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Cataract Detection Using Deep Learning

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ABSTRACT
The human eye is a fundamental organ of perception, as is common knowledge. The components of the eye that are interrelated are the iris, pupil, lens, retina, cornea, and optic nerve. According to the World Health Organization (WHO), there are currently at least 2.2 billion blind or visually impaired individuals in the globe. Fuzzy vision is the main symptom of a cataract, one of the most common eye conditions that can cause blindness. Although it rarely affects new borns, cataract is an age-related eye disorder whose incidence rate rises with age. Cataracts develop when protein build up results in the lens of the eye becoming cloudy. Early detection and rapid treatment can significantly reduce the risk of becoming blind. Deep learning methods, such as the Mobile net, CNN algorithm, and VGG 16 models, will be applied in the proposed model. People will benefit from the suggested method by being able to recognize and anticipate cataracts.

Keywords: Convolutional neural network (CNN), Deep learning, VGG-16, and Mobile Net.

INTRODUCTION

The most important organ in our body that also serves as our organ of signals is the human eye. The eye functions somewhat like a camera. The human eye's eyeball is spherical. The eyeball has a 2.3cm diameter. It is made up of a problematic fibrous membrane known as the sclerotic coat, which guards the inner workings of the eye. The eyeballs are the spherical structure that make up the eye. The many muscular unit related to the eyes, which are joined to the eye socket, is known as the eye muscles.

The condition known as a cataract is brought on by the development of hazy patches on the eye's lens. It will result in the lens losing its transparency and developing yellow or brown spots, which will reduce or completely impair vision. In general, proteins help eye lenses function perfectly, but an excess of proteins can lead to this condition. Late diagnosis is the main cause of cataract illness. If people are not sufficiently informed about them, some common eye illnesses might occasionally pose a serious threat. It is a lenticular opacity condition that typically leads to poor visual perception of the item or other entity being observed. Early detection and treatment of cataract disease will stop the development of visual abnormalities. According to WHO, cataracts were discovered in about half of all blind individuals.

Severity or symptoms After being diagnosed with cataracts, many patients typically put off having them removed for a couple of years.

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However, they should be aware that as time passes, the severity of the condition worsens. Additionally, because the lens that directs light onto the area of the retina in the eye for precise vision is sensitive, it was important to improve the pre-identification phase in cataract anomalies. Additionally, the lens modifies the eye's focus in order to change the rate of vision for observing both distant and nearer objects or entities. As they age, some people's eye proteins unintentionally mix with other protein particles to generate small patches of cloud structure in the lens of the eye. The nature of the lens gradually becomes opaque.

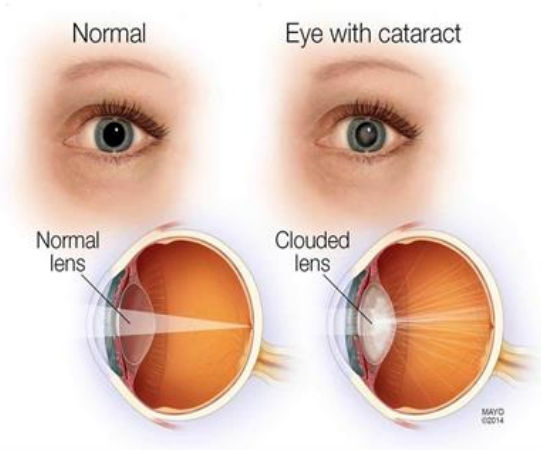

Fig 1:Comparing Normal eye with Cataract eye

LITERATURE SURVEY:

[1] Md. Ashikul Aziz Siddique1 , Jannatul Ferdouse1 , Md. Tarek Habib1 , Md. Jueal Mia1,Mohammad Shorif Uddin(2022),"Convolutional Neural Network Modeling for Eye Disease Recognition" iJOE – Vol. 18.

An osteopathic expert system that can handle an image of the eye and identify the condition is proposed in the research. To identify the disorders, they employed six CNN models: VGG16, VGG19, MoblieNet, Xception, InceptionV3, and Densenet 21. They gathered four different sorts of photographs, three of which were of disorders and one of which was of a normal eye. They focused on the three disorders chalazion, squint, and cataract. To determine which model was the best, they assessed the performance-related criteria accuracy, precision, recall, and F1score. 80% of the data are from training, while 20% are from testing. For the training dataset, they used six pre-trained models. They employed the adam and RMS prop optimizers to lower the error rate. These were crucial in reducing the errors Mobile Net performed well across all of these algorithms, with an accuracy of 97.49%.

[2] Halit BAKIR1, Şahin YILMAZ(2022),"Using Transfer Learning Technique as a Feature Extraction Phase for Diagnosis of Cataract Disease in the eye", Sivas University of Science and Technology, Department of Computer Engineering, Sivas.

One of the most vital organs for maintaining daily life is the eye. Therefore, preventing blindness brought on by eye disorders is effective and affordable with early detection of ocular disease. In this study, a deep learning model has been put out for using retinal fundus images to detect cataract illness. Retinal fundus photos total 6392 images. The algorithms employed include MobileNet, InceptionV3, Resnet, and VGG 16. The well-known deep learning model

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ResNet was employed in the suggested model's feature extraction phase to achieve the highest results, which were high detection accuracy results that reached 95.51%. 80% of the data are used for training, and 20% are used for testing Adam is an optimization algorithm and the sigmoid activation function is employed. ResNet's accuracy in these methods is 95%.

[3]JingRan,KaiNiu,ZhiqiangHe,HongyanZhang,HongxinSong(2018)IEEE,"Cataract detection and grading based on combination of DCNN and Random forest", Beijing University of Posts and Telecommunications, Beijing 100876, China.

They added that a recent analysis predicts that there would be 273.1 million people with moderate or severe vision impairment and 38.5 million people who will be blind by the year 2020. In this paper, a method for assessing cataracts on a six-level scale using a Deep Convolutional Neural Network (DCNN) and Random Forests (RF) is proposed. Ophthalmologists have a difficult time diagnosing cataracts because the condition takes a long time to develop and there aren't enough specialists. A1 assists in cataract diagnosis. A specific type of fundus camera records fundus images.Images undergo preprocessing to remove all the noise. On the extracted feature datasets, cataract grading is finished using DCNN and RF grader. The primary topic of this essay is cataract surgery. Grading is made on a six-level scale. Finally, this exhibits superior performance to cataract grading on four levels. There is a 90.69% accuracy.

[4] Linglin Zhanga, Jianqiang Lia , i Zhangb , He Hana , Bo Liua , Jijiang Yangc(2017)IEEE, "Automatic Cataract Detection And Grading Using Deep Convolutional Neural Network", Research Institute of Information Technology, Tsinghua University, Beijing, China.

The DCNN is responsible for feature extraction. This suggested DCNN classification system has undergone cross validation on up to 5620 clinical fundus images from hospitals that are population-based and were collected. 1) The interface of local uneven illustration and the reflection of the eyes were removed by using the retinal fundus in this. DCNN carries it out. 2) The accuracy of the DCNN increased from 86 to 93.5% with the increase in the number of samples. Non-cataractous, mild, moderate, and severe are the ratings they employed. The process is composed of two steps: combining fundus photos and erasing patient data. then removing uneven lighting. This technique makes use of RGB-colored photos.

[5]A.Sirajudeen, Anuradha balasubramaniam, Dr.S.Karthikeyan(2021), "Detection of Cataract Through Feature Extraction by the Novel Angular Binary Pattern (NABP) and Classification by Kernel Based Convolutional Neural Networks" Professor, Aurora's Scientific & Technological Institute, Ghatkesar, India.

In this study, the image processing technology is used to detect cataract disease. Separate features are retrieved for colour, texture, and shape. The Novel Angular

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Binary Pattern (NABP) for the extraction of texture features was suggested in this study. Following the feature extraction, the images are then classified using the innovative Kernel Based Convolutional Neural Networks that have been suggested. 97% of the time, this system is accurate.

METHODOLOGY:

The methodology of the project involves the following algorithms

- CNN (Convolutional neural networks
- VGG-16
- Mobile Net

CNN ALGORITHM:

Convolutional neural networks are a form of artificial neural networks used most frequently in deep learning to analyse visual images. A neural network called a CNN may find important information in both time series and picture data. The three levels of the CNN algorithm are

- Convolution layer
- Pooling layer
- Fully connected layer.

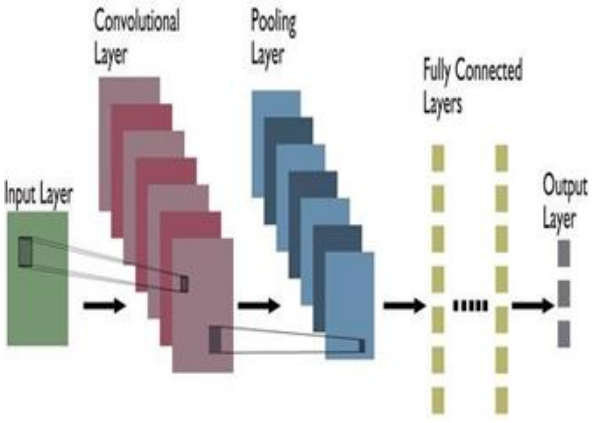

Fig 2 Architecture of CNN

VGG-16 ALGORITHM:

In this case, the 16 in VGG-16 stands for 16 layers with weights. Thirteen convolutional layers, five maximum pooling layers, and three dense layers make up VGG-16's total of 21 layers, but only sixteen of those levels or its learnable layers are weight layers. It is an object detection and classification system that can identify objects in 1000 photos and categorize them into 1000 separate groups. One of the top computer vision models to date is the VGG16 model of the CNN (Convolutional Neural Network). An image with three channels R, G, and Band a fixed size of 224 by 224 is taken as the input

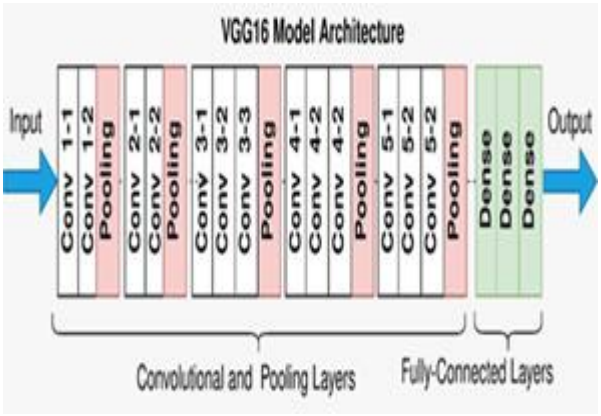

Fig 3 layers of VGG-16

MOBILE NET MODEL:

The CNN model called Mobile Net was created specifically for usage in mobile apps. In terms of object detection, Mobile Net is quite efficient. It is a simplified architecture that creates light weight deep convolutional neural networks using depth-wise separable convolutions and offers a useful model for embedded and mobile vision applications. Two processes are combined to create a depth wise separable convolution.

1)Depth wise convolution.

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2)Pointwise convolution

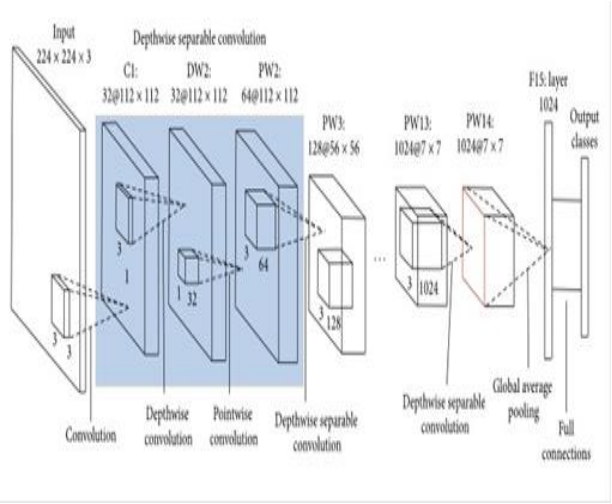

Fig 4 Mobile net Architecture

DATASET:

The dataset, titled "Ocular illness recognition dataset," was taken from the Kaggle website. A organized ophthalmic database of 5,000 individuals containing age, color fundus images of the left and right eyes, and diagnostic keywords from doctors is called Ocular Disease Intelligent Recognition (ODIR). Patients are categorized according to eight labels, including "normal," "diabetes," "glaucoma," "glaucoma with cataracts," "age-related macular degeneration," "hypertension," "pathological myopia," and "other diseases/abnormalities" (O).

SAMPLE SET OF OUR DATASET

ID	Patient Age	Patient Sex	Left-Fundus	Right-Fundus	Left-Diagnostic Keywords	Right-Diagnostic Keywords	N	D	G	C	A	H	M	O
0	0	69	Female	0_left.jpg	0_right.jpg	cataract	normal fundus	0	0	0	1	0	0	0	0
1	1	57	Male	1_left.jpg	1_right.jpg	normal fundus	normal fundus	1	0	0	0	0	0	0	0
2	2	42	Male	2_left.jpg	2_right.jpg	laser spot, moderate non proliferative retinopathy	moderate non proliferative retinopathy	0	1	0	0	0	0	0	1
3	3	66	Male	3_left.jpg	3_right.jpg	normal fundus	branch retinal artery occlusion	0	0	0	0	0	0	0	1
4	4	53	Male	4_left.jpg	4_right.jpg	macular epiretinal membrane	mild nonproliferative retinopathy	0	1	0	0	0	0	0	1

SAMPLE IMAGES

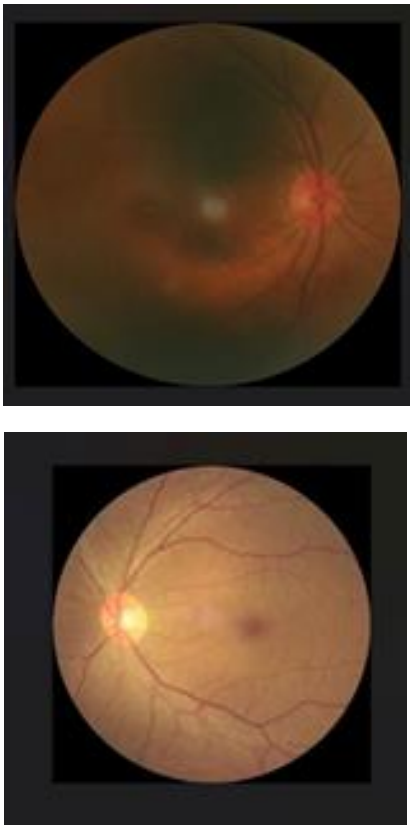

Fig 5 Sample images

DESIGN

The process of defining a system's constituent parts, including as its architecture, modules, and components, as well as its many interfaces and the data it processes, is known as system design. It is designed to meet certain goals and requirements of a company or organization by creating a system that is cohesive and efficient.The acronym for a data flow diagram is DFD. DFD represents the data flow of a system or process. It also sheds light on each entity's inputs, outputs, and the process itself. There are no loops, decision rules, or control flows in DFD. A flowchart can describe specific operations depending

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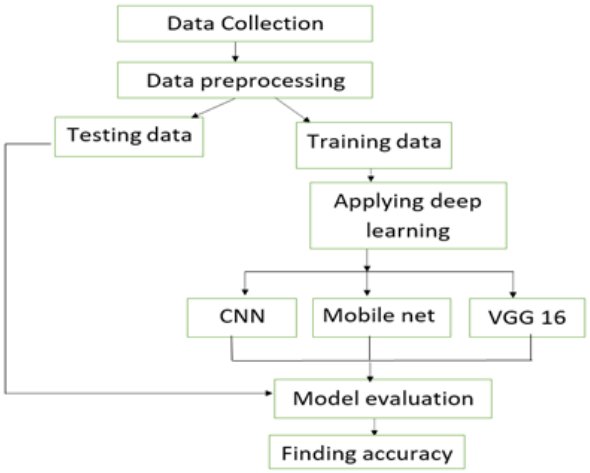
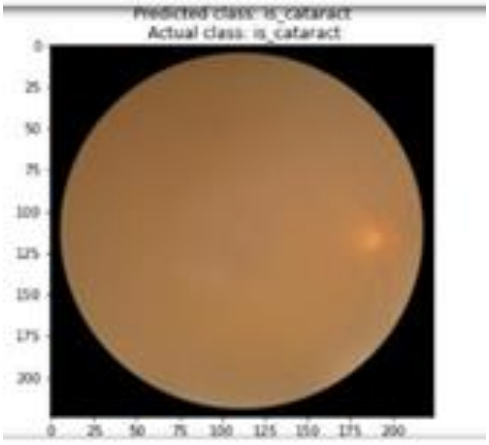
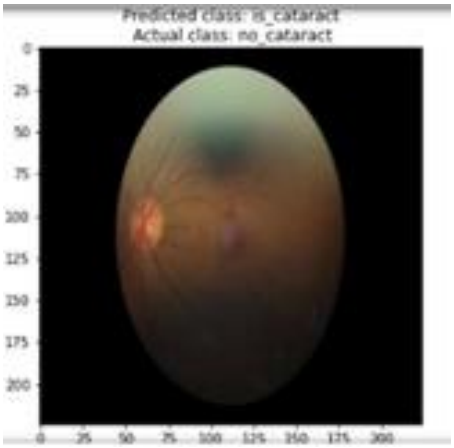
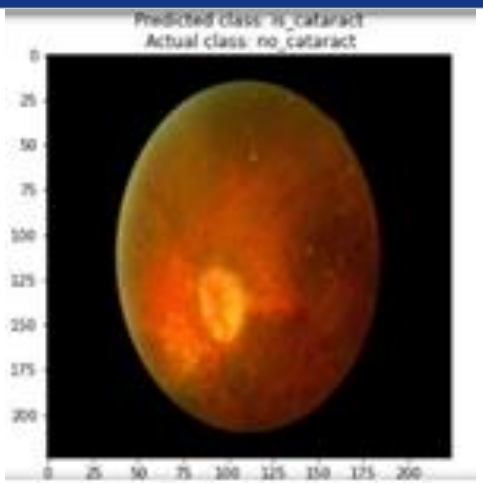
on the type of data. There are various ways to represent a data flow diagram. The data flow diagram for the cataract detection system is shown in the diagram below.

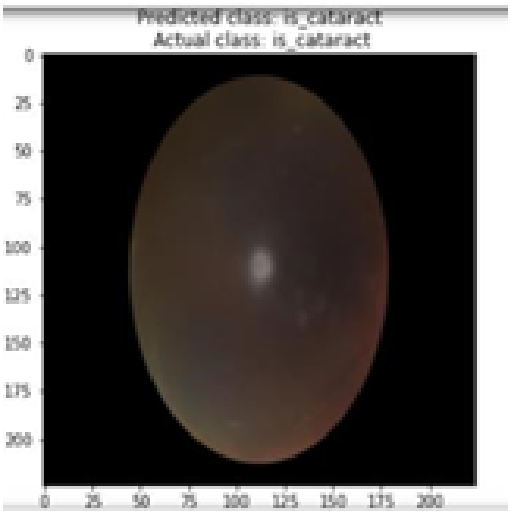


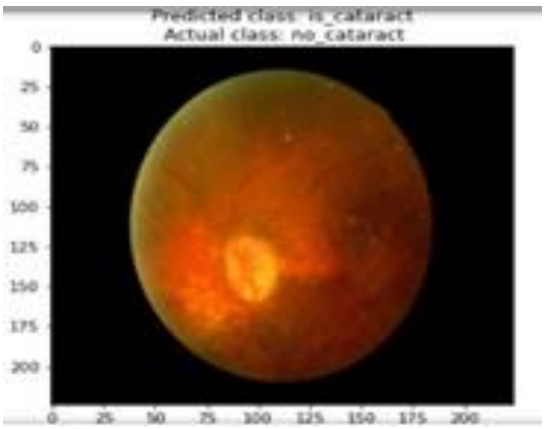
RESULTS











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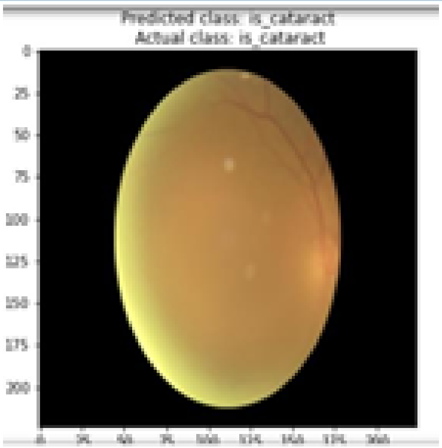
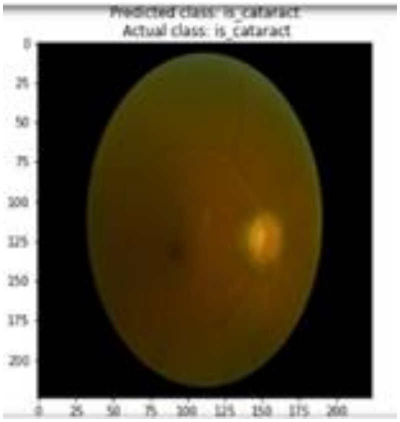
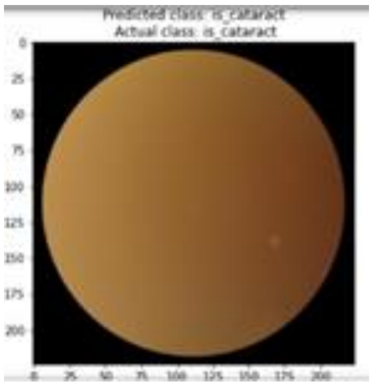
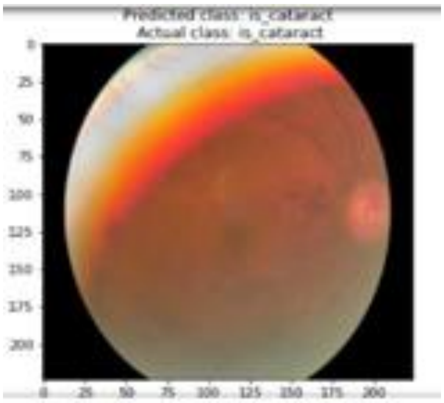








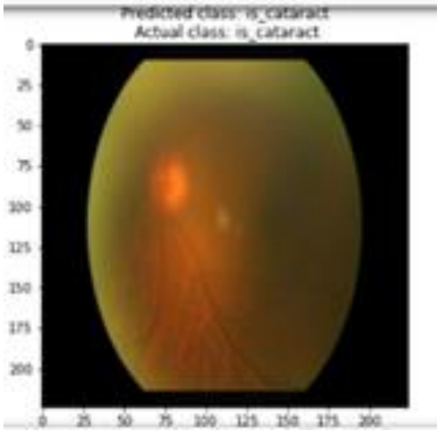
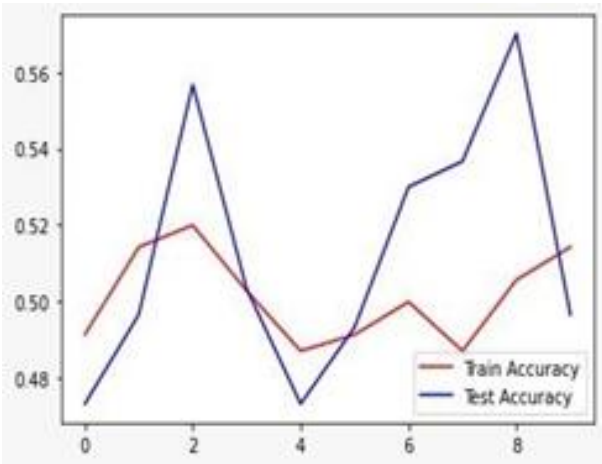
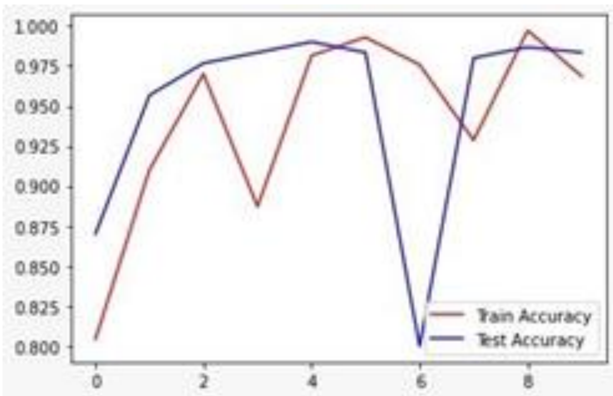


Fig 6 Output images

PLOTS





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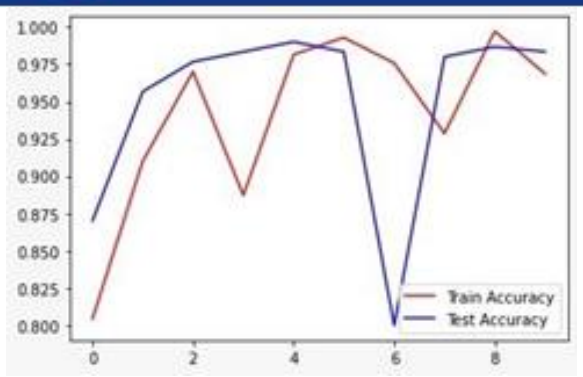

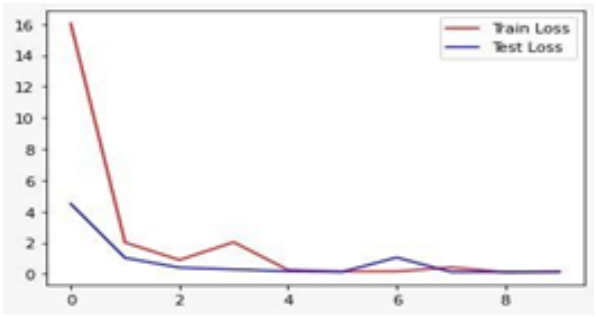

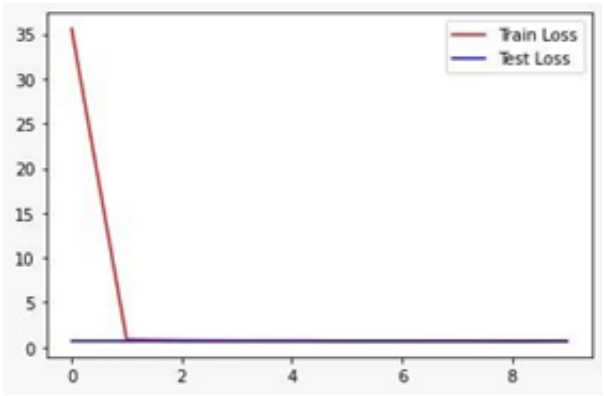

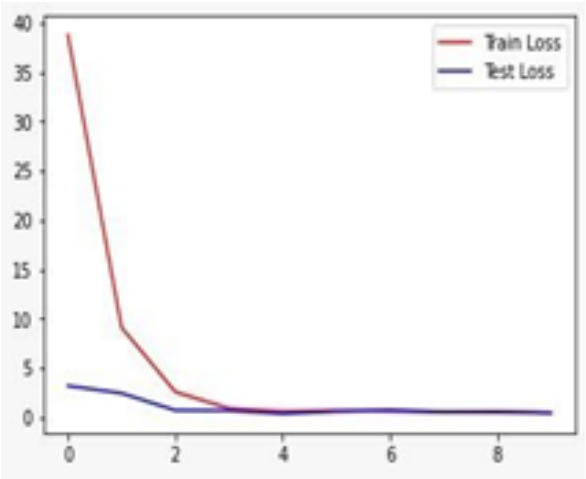

Fig 7 plots of accuracy and loss

ACCURACY TABLE

SNO	ALGORITHM NAME	PERCENTAGE
1	Convolutional neural network	49.6%
2	VGG 16	98.3%
3	Mobile Net	76.6%

CONCLUSION:

Eye diseases are the most common diseases and also dangerous diseases. The early interventionand timely treatment can largely avoid blindness. We initially started referring the paper and we came to know that cataract is one of the eye diseases and have the chance of losing the eye sight. This inspires us to take up the project and work on it. For the detection and prediction ofmodel we included three algorithms named Cnn,Vgg-16,Mobilenet. But after the analysis we came to know that VGG-16 algorithm gave best performance with the accuracy of 98.3 percentage. Finally, we can say that our model can predict the cataract disease properly and help to the many people. Finally, our work is contributed to the cataract eye disease detection we hope this model may help the people with better diagnosis for their eyes.

Further we are going to continue and present updates in this cataract detection system.

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