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Covid-19 Detection Using X-Ray Images By Using Convolutional Neural Network

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ABSTRACT -The coronavirus 2019 (COVID-19), which initially appeared in the Chinese city of Wuhan in December 2019, soon spread throughout the world and became an epidemic.It is critical to discover positive cases as soon as possible in order to prevent the illness from spreading further.The use of convolutional neural networks (CNN) methods in conjunction with medical imaging can aid in the accurate detection ofthis disease. A novel model for automatic COVID-19 identification utilising raw chest X-ray pictures is employed in this study.The model was created to provide reliable diagnosis for binary categorization (COVID vs No-Findings).Our model has a 98.44 percent accuracy rate.Keras and Tensorflow were used to train a model using the sequential model.On each lay, we used convolutional layers and applied various filtering.

Keywords:Convolutional neural networks, keras and Tensor flow, Flask ,numpy, Image processing.

1. INTRODUCTION

COVID-19 is a contagious disease caused by the Coronavirus 2 of the Severe Acute Respiratory Syndrome (SARS-CoV-2).The illness originated in China and has since spread around the world. As of December 12, 2020, there were more than 12,847384 verified COVID-19 cases and 55,587 confirmed COVID-19 fatalities. Breathing problems, cough, and fever are all symptoms of infection. In extreme situations, the infection can result in severe acute respiratory syndrome, septic shock, multi-organ failure, and death.The quantity of COVID-19 test kits accessible in the hospital is limited due to the constant increase in cases.Because an automated detection method is required as an alternate diagnosis to avoid the spread of COVID-19..To train a model utilising the sequential model, Keras and Tensorflow wereutilised.We built convolutional neural network layers and applied various filters to each layer.

The goal of this research is to enhance COVID-19 detection accuracy using chest X-ray pictures.CNNs (Convolutional Neural Networks) are a kind of deep neural networks[1]. The Convolutional neural network structure comprises two layers, one of which is the feature extraction layer, which links each layer's input to the local receptive fields of the preceding layer and extracts the local feature.Once the local feature has been retrieved, the positional connection between it and other features will be computed. In this regard, we explore a CNN-based system, because CNN is a strong feature extraction and classification approach with high picture classification recognition efficiency.Of course, in the case of medical image analysis, significant diagnostic accuracy might be a major aim alongside noteworthy results, and in recent years, essential facts in medical imaging have been discovered[2].

2. EXISTING METHEDOLOGIES

SWAB TEST:-

For a few seconds, the individual giving the test will swirl a long stick with a soft brush on the end, similar to a pipe cleaner, up your nose.A collection of secretions collected by the soft bristles will be collected for study[5].

To get a decent specimen, the swab must travel a long distance, so cells and fluids must be collected from the whole route that connects the base of the nose to the back of the throat.

Fig.1:Swab Test

However, because the body isn't used to having an item in that location, it experiences a variety of odd feelings.

For one thing, it triggers the lachrymal reflex, which means that if done correctly, it will bring tears to your eyes.I wouldn't say it hurt, but it's certainly unpleasant.Because the swab will also come into contact with the back of the throat, it may cause a gag reaction.

NASAL ASPIRATE:-

In nasal aspirate, secretions from the back of your nose and upper throat are collected using a swab.Sometimes, a suction device may be utilised to gently remove the secretions.Nasal (or nasopharyngeal) aspirate is the term for this.The secretions are taken to a laboratory and cultivated.This helps determining whether viruses, bacteria, or fungus are present easier.. The results are sent back to your doctor who will use them to help diagnose what germs could be causing your symptoms.

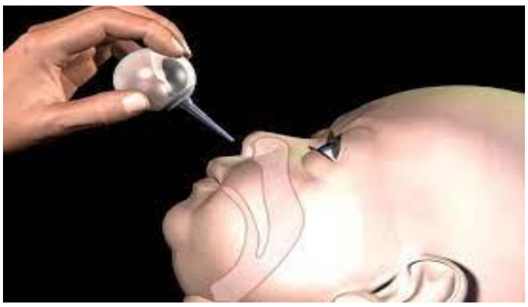

Fig.2: Nasal Aspirate

SPUTUM TEST:-

A sputum test, also known as a sputum culture, is a test that your doctor may prescribe to detect what is developing in your lungs if you have a respiratory tract infection or another lung-related illness.Sputum is a viscous material that builds up in the lungs.When bacteria or fungus multiply in the lungs or bronchi, it is called bronchitis.The developing material can make breathing difficult and create other problems as it builds.

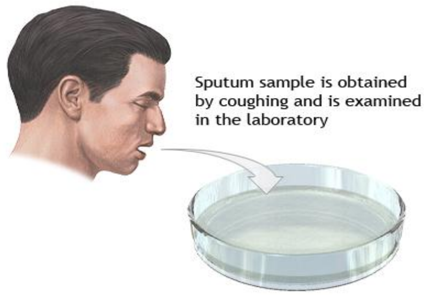

Fig.3: Sputum Test

3. PROPOSED SYSTEM

Using deep convolutional neural networks and chest X-ray images, we presented an automated prediction of covid-19[3].The Python programming language was utilised in conjunction with Tensor Flow Keras and OpenCV components for this solution.We used a Python backend and the Flask web development framework to deploy the previously trained CNN model in a web application. The website's frontend is made up of HTML and JavaScript.The suggested models will have an end-to-end structure that will eliminate the need for human feature extraction and selection procedures.The greatest tool for detecting covid-19 is a chest X-ray.The use-case diagram for COVID-19 detection utilising X-ray pictures is shown in Figure.4.

A use-case diagram depicts how a user interacts with a computer systemIt depicts the user's interaction with various use cases by using covid-19 patient CT data as input and processing the CT pictures and labels into a preprocessor for training - validating or testing into a neural network sent by set parameters to CNN model and forwarding it .The processes are represented using some unique type of symbols by which the user may quickly grasp the process to conduct computer as a user.

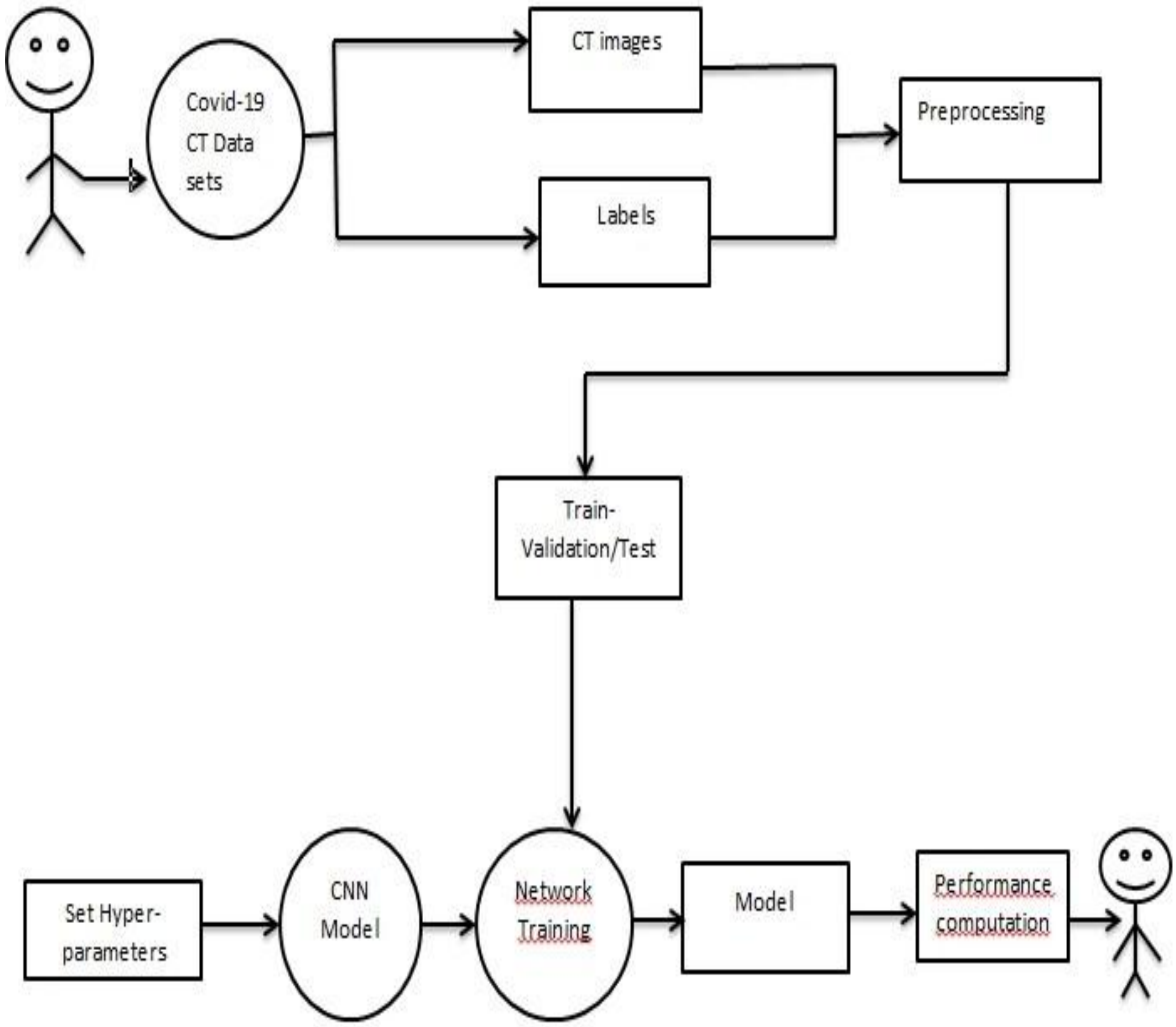

Fig.4: detection of COVID-19 using X-ray images

4. MODULES DESCRIPTION

For a novice, the Convolutional Neural Network (CNN) may appear intimidating[4][6].This project, on the other hand, will show how to use Tensorflow and Keras to construct a model to identify COVID-19.The following is a list of the project's content::

- Creating Dataset
- Data Preprocessing
- Training the CNN
- Webpage Creation

A.CREATING DATASET:

Praveen's Covid Chest X-Ray Dataset and Pneumonia dataset from GitHub and Kaggle, respectively, were used in this experiment. We generated a bespoke dataset called COVID19 Negative and COVID19 Positive using these two datasets[7].

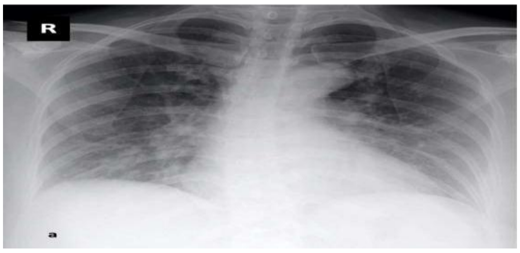

Fig.5 COVID-19 Positive X-ray Image

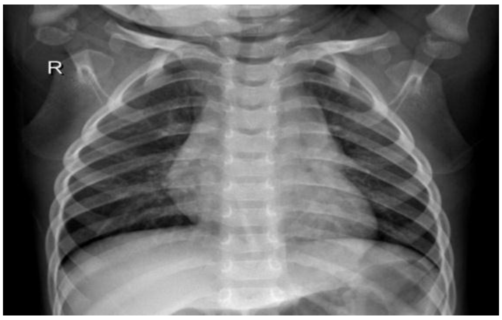

Fig.6 COVID-19 Negative X-ray Image

B.DATA PREPROCESSING

We are utilising two categories in this process: 0 for COVID-19 Negative and 1 for COVID-19 Positive, as stated below:

{'Covid19 Negative': 0, 'Covid19 Positive': 1}

['Covid19 Negative', 'Covid19 Positive']

[0, 1]

EVALUATIONMETHOD

The evaluation was done in order to figure out how well the suggested covid-19 identification procedure worked.Two kinds of covid-19 may be identified using the sequential approach utilised in this study.

This may be done in several layers, with the result divided into two categories: 0 and 1.

Category	Output
0	COVID-19 Negative
1	COVID-19 Positive

Table 1:Evaluation Method

Let's call the original picture collection S1, which is made up of n photos.

$S_1=\{s_1(1), s_1(2),\ldots, s_1(i),\ldots\}$

First, we convert the three-channel colour image to a grayscale image, which we refer to as S2.

$S_2=G(S_1|BGR \rightarrow Grayscale)$

$=\{s_2(1), s_2(2),\ldots, s_2(i),\ldots\}$

Because we require a fixed common size for all the pictures in the collection, we resize the grey scale to [100 100], and then add the image and the label(categorized) to the list (dataset).It will now be normalized before being stored as data and target[8].

C.TRAINING THE CNN:

We'll go through how CNN was built, as well as how CNN works, in the following six phases.

Step 1: Import the necessary libraries

Step 2: Set up CNN and add a convolutional layer

Step 3 – The procedure of pooling

Step 4 – Incorporate two convolutional layers.

Step 5 – Flattening procedure

Step 6 – Create a fully linked layer as well as an output layer.

We'll load the data and target before thinking about training the CNN.

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
model_1 (Model)              (None, 100, 100, 384)     11008
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 98, 98, 64)        221248
_________________________________________________________________
activation_1 (Activation)    (None, 98, 98, 64)        0
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 49, 49, 64)        0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 47, 47, 32)        18464
_________________________________________________________________
activation_2 (Activation)    (None, 47, 47, 32)        0
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 23, 23, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 16928)             0
_________________________________________________________________
dropout_1 (Dropout)          (None, 16928)             0
_________________________________________________________________
dense_1 (Dense)              (None, 128)               2166912
_________________________________________________________________
dropout_2 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_2 (Dense)              (None, 64)                8256
_________________________________________________________________
dropout_3 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_3 (Dense)              (None, 2)                 130
=================================================================
Total params: 2,426,018
Trainable params: 2,426,018
Non-trainable params: 0
```

Fig.7:Sequential Model Layers with parametres

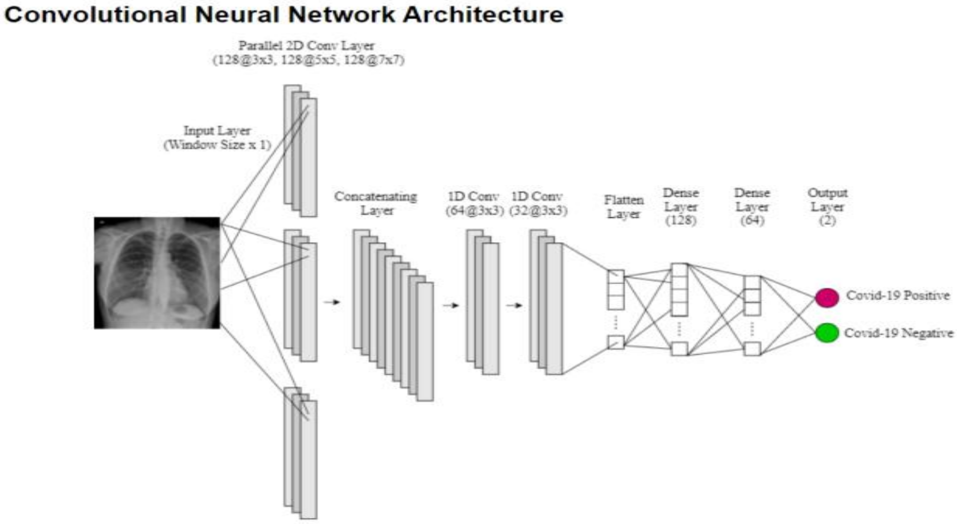

Fig.8: convolutional neural network architecture

Instead of classifying each image one by one, we'll build up data generators to read photos from source folders before training the model. Essentially, ImageDataGenerator labels images based on the directory in which they are stored. It refers to the data's subdirectory.Gray scale normalization should be performed using the rescale option to speed up CNN convergence[9][10].The picture pixel is transformed from [0...255] to [0...1] via the normalization process. Train data and train target are two generators to make. Train data refers to the train data subdirectory, whereas train target refers to the evaluation data subdirectory. Then run 15 epochs of training on the model.

```
Train on 1555 samples, validate on 173 samples
Epoch 1/15
1555/1555 [==============================] - 37s 24ms/step - loss: 0.4550 - accuracy: 0.7576 - val_loss: 0.1145 - val_accuracy:
0.9595
Epoch 2/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.1954 - accuracy: 0.9357 - val_loss: 0.0656 - val_accuracy:
0.9769
Epoch 3/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.1050 - accuracy: 0.9601 - val_loss: 0.0401 - val_accuracy:
0.9884
Epoch 4/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0850 - accuracy: 0.9711 - val_loss: 0.0671 - val_accuracy:
0.9827
Epoch 5/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0795 - accuracy: 0.9743 - val_loss: 0.0912 - val_accuracy:
0.9711
Epoch 6/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0737 - accuracy: 0.9730 - val_loss: 0.0381 - val_accuracy:
0.9884
Epoch 7/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0472 - accuracy: 0.9859 - val_loss: 0.0294 - val_accuracy:
0.9942
Epoch 8/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0466 - accuracy: 0.9852 - val_loss: 0.0728 - val_accuracy:
0.9653
Epoch 9/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0631 - accuracy: 0.9794 - val_loss: 0.0414 - val_accuracy:
0.9769
Epoch 10/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0506 - accuracy: 0.9820 - val_loss: 0.0471 - val_accuracy:
0.9769
Epoch 11/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0304 - accuracy: 0.9865 - val_loss: 0.0339 - val_accuracy:
0.9942
Epoch 12/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0362 - accuracy: 0.9878 - val_loss: 0.0224 - val_accuracy:
0.9942
Epoch 13/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0169 - accuracy: 0.9961 - val_loss: 0.0372 - val_accuracy:
0.9884
Epoch 14/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0259 - accuracy: 0.9916 - val_loss: 0.0309 - val_accuracy:
0.9942
Epoch 15/15
1555/1555 [==============================] - 26s 17ms/step - loss: 0.0171 - accuracy: 0.9942 - val_loss: 0.0315 - val_accuracy:
0.9942
```

Fig.9:Training and Validation results

D.WEBPAGE CREATION:-

The previously trained CNN model was deployed in a web application using a python backend and the flask web development framework.HTML and Javascript are used to build the website's front end..

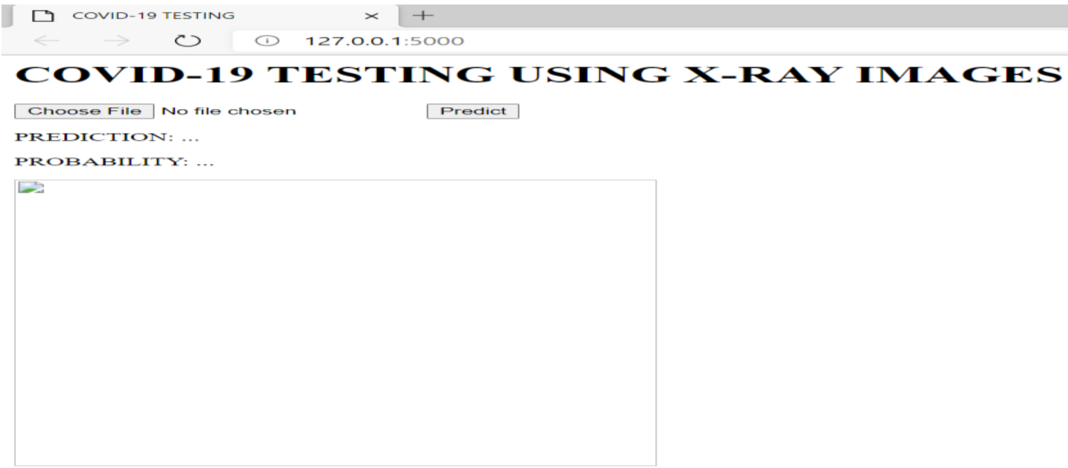

Fig.10: webpage

5. OUTPUT

The project's front end and back end scripts allow users to submit an image and assess whether the X-ray picture has been diagnosed with covid-19.When the user selects the predict button after importing the input as an X-ray picture, it will display the prediction and probability.The following are the project's two predictions:

Fig.11: Prediction of COVID-19 Positive in Webpage

Fig.12: Prediction of COVID-19 Negative in Webpage.

6. PERFORMANCE EVALUATION METRICS

The following is a comparison of model accuracy and loss rate between the train and validation datasets after 15 epochs of model training. This part is intended to portray the project in terms of evaluating the proposed system's performance. In addition, after 15 epochs after model training, the following analysis of model accuracy and loss rate between train and validation is shown in Fig.13 and Fig.14

Accuracy:
It is used to accurately measure the model's performance. It will be decided following the parameters, which will be computed as a percentage. It will compare the prediction measurement of our model to the through data.

Accuracy=(TP+TN)/(TP+TN+FP+FN)
Sensitivity=TP/(TP+FN) Specificity=TN/(TN+FP)

Where,
TP = True Positives TN = True Negatives FP = False Positive FN = False Negative

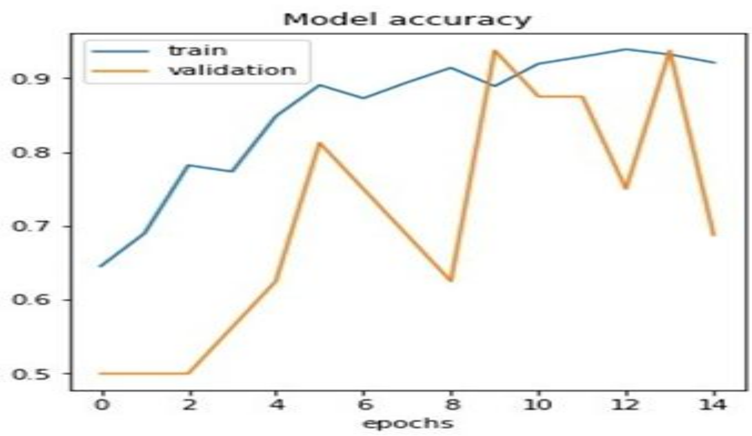

Fig.13: Model Accuracy

Loss:
It's a number that represents the model's poor forecast.The model prediction is perfect if the loss value is zero.
If the loss value is more than zero, the prediction will be incorrect. The loss will be computed as the total of all mistakes committed in training and validation for each epoch.

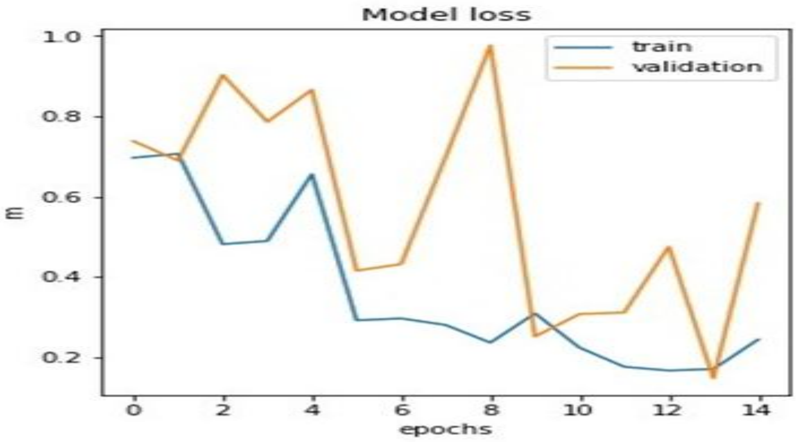

Fig.14: Model Loss

The test dataset will be used to forecast the results when the model has been fully trained.This model assessment phase is important for determining how well the trained model predicts data that has not yet been observed.As a consequence, 80 percent of the pictures were used for training.Validation was done using 10% of the total.Testing accounted for 10% of the total.98.44 percent accuracy was achieved throughout testing, indicating a reasonable or good model.

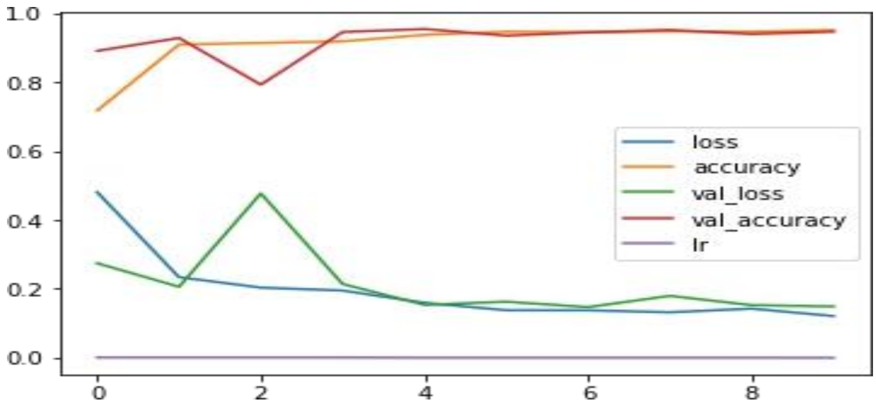

Fig.15: Plot Metrics Progress

7. CONCLUSION

In this study, we presented a sequential approach for identifying corona virus illness (covid-19) from chest X-ray pictures using a deep learning CNN model.As we've shown, this model can effectively capture covid-19 characteristics in the parallel layers of a convolutional

network, demonstrating that it outperforms certain well-known CNN architectures. Our experimental results suggest that this model has a 98.84 percent accuracy rate.
The findings of COVID-19 may be obtained quickly using our suggested model via a webpage.As a result, this approach can assist in halting the pandemic's spread at a lower cost and in less time.To make our suggested model more robust, we can employ transfer learning or pre-trained CNN models in future work.In addition, we may create mobile applications to make COVID-19 prediction more successful.

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