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# Deep Learning Based Chest X-Ray Image as a Diagnostic Tool for COVID-19

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***Abstract*—The COVID-19 pandemic has a rapid spread across the globe, which has deployed life threatening complications ever since it started from China in December 2019. A quick detection of positive cases on corona virus will prevent the further community spread and initiates a earlier treatment to common man. In Recent findings, the images of Chest X ray and CT scan have shown salient features that illustrates the severity of corona virus in lungs. Scientific advancement of Artificial Intelligence in deploying a deep learning based medical field is remaining powerful to handle a huge data with accurate and fast results in medical imaging to diagnose diseases more accurately and efficiently with further assistance in the remote areas. Proposed method is developed for analyzing chest X ray images to detect COVID-19 for binary classes with an accuracy of 99% and validation accuracy of 98%, where the loss is approximately 0.15% by using convolution 2D techniques that are applied on the open source datasets of COVID-19 available at GitHub and Kaggle.**

***Index Terms*—Covid-19, chest X Ray image, Radiology images, deep learning, convolution neural network, datasets.**

## I. Introduction

As the novel Corona virus is declared as global emergency by World Health Organisation (WHO) were most of the cases it is affecting the lungs, Radiologic work is extremely crucial for diagnosing the patients [1]. In most of the Countries due to exponential rise in cases precautionary measures like hygiene, social distancing and isolation is the solution [2]. The COVID-19 is Severe Acute Respiratory Syndrome cause fever, cough, and illness in respiratory system lead to infection or inflammation of air sacs in lungs plays an important role in oxygen exchange may be responsible to Pneumonia is highly in transmissibility [3] [5]. Severity depends on weak immune system, chronic diseases, smoking or elderly. Treatment depends on infection requires antibiotics, pain reliever or medicine. If the condition of patient is complicated need hospitalisation connected with ventilator support system to make breathe easy [4]. Due to limited (RT-PCR) Real Time Reverse Transcription Polymerase Chain Reaction testing kits are time consuming for results, radiology is in forefront for deciding the treatment and preventing spread with less chance of false negatives [6]. Radiology imaging of Chest Xray and CT scan of lungs are most prominent in ground glass opacities found in pulmonary vessels or bronchial walls shown an alert in COVID -19 infected people [7]. Though the patient in ICU(Intensive Care Unit) are highly infectious x-ray is safe and economical than the CT scan with less exposure to radiation. Chest Xray is a gold standard for pneumonia diagnosis of lungs findings from X ray images and also diagnose abnormalities like Atelectasis, Cardiomegaly, Edema, Effusion, Emphysema, Fibrosis, Infiltration , Mass, Nodule, Pleural Thickening and Pneumothorax. This Chest X Ray used as a gold standard for diagnostic applications to Lungs, Airways, Heart, Blood Vessels, Chest, spinal cord and Bones produce image. It is a non-invasive tests facilitates physicians to treat. This imaging involve a small dosage of ionizing radiation exposed to body part inside produce images identify breathing difficulty or persistent of cough or chest pain or injury or fever. X ray machine consists of X-ray tube connected to fixed or flexible arm placed six feet away to the patient, x-ray film holder or an image recording plate records image digitally which is placed underneath the patient. Complete process takes approximately 15 minutes and a painless procedure as shown in Fig 1. Availability of open sources in deep learning based methods are observed fast and accurate testing for COVID-19 the radiology images are visual indications of abnormalities as primary tool for screening.

Fig. 1. X ray Procedure

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The Covid chest Xray dataset from GitHub with COVID-19 Pneumonia Severity Scores (Mean of 3 expert raters). The extent of lung involvement by ground glass opacity or consolidation for each lung of total extent score ranged from 0 to 8 for geographic extent mean. The degree of opacity as total opacity score ranged from 0 to 6 for opacity mean. The chest X ray in Posteror Anteroir projection view by passing the Xray beam with patient in standing position for diagnosing acute and chronic conditions of all organs in thoracic cavity [8], [9].

The main aim is to identify pneumonia in different datasets in worldwide distribution types of classification and analysis [10]. Analysis of chest xray image is observed texture is one of the main visual attributes [11]. According to Seung Hoon Yoo etal. used CNN for the retrieval of three-level decision-tree classifier with 80 % accuracy [12]. In Samir Kumar Bandyopadhyay study used Long short-term memory (LSTM) in deep learning [13] compared the results recheck with clinical doctors. Charmaine Butt et al implemented on CT images in 2D and 3D models using CNN [14] were the data was low. To retrieve features by the popular textures by pretrained model using two dimensional CNN(Convolutional Neural Networks) model for learning was the major issues in the above methods.

## II. Methodology

In the proposed method 2D CNN network is implemented for feature and classification though CNN proved success in solving problems in medical imaging. Training very large medical data having many parameters but limited number of samples have a problem of overfitting can be well adapted by CNN. It has a reduced the number of parameters to learn by a simple network to speedup training on a selective typical value. From the input image pixels are used directly to feed forward network for image classification. CNN models works faster than the traditional fully connected networks [15], [16]. For 2D image classification either one or more channels(matrices) at the input generate multiple output matrices. Aj output matrix is computed as in Eq:1.

$$A_j = f(\sum_{i=1}^{N} I_i * K_{i,j} + B_j) \quad (1)$$

Input matrix Ii convoluted with kernel Ki,j and sum of convoluted matrix a bias Bj is added to produce only one output matrix Aj with an application to nonlinear activation function f. Every set in kernel matrix extract regional feature from input as local feature helps in learning to classify image. Back propagation optimises by connecting weights to train kernel matrix and bias of neural network. In the proposed method fine grained visual features like texture and sharpness is considered for identification of COVID in X ray image. Pooling layer has very important role in reducing feature dimension in output convolution layer by combining the neighbouring elements. Here max pooling with kernel 2 X 2 size produce highest value from input matrix of 4 neighbour elements were if any error

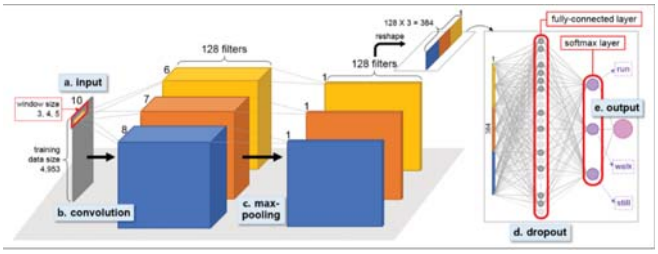


Fig. 2. Convolution Neural Network Architecture

gradient in the signal received is enrouted back. This feature extraction taken from the input data set for decision making, it consists of stacked convolution blocks, activation function and pooling layer. It is connected to classification through fully connected layers and SoftMax layers. A nonlinear transfer function is an activation function in neural networks. In non saturated nonlinear function output gradient reduces to zero with respect to the increase in input. RELU layer is a activation function applied elementwise, with max(0,x) threshold at zero produce size of image unchanged improves learning speed and performance in classification by 2.5%. Pooling layer is inserted periodically in between convolution layers which functions as progressively reduce spatial size, parameters and computation to control overfitting. It independently operates on the input and resize it using MAX operation as shown in Fig. 2 Fully connected layer connects to all activation of the previous layer as its activation are computed with simple matrix multiplication and bias offset. In the proposed method binary classification is used since in the dataset only two cases like COVID positive or normal is identified. Though the corona is recent outbreak attracting many researchers attention on image analysis using deep learning models. Presently scientific evidences and challenges globally are considered as vital references for study and development into economical automated models of hardware and software to reduce the risk and fast analysis for the medical front line worriers.

## III. Results and Discussions

The data set used for the implementation of the proposed work is from GitHub containing 60 images where 30 are normal and 30 COVID positive images [13]. If considered the raw chest X Ray image consists of the gray image and its pixel intensity distribution is as shown in Fig 3a & 3b.

The COVID-19 chest X Ray images day wise are as shown in Fig. 4 is observed on chest Xray images the multi focal Ground Glass opacification, visible intralobular lines (crazy paving) though the Xray images have low sensitivity.

The classifier and extraction of the features are implemented using the convolution neural network with architecture is sequential using activation function as ReLu for 32 bit image and adjust the weights in such a way with backward feedback to create more and more accuracy in the output . The pooling layers is by maximum elements from features will reduce dimension features by half also called as sub sampling followed by flattening layer to reduce image to one dimensional vector



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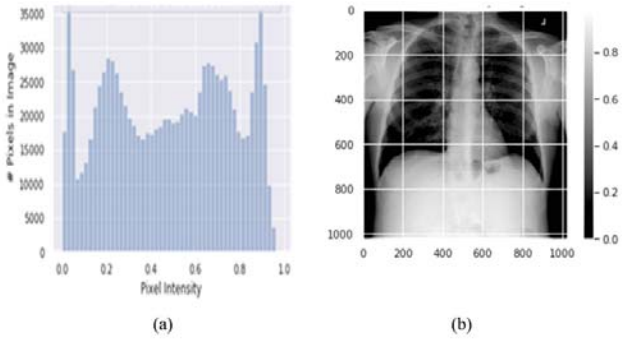



Fig. 3. a. Distribution of pixel intensities in image b. Normal Raw Chest X ray image

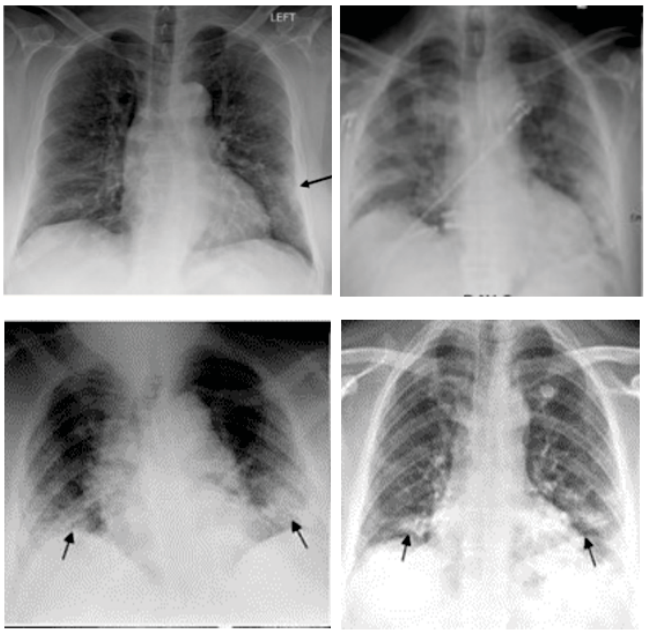



Fig. 4. Covid-19 images day wise

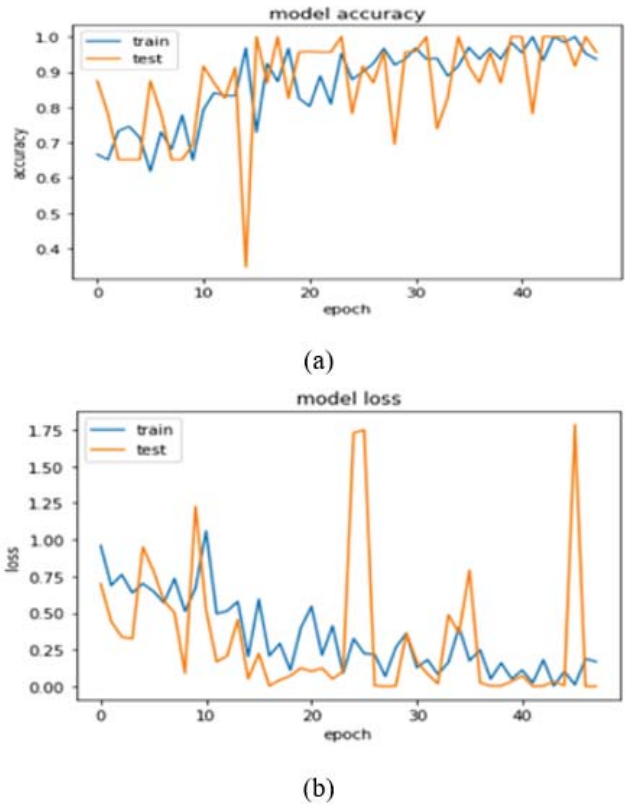
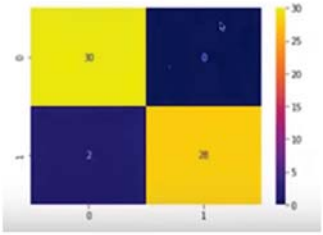



Fig. 5. a. Accuracy plot of training and testing from dataset b. Loss plot of training and testing from dataset



| | | Actual | |
|---|---|---|---|
| | | Positive | Negative |
| Predicted | Positive | TP (30) | FP (0) |
| | Negative | FN (2) | TN (28) |

Fig. 6. Confusion Matrix

to fed into neural network. For better optimisation dropout layer is created with reduced density. Training the model using Fit model using optimal values with training data and test data in a ratio of 80:20. Convolutional neural network shown very good response through increased accuracy in image processing application on training and test datasets as the number of echoes have increased the accuracy as shown in Fig. 5 a and the loss is observed in Fig. 5b and further the confusion matrix is shown in Fig. 6.

In Machine learning to design a best fit model accuracy, precision plays a major role. The True positive is a prediction on the test data and its outcome is correct, if incorrect depicts true negative.

Similarly if the prediction is false outcome is positive then false positive otherwise false negative. The confusion matrix shows the summary of prediction results to classification problem for any errors made on a set of test data by visualization as class-0 as non COVID case and class-1 as COVID positive. The True Positive(TP) is 30 and True Negative(TN) is 28, False Negative(FN) is zero and False Positive(FP) is 2. Therefore classification accuracy is 96% specifies the model is correctly classified and precision is 100% clarifies the detection of COVID positives. The accuracy and precision are calculated from (2) and (3).

$$Accuracy(A) = \frac{TN + TP}{TN + FP + TP + FN} \tag{2}$$

$$Precision(P) = \frac{TP}{TP + FP} \tag{3}$$



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The results were given a confidence in performing the experiment to analyse COVID-19 images to identify in very less time of approximately half an hour instead for awaiting for days through RT-PCR. By applying convolution neural network at least 20 iterations producing close accuracy for training set of 99.2%, validation accuracy of 98.3%, loss 0.3%, sensitivity of 99.1%, a specificity of 98.8%, and a precision of 100% was achieved by detecting COVID-19 images from normal gold standard Chest X Ray image. Though the datasets are easily accessible to research community as open source.

## IV. Conclusions

The proposed 2D convolution method used in classification of Lung Images by Chest Xray to identify COVID-19 with 224 images in two categories covid and normal images from GitHub datasets has shown appreciable results at a fast rate more 99% accuracy. As a future work plan on huge dataset working using GPU considering many more features to test for high computational speed, performance and efficient implementation of deep learning techniques

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