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CLASSIFICATION AND IDENTIFICATION OF OCULAR DISEASES

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Abstract

As we see, 2.2 billion people around the world suffer from visual impairment and eye diseases. And in India today there are 550 million people that is nearly half of India's population is estimated to be affected by eye problems. Some of these diseases include Age-related macular degeneration (AMD) which is the physical disturbance of the center of the retina called the macula, Bulging Eyes, Cataracts, Color blindness, Cataracts In Babies, CMV Retinitis, Crossed eyes (Strabismus), Diabetic Macular Oedema. Now, these diseases can be detected but the methods and technology used are costly or time-consuming. So, it becomes very important for doctors to adopt new technologies that are not only cost-effective but is also timesaving. Therefore, there comes the role of CNN. CNN (Convolution Neural Network) is a class of deep neural networks, mostly applied to analyzing visual imagery is a part of Deep Learning (where Deep Learning is a subpart of machine learning consisting of algorithms inspired by the structure and functions of the brain called artificial neural networks). So, we have worked on five ocular diseases. These are Cataracts, Glaucoma, Retinopathy, bulging eyes and crossed eyes. And the accuracy we achieved is 95%.

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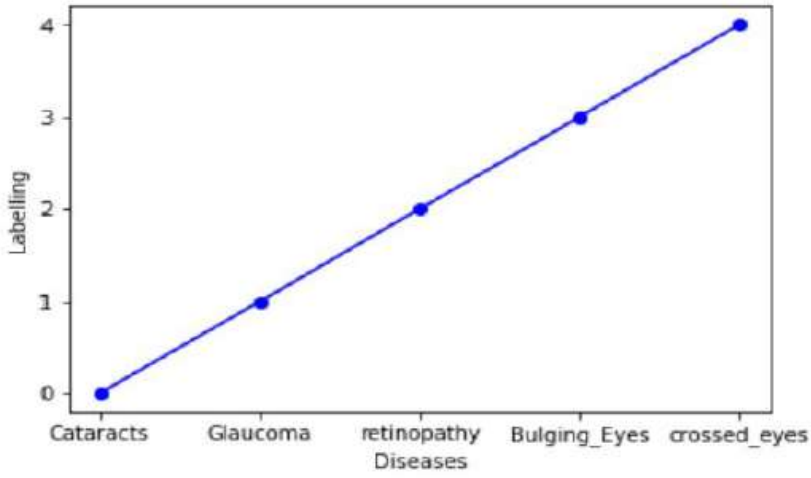


Figure 1. Graphical representation of five different diseases. Cataracts, Glaucoma, Retinopathy, bulging eyes and crossed eyes in which diseases are labelled as Cataracts as 0, Glaucoma as 1, Retinopathy as 2, bulging eyes as 3 and crossed eyes as 4.

1. Introduction

1.1 Cataracts

Cataract is blurring of the lens of the eye which forestalls clear vision. Albeit most instances of cataract are identified with the maturing cycle, infrequently kids can be brought into the world with the condition, or a waterfall may create after eye wounds, aggravation, and some other eye sicknesses.

There are three essential kinds of Cataract re examined under: Nuclear Sclerotic Cataracts, Cortical Cataracts, Posterior subcapsular cataract.

1.2 Glaucoma

Glaucoma can be a condition that harms your eye's optic nerve. It deteriorates over the long haul. It's regularly connected to a development of weight inside the eye. Glaucoma will in general spat families. You for the most part don't get it until another time throughout daily life. The expanded weight in the eye, called intraocular pressure, can harm the optic nerve,

which sends pictures to your mind. On the off chance that the harm intensifies, glaucoma can cause perpetual vision misfortune or even all out visual impairment inside a couple of years. A great many people with glaucoma don't have any early manifestations or torment. Visit the eye specialist routinely as they can analyze and treat glaucoma before you have long haul vision misfortune.

1.3 Retinopathy

Retinopathy implies that sickness has harmed the retina. The retina is the part that is inside the eye that detects light. Various sicknesses can cause retinopathy. There can be fractional or complete loss of vision. Retinopathy can grow gradually or unexpectedly, can improve all alone or lead to perpetual harm.

1.4 Bulging eyes

Eyes that swell, or jut out of their typical position, could be an indication of a genuine ailment. Proptosis and exophthalmos are the clinical terms used to depict swelling eyes. While a few people are brought into the world with eyes that distend more than typical, others create them because of a hidden ailment. By and large, the white portion of your eye shouldn't be noticeable over your iris (shaded piece of the eye) without lifting your eyelid.

On the off chance that the white of your eye shows between your iris and your upper eyelid, it could be an indication E of unusual swelling. Your suggested treatment plan will rely upon the basic reason for your eye swelling. Abrupt swelling of just one eye is a crisis. Look for clinical consideration right away. It could be an indication of a genuine clinical issue.

1.5 Crossed_eyes

Crossed eyes, likewise called strabismus, is a condition where your eyes don't arrange. On the off chance that you have this condition, your eyes look in changed ways. Furthermore, each eye will zero in on an alternate article. The condition is more normal in kids, however it can likewise happen sometime down the road. In more established youngsters and grown-ups, crossed eyes can be brought about by an assortment of basic ailments, as cerebral paralysis or stroke. Crossed eyes can for the most part be adjusted with remedial focal points, medical procedure, or a blend of both.

2. Objective

The objective is to get a better accuracy of the model which can easily classify the five different kind of eye diseases that is Cataracts, Glaucoma, Retinopathy, bulging eyes and crossed_eyes.

This will help easy, faster and cheaper detection of ocular diseases which will help both doctors as well as patients. And thus it will lead to the revolution of Machine Learning in terms of Medical Sciences.

3. Methodology

The whole CNN model is implemented in Python programming language.

3.1. Data Pre processing

The first and most important part of data analysis is data pre-processing. So, first, data (images) is imported using the cv2.imread function and an array of pixels of each image is stored in an array. Then each image is converted to grayscale and resized to 50×50. It is very important that the size of each image to be the same and Gray scale converts the image to a lesser number of pixels as in RGB image there are three layers where as in Gray scale image there is only one layer. Labels from each image are stored in a different NumPy array. Now the data is split into training data and testing data. The splitting is done in such a way that training data consists of 70% of the data and testing data consists of 30% of the data. Since the maximum value in the data array of pixels can be 255, so to convert it to between 0 to 1 each pixel is divided by 255 for each image, this makes computation easy.

3.2 Building Convolutional Neural Network

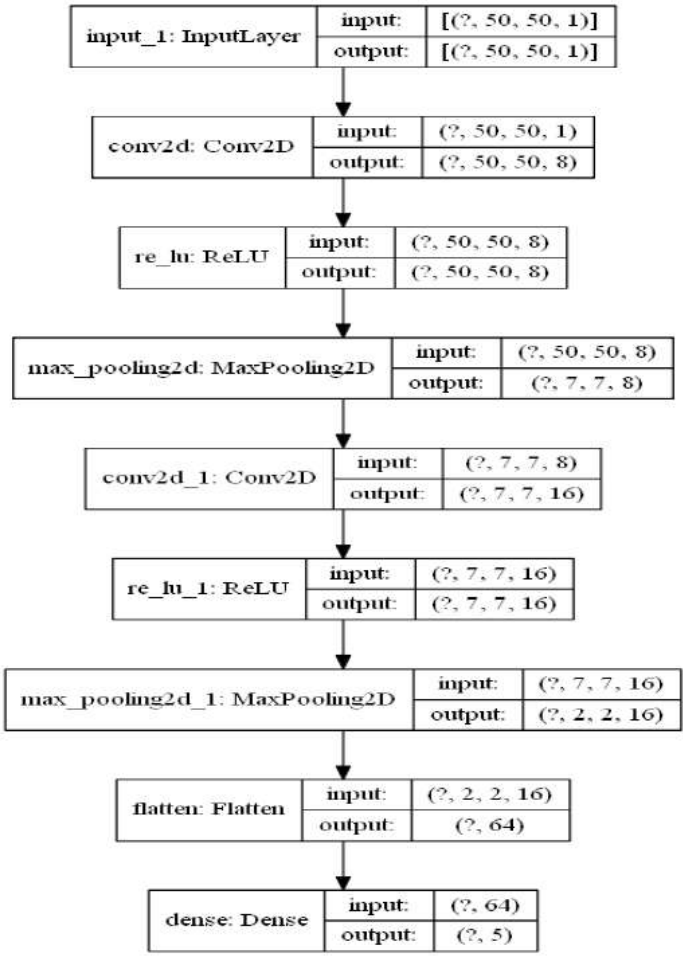
CNN belongs to in-depth neural networks, mostly used in analyzing visual images. Algorithm for building CNN model is mentioned below.

4. Algorithm

```
def convolutional_model(input_shape):
 input_img = tf.keras.Input(shape=input_shape)
```

```
 Z1=tf.keras.layers.Conv2D(8,(4,4), strides=1,padding='same')(input_img)
A1=tf.keras.layers.ReLU()(Z1)
P1=tf.keras.layers.MaxPooling2D((8,8),strides=8,padding='same')(A1)
Z2=tf.keras.layers.Conv2D(16, (2,2), strides=1,padding='same')(P1)
 A2=tf.keras.layers.ReLU()(Z2)
P2=tf.keras.layers.MaxPooling2D((4,4),strides=4,padding='same')(A2)
 F=tf.keras.layers.Flatten()(P2)
outputs=tf.keras.layers.Dense(5, activation='softmax')(F)
 model = tf.keras.Model(inputs=input_img, outputs=outputs)
 return model
conv_model = convolutional_model((50, 50, 1))
conv_model.compile(optimizer='adam',
                   loss='categorical_crossentropy',
                   metrics=['accuracy'])
```

The entire architecture of the CNN model is presented below:



5. About Data

We have taken data set in form of images for 5 different eye diseases i.e. Cataracts, Glaucoma, Retinopathy, bulging eyes and crossed eyes.

6. Work Plan

1. To implement CNN (Convolutional Neural Network) we used Python Programming language.

2. First, import all libraries which are required.

3. Import data and read the images one by one.

4. Convert each image to Gray scale.

5. Resize each image to (50, 50).

6. Make a list named "data set" and add information (pixels information, labels) of each image to the list.

7. Extract labels from each image and store it in a different list and convert it to NumPy array.

8. Convert data set to NumPy array and reshape it.

9. Split the data set into Training data set and testing data set.

10. Divide each pixel of training data set by 255.0.

11. Now, the basic CNN structure is as follows: Convolution -> ReLU Activation -> Max Pooling -> Convolution -> ReLU Activation -> Max Pooling -> Flatten -> Dense->Softmax Activation ->Output

13. Thus, first we add Convolution layer.

14. Then we add activation function ("relu").

15. Add pooling layer.

16. Repeat step 12, 13, 14 three times.

17. Convert the 3D feature maps to 1D feature vectors by using Flatten ().

18. Add dense layer.

19. Add sigmoid activation function.

20. Compile the model.

21. Train the model by using model.fit ().

22. Take batch size =50.

23. And epochs =2000.

24. Then we can plot the model accuracy and loss using Matplotlib.pyplot and the roc curve.

25. Now, we apply predict function on testing data set.

26. The Accuracy achieved is 95%.

27. computed sensitivity: 0.95.

28. computed specificity: 0.99.

7. Tools and Technologies Used

Python, TensorFlow, NumPy, Keras, Sklearn, Matplotlib.pyplot, OpenCV.

8. Results and Discussion

We used CNN (Convolutional Neural Network) and implemented the whole model in python. We first started with the classification of two diseases that is cataract and glaucoma and then added rest three diseases one by one to the model for classification. We used labels 0,1,2,3,4 for Cataracts, Glaucoma, Retinopathy, Bulging eyes and Crossed eyes, respectively. The accuracy we achieved on this model is 95% and sensitivity and specificity achieved is 0.95 and 0.99 respectively.

Roc_Auc Score: Cataract: 0.9993334901591782, Glaucoma: 0.9943098138974427, Retinopathy: 1.0, Bulging eyes: 0.9993777777777777, Crossed eyes: 0.9888627450980392

Confusion matrix:

1. Cataract:	2. Glaucoma:	3. Retinopathy:	4. Bulging Eyes:	5. Crossed eyes:
$\begin{bmatrix} 326 & 1 \\ 4 & 74 \end{bmatrix}$	$\begin{bmatrix} 306 & 6 \\ 6 & 91 \end{bmatrix}$	$\begin{bmatrix} 355 & 0 \\ 0 & 50 \end{bmatrix}$	$\begin{bmatrix} 370 & 5 \\ 0 & 30 \end{bmatrix}$	$\begin{bmatrix} 253 & 2 \\ 12 & 138 \end{bmatrix}$

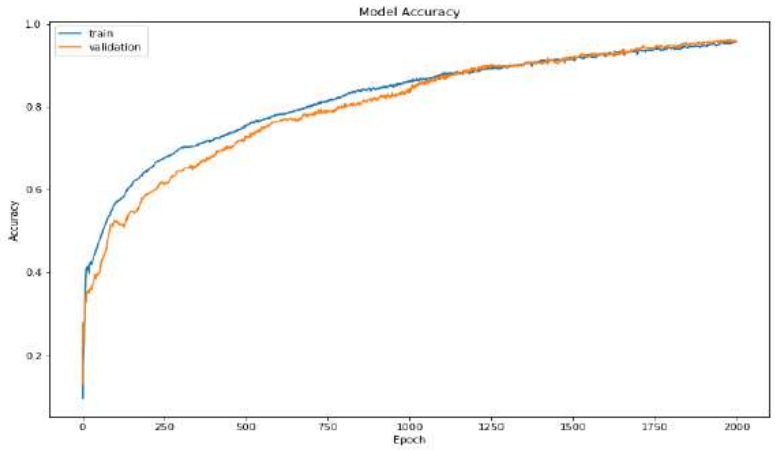


Figure 2. Model Accuracy Graph. The graph shows the accuracy curve for the CNN model made.

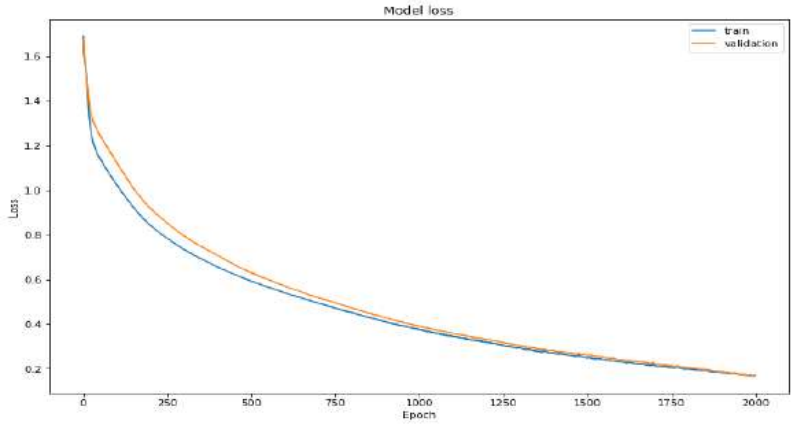


Figure 3. Model Loss Graph. The graph shows the loss curve for the CNN model made.

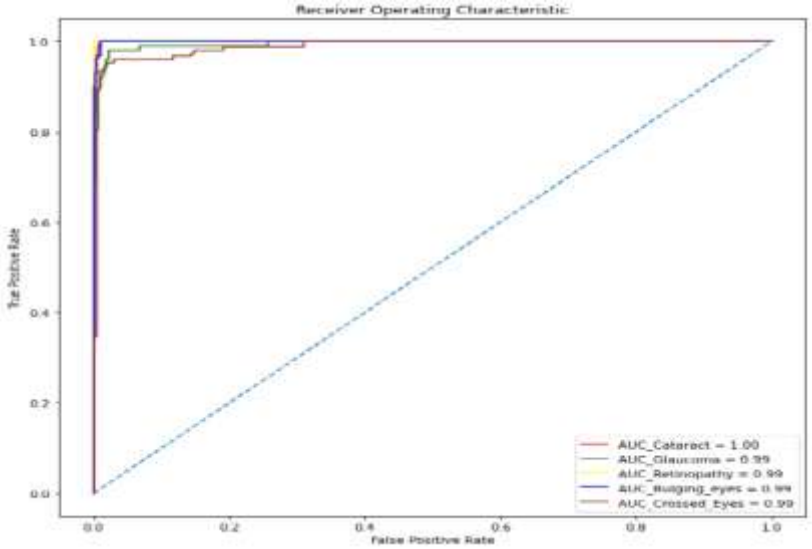


Figure 4. ROC CURVE.

Conclusion

With the help of the CNN model, we have developed a model that can predict five different eye diseases with an accuracy of 95%.

The five different diseases are: Cataracts, Glaucoma, Retinopathy, Bulging eyes and Crossed eyes. We have used CNN model because the CNN model gives better results for image data rather than other models. Now, this model will be very useful once it is converted to a mobile app. It will not be used by doctors but also will be used by common people for early prediction of eye diseases. It will not only be very inexpensive but will also be very time saving.

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