International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

Detection Of Covid-19 From Chest X-Rays

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Abstract - *The coronavirus (COVID-19) outbreak remains impacting the fitness or wellbeing of the worldwide population, with an excessive price of transmission affecting tens of thousands and thousands of people. In maximum situations, strategies utilized in pathogen laboratories, which include polymerase chain reaction (PCR), take greater time and regularly produce fake poor results, however are the usual strategies for diagnosis. Therefore, there may be a want for quicker and greater correct diagnostic strategies to locate early-level COVID-19 instances to forestall and combat the unfolding of the pandemic. The speedy screening process, primarily based totally on current technology which include X-rays and computed tomography scans, can assist lessen the quantity of labor concerned in big diagnostic tests. A chest X-ray is one of the handiest approaches to diagnose a pneumonia symptom, that's the primary symptom of COVID-19.*

This paper aims to propose a model for detecting COVID-19 effectively utilizing digital chest x-ray images with the highest level of accuracy in detection and classifying the images by using Inception V3 method and DNN.

Key Words: ***COVID-19, Convolutional Neural Network, Deep Learning, Inception V3, Deep Neural Network***

1. INTRODUCTION

Coronavirus (COVID-19) disease is a virus-borne infectious disease. The World Health Organization (WHO) labeled it a pandemic on March 11, 2020, due to its global expansion and its frightening velocity at which the disease spreads and the intensity with which it is manifested. Authorities in a lot of countries have established peripheral limitations, flight restrictions, home quarantine, social isolation, and increased cleanliness awareness. The virus, on the other hand, continues to spread at a quick speed. The majority of the patients infected with COVID-19 developed mild to moderate respiratory illness, but a few people suffered from life-threatening pneumonia.

The following are some of the major issues with current methods for identifying COVID-19 patients.

1. Healthcare providers must obtain respiratory tract samples. Nasopharyngeal swab collection is a typical procedure that requires the nurse to be in close proximity to the patient [6]. Cross infection may become more likely as a result of this.

2. The WHO-recommended RT-PCR kits for testing COVID cases are expensive, and the number of kits available in underdeveloped countries is insufficient to test the huge population. As a result, establishing cost-effective testing methods is required [7].

3. The sensitivity of fast antigen testing is not high enough to be utilized alone for first screening [8].

4. A delay in receiving the test result will cause a delay in tracking the afflicted individual's connections with another healthy person.

It has already been stated that obligatory patient screening and rapid clinical response for contaminated patients are crucial in preventing the spread of COVID-19 disease. The Reverse Transcription Polymerase Chain Response (RT-PCR) test is the highest quality level testing approach used for assessing COVID-19 patients. Although it is the most commonly used technique for COVID-19 identification, it is a difficult, time-consuming process and sometimes it gives false negative test results. Additional COVID-19 diagnostic approaches include clinical symptom evaluation, epidemiologic record, affirmative radiographic screening (CT)/(CXR), and positive pathogenic testing [4]. Due to a paucity of testing kits, it will be hard to examine every patient with a respiratory illness using routine techniques (RT PCR), X-rays were the first technology to play a significant role in COVID-19 illness diagnosis. Chest X-rays and computerized tomography (CT) imaging are considered viable screening methods because of their sensitivity and speed [2]. Chest X-rays might yield more accurate results than existing techniques.

Many biological problems (for example, detection of breast cancer, identification of brain tumor, and so on) are now being addressed with Solutions that are based on artificial intelligence (AI). Image features that were not included in the original photos can be revealed using a variety of Deep learning methods [4]. Convolutional Neural Networks (CNN) in particular have been shown to be extremely effective in the extraction and learning of data, and as a result, they have earned universal support among scientists. In low-light images from a high-speed video endoscopy, CNN was used to improve image quality and to distinguish the idea of aspiratory knobs using CT

images. The goal of this study is to use chest X-ray pictures to identify and classify Covid-19 disease, healthy people, and pneumonia patients.

2. LITERATURE REVIEW

In the paper "COVID19 detection using transfer learning and convolutional neural networks". To detect COVID19, the concept of deep learning of transfer learning is provided. Chest x-ray analysis to assess lung disease, compared to the total number of affected people, has become an essential technique for both diagnosis and prognosis of COVID 19 patients in the current situation. This study describes a metastatic learning (CNN) technique for detecting COVID 19 infections in X-ray images. A multivariate Neural network model (CNN) with Transfer learning approach Inception V3 has been created in the proposed model. It uses convolution and pooling to extract features in the same manner as CNN does, except this transfer learning model contains weights from the ImageNet dataset. As a result, it can recognize characteristics rather successfully, providing it an advantage in terms of accuracy. This model highlights how computer vision has the potential to change radiological image analysis. The recommended model performs well with a small dataset, with a validation accuracy of eighty four percent compared to seventy one percent for the InceptionV3 model. This model also surpasses all prior CT scan-based models.

COVID-19 victims must be discovered as soon as avert the infection from spreading. Inception V3 with transfer learning, a DCNN-based model for the diagnosis of coronavirus pneumonia patients using chest X-ray radiographs, was created in 2020, with a classification accuracy of more than ninety eight percent. Transfer learning was found to be an effective, robust, and easily deployable technique for COVID-19 identification. By quickly training itself from a smaller number of photos, the Inception V3 model works brilliantly in identifying COVID-19 pneumonia. Researchers believe that using this computer-aided diagnosis approach will increase the speed and accuracy of diagnosing COVID-19 patients significantly. [4].

According to the study detection of Covid chest Xray based on Multi-Level Thresholding and Support Vector Machine, published in 2020, the early detection of SARS-CoV-2, is currently a serious problem for clinical practitioners. The proposed method is widely recommended for using X-ray images to detect COVID-19 infected people. The assist vector device identifies corona-affected X-ray images from others by utilizing deep characteristics. The proposed multi-level thresholding using SVM technique shown high precision in characterizing the affected lung with Covid-19. The pictures were all the same size and format, JPEG with a resolution of 512 * 512 pixels. The average sensitivity, specificity, and accuracy were ninety-five, ninety-nine, and ninety seven percent, respectively [9].

A lung X-ray is one of the most effective methods for detecting pneumonia, the most significant symptom of COVID-19. As a result, a minimalist model is essential since it enables the model to function on a number of services, including cell devices and conventional PCs, independent of flash volumes. To diagnose COVID-19 illness at various levels of severity, the proposed model employs fourteen layers of convolutional layers and a redesigned spatial pyramid pooling module. The proposed SPP-COVID-Net seems to have the highest accuracy correctness of 0.946 and the smallest mean error among the training layers accuracy, according to the performance data. It's perfect for quick results.[9].

3. METHODOLOGY

3.1 Chest X-Ray Image Datasets

In most cases, the ranges of symptoms of pneumonia and the Covid-19 virus are the same. Both are infections of the lungs. Hence, the dataset consists of three separate datasets of X-rays of the chest (COVID-19 patients, normal people, and pneumonia patients). There are 300 photos in all (100 COVID-19 images, 100 pneumonia images and 100 healthy images). After that, the datasets are divided into two sections: training and testing the classifiers. Fig 1,2,3 shows an example of chest X-ray image collections.

Fig. 1. COVID chest X-Ray images

Fig. 2. PNEUMONIA chest X-Ray images

Fig. 3. NORMAL chest X-Ray images

3.2 Transfer Learning Approach

Transfer Learning is a kind of deep learning that allows us to apply previously learned skills and knowledge to new learning or challenge circumstances. Because it allows you to train deep neural networks with relatively

little input, it's a popular deep learning method. To train a neural network from the start, a lot of data is usually required, but access to that data isn't always feasible. This is when transfer learning comes in handy.

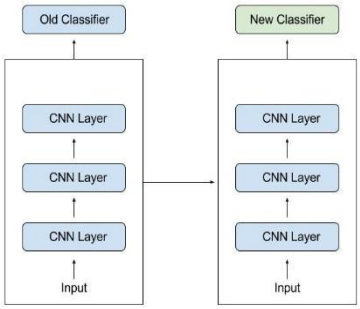

Fig. 4. Transfer Learning

Because the model has been pre-trained, transfer learning can produce an effective deep learning model with less training data. Fig 4 shows the working of transfer learning approach.

Shorter training timeframes, improved neural network performance in most circumstances, and the elimination of a large amount of data are few of the advantages of transfer learning. This is particularly valuable in the field of medicine because most medical cases do not have most of the labeled data in the initial days. For example, COVID-19, for example, is an illness that has only recently been found. As a result, the covid chest image sample is insufficient. To detect this ailment, a transfer learning model was applied. In this situation, Inception V3 can be used to provide results with a smaller training dataset. It is always preferable to develop a deep learning model on top of a foundation of an established and tested model rather than starting from scratch [14].

In this paper, a two-section deep learning-based neural network model is proposed. The initial component of this is a transfer learning model called Inception V3. second part of this network is a customized deep neural network (DNN) layer, while the

3.2.1) Inception V3:

The Inception family's Inception-V3 is a convolutional neural network. that includes factorized 7 x 7 convolutions. You can simply import a pre-trained version of the network from the ImageNet database, which has been trained on over a million photographs. Inception Net was the first CNN classifier to apply precise approaches to assure improved performance while balancing speed and accuracy. The Convolution Layer can be factorized in the Inception-v3 model, lowering the number of parameters while preserving accuracy. It can combine the max-pooling and convolutional layers, allowing for more effective feature reduction [13].

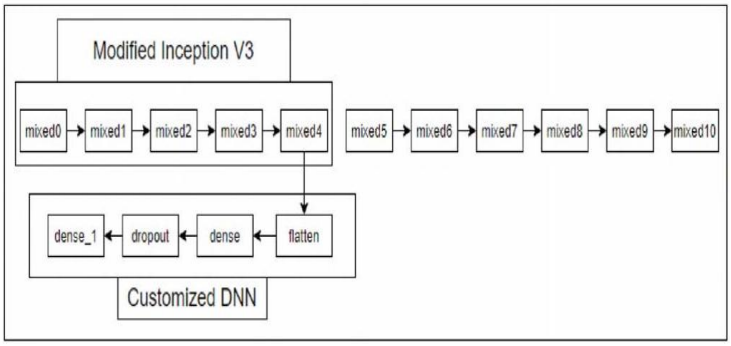

Fig. 5. Neural Network Model Structure [13]

The model has the advantage of allowing output to be extracted from any concatenated node. There are 11 of them, and they're called mixed layers. Total number of layers in order to enhance the model's effectiveness, the model's general structure was changed as a result of the experiment. Fig.5 shows how to use only four of them. Otherwise, it's possible due to our limited dataset causing overfitting.

3.2.2) DNN Model:

The model's final layers were replaced with a DNN that extracted the output using four customized layers, flatten to convert the mixed layer output to a one-dimensional array, and a dense layer of 1024 layers. The following layer was utilized to drop out 20% of the neurons. Finally, a dense 1 layer with sigmoid activation function of 1 neuron was employed [13].

3.3 Performance metrics

Class accuracy, sensitivity, and F1-score are the measures used to evaluate the overall efficiency of the suggested technique, and they are determined as follows.:

Classification accuracy = TP+T N /TP+TN+FP+FN

Sensitivity = TP/ TP+FN

F1 Score = 2×S×P /S+P

Where, TP denotes True Positive, FP denotes False Positive, FN is False Negative, and Volunteer State denotes True Negative, with S denoting sensitivity and P denoting accuracy. We will draw a confusion matrix for the model, if the model gives a correct classification for Covid positive cases then it is correct positive and misclassified Covid negative cases then it is correct negative. Similarly, true negative participants are accurately identified as Covid

negative, while false negative subjects are wrongly labeled as Covid positive.

3.4 Experimentation

Our Inception V3 model performs admirably and accurately predicts Covid-19. To that goal, we conducted a number of trials. These experiments and their outcomes are described in the following sections:

3.4.1) Dataset

We had given chest x-rays as input for our model. where we split the dataset into an 8:2 ratio, with 80% of the images reserved for training purposes and 20% of the images for testing purposes. By default, all set of data photos are downsized to the (224,224) image size.

3.4.2) Feature Extraction

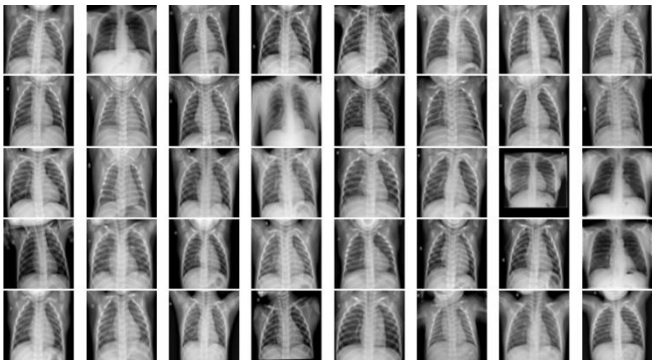

Fig. 6. Feature extraction in inception v3 from chest x-ray

For the feature extraction component of Inception v3, the layers from the input layer to the last max pooling layer are taken into account [10]. Figure 6 depicts the process of inception v3 extracting features from photos.

3.4.3) Hyperparameter Tuning

To encourage a stable model, the parameter settings have been fine-tuned. The learning rate, optimizer selection, loss functions, dynamic epoch variation, stack size, inspect dimensions, rotations span, and other parameters are all changed. We tried a variety of other optimizers and loss functions, but none had a substantial influence on the model's performance, so we stuck with Adam as the optimizer and the binary cross entropy as the loss function throughout the model. The number of epochs is defined by the number of times the model is applied to coaching data, and the batch size is determined by the number of samples in the network. Dropout could be a regularization strategy that requires training while ignoring certain random neurons. In most cases, increased dropout will improve accuracy [10].

4. RESULTS

Initial Random callbacks were used to train all of the models for 50 epochs. The Adam optimizer, which is a mix of SGD with momentum and RMSProp, is used for quicker parameter determination.

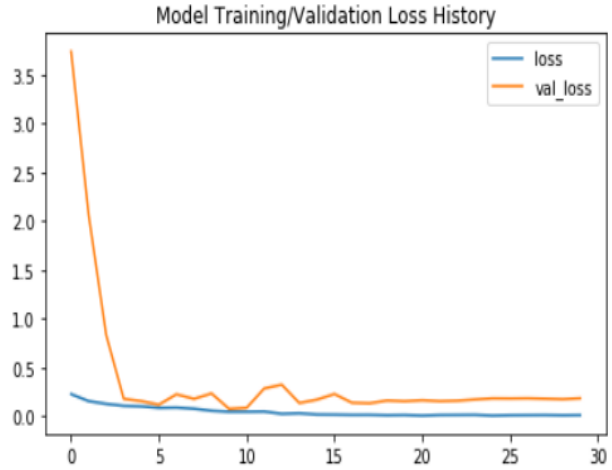

Fig. 7. Training and validation loss of Inceptionv3

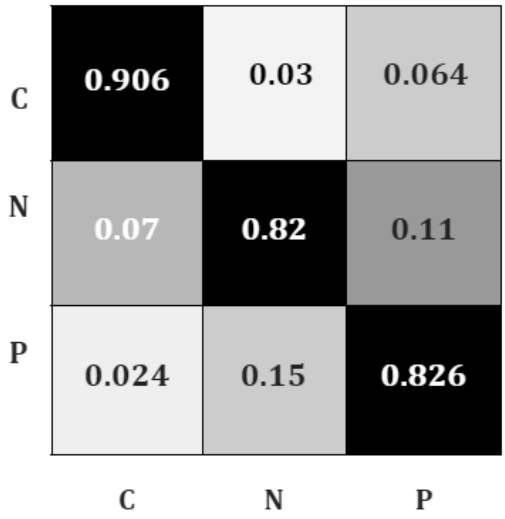

Fig. 8. Confusion Matrix

For the inception v3 model, model training takes 19 seconds each epoch. For the inception v3 model, the gradual change in loss (both training and validation/testing) during epoch was depicted in Fig.7. This shows that during training the models, Inceptionv3 has the lowest loss.

Figure 8 depicts the confusion matrix for the behavior of several trained models over various layers where C is Covid, P is Pnuemonia, and N is normal chest Xrays. The suggested inception v3 model produces the most accurate results even while being one of the best, with significant

true positive and true negative counts for all COVID +ve and COVID –ve pictures.

5. CONCLUSIONS

The COVID-19 outbreak has undoubtedly endangered human life. The healthcare system is being strained as a result of measures to contain the disease's spread. The cost of testing for the existence of the virus is high, and it may not be sufficient to reach a broader population. Deep learning algorithms have shown to be an effective technique for sifting enormous volumes of data. The purpose of this study was to demonstrate that deep learning techniques might be utilised to identify COVID-19 infection. Deep neural network (DNN) models, according to the study's findings, can be utilised in the healthcare industry to screen for and detect the presence of COVID-19 in chest X-rays. Transfer learning has been demonstrated to improve the model's learning ability. The model Inception V3 with DNN correctly identified and classified COVID-19 chest X-rays with 90.64 percent, whereas from other types of chest abnormalities it was 85.06 percent. This study illustrates that by properly using AI technology, the burden on medical institutions may be reduced. Because no physical exams are required of doctors or patients at the screening level, the use of this technology minimizes the danger of disease dissemination while increasing the number of cases.

6. FUTURE WORK

Our key objective for the future is to train this model on a huge trustable data set so that we can train it properly and therefore raise the accuracy, as training the machine learning on more data results in the model being much better on invisible data shuts off. This may also be improved to forecast the chance of the affected person surviving.

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