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Detection of Lungs Infection Using Convolutional Neural Network

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ABSTRACT

Many countries are challenged by the medical resources required for COVID-19 detection which necessitates the development of a low-cost, rapid tool to detect and diagnose the virus effectively for a large numbers of tests. Although a chest X-Ray scan is a useful candidate tool the images generated by the scans must be analyzed accurately and quickly if large numbers of tests are to be processed. COVID-19 causes bilateral pulmonary parenchymal ground-glass and consolidative pulmonary opacities, sometimes with a rounded morphology and a peripheral lung distribution. In this work, we aim to extract rapidly from chest X-Ray images the similar small regions that may contain the identifying features of COVID-19. This paper therefore proposes a COVID-19 detection model based on Convolution Neural Network for X-Ray image segmentation.The model begins by taking input image, it extract features of the image using CNN which further shows the prediction whether it is covid positive or covid negative. Finally, the model begins a classification and prediction process with a fully connected network formed of several classifiers. model explains an integrated bio-informatics approach in which different aspects of information taken from different data sources are put together to form the user friendly platforms for physicians and researchers. The main precedence of the Artificial Intelligence based platforms is to increase the process of diagnosis and the treatment of the COVID-19 disease.

Keywords : Covid-19, Deep Learning,Convolution Neural Network, Image Processing, X-Ray

I. INTRODUCTION

Due to the limited diagnosis tools available, many countries are only able to apply the COVID-19 test for a limited number of citizens. Despite the great efforts to find an effective way for COVID-19 detection, the required medical resources in many countries represent a big challenge. Accordingly, there is an urgent need to identify a low-cost and rapid tool to detect and diagnose COVID-19 effectively.

COVID 19 is an infectious illness triggered by the recently identified coronavirus virus. It was not understood until the outbreak in Wuhan, China, started in December 2019. The most frequent signs of COVID-19 include fever, tiredness, and dry cough. Pneumonia is a type of acute respiratory infection that

affects the lungs. The lungs are made up of little pockets called alveoli, which are packed with oxygen as a stable person breathes. When anyone has pneumonia, these alveoli are packed with pus and blood, rendering ventilation painful and therefore raising the absorption of oxygen.

Hence CNN becomes a natural candidate for diagnosis recommendation of COVID-19 patients. In seven different existing deep learning neural network architectures were compared using small data sets consisting of only 50 images.

In such scenario, Deep Learning techniques are artificial neural networks in which each layer has multiple neurons that function similarly to the neurons of the human body. Convolutional neural networks (CNNs) are one of the deep learning techniques that have proven to be successful and effective in the field of medical imaging classification. There have been several studies that have used CNN to diagnose pneumonia and other diseases based on radiography. CNN based architecture has been proposed in to identify different lung diseases. Hence CNN becomes a natural candidate for diagnosis recommendation of COVID-19 patients.By training convolutional neural networks (CNN) using these characteristics extracted from X-ray images, we could accurately predict COVID19.

The results are encouraging and demonstrate the effectiveness of deep learning, and more specifically, transfer learning with CNN to the automatic detection of abnormal X-ray images from small datasets, related to the Covid-19 disease.

Some researchers have proposed new architectures of CNN, or fine-tuned ResNet50 for the problem of classifying Chest X-Rays.

II. METHODOLOGY

In this section, we first describe the dataset used in the study, followed by the proposed CNN. The definition of the input data and desired outputs prior to the actual methods provides a better definition of the problem and thus a better understanding of the methods.

A. Collection of Dataset

We set up a database composed of three classes of chest radiographic images. The first class is made up of images of patients declared positive for COVID-19 that we collected from the database published by Cohen . This database contained 230 images is open to various researchers to add new images or to use the already existing images. The second class consists of 100 images of patients declared normal without any pneumonia. A first learning group noted internal validation containing 80% of the images of the constructed base. The second group noted external validation will be formed by 20% of the images of the base constructed plus ten images provided by our radiologist colleagues and will be used for the validation of our proposed CNN model.

B. Deep Learning Algorithm

Deep learning has special techniques which functions like neurons of human body called as artificial neural network in which each layer has multiple neurons. CNN is a very powerful algorithm which is widely used for image classification and object detection. CNN algorithm train on large database such as ImageNet. ImageNet need not to train on first few layers. Upper layers is used to match current problem which is called Transfer Learning which is discuses in next paragraph. In this model we are going to use pre-trained CNN models on the ImageNet database which reduces the need to train the data from scratch. A pre-trained model is useful when there is time boundary , every-time it is not possible to build the model from scratch that why pre-trained model come into existence. Image Net in one of most wide, large ,real-

world database with the help of these pre-trained models weights obtained are then transferred to the specific CNN model which going to use transfer learning technique.

C. Transfer Learning

Transfer learning is the type of machine learning Transfer learning has capacity to create new artifificial intelligence model by existing neural network. So by using it as base for new model .

In deep learning, this process involves the initial training of a CNN for a specific task , utilizing large-scale datasets. The availability of data for the initial training is the most vital factor for successful training since CNN can learn to extract significant characteristics of the image. Depending on the capability of the CNN to identify and extract the most outstanding image features, it is judged whether this model is suitable for transfer learning.

D. Training of CNN model

We will be using Keras framework with Tensor Flow . Keras provides pre-trained weights from the ImageNet database on these pre-trained mmodel. ImageNet database on which our model is based may not similar to images but it help to make task more efficient. It also help to reduce requirement of large volume date for training. We are using Adam algorithm optimization which is next version of stochastic gradient descent and Adam is getting more and more popular in recent days and has seen border adoption for deep learning application. Further will be using ReLu activation function as it is most commonly used activation function for the output of CNN neurons.

As the current dataset is to large we will be requiring high computational power for training our CNN model. The accuracy of our model will be depending on our optimization algorithm which will be used. The performance of the models which we will be using will be measured on parameters like accuracy, specificity, precision and recall/sensitivity. It is a great advantage for us that today large number of datasets is available. With this available dataset further we will be implementing a system which will be used for detecting COVID-19 and differentiate between Bacterial Pneumonia and COVID-19 Pneumonia.

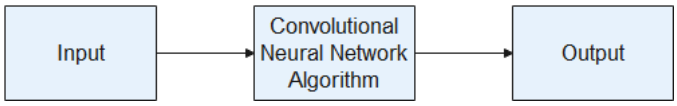


Fig. 1.

E. Image pre-processing and Feature

Image pre-processing and feature Extraction is technique are needed for any image based application. The aim of Image pre-processing technique is to remove background of image with lot of noise. In our application raw size of image is 1012 * 974. First step of Image pre-processing is to pruning images with cropping the background and newly generated is 140240 pixels. In addition, the median filter is applied. After removing the noisy images, a dataset with images for three labels COVID-19, PNEUMONIA and NORMAL with given images in each label was extracted.

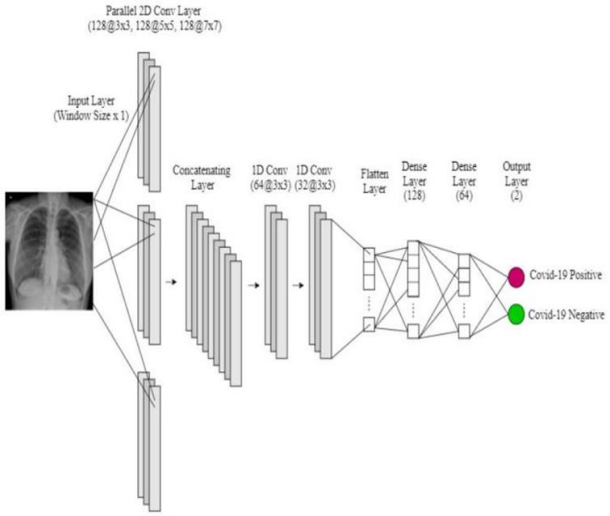


Fig. 2.

III. RESULTS AND DISCUSSION

Focusing on the possibility of the ANN application for analyzing COVID-19-related infection problems, such as high-risk patients, control of the outbreak, recognizing and radiology, we used CNN, Deep Leaning to suggest several AI-based methods. Advanced machine learning algorithms can integrate and analyse large-scale data related to COVID-19 patients to facilitate a deeper understanding of viral spread pattern, improve the speed and accuracy of diagnosis, develop fresh, effective therapeutic approaches, and even identify individuals who, depending on their genetic and physiological features, are most susceptible to the disease. Despite much praise that such data has received because of its role in improving efficiency, productivity and processes in different sectors, it has been criticized for its small number of users who collect, store, manage the data and have access to them.

However in this model the first step is to collect datasets from various sources. The Data sets are then used to train the CNN model which is called pre-processing. In the last step CNN based model extract the features of the , using various layers of CNN. The various Layers used in CNN are concatenation Layer, 1D convolution, 2D Convolution layer, Flatters Layer, Dense Layer, and Output Layer.

The first layer i.e., concatenation layer takes the input and concatenates them along a specified dimension. The inputs must have the same size in all dimensions. 1D convolution layers recognize local patterns in a sequence which is further passed on to 2D Convolution Layer. Flatten layer in CNN converts the pooled feature map to a single column that is passed to the fully connected layer. Dense layer further adds the fully connected layer to the neural network.

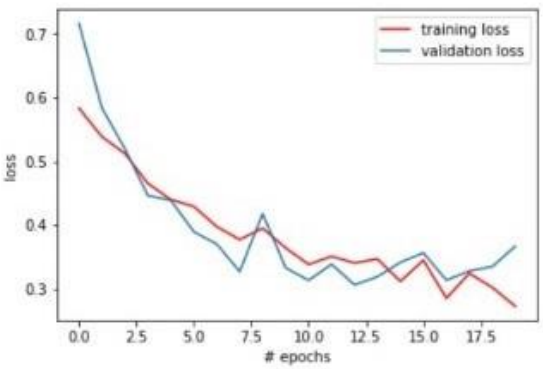
The model is for the prediction which is the classification of the best treatment method. The model shows the accuracy which varies from 90% to 97%. Convolutional Neural Network seems to be good options for classification, process, and prediction according to time series data because lags of unknown duration may take place between major events in a time series.

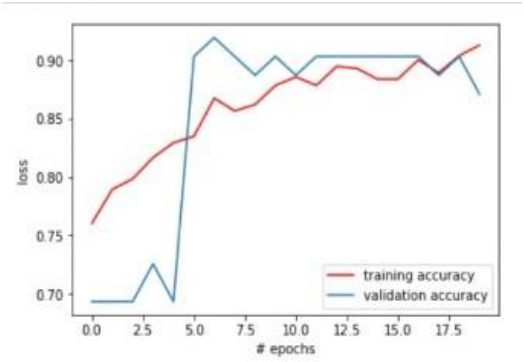
TABLE I

Sr. no	Comparative study of classifiers model based features is shown in the table 1 Table 1 :Analysis of literature survey			
	Paper Name	**Methodology**	**Result**	**Author**
1	Deep Learning based Diagnosis Recommendation for COVID-19 using Chest X-Rays Images	Deep Learning, Convolutional Neural Network ImageNet	89%	Rachna Sethi,Monica Mehrotra and Dhaarna Sethi
2	Artificial Intelligence based COVID-19 classification by using Deep Learning and Convolutional Neural Network		90%	Pallavi Shimpi, Omkar Gaikwad[1],Divyanshu Tripathi[2], Madhuri Dange[3] ,Harshada Mohite[4],Prof.
3	Development of a clinical decision support system for the early detection of COVID-	3 step architecture - preprocessing of input images, feature extraction and use of	80%	M. Qjidaa , A. Ben-fares , Y. Mechbal ,H. Amakdouf , M. Maaroufi , B. Alami

	19 using deep learning based on chest radiographic images	fully connected network for classification and prediction.		,H. Qjidaa Sidi Mohamed Ben Abdellah University. Faculty of Science Dhar El Mehraz Fez,Faculty of Medicine and Pharmacy Fez
4	Iteratively Pruned Deep Learning Ensembles for COVID-19 Detection in Chest X-Rays	use of iteratively pruned deep learning model ensembles for detecting pulmonary manifestations convolutional neural network and a selection of ImageNet pre-trained models	90%	Sivaramakrishnan Rajaraman , Jenifer Siegelman ,Philip O. Alderson, Lucas S. Folio, Les R. Folio And Sameer

Performance Analysis






```
Train on 551 samples, validate on 62 samples
Epoch 1/20
551/551 [==============================] - 465s 844ms/step - loss: 0.5833 - accuracy: 0.7604 - val_loss: 0.7161 - val_accuracy:
0.6935
Epoch 2/20
551/551 [==============================] - 180s 327ms/step - loss: 0.5385 - accuracy: 0.7895 - val_loss: 0.5836 - val_accuracy:
0.6935
Epoch 3/20
551/551 [==============================] - 204s 370ms/step - loss: 0.5122 - accuracy: 0.7985 - val_loss: 0.5197 - val_accuracy:
0.6935
Epoch 4/20
551/551 [==============================] - 188s 342ms/step - loss: 0.4652 - accuracy: 0.8167 - val_loss: 0.4463 - val_accuracy:
0.7258
Epoch 5/20
551/551 [==============================] - 179s 324ms/step - loss: 0.4400 - accuracy: 0.8294 - val_loss: 0.4387 - val_accuracy:
0.6935
Epoch 6/20
551/551 [==============================] - 224s 407ms/step - loss: 0.4290 - accuracy: 0.8348 - val_loss: 0.3894 - val_accuracy:
0.9032
Epoch 7/20
551/551 [==============================] - 248s 449ms/step - loss: 0.3975 - accuracy: 0.8675 - val_loss: 0.3701 - val_accuracy:
0.9194
Epoch 8/20
551/551 [==============================] - 292s 530ms/step - loss: 0.3771 - accuracy: 0.8566 - val_loss: 0.3269 - val_accuracy:
0.9032
Epoch 9/20
551/551 [==============================] - 213s 387ms/step - loss: 0.3950 - accuracy: 0.8621 - val_loss: 0.4178 - val_accuracy:
0.8871
```

IV. CONCLUSION

This paper on the proposed clinical support system for the early detection of COVID-19 using deep learning based on chest X-ray images. This methodology also differentiates the patients suffering from pneumonia and COVID-19 as both have the same symptoms and patients usually got confused between the two. Detecting COVID-19 using X-Ray is much cheaper than the medical COVID-19 test kit and as fast as the current thermal imaging technique. The model will be much more accurate and useful in current situation.

This model particularly focuses on prediction of covid-19 positive and negative symptoms but if there some other symptoms then it will not be able to distinguish it into another disease.

The results suggest that CNN based architectures have the potential for the correct diagnosis of COVID-19 disease. Transfer learning plays a major role in improving the accuracy of detection. Fine-tuning of these models may further improve the accuracy. Other pre-trained models may also be explored for building a recommend-er diagnosis system.

V. FUTURE SCOPE

Future work may include developing new architectures based on CNN for the detection of COVID-19 as well as other diseases in the medical domain. The model can detect the new disease by training and testing and adding categorized dataset of that particular disease.

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