Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.7765883

# EYE DISEASE DETECTION USING MACHINE LEARNING
## (With medicine specification and doctor recommendation)

**Jagbeer Singh, UrujFatima, Simra, Urvashi, Mohd. Nabeel Alvi**
Meerut Institute of engineering and technology, Meerut
Corresponding Id-jagbeer.singh@miet.ac.in

**Abstract**
Eyes are one of the fifth senses of the human body. It helps us to look around the environment in which we are living. But today our eyes have lost shine due to the effect of pollution due to various carcinogenic and chemicals present in the air other than this our eyes are getting highly affected by the access usage of screens like mobile phones, laptop, etc. Hence, facing this problem in our day to day life this retinify system is able to detect various diseases like cataract and glaucoma using machine learning based algorithms and modules of python like tkinter. With an aim of the software to determine the disease present in the retina. The module is being trained using the ResNet-50 Algorithm. The system works on the percentage of probability of one of the two diseases cataract and glaucoma. Based on the analysis of the retinal image via classifying into left and right retinoidal image. The system retinify software predict the accuracy of the diseases(cataract and glaucoma) by 90% which is more than the previously existed systems of eye disease detection.

**Keywords-** Convolutional Neural Network (CNN), Resnet50 Algorithm, Graphical User Interface (GUI), Cataract, Glaucoma, tkinter, Keras.

## 1. Introduction
In our ancient times, our diet and environment was clean and hence no disease was found but now a days both environment and diet has been affected in such a way that it has caught humans into the trap of diseases and illness due to which our current testing methods and technology which leads to the detection of age related macular degeneration, diabetic retinopathy, and glaucoma which are counted amongst the diseases with no early stage symptoms[1]. People has to understand the need for eye checkup is not just to make out your spectacle numbers but to have a regular eye check up with maximum accuracy made out after analyzing the input data and giving the best results containing optimized prescription so that one could act accordingly resulting in minimum damage to his eyes that is why early treatment becomes very necessary to prevent loss of sight.
There are many approaches prior to our project like eye disease recognition are found in the literature and detection of diabetic eye disease from retinal images, a survey on computer aided diagnosis for ocular disease[1].
According to latest researches, the new technologies are designed to tell sign of major blinding disease in retinal blood and tissue using PARS (Photo Acoustic Remote Sensing)[2]. In recent researches it has been

found that ophthalmologist can be assisted by AI in directly helps in accurate diagnosis with the help of integration of recently developed technologies. When applied, a visual field of examination was achieved detecting retinal and cornial abnormalities with the help of powerful classification[3].

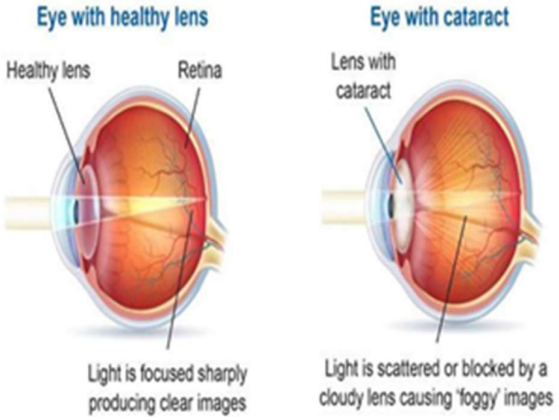



Fig.1 Eye Structure

According to the latest report issued by World Health Organisation, an estimation has been made which depicts that people getting blind due to glaucoma are 4.5 million and more than 94 million people are affected by cataract worldwide[4]. These are the leading cause of blindness and increasing progressively. There is currently no cure for glaucoma as early detection is critical hence once diagnosed in early stages may prevent from vision loss with medications and surgery and hence regular testing is very crucial by an eye specialist which is a standard eye exam including ophthalmoscopy[5]. Our software retinify has been trained on 80% data and been tested on 20% on it and using the Resnet50 algorithm with the CNN, it is able to detect Glaucomaor Cataract so that one can act accordingly in early stages of his disease. It also ensures of the best medication which can be taken by the patient and if he trust than this system also recommends a doctor nearby which makes the user more satisfy than any other system.

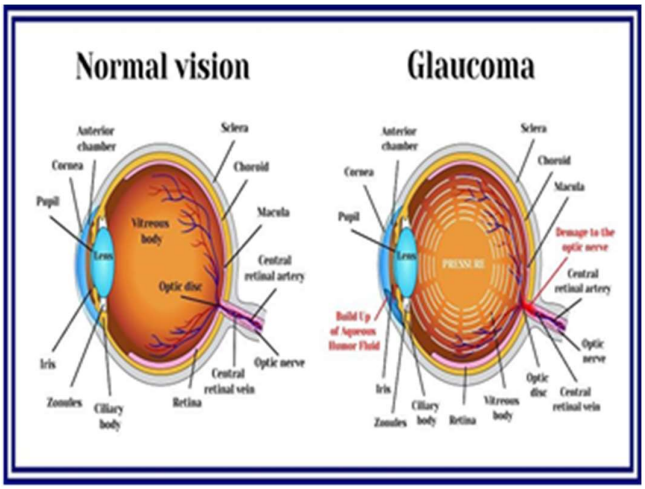



Fig.2

## 2. Literature Review

There are a lot of eye diseases from which some of them are left undetected while some are detected. In other words, the undetected diseases have less accuracy while the detected diseases can be predicted on the basis of percentage of accuracy. This project retinify takes the dataset of retinal images which in turn analyze and examine on the trained model using sequential model of CNN (convolutional neural network) via Resnet50 algorithm which in turn display the result accordingly with the inclination of dataset of medicine and doctors's recommendation on the basis of location.

According to the researches[6], it has been found that many Machine Learning models can predict the diseases not only of an eye but also other organs as well namely skin, diabetes etc. Although there are models[6] giving certain percent of accuracy but our system ensures profoundly on the type of disease as well as predicting it with higher rate of accuracy which seem to be challenging. In our system, an algorithm Resnet50 ensures to maintain the utility of this model.

We found out that few people has been researched on many types of eye disease with accuracy that can be further improved[7]. The diseases taken are cataract and glaucoma. If none of them are present then the person can be assumed as normal. It has been found that some eye diseases are the cause of genes carried by their forefathers from generation to generation like diabetic retinopathy while others may be caused due to the faulty lifestyle. This made it to be atmost important to have regular eye exam and treatment of the respective disease which may include medications, creams, eyedrops, lubricants or lifestyle changes.

We found out the future scope of it hence we chose this topic (eye disease detection)[8]. This software consists of four icons that are browse image of diseases, predict eye disease, tells about the disease and then exit option. This allows the user to browse the image from his system then software use image analysis to identify the type of disease. Then it display the result containing the predicted eye disease with the medications recommended by doctor and recommends the doctor based on locality according to the need of the user based on the dataset of the retinal eye taken from Kaggle (an online platform known for extraction of dataset) and the dataset in excel format containing the medicine specification and the other excel sheet containing the recommendation of doctor based on location. The retinal images of dataset consists of 14000 images of retina of eyes which consists of 10000 retinal images of cataract disease and 4000 images of Glaucoma retinal images so this dataset is very unequalize and hence it cannot predict the disease correctly like if a person has glaucoma but the system predict it to be cataract disease because it is more trained on cataract disease than the glaucoma disease and hence we need to equalize the dataset which consists of 7000 retinal images of cataract disease and 7000 retinal images of glaucoma. Now the system will predict the disease correctly.The future approach is simple, fast and efficient which does not require expensive equipments. Hence the system finally detects an eye disease successfully. The data has been manipulated in such a way that 80% of it is used in training the model while the remaining 20% for testing the same. The system predicts the disease with better accuracy and also provides specifications accordingly. Hence, satisfying all the requirements of the user in the accordance of the predicted disease.

## 3. Proposed Methodology

In this section, we describe about the general architecture of the model which represents the flow of the retinify system, module description describes the modules used in the retinify system, resnet50 algorithm is described below which is used in the system and then input/output screen is shown below.

a. General Architecture

In this paper, an automated eye disease detection system retinify is machine learning based project which is designed using tkinter module of python and developed using python programming language whereas Resnet50 is the algorithm that is used to train the model. As the following flowchart reveals the general architecture of the model which works in such a way that it starts by allowing the user to input the image using the browse option permitting the user from his system to browse the image then the system checks the quality of the image if it is not up to the mark then it will allow the user to again browse the image and if its quality is good then it does the preprocessing that consists of the following stages image filteration, image rotation and image segmentation leading to the match of compatibility in terms of size and quality with that of trained dataset and then finally predict the type of disease with medicine specification and doctor recommendation and if there is no disease in eye then it will display normal eye i.e. an eye with no disease. Lastly user can exit on clicking exit button and choosing the option yes to exit whereas no option will lead the user to home screen.

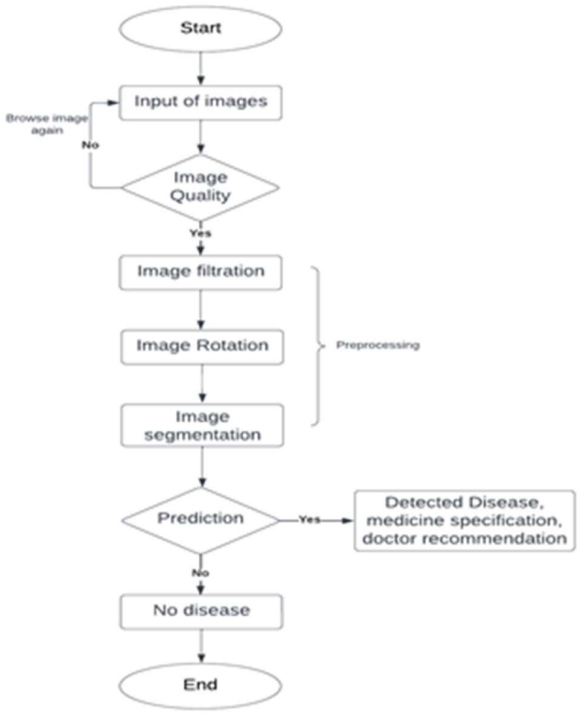



Fig.3

### b. Modules description

i. Tkinter module- Tkinter package is the default python interface. Mac OS as well as Windows machine supportTkinter. Tkwhich is the C implementation of the TcI package that includes new custom commands for generating and modifying GUI widgets. Tk is loaded into each Tk

object's embedded TcI interpreter instance[8]. The eye degree of customization offered by Tk's widgets comes at the expense of an antiquated design. To create a handle GUI events, Tk makes use of the TcI event queue.

ii.Pil module- It is the python imaging library. It is used to gain the utility in processing of image with the help of python interpreter.Various productive internal representation, and moderately potent image processing features can be achieved with a wide range of file format compatibility.

iii. Tensorflow- It is a free and open source library considered to be the most popular tool for machine learning, deep learning, artificial intelligence. It is basically compared with an array of one dimensional and a matrix of two dimension. Values contained in tensor are considered to be of same data types and shapes[9]. This library is basically used to trainedthe data. It also helps to develop data flow graphs depicting how data actually flows across the graph or the processing nodes.

iv.cv2-Used to solve computer vision problems. The method cv2.imread() is used to extract an image from the specified file and it returns the empty matrix in case the image can't be read due to improper permission, unsupported format or missing file [10]. Cv2 is a function of OpenCV which is used to read video. By passing 0 in the function parameter we can access our webcam.

v.pandas-This module ensures high performance data structures and tools for data analysis and proves to be of higher utility. When it comes for data science and analysis, pandas are preferred over numpy. The data frame is a primary data structure. To store and manage tabular data can be done by this.

vi. Matplotlib-Matplotlib is a cross platform, data visualization, graphical charting package. A strong open source substitute for MATLAB is presented by this module[11]. To create a visual data plot in majority of cases with just few lines of code can be achieved with the help of this module. The matplotlib scripting layer provide two API's.

vii.numpy-Numpy on numerical python contains multi-dimensional array objects and also provides a selection of procedures for handling those arrays[12]. It is a python programming language library which is specially designed to help with the data work.

Cataract

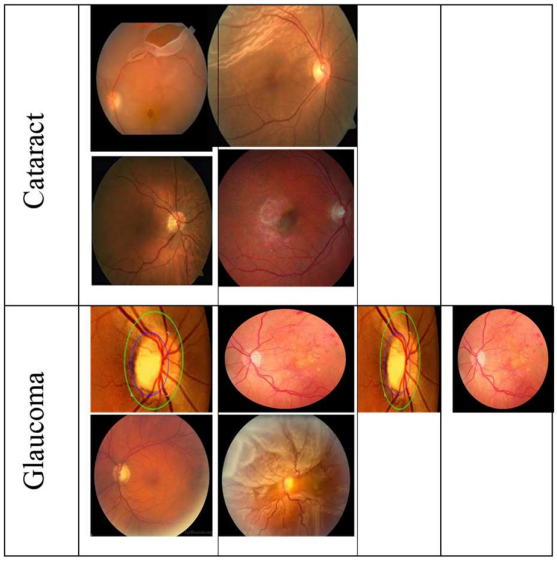
Glaucoma

viii.geocoder- It is one of the python library used by google providing geocoding services which has distinct JSON effects amongst each other[13]. Its primary function is to represent the location by grabbing IP address and converting them to give the locations.

ix.keras- It is considered to be a library of neural network of open source written in python found to be present on top of tensorflow. It is restricted from dealing with low level computation and so uses another library to do the same termed as backend[14]. Our models can be made combined with layers, definitions and setting up numerous input output models.

x.globe-We may use the many building python module to execute a variety of jobs that include searching and locating all files on our system which follows a similar pattern[15]. With the assistance of python globe module one can find all path names searching for file matching a defined pattern where the definition is given by user by following the rules made by unique shell.

xi.os- Python os module enables to make interactions amongst the user and operating system. Many importantos functions made to exhibit os based task and received information about operating system related to it with the help of this os module. It is counted to be a part of python's standard utility modules[16]. It provides an operating system which is portable and is dependent on its functionality.




**a. Algorithm used- ResNet-50 Algorithm**

ResNet known for Residual Network which is the type of convolutional neural network, HeKaiming, Zhang Xiangyu, RenShaoqing, and Sun Jian's2015 study "Deep Residual Learning for Image Recognition" develop the convolution neural network (CNN) variant called ResNet. Applications using computer vision frequently used CNNs[17]. A 50 layer convolutional neural network is called Resnet50 which consists of 48 convolutional layers, one max pool layer and one average pool layer as shown in fig.5. Artificial neural network that used residual blocks to build networks are known as residual neural network.

As listed in fig.6, the 50 layer ResNet design consists of the following components19]:

A convolution of 77 kernel with a two-sized stride and 64 additional kernels. with a maximum pooling layer a stride of two size.

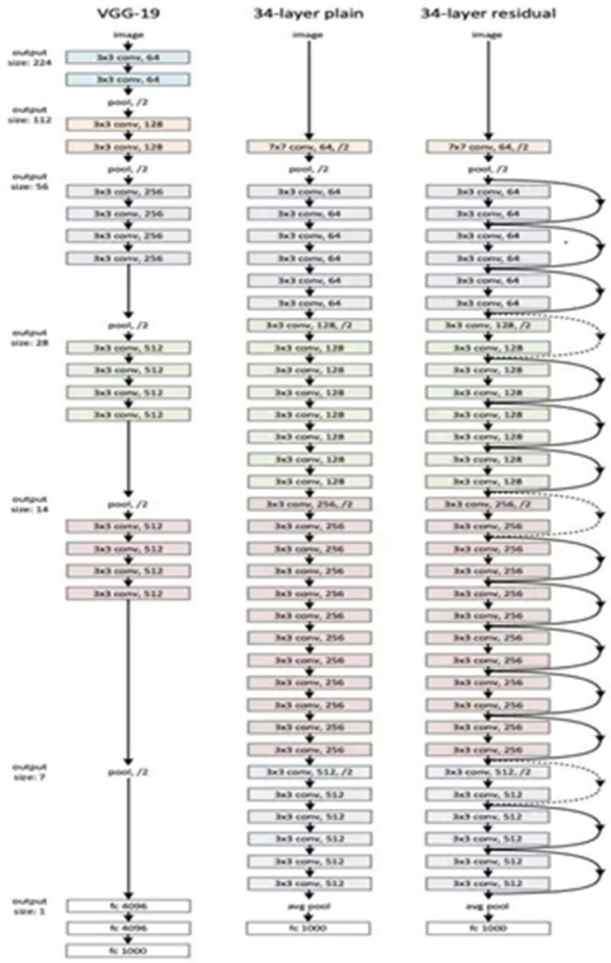



Fig.5

Unique qualities of ResNet-50:

Fig.5 shows the architecture concept of ResNet50 with one significant exception. The 50-layer ResNet uses the bottleneck building block[18]. A bottleneck residual block also referred to as a "Bottleneck", uses 11 convolutions to cut down on the number of parameters and matrix multiplications. This makes each layers training significantly faster. It employs three layers instead of using a stack of two levels,

9 more layers total 3x3,64 kernels convolution levels, 1x1,64 kernels layers, and one by 1,256 kernel layers repeating these layers three times.

12 layers of 1x128 kernels, 3x3,128 kernels, 1x1,512 kernels repeating 4 times.

18 layers having 1x1,256 cores with two of 3x3,256 and 1x1,1024 repeating 6 times.

9 layers of 1x1,512, 3x3,512, 1x12,048 cores respectively repeating 3 times (up to this 50 layers are found of networks).

| layer name | output size | 18-layer | 34-layer | 50-layer | 101-layer | 152-layer |
|---|---|---|---|---|---|---|
| conv1 | 112×112 | 7×7, 64, stride 2 | | | | |
| conv2_x | 56×56 | 3×3 max pool, stride 2 | | | | |
| | | $\begin{bmatrix} 3\times3, 64 \\ 3\times3, 64 \end{bmatrix} \times 2$ | $\begin{bmatrix} 3\times3, 64 \\ 3\times3, 64 \end{bmatrix} \times 3$ | $\begin{bmatrix} 1\times1, 64 \\ 3\times3, 64 \\ 1\times1, 256 \end{bmatrix} \times 3$ | $\begin{bmatrix} 1\times1, 64 \\ 3\times3, 64 \\ 1\times1, 256 \end{bmatrix} \times 3$ | $\begin{bmatrix} 1\times1, 64 \\ 3\times3, 64 \\ 1\times1, 256 \end{bmatrix} \times 3$ |
| conv3_x | 28×28 | $\begin{bmatrix} 3\times3, 128 \\ 3\times3, 128 \end{bmatrix} \times 2$ | $\begin{bmatrix} 3\times3, 128 \\ 3\times3, 128 \end{bmatrix} \times 4$ | $\begin{bmatrix} 1\times1, 128 \\ 3\times3, 128 \\ 1\times1, 512 \end{bmatrix} \times 4$ | $\begin{bmatrix} 1\times1, 128 \\ 3\times3, 128 \\ 1\times1, 512 \end{bmatrix} \times 4$ | $\begin{bmatrix} 1\times1, 128 \\ 3\times3, 128 \\ 1\times1, 512 \end{bmatrix} \times 8$ |
| conv4_x | 14×14 | $\begin{bmatrix} 3\times3, 256 \\ 3\times3, 256 \end{bmatrix} \times 2$ | $\begin{bmatrix} 3\times3, 256 \\ 3\times3, 256 \end{bmatrix} \times 6$ | $\begin{bmatrix} 1\times1, 256 \\ 3\times3, 256 \\ 1\times1, 1024 \end{bmatrix} \times 6$ | $\begin{bmatrix} 1\times1, 256 \\ 3\times3, 256 \\ 1\times1, 1024 \end{bmatrix} \times 23$ | $\begin{bmatrix} 1\times1, 256 \\ 3\times3, 256 \\ 1\times1, 1024 \end{bmatrix} \times 36$ |
| conv5_x | 7×7 | $\begin{bmatrix} 3\times3, 512 \\ 3\times3, 512 \end{bmatrix} \times 2$ | $\begin{bmatrix} 3\times3, 512 \\ 3\times3, 512 \end{bmatrix} \times 3$ | $\begin{bmatrix} 1\times1, 512 \\ 3\times3, 512 \\ 1\times1, 2048 \end{bmatrix} \times 3$ | $\begin{bmatrix} 1\times1, 512 \\ 3\times3, 512 \\ 1\times1, 2048 \end{bmatrix} \times 3$ | $\begin{bmatrix} 1\times1, 512 \\ 3\times3, 512 \\ 1\times1, 2048 \end{bmatrix} \times 3$ |
| | 1×1 | average pool, 1000-d fc, softmax | | | | |
| FLOPs | | $1.8\times10^9$ | $3.6\times10^9$ | $3.8\times10^9$ | $7.6\times10^9$ | $11.3\times10^9$ |

Fig.6

d. Input / Output Screens

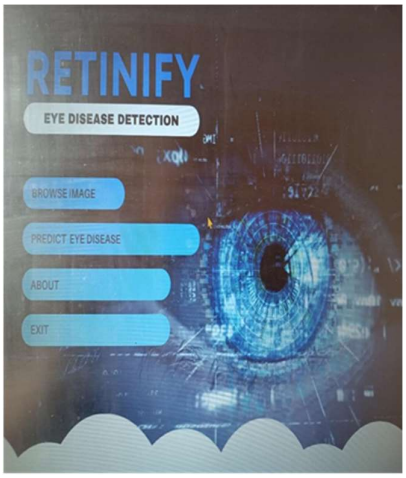



Fig.7

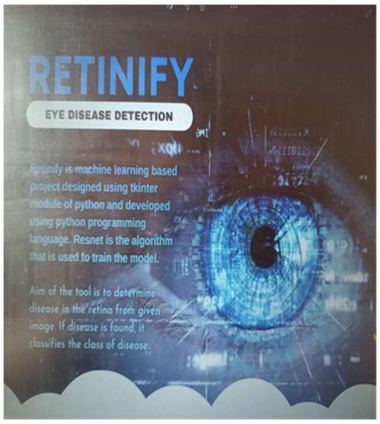



Fig.8

Input Screen

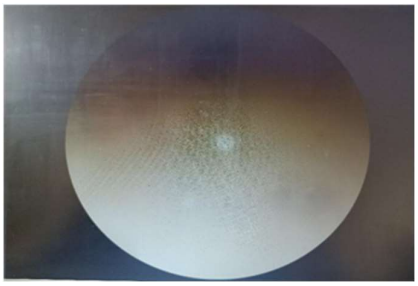


Fig.9
Output Screen

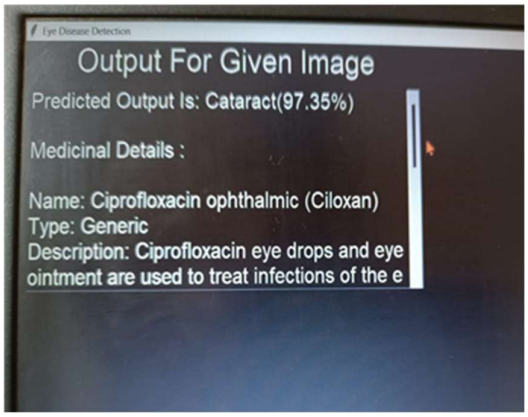



Fig.10(a)

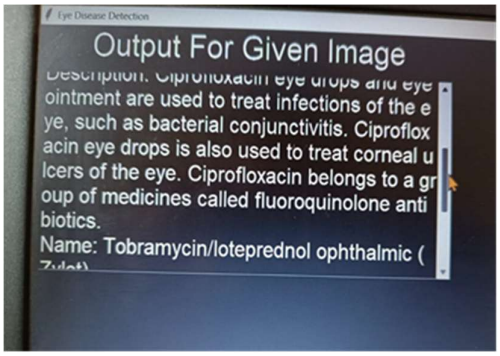



Fig.10(b)

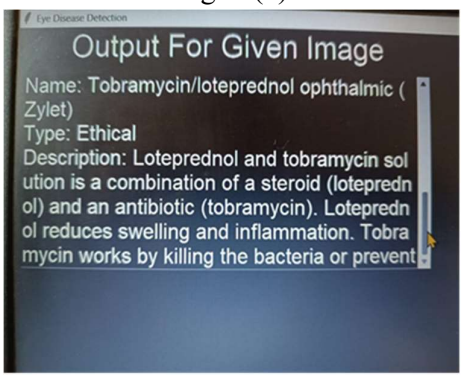



Fig.10(c)

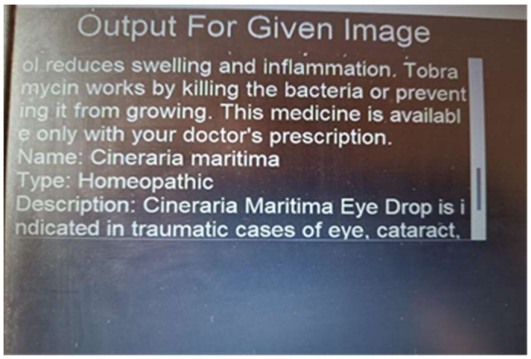



Fig.10 (d)

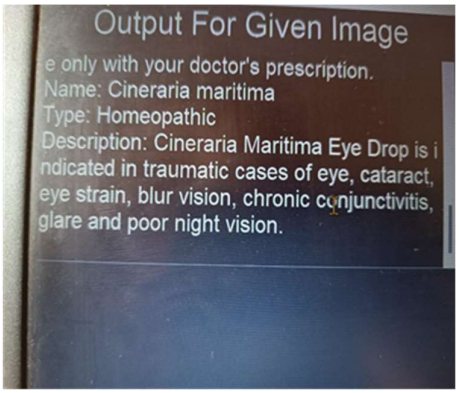



Fig.10(e)

Input Screen

Fig.11

Output Screen

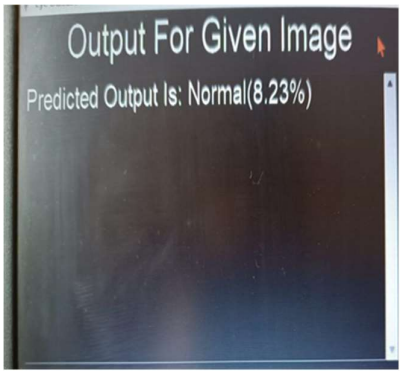



Fig.12

## 4. Experimental Result Discussion

This experiment took place on a system with the following properties Intel core i5, 10351CPU, 8GB RAM, and with combination of Keras and Tensorflow at the backend of it. Every model's output was processed with the help of open CV and python. Our dataset on which we have trained our model consists of 14000 images containing all the three type of images that are cataract, glaucoma and normal eye as shown in Table 1.

**Table 1: Statistics of image dataset**

| Images | Number of images |
|---|---|
| Cataract | 7000 |
| Glaucoma | 7000 |
| Total | 14000 |

We performed comparative experiments for the successful recognition of eye disease with the help of ResNet-50 algorithm. Another term for CNN (convolutional neural network) performing task as a model sequential[20].

It was made in such a manner that 80% of the dataset helped us to train the model while 20% of it was used for testing the same.

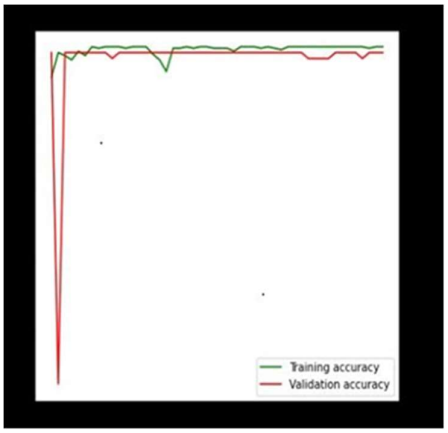



Fig.13

Validation accuracy:It is considered to be the process of calculating the performance efficiency of model. It is really very important to validate it taking into consideration the aspects and components before including them into the actual ecosystem of production. It comes out to be 0.9672130942344666 for our software retinify as shown in fig 13.

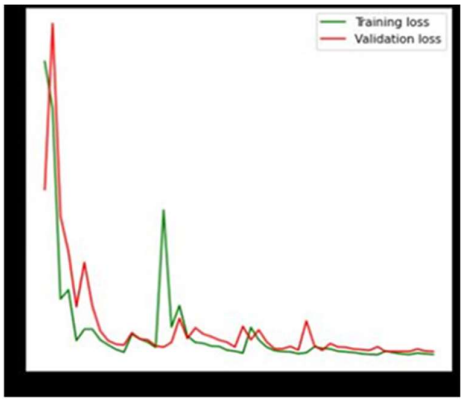



Fig.14

Validation loss:ML model's performance on the validation set is evaluated using the metric of validation loss. The dataset's validation set is a section set assigned to check model's efficacy. Similar to the training loss, the validation loss is determined by adding the errors for each sample in the validation set. It comes out to be 0.20418578386306763 as shown in fig. 14.

| | Actual Class: Positive | Actual Class: Negative | Predicted Class |
|---|---|---|---|
| Positive | True Positive(TP) | False Negative(FN) Type 2 Error | Sensitivity TP/(TP+FN) |
| Negative | False Positive(FP) Type 1 Error | True Negative(TN) | Specificity TN/(TN+FP) |
| | Precision TP/(TP+FP) | Negative Predictive Value TN/(TN+FN) | Accuracy (TP+TN)/(TP +TN+FP+FN) |

Table 2

True Positive: The observation and prediction are both positive.
False Negative: Positive observation with an anticipated negative outcome.
False Positive:When an observation is negative but the result predicted is positive.
True Negative:The observation and prediction are both negative.

| | Precision | recall | f1-score | support |
|---|---|---|---|---|
| Cataract | 0.00 | 0.00 | 0.00 | 1 |
| Normal | 0.98 | 0.98 | 0.98 | 60 |
| Accuracy | | | 0.97 | 61 |
| macro average | 0.49 | 0.49 | 0.49 | 61 |
| Weighted average | 0.97 | 0.97 | 0.97 | 61 |

Table 3

## 5. Conclusion

In this paper, we proposed the software retinify used for eye disease (cataract and glaucoma) detection providing the freedom to the user to browse the image from the system and predict the disease present. In this process, we have trained our model on 14000 images of dataset taken from kaggle. The data has been processed in such a way that it consists of 80% of training dataset and 20% for testing it. Other than that the results shown to the user consists of the predicted eye disease with medicine specification and doctor recommendation based on the location of the user besides this the dataset for medicine and doctor are in the form of excel sheets which allows the developer to trained on as much data as one wants.

For a significant increment in the efficiency and accuracy of the system which is calculated to be 90% by using ResNet-50 algorithm and many python modules like tkinter, tensorflow, geocoder, cv2, pandas, numpy, matplotlib, etc. made a successful machine learning based project with accurate and correct results differentiating it from other models. The already existing systems of eye disease detection has accuracy of 88% or 89% which is less than our software retinify. Hence, it predicts the disease with higher accuracy than any other system[20].

## 6.References

[1] Zhao, R.; Chen, X.; Liu, X.; Chen, Z.; Guo, F.; Li, S. Direct Cup-to-Disc Ratio Estimation for Glaucoma Screening via Semi-Supervised Learning. IEEE J. Biomed. Health Inform. 2020, 24, 1104–1113

[2] Gunay M, Goceri E, Danisman T. Automated detection of adenoviral conjunctivitis disease from facial images using machine learning. In: 2015 IEEE 14th International Conference on Machine Learning and Applications; Miami, FL, USA; 2015. pp. 1204-1209. doi: 10.1109/ICMLA.2015.232

[3] Narayan, Vipul, et al. "To Implement a Web Page using Thread in Java." (2017).

[4]Dalal N, Triggs B. Histograms of oriented gradients for human detection. In: 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition; San Diego, CA, USA; 2005. pp. 1-20. doi: 10.1109/CVPR.2005.177

[5] Rajkumar N, Jaganathan P. A new RBF kernel based learning method applied to multiclass dermatology diseases classification. In: 2013 IEEE Conference on Information & Communication Technologies; Thuckalay, India; 2013. pp. 551-556. doi: 10.1109/CICT.2013.6558156

[6] Moore B. Principal component analysis in linear systems: controllability, observability, and model reduction. In: IEEE Transactions on Automatic Control 1981; 26 (1): 17-32. doi: 10.1109/TAC.1981.1102568

[7] Sagonas C, Tzimiropoulos G, Zafeiriou S, Pantic M. A semi-automatic methodology for facial landmark annotation. In: CVPRW '13 Proceedings of the 2013 IEEE Conference on Computer Vision and Pattern Recognition Workshops; Washington, DC, USA; 2013. pp. 896-903. doi: 10.1109/CVPRW.2013.132

[8] Irfan, Daniyal, et al. "Prediction of Quality Food Sale in Mart Using the AI-Based TOR Method." Journal of Food Quality 2022 (2022).

[9]Yang, P.; Xiong, N.; Ren, J. Data Security and Privacy Protection for Cloud Storage: A Survey. IEEE Access 2020, 8, 131723–131740

[10] Qi, L.; Hu, C.; Zhang, X.; Khosravi, M.R.; Sharma, S.; Pang, S.; Wang, T. Privacy-Aware Data Fusion and Prediction with Spatial-Temporal Context for Smart City Industrial Environment. IEEE Trans. Ind. Inf. 2020, 17, 4159–4167

[11] Sivaswamy, J.; Krishnadas, S.R.; Datt Joshi, G.; Jain, M.; Syed Tabish, A.U. Drishti-GS: Retinal Image Dataset for Optic Nerve Head(ONH) Segmentation. In Proceedings of the 2014 IEEE 11th International Symposium on Biomedical Imaging, Beijing, China, 29 April–2 May 2014; pp. 53–56

[12] Lowell, J.; Hunter, A.; Steel, D.; Basu, A.; Ryder, R.; Fletcher, E.; Kennedy, L. Optic Nerve Head Segmentation. IEEE Trans. Med. Imaging 2004, 23, 256–264

[13] Pramanik, Sabyasachi, et al. "A novel approach using steganography and cryptography in business intelligence." Integration Challenges for Analytics, Business Intelligence, and Data Mining. IGI Global, 2021. 192-217.

[14] Fu, H.; Cheng, J.; Xu, Y.; Zhang, C.; Wong, D.W.K.; Cao, X. Disc-Aware Ensemble Network for Glaucoma Screening From Fundus Image. IEEE Trans. Med. Imaging 2018, 37, 2493–2501.

[15] Mall, Pawan Kumar, et al. "FuzzyNet-Based Modelling Smart Traffic System in Smart Cities Using Deep Learning Models." Handbook of Research on Data-Driven Mathematical Modeling in Smart Cities. IGI Global, 2023. 76-95.
[16] Gao X, Lin S, Wong TY. Automatic feature learning to grade nuclear cataracts based on deep learning. IEEE Transactions on Biomedical Engineering 2015; 62: 2693-2701. doi: 10.1109/TBME.2015.2444389
[17] Sawhney, Rahul, et al. "A comparative assessment of artificial intelligence models used for early prediction and evaluation of chronic kidney disease." Decision Analytics Journal 6 (2023): 100169.
[18] Sun, X.; Xu, Y.; Zhao, W.; You, T.; Liu, J. Optic Disc Segmentation from Retinal Fundus Images via Deep Object Detection Networks.Proceedings of 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society , Honolulu, USA, 18–21 July 2018; pp. 5954–5957.
[19] Diaz-Pinto, A.; Colomer, A.; Naranjo, V.; Morales, S.; Xu, Y.; Frangi, A.F. Retinal Image Synthesis and Semi-Supervised Learning for Glaucoma Assessment. IEEE Trans. Med. Imaging 2019, 38, 2211–2218
[20] Srivastava, Swapnita, et al. "An Ensemble Learning Approach For Chronic Kidney Disease Classification." Journal of Pharmaceutical Negative Results (2022): 2401-2409.