A WEB APP FOR CATARACT CLASSIFIER

1. Introduction

Cataract is one of the most common eye disorders that causes vision distortion. Accurate and timely detection of cataracts is the best way to control the risk and avoid blindness [1]. There are different works done for developing Artificial Intelligence models for classifying cataracts [2],[3],[4],[5],[6]. In this paper,an AI model for classifying cataracts using MobilenetV2, is proposed for automatic cataract detection. MobilenetV2 is known for its simplicity and especially developed for mobile devices with lower resource capabilities.The Learning rate and no of epochs are tuned to train the network. The proposed network is optimised with the Adam optimizer. A total of 641 cataract and non-cataract images are collected to train the model.Experimental results prove that the proposed AI model detects cataracts with an average accuracy of 96%.

2. Related Work

There may be many reasons for visual impairment. According to a study by WHO 2.2 billion people are suffering from visual impairment among which 1billion alone are suffering from cataracts [7]. Cataracts are one of the major causes of blindness in the world. Early detection of cataracts can reduce the risk of blindness to the patients. Till now for detection of cataracts, ophthalmologists use slit lamps ,fundus cameras which are costly and requires domain knowledge to take a decision. The application of convolution neural networks seems to be a promising approach for cataract classification and detection[7,8]. Lai, Chi-Ju et alI proposed a system CNNDCI, which used digital camera images for training the convolutional neural network and achieved a satisfactory accuracy. S. V. Nair and P. Shete used MobileNetV2 architecture for developing a mobile application for cataract detection. But their application is based on fundus images and reported an accuracy of 94%. In this paper the proposed work uses digital images to train MobileNetV2 model and has been evaluated with various performance parameters like model accuracy, precision, recall and f1 score. Based on the results, the cataract detection system provides a training accuracy of 96 %.

3. Materials and Experimental Evaluation

3.1 Dataset

The dataset namely cataract dataract for this experiment purpose has been downloaded from kaggle.com. Dataset consists of jpeg images. All are real images which are not taken from medical records.The dataset has been divided into two

classes normal and cataract classes.Both the classes are making 50 -50% of the data.The data hierarchy is like in the training set we have two directories normal (245 images) and cataract sets (246 images) and in the testing set also contains two directories normal (61images) and cataract sets (60 images). As it can be seen 80% of the data is used for training and 20% for Validation.

3.2 Methodology

Convolutional neural networks offer a promising approach for image classification. Mobilenetv2 is one of several variants of CNN's which provides a strikingly good balance between model size and accuracy, rendering it ideal for resource-constrained devices such as mobiles. The lightweight architecture of Mobilenetv2 helps in efficient deployment on mobile and embedded devices with limited computational resources. Mobilenetv2 architecture achieves competitive accuracy compared to larger and more computationally expensive models.Also the model's small size enables faster inference times, making it suitable for real-time applications. The Cataract classifier model developed in this paper uses Mobilenetv2 architecture and has achieved an accuracy 0f 95%+.

The model is initially trained with training dataset consisting of two directories namely cataract and normal. The cataract directory consists of 245 images. The normal directory consisting of 246 images.The model is trained by tuning the hyper parameters like learning rate and no of epochs. A Hyper parameter tuning sheet has been created by noting the values with every change in hyper parameters. The model is tested for maximum 50 epochs with various learning rates. For each change in hyperparameters the model accuracy has been noted. The highest accuracy 95% achieved for epoch 40 and learning rate 0.0001. Various parameters, accuracy, precision, recall and F1 score are used to evaluate the model. The best accuracy model is converted to h5 model and then converted to onnx formats for execution purposes. The model is then deployed in to navigator which is an AI tool for evaluating various models. The model is then converted to cataract classifier app using streamlit.

Epochs/learning	0.000001	0.00001	0.0001	0.001	0.005	0.01	0.05
10	0.4787	0.7653	0.9081	0.9183	0.9285	0.9183	0.9081
20	0.6531	0.8673	0.9387	0.9285	0.9183	0.9285	0.9081
30	0.6224	0.8571	0.9285	0.9183	0.9387	0.9183	0.9183
40	0.7959	0.8775	0.9489	0.9285	0.9387	0.9081	0.9081
50	0.6632	0.9081	0.9285	0.9285	0.9285	0.9183	0.8771

Fig 1: Hyper parameter tuning sheet

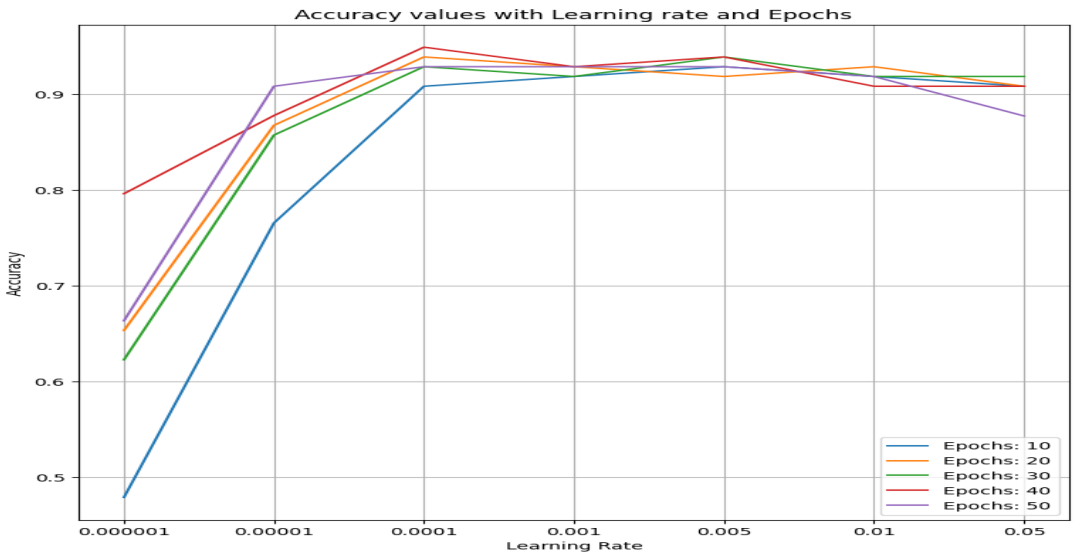


Fig2: Multiline plot of the model for various learning rates.

3.3 Results

The parameters like accuracy, precision, recall, f1 score are used in our model and we are evaluating the model by tuning the model to different hyper parameters. This provides better understanding of the model results and insights in to model working.

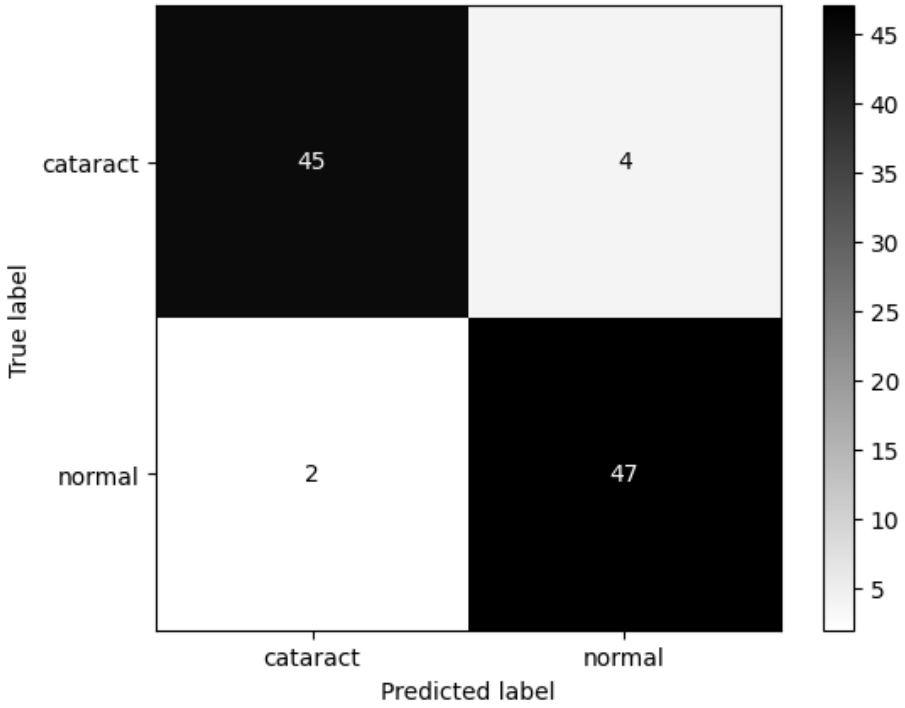


Figure 3: Confusion Matrix - Cataract Classifier

The confusion matrix shows that the over all correct classification with 94% accuracy. But when it comes to individual classes the model is classifying cataract images correctly with 95% accuracy and normal images with 93% accuracy.

```
print('Classification Report : ')
print(classification_report(y_validation, predictions))
```

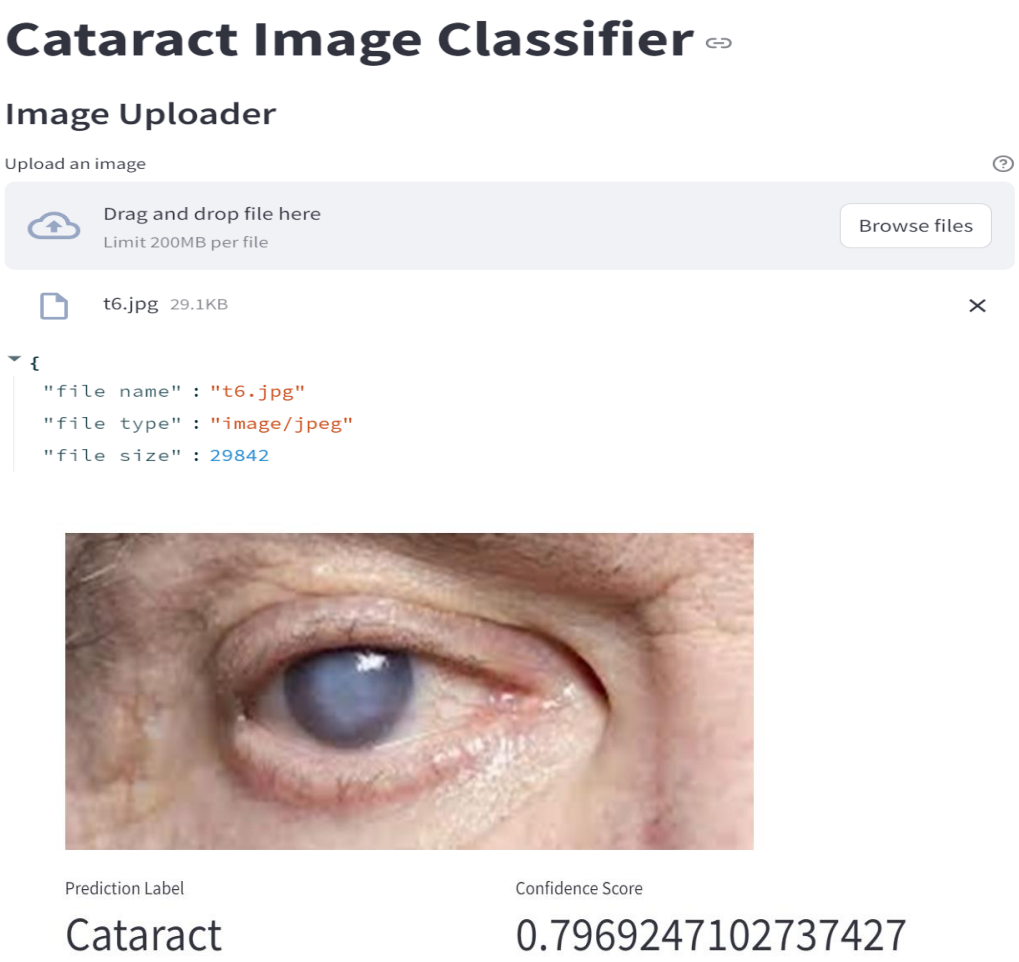
```
Classification Report :
              precision    recall  f1-score   support

           0       0.96      0.92      0.94        49
           1       0.92      0.96      0.94        49

    accuracy                           0.94        98
   macro avg       0.94      0.94      0.94        98
weighted avg       0.94      0.94      0.94        98
```

Fig 4: Classification Report- Cataract Classifier

Validation of the model performance is done through streamlit app. A real image image will be fed to the model for validation.the model classifies the image in to either of the classes with a confidence score. The confidence score specifies the probability of belongingness to a class .



4. Discussion and Future work

The model is deployed on to the web and is being realised as a web app. The app is being accessed in web browser and mobile. So the characteristic described for Mobilenetv2 is achieved and successfully a web app is being developed for detecting the cataracts. This makes it easy for medical practitioners to detect cataracts as early as possible and can suggest the patients to meet a doctor for further investigations. The model currently is again a black box model which lacks explanation for its decision. An approach for incorporating explainable decisions in to the model can be taken up as a future direction for research in this area. Also the model can be extended for other categories which are not cataracts but can wrongly be diagnosed as cataracts. Also an accuracy threshold can be taken , so that whenever the model predicts the accuracy below threshold value , it has to store the image for training purpose. After collecting a group of such images , the app has to remind the admin to retrain the model by incorporating the newly gathered images. This may cause implementation overheads but comes with an advantage of automatic updation of model from time to time.

5. Conclusion

A web app for cataract classification has been developed by training a variant of convolution neural network namely Mobilenetv2.A training accuracy of 94% ,testing accuracy of 99% has been achieved . when deployed the model was able to validate the images with an average of 96% accuracy. The incorporation of explainability makes the model more trustworthy to the medical practitioners.Also there is a need for updating the database with images from time to time. The app can remind the admins to update the database after regular intervals so that the model performance will remain intact with time.

6.Reference

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https://www.kaggle.com/datasets/nandanp6/cataract-image-dataset