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PREDICTION OF COVID-19 FROM X-RAY IMAGE USING CONVOLUTIONAL NEURAL NETWORKS

ChaithraK, Ramya S Poojari, SudhanyaK, Yashwi Rai N, Alakananda K,
Assistant Professor, SCEM
Department of Computer Science and Engineering,
Sahyadri College of Engineering and Management, Mangalore.

***Abstract*-A new virus SARS COV 2 spillover event has developed as a global pandemic that is impacting people's health. Later it was named Covid-19. It is essential to screen the affected patients in a timely and cost-effective manner in order to fight this disease. The standard method for detecting COVID-19 is the Reverse transcription-polymerase chain reaction (RT-PCR) test. But the availability of RT-PCR tests is in short supply. As a result of this, the early detection of the disease is difficult. This paper presents the prediction of COVID-19 with Chest X-Ray images in which detection can be quickly compared to RT-PCR and the implementation of an image processing system operated using deep learning and neural networks. In this paper, a Deep Learning, and Convolutional Neural Network-based approach for predicting Covid-19 positive and normal patients using Chest X-Ray pictures is proposed. In this study, deep learning tools such as TensorFlow were used for building and training neural nets. Scikit-learn was used for deep learning from end to end. Various deep learning features are used, such as Conv2D, Dense Net, Dropout, and Maxpooling2D for creating the model. The proposed approach had a classification accuracy of 98 percent after training and testing the X-Ray pictures. Finally, a web application has been developed using flask for general users, which will detect chest x-ray images either as covid, normal or viral pneumonia also gives covid-19 graph representation to display death, conformed, and recovery cases in Mangalore regions.**

***Index Terms*- Covid-19 prediction, covid-19, coronavirus, normal, deep learning, convolutional neural network, image processing, chest x-ray.**

I. INTRODUCTION

On 31 December 2019, the WHO China Country Office was informed of cases of pneumonia of unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China. As of 3 January 2020, a total of 44 patients with pneumonia of unknown etiology have been reported to WHO by the national authorities in China. Of the 44 cases reported, 11 are severely ill, while the remaining 33 patients are in stable condition.At the time of writing (September 8, 2020), there have been more than 27,000,000 confirmed cases and more than 875,000 confirmed deaths worldwide. Considering the time required for diagnosis and the financial costs of the laboratory kits used for diagnosis, artificial intelligence (AI) and deep learning research and applications have been initiated to support doctors who aim to treat patients and fight illness. In a medical environment, learning the resulting outcome takes about 6–7 days, and it is also expensive for the general population. Due to these limitations, radiography checks can be used as a stand-in for diagnosing the disease. Chest radiography images can be evaluated to determine the presence of the novel coronavirus or its side effects. Infections are found in this family, according to studies, and show up as crucial symptoms in radiographic images. Furthermore, Polymerase Chain Reaction (PCR) test results are not always accurate. Furthermore, chest X-rays are more tolerant than other radiological examinations, such as Computed Tomography (C.T) scans, and are available in almost every clinic. The difficulties of locating Covid-19 patients using chest x-rays (CXR) have been demonstrated, with prepared specialists not always being available, especially in the higher ranges [3]. Furthermore, the radiological indications associated with Covid-19 are novel and unexplored, with many specialists who have no experience with Covid-19 reporting positive, persistent CXRs. It has also been contrasted with a couple of existing benchmark works by different experts.

Although some deep learning convolution neural network (CNN) models are applied to CT images [5], more studies applied CNN models to detect and classify COVID-19 cases using chest X-ray images. They include different existing CNN models (i.e., Resnet5, MobileNetV2 [8], CoroNet, Xception + ResNet50V2) and several new special CNN models (i.e., DarkCovidNet [11], COVID-Net and COVIDX-Net). These studies used different image datasets with a varying number of COVID-19 cases (i.e., from 25 to 224) among the total number of cases from 50 to 11,302. The reported sensitivity to detect COVID-19 cases ranged from 79.0%–98.6%.

The study's main goal is to estimate the most accurate result, to save time and money when it comes to Coronavirus tests. It shows a fully programmed framework for differentiating coronavirus-infected lungs from chest CXR scan images and other lung disorders. Flask is used as front-end application. The novelty of this paper is that have used (CNN, Sequential model) types of model. The accuracy obtained from the CNN model is 97.3 percent. Also, Flask will detect the covid patients' results within a sec using the given x-ray images. In this way, it can be claimed that classification using radiographic images, such as a chest X-ray (CXR), can be precise while also being significantly faster and less expensive than a PCR test.

II. STUDIES AND FINDINGS

In [3] author describes that, in December 2019, the first infectious new Coronavirus case (COVID-19) was discovered in Hubei, China. The COVID-19 epidemic has expanded to 214 nations and regions throughout the world, affecting nearly every facet of human existence. At the moment of writing, the number of infected cases and fatalities continues to rise dramatically, with little evidence of a very well scenario. For example, on July 13, 2020, 571527 deaths were recorded worldwide, out of a total of roughly 13.1 million confirmed cases. This study seeks to emphasize the relevance of artificial intelligence (AI) and big data in light of current advancements and uses in many fields. Begin by providing an introduction of AI and big data, then explore technologies targeted at combating COVID-19, then emphasize problems and issues connected with province technologies, and lastly make a recommendation for successful COVID-19 scenario reporting. This article intends to provide academics and the general public with important discoveries on how AI and big data might help with the COVID-19 issue, and also to encourage more research into how to control the COVID19 outbreak.

In [4] author mentions that rapid and reliable COVID-19 identification is enabled by a precise SARS-CoV-2 test, decreasing the pressure on healthcare organizations. Prediction techniques that combine several parameters have been developed to estimate the risk of transmission. These would be designed to assist medical workers across the world in tracking casualties, particularly in places with few healthcare facilities. They created a machine-learning system based on the data of 51,831 persons who had undergone testing. The statistics in the testing set came from the next week. With just 8 binary variables, the model can predict COVID-19 testing results with excellent accuracy: sex, age of 60 years, confirmed interaction with an infected person, and the emergence of five early clinical signs. Altogether, they built a model that predicts COVID-19 instances using simple characteristics obtained by questioning basic information, based on countrywide data publicly provided by the Israeli Ministry of Health. Whenever testing resources are insufficient, the methodology may be used to prioritize assessment for COVID-19, among several other things.

Deep learning has shown a dramatic increase in medical applications in general and specifically in medical image-based diagnosis. Deep learning models performed prominently in computer vision problems related to medical image analysis. ANNs outperformed other conventional models and methods of image analysis [7, 8]. Due to the very promising results provided by CNNs in medical image analysis and classification, they are considered as de facto standard in this domain. CNN has been used for a variety of classification tasks related to medical diagnosis such as lung disease [10], detection of malarial parasite in images of thin blood smear [11], breast cancer detection [12], wireless endoscopy images, interstitial lung disease, CAD-based diagnosis in chest radiography, diagnosis of skin cancer by classification, and automatic diagnosis of various chest diseases using chest X-ray image classification.

Apostolopoulos and Mpesiana[6] performed one of the first studies on COVID-19 detection using X-ray images. In their study, they considered transfer learning using pre-trained networks such as VGG19, MobileNet V2, Inception, Xception, and Inception ResNet V2, which are the most frequently used. Several evaluation metrics were used to evaluate the results obtained from two different datasets. MobileNet V2 and VGG19 achieved 94.40% and 92.75% accuracy, respectively, for two-class experiments (COVID-19/Normal and COVID-19/Pneumonia), and 92.85% and 93.48% for three-class experiments (COVID19/ Pneumonia/ Normal). The final conclusion was made by the authors using the obtained confusion matrices, not the accuracy results because of the imbalanced data.

In [14], the authors developed a deep learning model to predict COVID-19 using patients' CT images. Using deep learning, they have trained a neural network to diagnose COVID-19 using the patients' CT images. They have attained an accuracy of 76% using their model.

Barstugan et al. [15] provided early detection of coronavirus using machine learning methods through computerized tomography (CT) images. The feature extraction process has been applied for corrections to increase classification performance, and the wavelet transformation algorithm has been used to extract and classify features by SVM and obtain a 95.68% rating accuracy.

Ying et al. [2] The study was conducted on a sample of images from a CT scan of 88 patients who were infected with Covid-19, 86 healthy people for modeling and comparison, and 101 patients with pneumonia that were taken from hospitals in China, where the results showed high accuracy in identifying Covid-19 patients, reaching 93%. The patient can be diagnosed within 30 seconds, and thus the model achieves accurate and rapid identification of Covid-19 in human samples.

Work is done by evaluating a Convolutional Neural

Network (CNN) model that was built on a dataset of chest X-ray images collected from Kaggle so that it can accurately detect the effects of COVID-19 and demystify these uninfected people also collected our own dataset having patients' details of Dakshina Kannada region show the number of cases on that day using graph representation.

III. IDENTIFY, RESEARCH, ANDCOLLECTIDEA

Dataset Collection

The proposed system aims to predict Covid-19 from chest X-ray images using Deep Learning and Convolutional Neural Networks. The available first dataset was collected from Kaggle which is about normal, pneumonia, and covid chest x-ray images. The dataset had 1125 samples. The second dataset consist of total number death rate, active cases and recovery cases of Dakshina Kannada.

Convolutional Neural Network

The training phase is where the deep learning algorithms are used. For the proposed model, i.e., the CNN model, after data Preprocessing, we train the dataset with Convolutional Neural Network. Used the NumPy array data from data preprocessing to train the model.primarily focused on feedforward networks in that article, there are various types of neural nets, which are used for different use cases and data types.

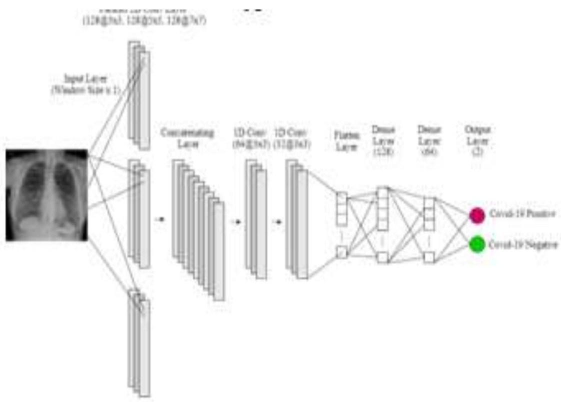

Fig 1: Architecture Diagram of Proposed Work

Trained sequential model with the parallel convolutional layer. Applied a parallel 2D convolutional layer to the input layer with 128 filters to the kernels of sizes 3, 5, and 7. We concatenate all the conv2D layers into a single layer with padding as same to get the convolution output size same as the input then reduce spatial dimensions using max pooling. Then we apply a convolutional layer with 64 and 32 filters to kernel size 3x3. For the activation parameter, we have used Relu to get either 0 or 1, depending on whether the input is negative or not. Then reduce spatial dimensions using max pooling.

Flatten the output of the convolutional layers into a single-dimensional array. This is connected to the 128 and 64 neurons dense layer, also called a fully-connected layer. To prevent the overfitting of the training data, we've added dropout layers with a dropout rate of 0.5. We've grouped the dataset into 2 batches by giving batch_size=2 since the amount of data is large and requires more storage space and given a total of 20 epochs for the training process.

The model summary given above shows the layers used in our proposed model and their types, namely convolution layer, flatten layer, dense layer, activation and pooling layer. The output layer will be of two neurons for the positive and negative results of COVID-19. So once the model is fully trained, the best model with the least loss and high accuracy is saved by setting save_best_only=True.

Algorithm:

Convolutional Neural Network

Step 1: Input data: for CXR real images, let x be input image and y be output label. y = {normal, pneumonia, and COVID-19}.

Step 2: Output data: for output label y, the result may return as normal, pneumonia, or COVID-19.

Step 3: Preprocessing phase: CXR images are modified to the height and width dimension of 256*256.

Step 4: Training Phase: for number of training iteration.

Step 5: Testing phase: output label is generated.

Flowchart

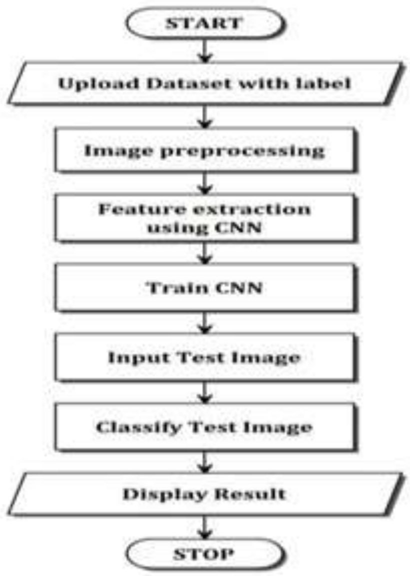

Fig 2: Flow chart of CNN model.

Methods

Dataset generation:

These open-source public datasets contain CXR images of COVID-19 positive patients, patients having pneumonia and other infections and healthy subjects. This data contains CXR images of different patients from which only the frontal images are considered and lateral images are discarded. This is because our region of interest is the lungs and lungs can be better examined with a frontal view than a lateral one. The original set of CXR images are labeled as COVID-19, Pneumonia, and Normal. However, for this work, have segregated the images into two broad categories—COVID-19 POSITIVE (referred to as class 0) and COVID-19 NEGATIVE (referred to as class 1). For Class 0 there are 125 images whereas for Class 1 there are 500 images of COVID negative patients.

Tools used
Project used PyCharm Community Edition 2016.3.2, python 3.5.4 and TensorFlow for the implementation of CNN, the deep learning library of TensorFlow is used, and the training and the testing procedures are done in the PyCharm Community Edition 2016.3.2.

Performance metrics
To evaluate the performance of the proposed approach, the metrics adopted are classification accuracy, sensitivity and F1-score, measured as follows:
Classification accuracy = TP + TN / TP + TN + FP + FN
Sensitivity = TP / TP + FN
F1 Score = 2 × sensitivity × precision sensitivity + precision
where TP stands for True Positive, FP for False Positive, FN for False Negative and TN for True Negative. In a confusion matrix, the COVID-19 +ve cases that are correctly classified by the model are termed as True Positive and incorrectly classified as COVID –ve are termed as False Positive. Similarly, COVID –ve subjects classified correctly are termed as True Negative and incorrectly classified as COVID +ve are termed as False Negative.

Figure 2 shows the plots drawn from the training and testing accuracy achieved by the proposed CNN model having epoch =20.

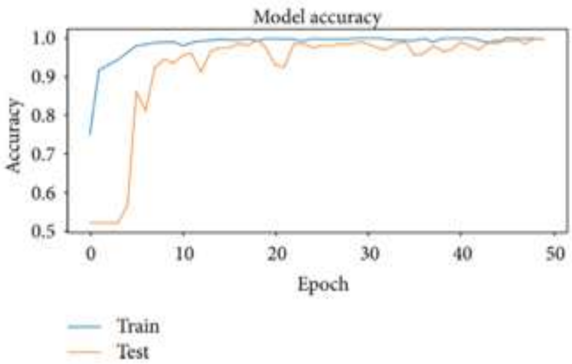

Figure 3: Training and testing accuracy plot achieved by the CNN model.

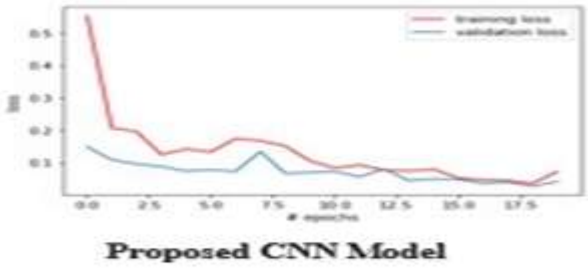

Figure 4: Training and validation loss of sequential model.

The loss rate of the best epoch in CNN i.e. sequential model is 0.04 whereas the loss rate of VGG-16 and MobileNet is 0.25 and 1.53 respectively.

IV. RESULTS & DISCUSSION

The important goal of this proposed model i.e. sequential model is to build an effective deep learning model which predicts COVID-19 disease with higher accuracy. Here, in this proposed model, we've collected a total of 1125 X-ray images of COVID and Non-COVID chest X-Rays.
Compared two pre-trained models with proposed CNN model (Sequential model) with a parallelization strategy. The two pre-trained models are VGG-16 and MobileNet. VGG-16 consists of 16 layers with millions of parameters. Here imported these two pre-trained models and used them for training purposes separately.Sequential models is used in this project and compared two pre-trained models with proposed CNN model with a parallelization strategy. The two pre-trained models are VGG-16 and MobileNet. VGG-16 consists of 16 layers with millions of parameters.

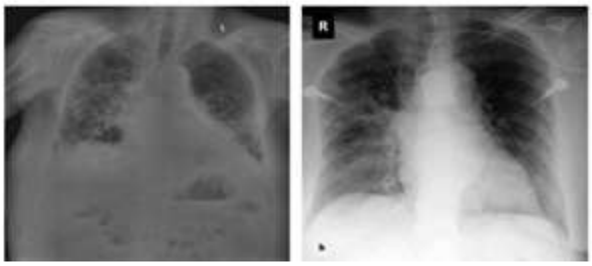

Figure 4: Covid-19 positive patient CXR pictures

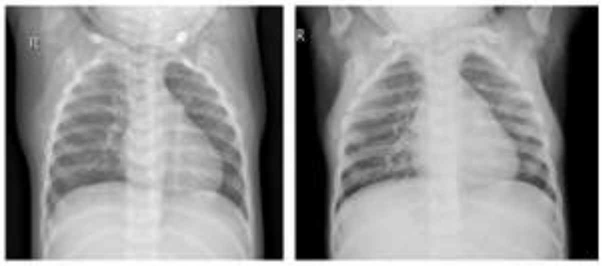

Figure 5: Covid-19 negative patient CXR pictures

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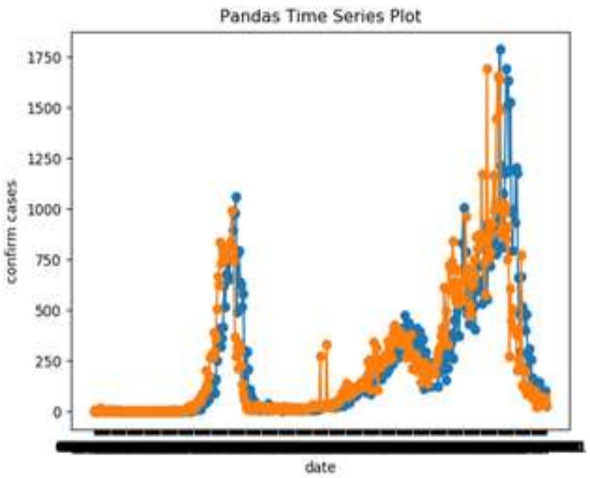

Figure 6: Output screen of conformed cases and recovery cases based on daily dates in Dakshina Kannada.

Figure 7**:** Output Screen

Figure 7 shows flask as a backend implementation and loaded in the model with the least validation loss from training.

V. CONCLUSION

COVID-19 is spreading rapidly throughout the world. COVID-19 can be detected by a lung infection of the patients. The standard method for detecting COVID-19 is the Reverse transcription-polymerase chain reaction (RT-PCR) test. But the availability of RT-PCR tests is in short supply. As a result of this, the early detection of the disease is difficult. The easily obtainable modes like X-rays are often used for detecting infections in the lungs. It is confirmed that X-ray scans can be widely used for efficient COVID-19 diagnosis in hospitals. But a physical diagnosis of X-rays of an outsized number of patients is a long-term process. A deep learning-based diagnosis process can help radiologists in detecting COVID-19 from X-ray scans. This paper proposes a CNN model that extracts the features in the X-ray images by applying filters through the images. After calculating accuracy from the above formula, got an accuracy of 93.3% and 91.6% for VGG-16 and MobileNet respectively which is lesser than that of Sequential model which has an accuracy value of 97.3%.

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