprint for completing a project with as little cost growth as possible. SRS is often referred to asthe parent document because all subsequent project management documents, such as design specifications, statements of work, software architecture specifications, testing and validation plans, and documentation plans, are related to it. Requirement is a condition or capability to which the system must conform. Requirement Management is a systematic approach towards eliciting, organizing and documenting the requirements of the system clearly along with the applicable attributes. The elusive difficulties of requirements are not always obvious and can come from any number of source.

3.2 FEASIBILITY STUDY

At the name implies a feasibility study in an analysis of the visibility of an idea the feasibility study focuses on helping answer the essential question of the “should we proceed with

the project idea?" All activates of the study are directed toward helping answer this question feasibility studies can be used in many ways but primarily focus on proposed business ventured. Formers and other with business idea should conduct a feasibility study to determine the viability of their before proceeding with the development of business. Feasibility studies allow companies to determine and organize all of the necessary details to make the work. A feasibility study helps identify logical problems and nearly all releted problems along with the solutions to alleviate them. Feasibility studies can also lead to the development of marketing strategies.

3.2.1 TECHNICAL FEASIBILITY

Lays out details on how a good or service will be delivered which includes transportation location technology needed materials and labor.

3.2.2 ECONOMIC FEASIBILITY

A projection of the amount of findings or startup capital needed what sources of capital can and will be used what king of return can be expected on the investment.

3.2.3 OPERATIONAL FEASIBILITY

Operational feasibility is a measure of hw well a proposed system solves the problems and takes advantages of the opportunities identified during scope definition and how it satisfied the requirements identified in the requirements analysis phase of system development.

3.3 FUNCTIONAL AND NON FUNCTIONAL REQUIREMENTS

3.3.1 FUNCTIONAL REQURIMENTS

Functional Requirement defines a function of a software system and how the system must behave when presented with specific inputs or conditions. These may include calculations, data manipulation and processing and other specific functionality. Following are the functional requirements on the system:

- Collecting Datasets and data pre-processing is performed for that dataset

- The dataset will be subjected to various date mining techniques ,Clustering will be performed on the given data set
- The clusters are then subjected to other algorithms like Association rule mining and trend analysis.

3.3.2 NON FUNCTIONAL REQUIREMENTS

Non functional requirements are the requirements which are not directly concerned with the specific function delivered by the system. They specify the criteria that can be used to judge the operation of a system rather than specific behaviors. They may relate to emergent system properties such as reliability, response time and store occupancy. Non functional requirements arise through the user needs, because of budget constraints, organizational policies and the need for interoperability with other software and hardware systems.

Reliability:- The structure must be reliable and strong in giving the functionalities. The movements must be made unmistakable by the structure when a customer has revealed a couple of enhancements. The progressions made by the Programmer must be Project pioneer and in addition the Test designer.

Maintainability:- The system watching and upkeep should be fundamental and focus in its approach. There should not be an excess of occupations running on diverse machines such that it gets hard to screen whether the employments are running without lapses.

Performance:- The framework will be utilized by numerous representatives all the while. Since the system will be encouraged on a single web server with a lone database server outside of anyone's ability to see, execution transforms into a significant concern. The structure should not capitulate when various customers would use everything the while. It should allow brisk accessibility to each and every piece of its customers .For instance, if two test specialists are all the while attempting to report the vicinity of a bug, then there ought not to be any irregularity at the same time.

Portability:- The framework should to be effectively versatile to another framework. This is

obliged when the web server, which s facilitating the framework gets adhered because of a few issues, which requires the framework to be taken to another frame work.

Scalability:- The framework should be sufficiently adaptable to include new functionalities at a later stage. There should be a run of the mill channel, which can oblige the new functionalities.

Flexibility:- Flexibility is the capacity of a framework to adjust to changing situations and circumstances, and to adapt to changes to business approaches and rules. An adaptable framework is one that is anything but difficult to reconfigure or adjust because of diverse client and framework prerequisites. The deliberate division of concerns between the trough and motor parts helps adaptability as just a little bit of the framework is influenced when strategies or principles change.

3.4 SOFTWARE AND HARDWARE REQURIMENTS

3.4.1 SOFTWARE REQUIREMENTS

LANGUAGE	**PYTHON**
IDE	PYTHON 3.7
OPERATING SYSTEM	WINDOWS 10 64BIT
FRONT END BACKEND	PYTHON

3.4.2 HARDWARE REQUIREMENTS

PROCESSOR	**INTEL I3 MINIMUM**
HARDISK	**250GB MINIMUM**
KEYBOARD AND MOUSE	**ANY STANDARD KEYBOARD AND MOUSE**
SPEAKERS	**SYSTEM BUILT IN SPEAKERS**
RAM	**2GB MINIMUM**

CHAPTER 4

DESIGN

4.1 INTRODUCTION

System Development methodology is the development of a system or method for unique situation. Having a proper methodology helps us in bridging the gap between the problem statement and turning it into a feasible solution. It is usually marked by converting the System Requirements Specifications (SRS) into a real world solution. System design takes the following inputs: Statement of work. Requirement determination plan. Current situation analysis. Proposed system requirements including a conceptual data model and metadata (data about data).The development method followed in this project is waterfall model.

4.2 SYSTEM DESIGN

4.2.1 SYSTEM ARCHITECTURE

The system architecture shown in Figure 4.1.2 gives overall view about all the modules in the proposed system of Glaucoma and the flow of the process right from data collection to detection. Initially, input images are collected from open-source RIGA dataset. All the images are of size256X256. Next, images are given as input to the data augmentation. The augmented images are trained using the CNN model. Finally ,the class prediction is done with the test data.

Software architecture in software engineering helps **to** expose the structure of a system while hiding some implementation details. Architecture focuses on relationships and how the elements and components interact with each other, as does software engineering. The above picture shows the architecture of the Glucoma detection model.

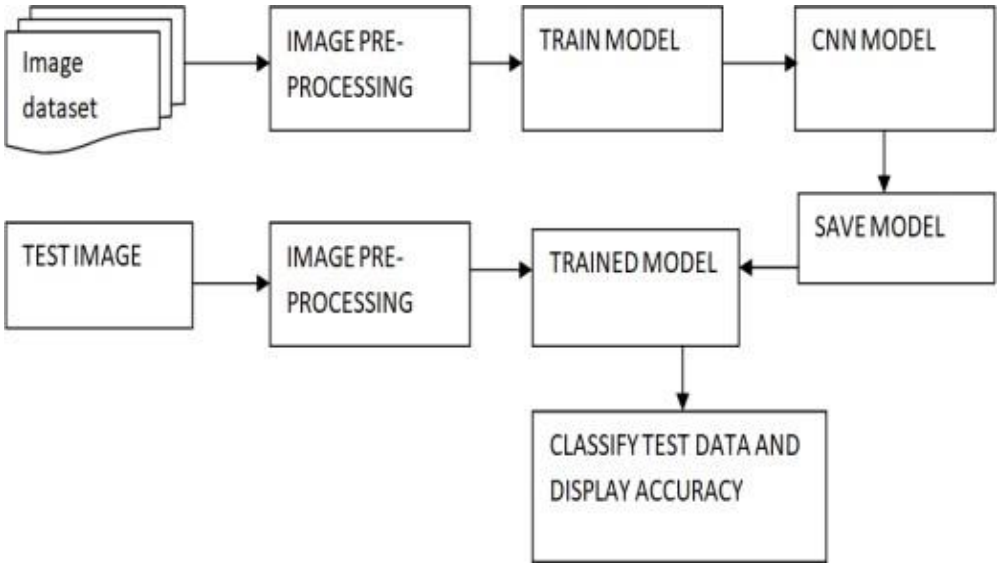


Fig 4.2.1: System Architecture for Glaucoma

The image dataset is fed to the pre-processing unit, in this unit the image is resized to the standard format and image smoothing is done, once the image is pre-processed the image is fed to the training model this model passes the dataset to then cnn algorithm, then the algorithm is trained and the trained model is saved. Once the model is trained we can now test our images to know whether the image is normal eye image or glaucoma defected image.

4.2.2 Use case Diagram

Use case diagram is a graph of actors set of use cases enclosed by a system boundary. Communication association between the actor on the use case. The use case diagram describe how a system interacts with outside actor which use case represents a peace of functionality but a system provides to its users. A use case is known as an ellipse containing the

name of the use case and an actor is shown as a stick figure with the name of the actor below the figure.

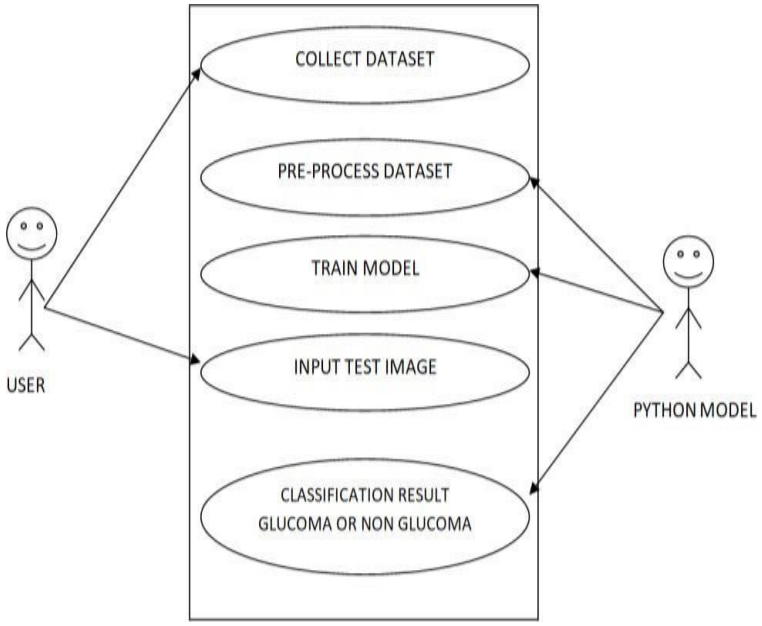


Fig 4.2.2: Use case Diagram

4.2.3 FLOW CHART

A flowchart is a type of diagram that represents a workflow or process. A flowchart can also be defined as a diagrammatic representation of an algorithm, a step-by-step approach to solving a task. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows.

A formula to calculate activation function in hidden layer of CNN

Rectified linear unit (ReLU)

$$\begin{cases} 0 & \text{if } x \leq 0 \\ x & \text{if } x > 0 \end{cases}$$
$$= \max\{0, x\} = x\mathbf{1}_{x>0}$$

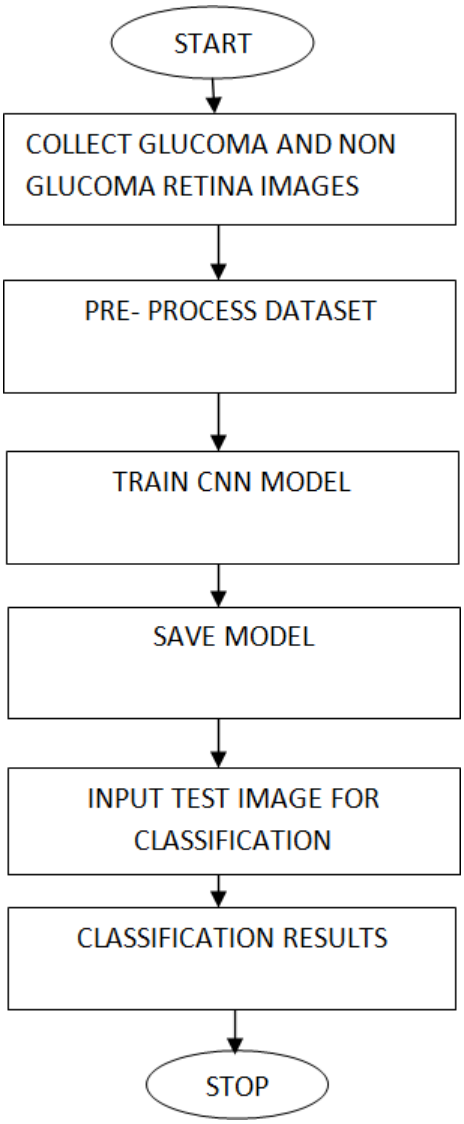


Fig 4.2.3 : Flow Chart

4.3 DETAILED DESIGN

This project consists of two modules they are :

Training:

The idea of using training data in machine learning programs is a simple concept,υ but it is also very foundational to the way that these technologies work. The training data is an initial set of data used to help a program understand how to apply technologies like neural networks to learn and produce sophisticated results.

Testing:

A test dataset is a dataset that is independent of the training dataset, but that followsυ the same probability distribution as the training dataset. If a model fit to the training dataset also fits the test dataset well, minimal over fitting has taken place.

Pseudo code

Input : extracted features

Output: Classification of retinal fundus images

Begin

Initialize the number of features L1,L2,…..Li and number of layers N for every feature

do

Calculate convolution function using

$(NL_a)_i^m = NL_a(q_i^n)$

For all features

do

Calculate pooling function using

$y_i^m = P_o((NL)_a)_i^m)$

End for

End for

For every feature

Do

Calculate the output of the RBF networking using

$\emptyset(L) = \sum_{i=1}^{N} di\rho(\|L - fi\|)$

End for

end

4.3.1 DATA FLOW DIAGRAMS

Glucoma disease detection using CNN in Deep Learning B.E, Dept of ISE, CMRIT 2019-20 Page 8 3.2.4 Data flow diagrams A data-flow diagram (DFD) is a way of representing a flow of a data of a process or a system (usually an information system). The DFD also provides information about the outputs and inputs of each entity and the process itself

DFD level -1

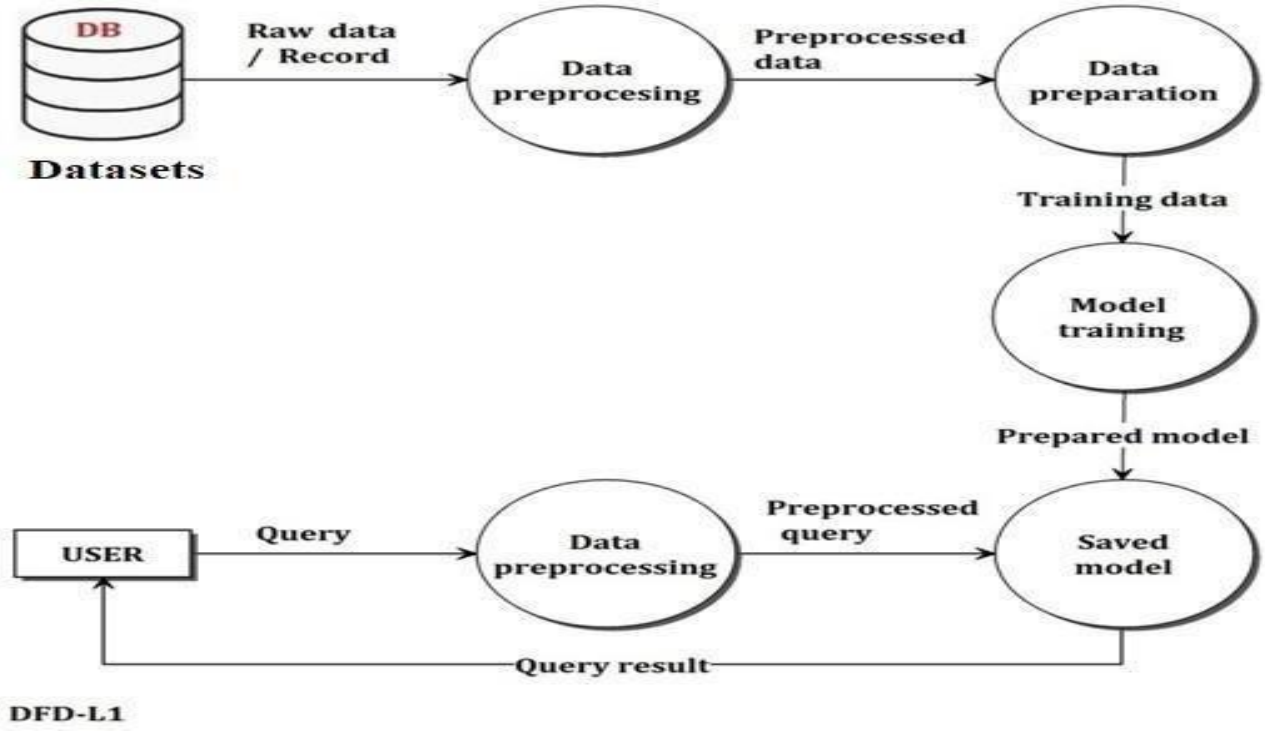


Fig 4.3.1: DFD level 1

DFD level -2

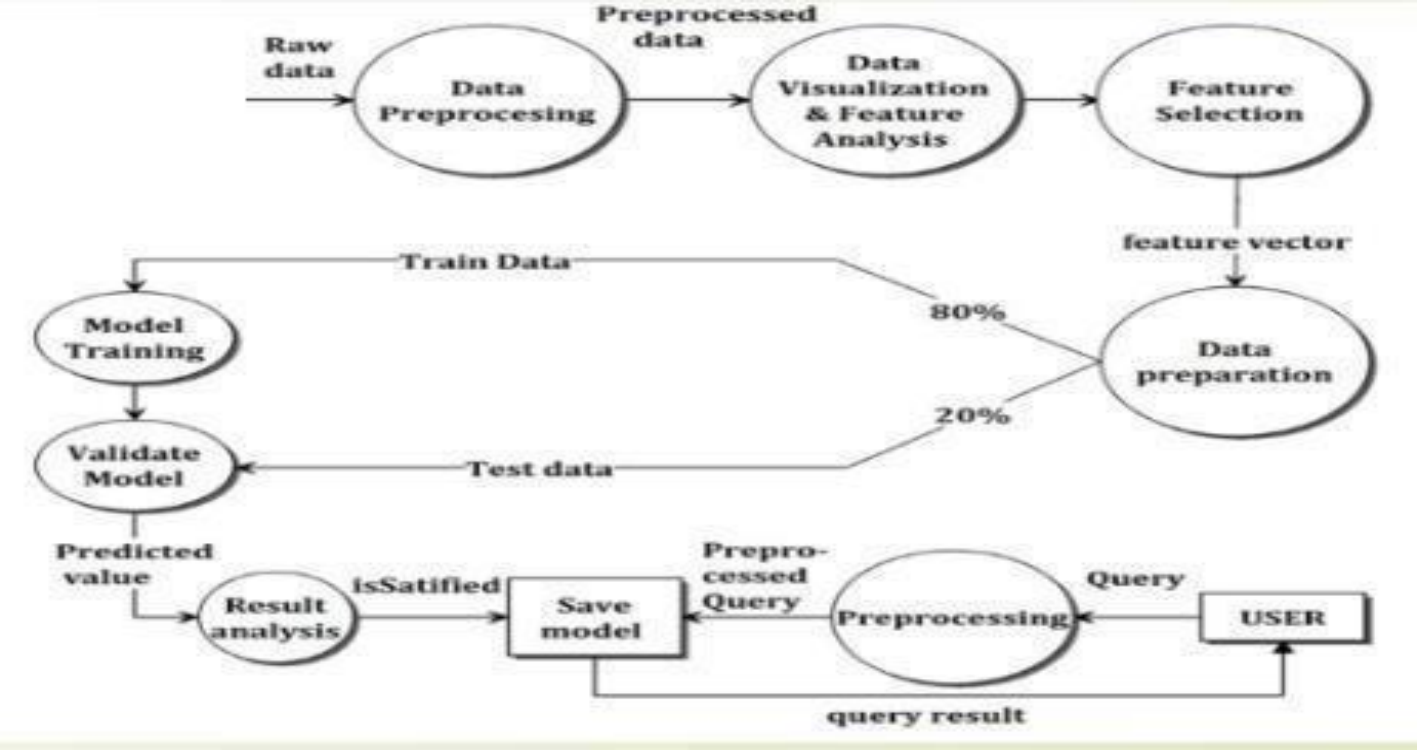


Fig:4.3.2: DFD level 2

CHAPTER 5

IMPLEMENTATION

5.1 INTRODUCTION

Implementation is the process of converting a new or a revised system design into an operational one. The objective is to put the new or revised system but has been tested into operation while holding cost, risks and irritation to the minimum. it critical aspects of the implementation process is to ensure that there will be no decrypting the functioning of the organization. The best method for gaming control while implanting any new system would be to use well planed test for testing all new programs. Before production files are used to test live data, text files must be created on the old system, copied over to the new system, and used for the initial test of each program.

This project consists of Four Parts they are :

- Pre-processing
- Loading image datasets
- Disease detection
- Plot graph

- **Pre-processing**

  We have imported Sequential **from keras.models**, to initialise our neural network model as a sequential network. There are two basic ways of initialising a neural network, either by a sequence of layers or as a graph.

- We have imported **Conv2D from keras.layers,** this is to perform the convolution operation that is, the first step of a CNN, on the training images. Since we are working on images here, which a basically 2 Dimensional arrays, we're using Convolution 2-D, you may have to use Convolution 3-D while dealing with videos, where the third dimension will be time.
- We have imported **MaxPooling2D from keras.layers,** which is used for pooling operation, that is the step — 2 in the process of building a cnn. For building this particular neural network, we are using a Maxpooling function, there exist different types of pooling operations like Min Pooling, Mean Pooling, etc. Here in MaxPooling we need the maximum value pixel from the respective region of interest.
- We have **imported Flatten from keras.layers**, which is used for Flattening. Flattening is the process of converting all the resultant 2 dimensional arrays into a single long continuous linear vector. And
- Finally we have imported **Dense from keras.layers,** which is used to perform the full connection of the neural network, which is the step 4 in the process of building a CNN.

•Loading image datasets

We need to fit our CNN to the image dataset that you've downloaded. But before we do that, we are going to pre-process the images to prevent over-fitting. Overfitting is when youget a great training accuracy and very poor test accuracy due to overfitting of nodes from one layer to another. So before we fit our images to the neural network, we need to performsome image augmentations on them, which is basically synthesizing the training data. We are going to do this using keras.preprocessing library for doing the synthesizing part as wellas to prepare the training set as well as the test set of images that are present in a properly structured directories, where the directory's name is take as the label of all the images present in it. For example : All the images inside the 'cats' named folder will be considered as cats by keras.

• Disease Detection

The test image holds the image that needs to be tested on the CNN. Once we have the test image, we will prepare the image to be sent into the model by converting its resolution to 64x64 as the model only excepts that resolution.

- Then we are using predict() method on our classifier object to get the prediction.

- **Plot Graph**

  Plotting the graph according to the accuracy and loss, with epoch as X axis and accuracy and lossas the Y axis.

  The graph is plotted for each image tested.

- **Pseudo code**

Input : extracted features

Output: Classification of retinal fundus images

Begin

Initialize the number of features L1,L2,…..Li and number of layers N for every feature

do

Calculate convolution function using

$(NL_a)_i^m = NL_a(q_i^n)$

For all features

do

Calculate pooling function using

$y_i^m = P_o((NL)_a)_i^m)$

End for

End for

For every feature

Do

Calculate the output of the RBF networking using

$$\emptyset(L) = \sum_{i=1}^{N} di\rho(\|L - fi\|$$

End for

end

5.2 ALGORITHM

5.2.1 CONVOLUTION NEURAL NETWORK:

INTRODUCTION

A system of interconnected artificial neurons that have learnable weights and biases forms a Convolutional Neural Network. These neurons exchange messages between each other. The connections have numeric weights that are tuned during the training process, so that a properly trained network will respond correctly when presented with an image or pattern to recognize. The network consists of multiple layers of feature-detecting neurons. Each layer has

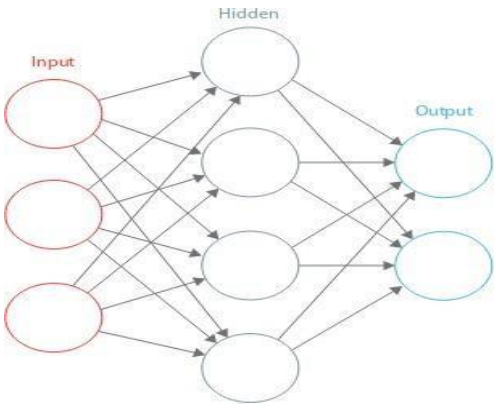


FIG 5.2.1: An Artificial Neural Network

many neurons that respond to different combinations of inputs from the previous layers. As shown in Figure , the layers are built up so that the first layer detects a set of primitive patterns in the input, the second layer detects patterns of patterns, the third layer detects patterns of thosepatterns

. Layers of CNN

For classification problems, complex architectures are built by stacking multiple and different layers in a CNN. The four types of layers are convolution layer, pooling/subsampling layers, non-linear (ReLU) layers, and fully connected layers. Figure 3.3 shows the various layers of CNN. A portion of the input image is fed to the convolution layer. The output of this layer is then fed to the pooling layer. This is repeated again followed by fully connected layer which performs classification.

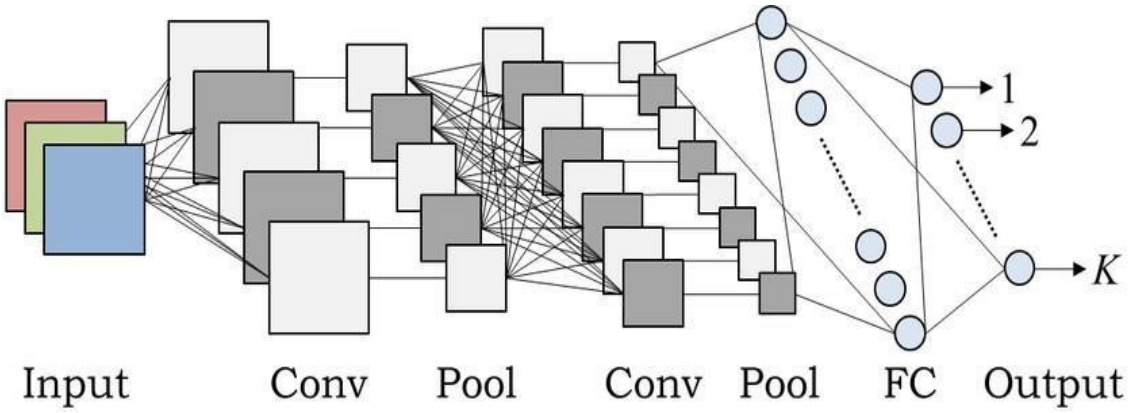


Fig 5.2.2: Architecture of CNN

Convolution Layer

Different features of the input are extracted by the convolution operation. The first convolution layer extracts low-level features like edges, lines, and corners. Higher-level layers extract higher-level features. Figure 3.5 illustrates the process of 3D convolution used in CNNs. The input is of size N x N x D and is convolved with H kernels, each of size k x k x D separately. Convolution of an input with one kernel produces one output feature, and with H kernels independently produces H features. Starting from top-left corner of the input, each kernel is moved from left to right, one element at a time.

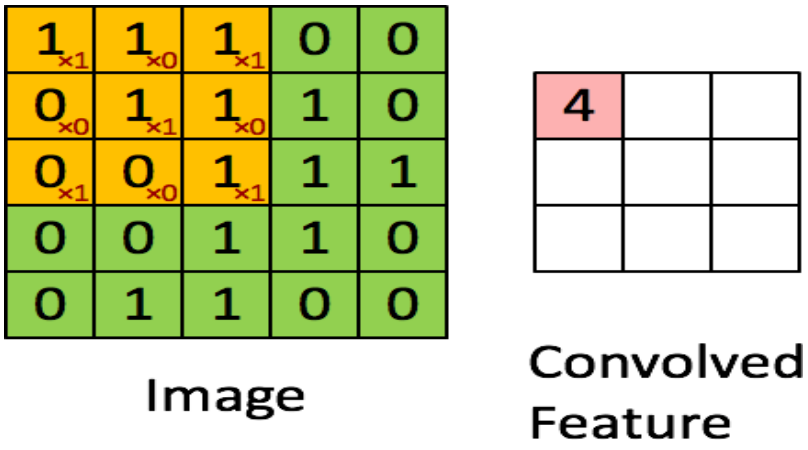


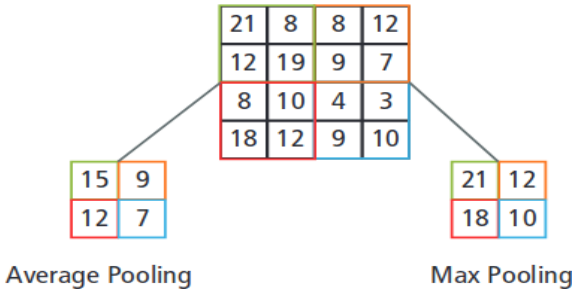
Fig 5.2.3: Representation of Convolution Process

For example, if N = 5 and k = 5 , there are 5 separate positions from left to right and 5 separate positions from top to bottom that the kernel can take. Corresponding

to these positions, each feature in the output will contain 28x28 (i.e., (N-k+1) x (N-k+1)) elements. For each position of the kernel in a sliding window process, k x k x D elements of inputand k x k x D elements of kernal are element-by-element multiplied and accumulated. So to create one element of one output feature, k x k x D multiply-accumulate operations are required.

Pooling Layer

The pooling (subsampling) layer helps to reduce the resolution of the features. The features are robust against noise and distortion. The two ways to perform pooling operation is as follows: max pooling and average pooling. In both the cases, the input is divided into non- overlapping sub-



regions.

Fig 5.2.4: Representation of Max Pooling and Average Pooling

Figure5.2.1.4 elaborates further on the pooling process. The input is of size 4x4 input image is divided into four non-overlapping matrices each of size 2x2 shown in green, yellow, red and blue squares. In the case of max pooling operation, the maximum value of the four values in the 2x2 matrix (21 from the green matrix, 12 from the yellow matrix, 18 from the red matrix and 10 from the blue matrix) is taken as the output. But in the case of average pooling, the average of the four values (15 from the green matrix, 9 from the yellow matrix, 12 from the red matrix and 7 from the blue matrix) is taken as the output. If the result of averaging is a fraction, then it has to be rounded to nearest integer.

Applications of CNN

- **Image Classification:**

On large scale datasets CNNs acheive better classification accuracy compared to other methods due to their capability of join feature and classifier learning.

- **Speech Recognition:**

Convolutional Neural Networks have been used in Speech Regognition recently. CNN has given better results over Deep Neural Networks (DNN). In 2015, Microsoft Corporation researchers came up with four domains in which CNN give better results than DNN. They are

(1)Noise robustness (2)Distant speech recognition (3)Low-footprint models

(4)Channel-mismatched training-test conditions.

- **Face Recognition:**

Problems like focusing on each face despite bad lighting or different pose, identifying all the faces in the picture, identifying unique features, comparing identified features to existing database and determining the person's name is a part of the face recognition process. Faces represent a complex, multi-dimensional, visual stimulus. It is presented using a hybrid neural network combining local image sampling, a self-organizing map neural network and a convolutional neural network.

- **Scene Labelling:**

In scene labelling each pixel is labelled with the category of the object it belongs to, CNNs are very effective in scene labelling.

- **Action Recognition:**

The translation and distortions of features in different patterns which belong to the same action class are the difficulties in developing an action recognition system. These difficulties can be overcome by using CNNs.

- **Human Pose Estimation:**

In computer vision, human pose recognition has been a long standing problem. Due to the high variability of possible body poses and high dimensionality of the input data, this problem couldn't be solved. Now CNNs are useful in human pose estimation.

- **Document Analysis:**

The sequential nature of the pen trajectory by representing the input in the time domain is used in traditional handwriting recognizers. These representations are sensitive to writing speed, stroke order, and other irrelevant parameters**.**

CHAPTER 6

TESTING

6.1 INTRODUCTION

The purpose of testing is to discover errors. Testing is a 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. Software testingis an important element of the software quality assurance and represents the ultimate review of specification, design and coding. The increasing feasibility of software as a system and the cost associated with the software failures are motivated forces for well planned through testing. Types of Testing: In order to make sure that the system does not have errors, the different levels of testing strategies that are applied at different phases of software development are :

6.1.1 Unit Testing:

- Unit testing is done on individual models as they are completed and becomes executable. It is confined only to the designer's requirements. Unit testing is different from and should be preceded by other techniques, including:
- Inform Debugging
- Code Inspection

6.1.2 Black Box testing

In this strategy some test cases are generated as input conditions that fully execute all functional requirements for the program. This testing has been used to find

error in the following categories: Incorrect or missing functions

- Interface errors
- Errors in data structures are external database access
- Performance error
- Initialization and termination of errors
- In this testing only the output is checked for correctness
- The logical flow of data is not checked

6.1.3 White Box testing

In this the test cases are generated on the logic of each module by drawing flow graphs of that module and logical decisions are tested on all the cases. It has been used to generate the test cases in the following cases.

- Guarantee that all independent paths have been executed
- Execute all loops at their boundaries and within their operational
- Bounds.Execute internal data structures to ensure their validity.

6.1.4 Integration Testing

Integration testing ensures that software and subsystems work together a whole. It test the interface of all the modules to make sure that the modules behave properly when integrated together. It is typically performed by developers, especially at the lower, module to module level .Testers become involved in higher levels

6.1.5 System Testing

Involves in house testing of the entire system before delivery to the user. The aim is to satisfy the user the system meets all requirements of the client's specifications. It is conducted by the testing organization if a company has one. Test data may range from and generated to production .Requires test scheduling to plan and organize:

- Inclusion of changes/fixes.
- Test data to use

One common approach is graduated testing: as system testing progresses and (hopefully) fewer and fewer defects are found, the code is frozen for testing for increasingly longer time periods.

6.2 TEST PLAN

It is a document which describes the testing environment, purpose, scope, objectives, test strategy, schedules, mile stones, testing tool, roles and responsibilities, risks, training, staffing and who is going to test the application, what type of tests should be performed and how it will track the defects.

Test Development

- Preparing test cases, test data, Preparing test procedure, Preparing test scenario, Writing test script.

Test execution

- In this phase we execute the documents those are prepared in test development phase .

Analyze Result

- Once executed documents will get results either pass or fail. We need to analyze the results during this phase.

Defect Tracking

- Whenever we get defect on the application we need to prepare the bug report file and forwards to Test Team Lead and Dev Team. The Dev Team will fix the bug. Again we have to test the application. This cycle repeats till we get the software without defects.

6.3 TEST CASES

TEST CASE NUMBER	TEST SCENARIO	EXPECTED RESULTS	RESULT
1	Al the imported packagesworking successfully.	Test successful	100%
2	All libraries working successfully.	Test successful	100%
3	All the graphical visualization working successfully	Test successful	100%
4	All importing datasets working successfully	Test successful	100%
5	create channels by entervalid channel information.	Test successful	100%
6	The complete modelis working successfully.	Test successful	100%

Table 6.3: Test cases

CHAPTER 7

CONCLUSION AND FUTURE ENHANCEMENT

In this project, we try to design and implement an algorithm to identify glaucoma. The novel method uses Morphological techniques to extract two major features for detection of Glaucoma i.e. Area ratio of NRR in ISNT quadrants, Cup to Disc Ratio. The developed methods were tested on three different databases i.e., DMED, FAU and, MESSIDOR. The proposed method achieves an average accuracy of 97.5% having an average computational cost of 0.8141 seconds.

Future enhancement:

We will convert that model into real time application for detection of GLAUCOMA. The application will be easy to access to each person. In this way, the raw raster image is transformed into a more abstract and a priori unknown. Representation that fosters effective vessel segmentation. The features learned at multiple levels of abstraction are then automatically composed into a complex function that maps an input patch to its label. An average accuracy of 95.64% is determined in the classification of blood vessel or not.

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SNAPSHOTS:

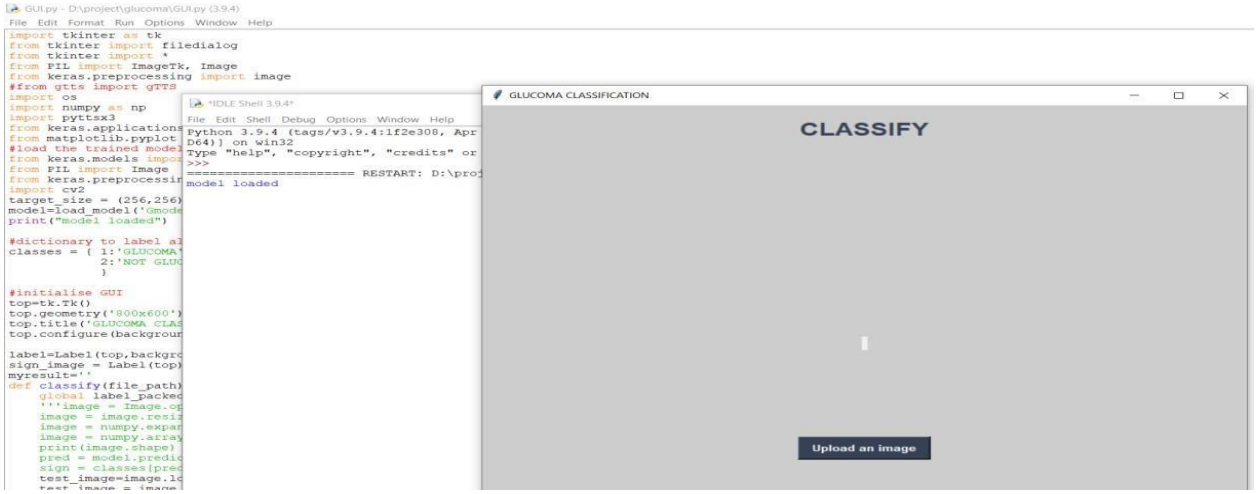

Fig 1: Home Page

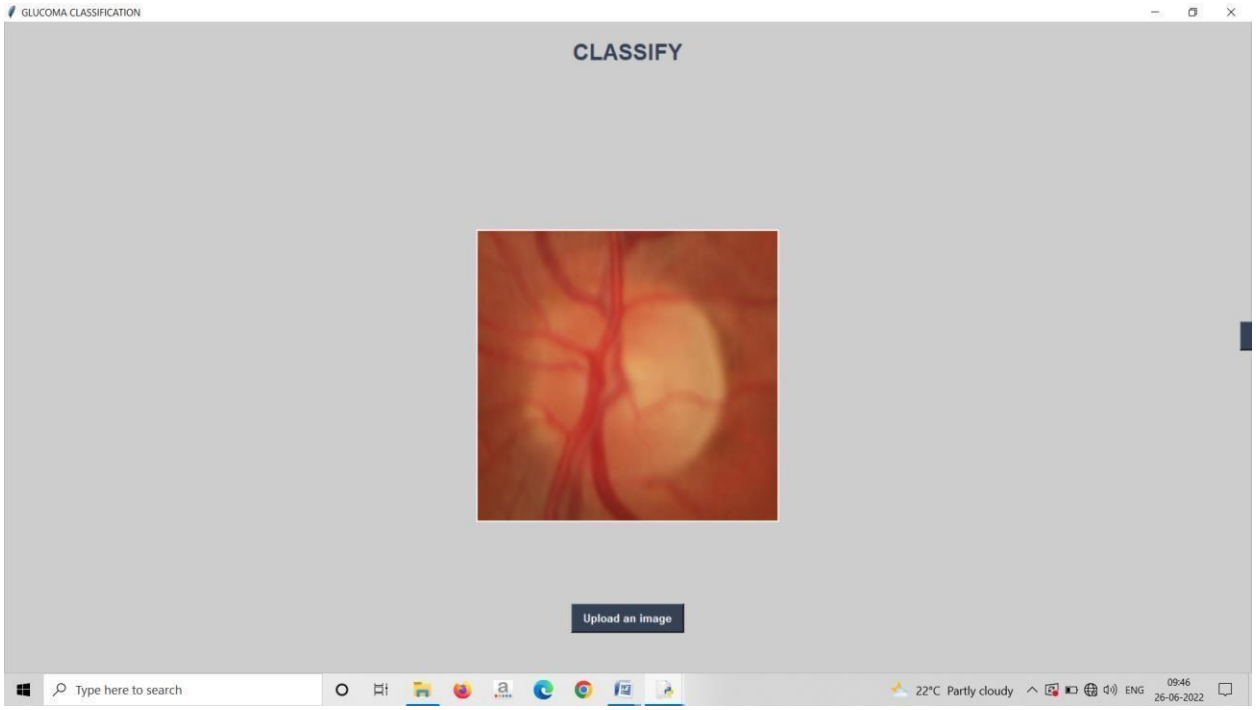

Fig 2: Upload Image

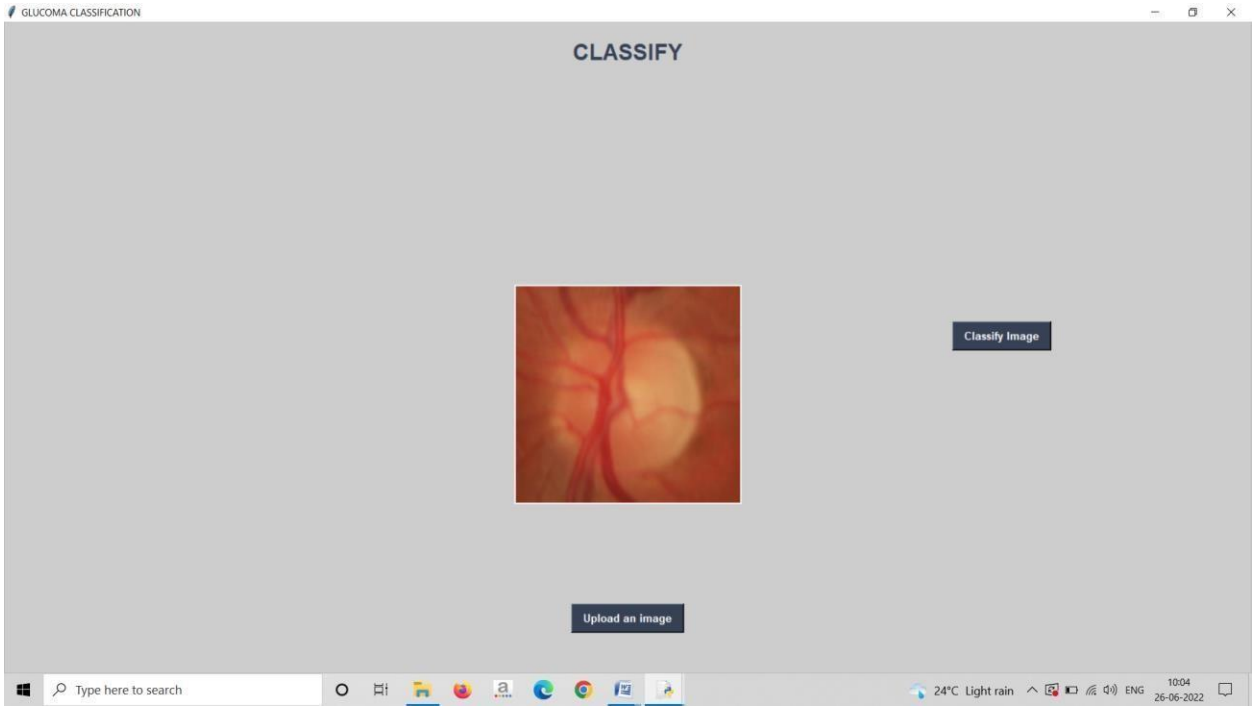

Fig 3: Classification Image

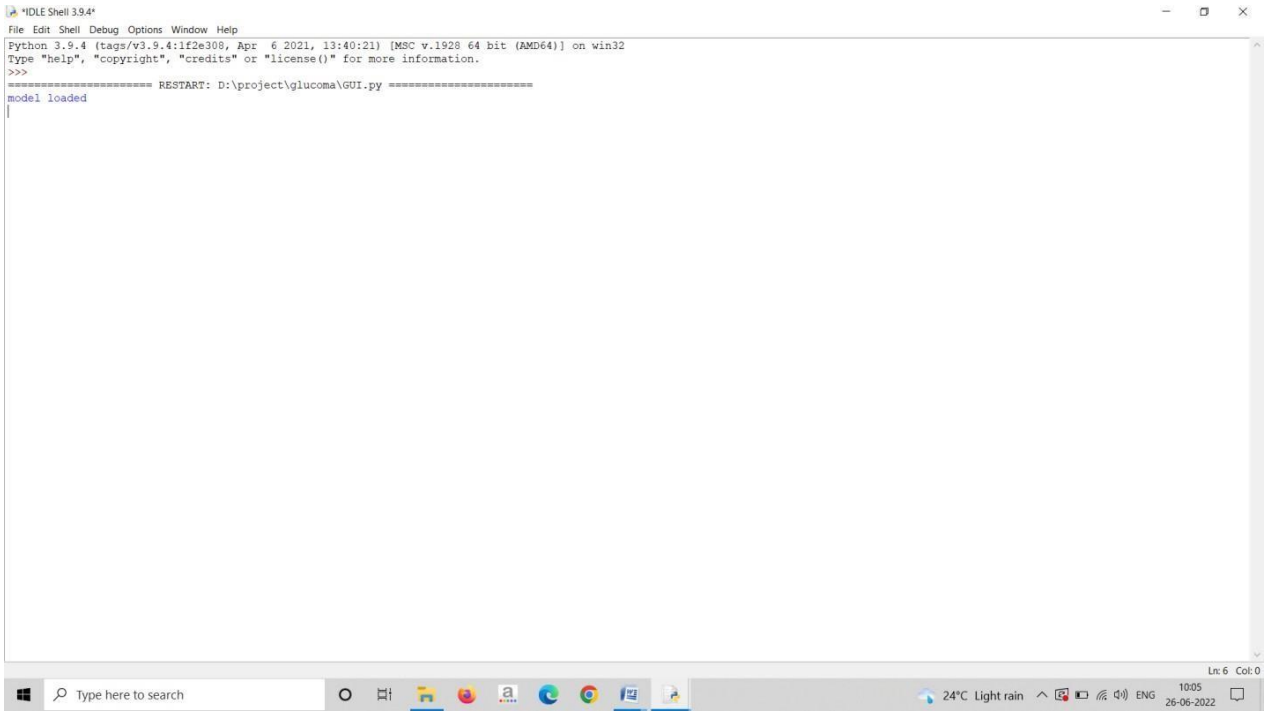

Fig4: Load model

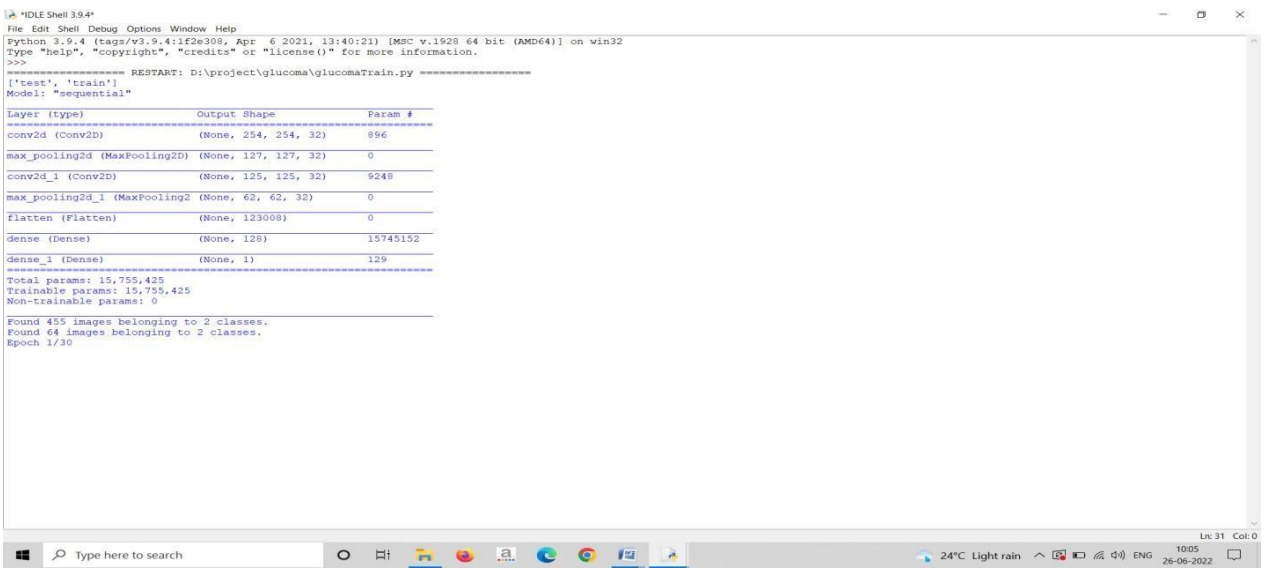

Fig 5: CNN images

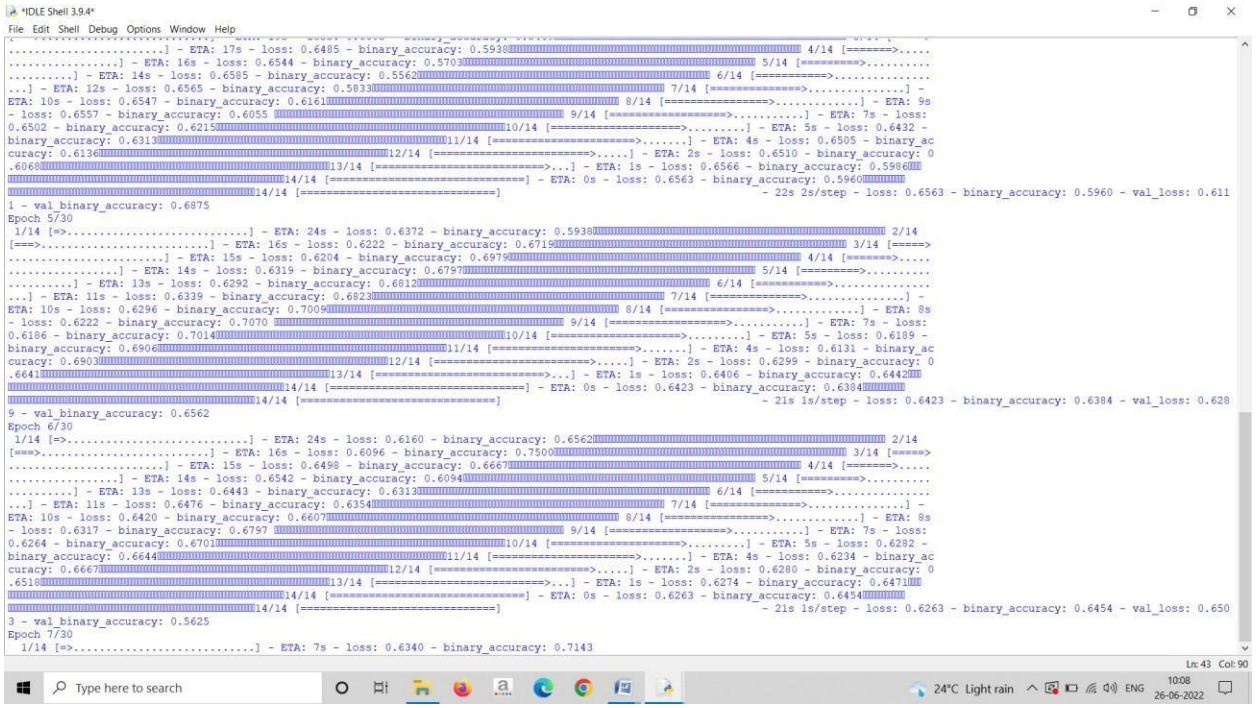

Fig 6: Accuracy.

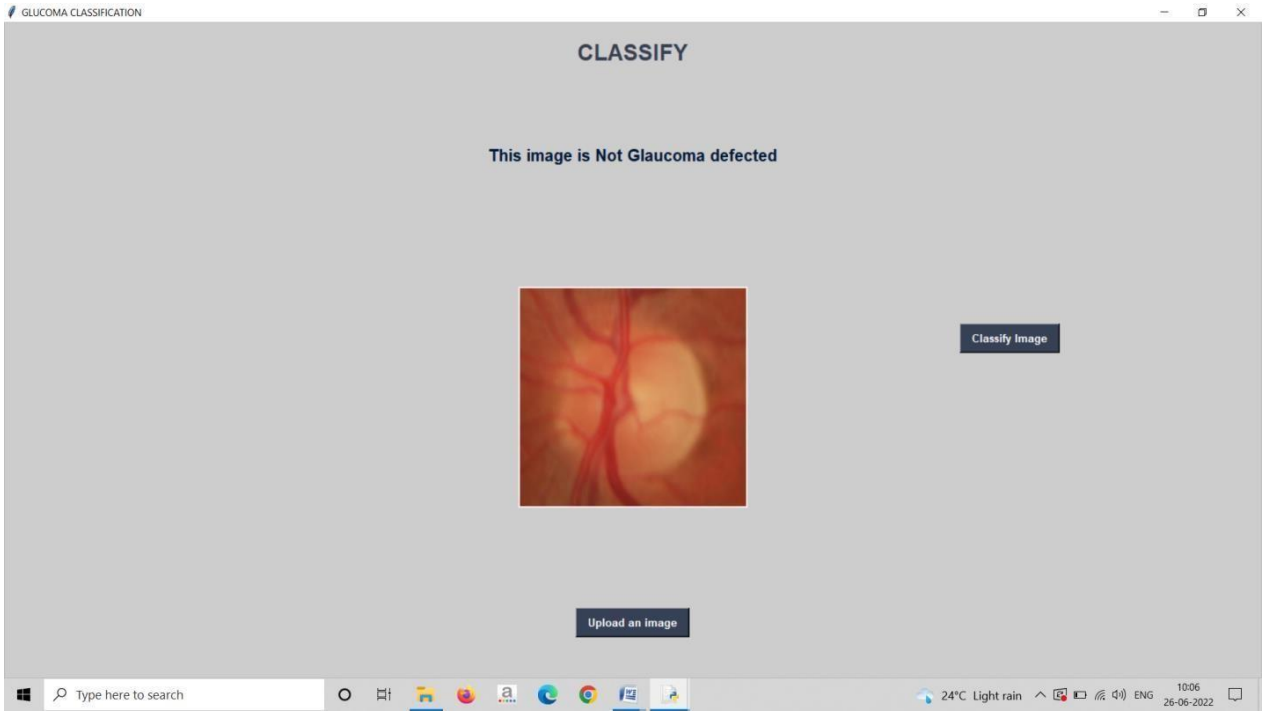

Fig 7: Output

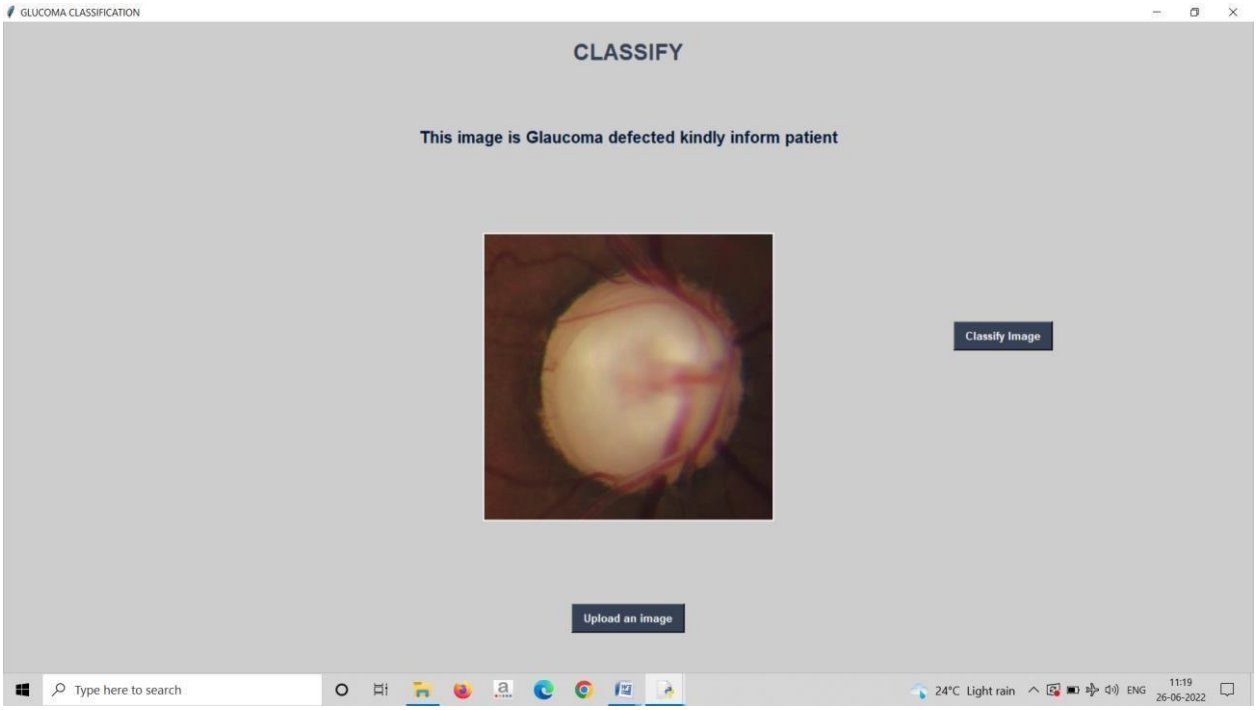

Fig 8: Glaucoma defected