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# Non-contact advanced method of COVID-19 classification using deep learning with chest x-ray images

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*Abstract:* The first appearance of the novel coronavirus (COVID-19) was on December 31st 2019, in the Wuhan City of China. This novel coronavirus (COVID-19) spread rapidly around the world, thus causing a pandemic. The most devastating effect was caused on the daily lives, global economy and public health system. In order to treat the affected patients quickly the most critical step is to detect the positive cases in much advance period of time in order to help prevent further spread of this disease. With the help of the recent findings, it has been found that the radiology imagining techniques contain the salient information about this virus. The advanced Artificial Intelligence (AI) technique coupled with this radiological imaging has found to be helpful for the accurate detection of this novel coronavirus (COVID-19) disease. This is an advanced application which is helpful for the study of this paper. In this study, the new model used for the detection of this coronavirus (COVID-19) by using the raw chest X-ray images automatically. This proposed model provides accurate diagnostics for binary classification (COVID-19 vs normal) and also the multi-class classification (COVID-19 vs Normal vs Pneumonia). The classification accuracy from this proposed model is about 98.09% for binary classes classification and 87.03% for multi-class classification.

*Keywords:* Coronavirus (COVID-19), Classification, Chest X-ray images, Deep Learning.

## I. INTRODUCTION

Coronavirus (COVID-19), which was reported in Wuhan Hubei province of China on December 31st 2019, causing unknown reports of pneumonia became a pandemic in no time across the world. This virus is termed as Severe acute respiratory syndrome coronavirus-2 (SARS-COV-2) and the disease is called COVID-19. This is a new virus which was spreading rapidly across China in a span of about 30 days. Not only was this virus spreading in China, it was spreading in other countries as well. For example, United State of America reported the first eight cases in January 2020, with the rapid increase it reached over 200,000 cases by April 2020. Coronavirus (COVID-19) was spreading rapidly as it is a very easy human transmitted virus. It is spread due to the respiratory droplets of the infected person via cough, sneeze or by speaking. Another main cause is by touching a surface which is contaminated and the touching their eyes, mouth or nose without sanitizing the surface or hand. Studies have found that the most severe symptom is the respiratory disease where the lung are infected, this can cause death in human. The other of this virus include fever, sore throat, fatigue, cough, headache, shortness of breath and muscle pain. The test which is currently used for diagnosis of COVID-19 is real-time reverse transcription polymerase chain reaction (RT-PCR). X-ray images have a vital role in early detection, diagnosis and treatment of this virus. Chest radiological images such as Computed tomography (CT) play a vital role in the detection of this virus. Since RT-PCR has low sensitivity which is about 50-60%, so even if the test detects the result as negative, symptoms of this virus can be detected by inspection of the radiological images of the patients. Also, CT is sensitive as well in detecting the result of COVID-19 pneumonia so it is used as a screening tool with RT-PCR. Suppose a patient has done a CT scan, it will show a result of normal CT image for the first 2 days, the right CT findings are noticed over a long interval of time after the onset of symptoms. In 2019 and 2020, there was lack of test kits, so doctors were encouraged to diagnosis and treat based on the chest CT result. CT is widely used for COVID-19 detection across various countries for example Turkey, where very few test kits were available during the pandemic. A study based on the lung CT scan of patients who have survived COVID-19 pneumonia resulted in noticing the lung disease after 10-11 days. This study also assessed the accuracy of chest imagining of people of any age group who have high suspicion of being infected by COVID-19. Thus, the information obtained i.e., the radiological images is useful for this study. As stated by researchers, these images combined with the lab results can help in early detection of COVID-19 which is the main approach of this study. In this study, a supervised deep learning model to detect COVID-19 infected regions using chest CT image data. In result, this test classifies as COVID-19, normal and pneumonia.



 

## II. RELATED WORK

There is abundant work related to the field of COVID-19 disease using Kaggle dataset, to predict the disease.

- Siti Raihanah, Mohd Asyraf and Nuraisyah [1] stated that SPP-Covid-Net method achieves a better mean accuracy than bench-marked model. It has been known as the one of the most lightweight models with about 973,34 total number of parameters. Being of the most stable algorithm which produces an accuracy reading within the range of [0.837, 0.867]. SPP-Covid-Net strength is attributed with the ability to be able to process multiscale feature, due to any SPP-model integrate. This proposed algorithm is known to be suitable for phone appliances fastening the process of screening of the result of COVID-19.
- Tulin Ozturk and Eylul Azra [2] proposed a deep learning-based model which detects and classifies COVID-19 cases from X-ray images. This model has an end-to-end like structure which is completely automated without the need for extracting the features manually. The system provides both binary and multi-class task with about an accuracy of 98.09% and 87.03%. This system can test larger database by the experts giving a better performance level.
- Abdul Ella and Hassan Ella [3] proposed the deep studying based on the methodology of detection of COVID-19 infected patients using X-ray images. This classifies the affected corona patient using X-ray images, with the help of a gadget. This system has a multi-level thresholding which sums the classification and gives a High accuracy of the infected lung containing this virus. Thus, the proposed model gives a result of about 95.77% and 97.49% respectively.
- Sohaib Asif, Wenhui, Jin, Tao and Si Jinhai [4] proposed a deep transfer learning model with the use of chest X-rays images. This is the approach where the X-ray images are obtained from COVID-19 patients, normal and pneumonia. Thus, this proposed model for the classification and detection of COVID-19 achieves a accuracy of more than 96%.

## III. METHODOLOGY

The step that this system follows are Preprocessing, Feature selection, Feature extraction, Classification & Staging

### *A. Data Set:*

The dataset is collected from Kaggle which contain three types of data which are COVID-19, normal, pneumonia. This dataset contains the CT images of patients. An example of the dataset is shown below-

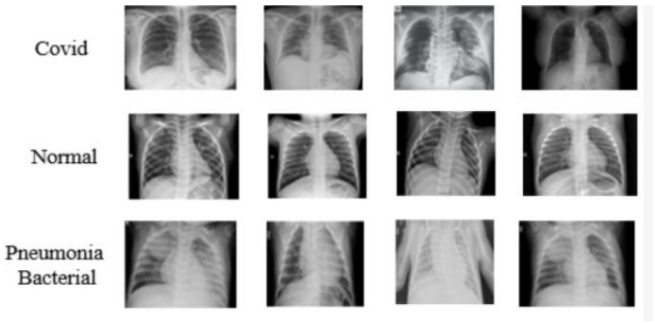


**Fig 1- COVID-19, Normal and pneumonia Images**

### *B. Pre-processing:*

The image is collected from the above Dataset and the affected part from the image in the dataset is extracted. This extracted image is without any blurriness and any noise. This part is then applied with some pre-processing methods like Histogram Equalization, noise removal, Filtering, Enhancement, etc. Python software is being used for the most pre-processing of the image. The main aim of pre-processing is to selectively remove any redundancy which is present in the scanned images. This process of pre-processing shouldn't affect any vital information or detail which could be playing a role in the diagnostic process. The pre-processing is done on every image in order to improve its quality. The application of pre-processing is as follows-

- Histogram Equalization is used for enhancing the image contrast.
- Filtering is required to remove any effect caused due to noise, glare and any other effected bad lighting condition during the capturation of image. The pixel value is replaced by median pixel value by generating low- frequency image.

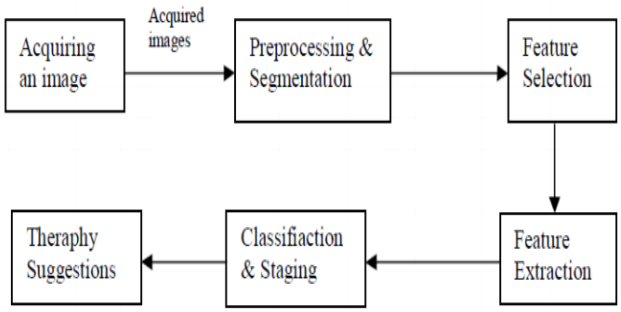


**Fig-2 Block diagram of proposed system.**

The above figure 2 shows the block diagram of the proposed system. Initially images of CT scan are acquired. It is known that the scanned or medical images cannot have high resolution because of the number of slices in each pixel which contains noise. In order to overcome this, the image is pre-processed by applying the techniques such as Filtering and Histogram equalization. This step removes the noise and also enhances the image. The images are labelled. Next, the labelled images is segmented which gives the right portion of the infected region. Then this region is selected and extracted using CNN algorithm and stored in the database for classification. The images are classified as COVID-19(one


 

folder), Normal (one folder), pneumonia (one folder). After classification next step is training.

### *C. Feature Selection:*

Feature (Variable) selection is used for selecting a small set of relevant features for use. Once the pre-processing is done then this step selects the feature from the pre-processed image, using one of the best algorithms for selecting the feature for medical images which is genetic algorithm

### *D. Feature Extraction:*

Feature Extraction is a process where once the features are selected in the feature section process, it is extracted. This process involves classifying the resources which are required from a large dataset accurately. This step is a very important step as it uses algorithms and technique suitable to detect the desired shape and required portions. So, in this module, the selected features i.e., the affected portion of the image is extracted.

### *E. Classification:*

Classification of COVID-19 is where the research has key procedures which is useful for establishing and also for assigning a certain set of forms to the pre-defined dataset provided containing Machine learning models. Using this Machine learning technique, the identification of positive cases was defined using the Chest X-ray images and were classified as COVID-19, normal and pneumonia.

Algorithm:

#### *I. Convolutional neural network (CNN):*

The data training in this CNN model has to satisfy following constraints:
1) There should be no missing values in the dataset.
2) The dataset must distinctly be divided into training and testing sets, either the training or the testing set shouldn't contain any irrelevant data out of this model domain in case of an image dataset all the images must be of the same size, one uneven distribution of image size in the dataset can decrease the efficiency.
3) The images should be converted into black and white format before feeding it into the convolution layer because reading images in RGB would involve a 3-D NumPy matrix which will reduce the execution time of our model by a considerable amount.
4) Any kind of corrupted or blurred images should also be trimmed from the database before feeding it into the neural network.

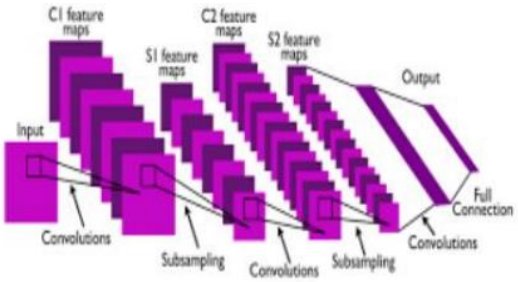


**Fig 3- CNN layers**

#### *II. Convolution layer:*

This layer is the first layer here multiplication happens. Input images are already trained images where the whole image is scanned in the form of 3x3 matrix. Resulting in pattern formulation. The image which is convolved in this matrix is called kernel.


**Fig 4- Convolution layer**

#### *III. Pooling Layer:*

After convolution is the pooling layer where the breaking down of image matrix takes place resulting in 4 sets of segments which are non-overlapping. The two types of pooling are Max pooling which gives the largest value from the matrix portion and average pooling which gives the average value from the matrix portion. These are in rectangular shapes. This layer gives the exact image.

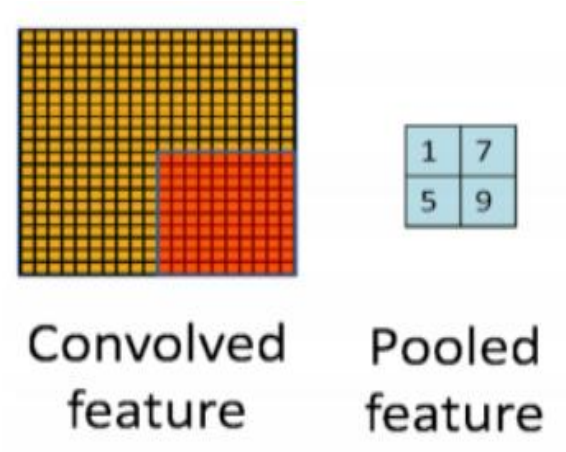


**Fig 5- Pooling layer**

#### *IV. Activation layer:*


 

This is a part of Convolutional neural network in which the vales have been Normalized in an accurate range. In this the convolutional function is ReLU, which accepts positive values and converts negative values to zero.

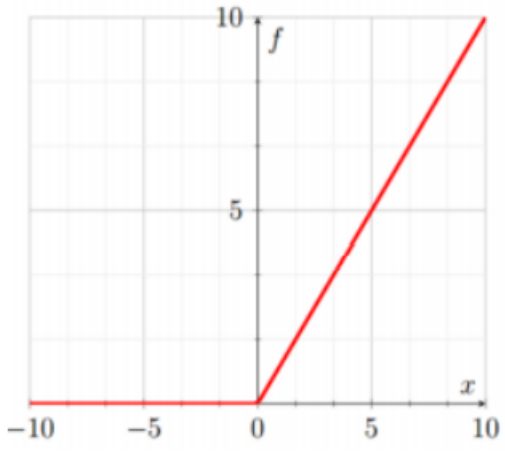


**Fig 6- ReLU function**

### *V. Fully connected layer:*

This is where the output is predicted. Here the selected features are compared with the test image and any other similar features containing in the associated label. This label is encoded in numbers for ease in computation. Here the features are compared with the features of the test image and associate similar features with the specified label. The labels are encoded in the form of numbers for the computational ease. Once the output is predicted it is then converted into strings respectively.

## IV. RESULTS AND DISCUSSION

As a result of this model, we get a classification accuracy of about 95.3%, Following images are the result showing if its covid, normal or pneumonia.

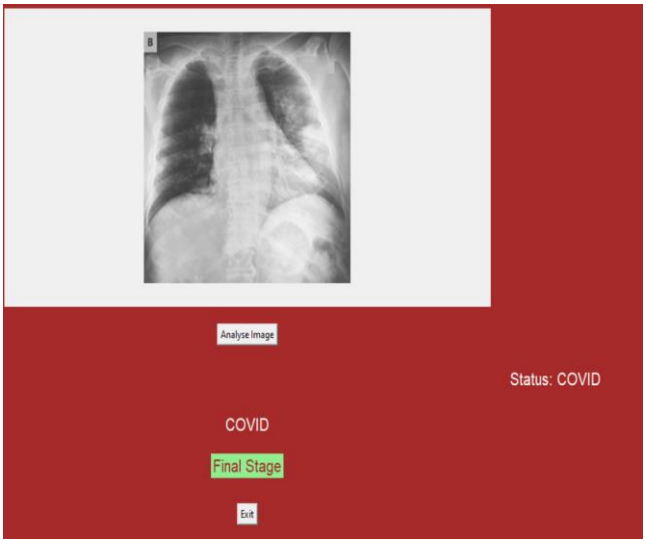


**Fig 7- Analysis image as COVID-19**

The accuracy of the result is shown in the below accuracy matrix graph.

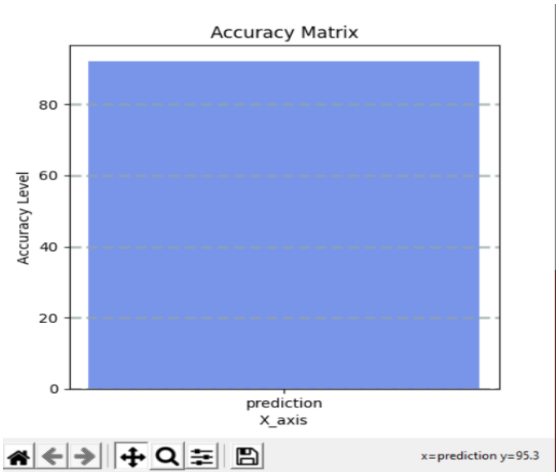


**Fig 8- Accuracy matrix for COVID-19**

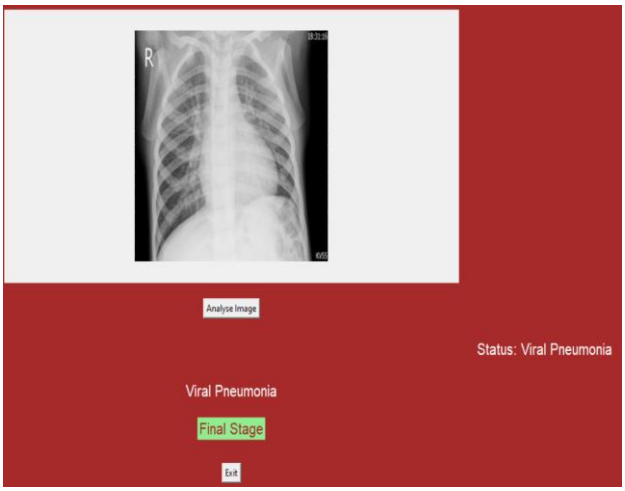


**Fig 9- Analysis image of Pneumonia**

The accuracy of the result will be the same.



 

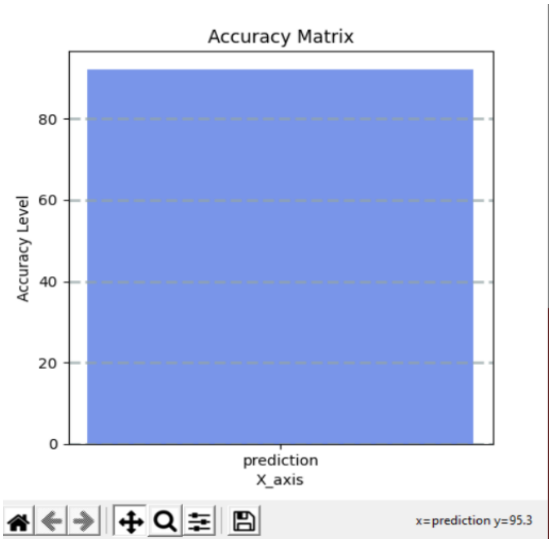


**Fig 10- Accuracy matrix for pneumonia**

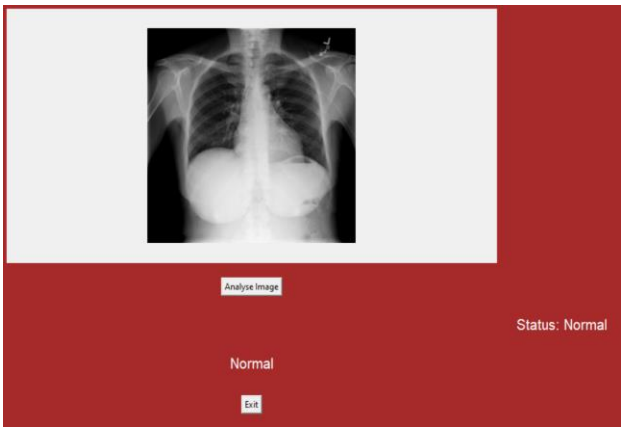


**Fig 11- Analysis image of Normal**

## V. CONCLUSION

Early diagnosis is essential for early intervention to the patient and to prevent the risk of quick transmission. For this purpose, chest x-ray images were used obtained from COVID-19 and non-COVID-19 patients. These images are classified using the CNN algorithm. The classification accuracy is been calculated with a high accuracy of 96%. This model can be used in today's worlds during the pandemic. The result is promising and encouraging in terms of clinical practice and computer-aided. This indicates that the model is great at distinguishing between X - Ray slices with no COVID nodules compared to the ones with COVID-19.

## VI. ACKNOWLEDGMENT

I would like to express my gratitude to my guide Dr. Viswanath R.H for giving me this valuable opportunity to do this project on the topic of non-contact advanced method of Detecting COVID-19 cases using deep neural networks with chest x-ray. This project helped me to acquire knowledge about many new topics and I could learn new things.

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