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Chest X-Ray analysis and detection classifier of Covid-19 using 2D-CNN

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ABSTRACT: With nearly 5 million positive cases and 2 million deaths, Covid-19 is one of the worst pandemic the world has ever seen. It is important to prevent Covid-19 by early detection to avoid massive transmission. As there are very less clinical test kits and medical facilities available in the hospitals during this emergency situation, it is very important to initialize a reliable but fast Corona virus detection method which is effective to detect the virus properly. With the help of deep neural network and data segmentation method, in this work we have presented a convolutional neural network model that is capable to differentiate between normal and Covid-19 patient's lungs radiological images or X-Ray.

KEYWORDS: Binary disease classification, Covid-19 detection, Convolutional neural network, Machine learning classification.

I. INTRODUCTION

The Covid-19 pandemic is one of the worst scenarios in the history of mankind. It is still continuing to show its devastating effects on the health and the stability of the global population. As of October 2020, there are more than 4.5 million positive cases reported according to the government records with 1.1 million reported deaths. This all happened within less than a year. An important step to fight against this fatal disease is effective screening process and isolation to reduce the chances of transmission as much as possible. This virus primarily spreads through the droplets of saliva when an infected person sneezes or coughs. With the sudden outbreak of Covid-19, rapid diagnostic and testing has become one of the major challenges due to the major shortage of clinical testing kit and pathologists. To detect whether a patient has Covid-19 or not, analysing chest X-Ray would be the best diagnosis option as it directly affects the inner membrane of the lungs. The air sacs present in the lungs, named alveoli filled with mucus, fluid and other cells that tries to fight the virus. Due to this phenomenon, the inner wall of the alveoli gets more inflamed and oxygen carbon dioxide exchange becomes harder. This condition is called Pneumonia or Acute Respiratory Distress Syndrome (ARDS). Clinical studies have shown that, major lung infection is the cause of Corona virus fatality. Recently Chest X-Ray has proved to be a promising imaging technique for lung related diseases. Accessibility of chest X-Rays would be more available rather than CT because - (1) its cost effective, (2) takes less time to publish the report. On the top of that, using deep learning- one of the most efficient and prominent artificial intelligence techniques to analyse the vast amount of Chest X-Rays within short period of time is the effective way of cost effective and reliable screening. In this paper, we have used convolutional neural network (CNN) to classify chest X-Rays into 2 categories- Covid positive and Covid negative. Among all deep learning algorithms, CNN proved its ability for classification of speech and image classification. Several image transformation techniques have been introduced to handle the imbalance data set. The contribution of this paper focuses on developing a classifier that can efficiently analyse the radiological image of Covid-19 patients that is better than other state-of-the-art facilities.

II. RELATED WORK

As the Covid-19 pandemic is the most recent topic, so research works are still being carried on. Very less research works are being completed so the related works in this category is very less. Akib et al. [2] in his paper used machine learning approaches for detecting covid-19. They used several machine learning approaches like Logistic Regression (LR), Multinomial Naïve Bayes, Support Vector Machines (SVM) and Decision Tree (DT). The use of ensemble machine learning techniques like Bagging, AdaBoost, Random Forest classifier and Stochastic gradient boosting are also found in this paper. After comparing and performing classification, it was revealed that logistic regression and multinomial Naïve Bayesian classifier gives excellent results by having 94% precision, 96% recall, 95% f1 score and accuracy 96.2%. Various other machine learning algorithms that showed better results were random forest, stochastic gradient boosting, decision trees and boosting. Moutaz et al. [3] used deep learning methods for Covid-19

prediction and detection. They collected the chest X-ray images for the dataset from COVID-19 patients and healthy persons and generate 1000 chest X-ray images using data augmentation. Then they applied deep learning technique, VGG-16. The model allows the rapid and reliable detection of COVID-19, enabling it to achieve an F-measure of 94% using an augmented dataset. Mohamed et al. [4] in their paper led a research on image based diagnosis on Covid-19. They proposed a method for the visual diagnosis of COVID-19 cases on chest x-ray images. The proposed method utilized a fractional moment (i.e., FrMEMs) to extract features of the COVID-19 x-ray images. Then, a modified version from Manta Ray Foraging Optimization (MRFO) was applied as a feature selection method, which modified using differential evolution to improve the ability of MRFO to find the relevant features from those extracted features. In the proposed MRFODE feature selection method, the k-nearest neighbor classifier was utilized to decide whether a given chest x-ray image as a COVID-19 or normal case.

Azemin et al. [5] used deep learning prediction model using the publicly available radiologist adjusted chest X-ray images. They used the ResNet-101 architecture for residual learning framework advantage. The parameters were updated using Stochastic gradient descent. The performance evaluation was done using Receiver Operating Characteristic curve and the area under the curve was reported to be 0.82. Tulin et al. [6] in their paper used X-ray images to detect Covid-19. They used the DarkCovidNet deep learning model to classify X-ray images into three categories: COVID-1, No-Findings, pneumonia. Secondly, the DarkCovidNet model was also trained to detect two classes: COVID-19 and No-Findings categories. The performance of the proposed model is evaluated using the 5-fold cross-validation procedure for both the binary and triple classification problem. The proposed model achieved an accuracy of 87%. Harsh et al. [7] used deep learning for fast detection of Covid-19 in X-Rays. They proposed an algorithm 'nCOVnet' to detect the COVID-19 patients using X-ray images. They focused on the observational analysis of lockdown is not only the solution and some artificial intelligence methods are extremely required to overcome this solution. They also presented the fast detection method using X-ray image analysis that would be a contribution to the society and carefully analyzed the X-ray images of lungs for person in order to detect the COVID-19. The proposed model can correctly detect the COVID-19 positive patients with an accuracy of 94% whereas the overall accuracy of the proposed model is reported to be 88%. Jamshidi et al. [8] proposed artificial intelligence and deep learning approaches for diagnosis and treatment of Covid-19. They used several machine learning approaches like Recurrent Neural Network (RNN), Long Short-term Memory (LSTM), Extreme Learning Machine (ELM) for addressing COVID-19-related infection problems, such as high-risk patients, control of the outbreak, recognizing and radiology. The geographical issues, high-risk people, and recognizing and radiology were the main problems with COVID-19 and were studied and discussed in this work. Also, they showed a mechanism for selecting the appropriate models of estimation and prediction of desired parameters using a number of clinical and non-clinical datasets.

III. METHODOLOGY

DATA SOURCE

For this project, the data was taken from CoronaHack- Chest- X-Ray-Dataset [1]. The data set consists of chest X-Ray images of healthy lungs and Pneumonia or Corona virus affected lungs. Alongside with the lung X-Ray images, there are some other labelled chest images like SARS (Severe acute respiratory syndrome), Streptococcus & ARDS (Acute respiratory distress syndrome) which are also present in the data set. To make this classifier, we concentrated on normal and covid-19 label only. For training and testing purposes, we split the data set in 70:30 ratios. The original images and distributions of classes are presented below in the Fig. 1 and Table 1 respectively.

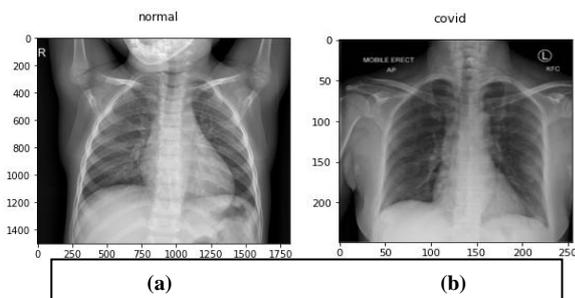


Fig 1: Original images of (a) Normal, (b) Covid-19 patients

Class	Number of samples
Normal	1576
Pneumonia	58

Table 1: Data set distribution

DATA AUGMENTATION AND PRE-PROCESSING

The data set are severely imbalanced with 1576 entries in one category and 58 in other. So, to balance the number of data we performed data augmentation technique in the pre-processing stage to increase the number of data present in the Covid-19 class. Data augmentation is known to be an effective technique when it comes to balancing the imbalance data set, by modifying or re-creating the existing data images. For this classifier, we mainly focused on performing geometrical and colour based transformations. The several types of image transformation or data augmentation are listed below-

- By rotating the image by positive 45 degree with respect to its vertical middle axis.
- Cropping them from both sides horizontally.
- Flipping images both horizontally and vertically.
- Changing the image condition; increasing brightness, contract and by adding noise.
- Rescaling the images in different ratios.

The colour space transformation technique like increasing or decreasing brightness, contrast and other image illumination related parameters addressed the challenges related to the quality of the chest radiological image. For avoiding general geometric transformation related problems, we performed neural style transfer based augmentation for some images too; deep neural networks were trained to extract value from one image and content from some other image, in order to blend them together and form augmented images. It is not exactly like the original patient's chest x-ray images, but created in a manner to look like one. The transformed covid-19 chest x-rays are presented below.

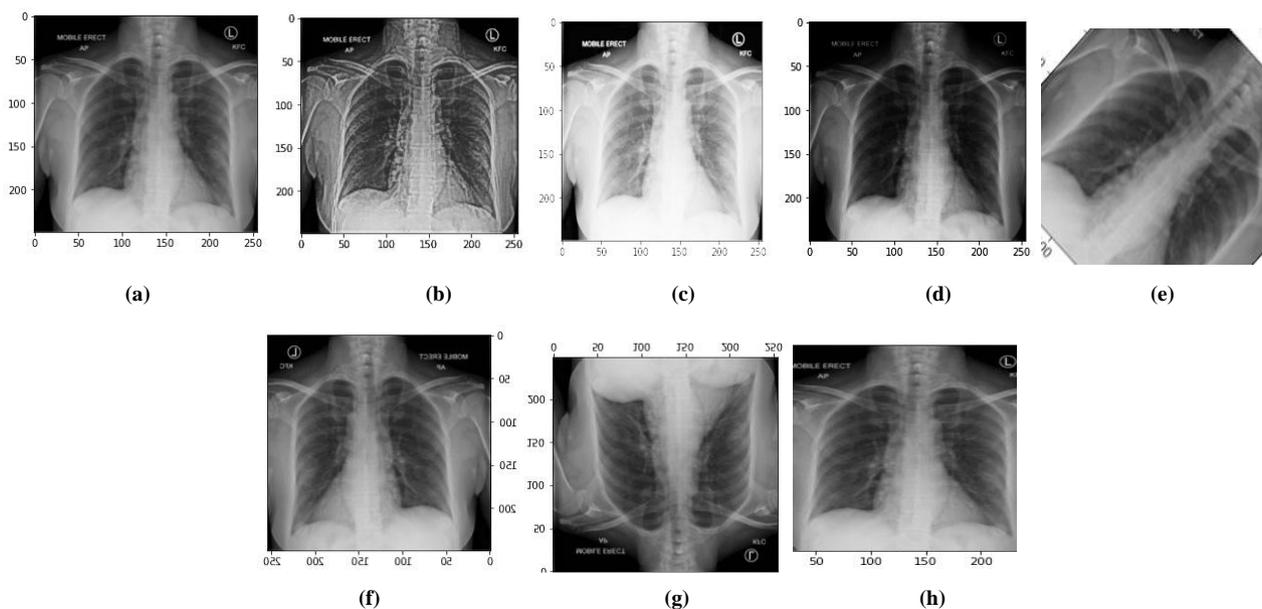


Fig. 2: Image transformation technique used (a) Original Covid-19 image (b) Rescaled image (c) Increased brightness by 50% (d) Increased contrast by 50% (e) Rotated the original image in positive direction by 45 degree (f) Flipped the original image horizontally (g) Flipped the image vertically (h) Cropped image from both horizontal side.

ARCHITECTURE OF CONVOLUTIONAL NEURAL NETWORK

After image transformation, the data was fed to the convolutional deep neural network in the final stage. For this binary classification problem, we used simple stack of convolutional layers followed by max-pooling layers.

- **Input-** The input given to the first convolutional layer is (150, 150, 3) in a manner of (sample width, sample height, channel). The channel number 3 signifies that the images have 3 colour channels; red, yellow, and blue.
- **2D- convolutional layers-** In this CNN architecture, we have six 2D- convolutional layers with Rectified linear circuit (ReLU) activation unit because that only takes the positive part of the argument.
- **Max Pooling and average pooling layers-** Max pooling is used to reduce the image size by reducing the parameter and taking the maximum value from the given window. Average pooling is the average value of the given window. In this network, there is one max pooling layer followed by every 2D- convolutional neural network to lessen the image width and height than the previous layer.

- **Flatten**-It transforms its previous layer output into an array. The stack of the blocks of images lined up in a single line to form an array to transform the data from 3D to 1D.
- **Dense**- The 1D data output of the previous layer passes through this layer. In this proposed network, dense layer is used with only one neuron, which allows one dimensional information to pass to the output.
- **Dropout**- Dropout reduces the chances of over fitting, by randomly making some neuron neutral which forces the data to take different path.
- **Output**- After passing through one dense layer, the desired output is obtained. In the output section, we used sigmoid activation as it is a binary classification problem where the model has to determine whether the x-ray belongs to a Covid-19 patient or not.

IV. RESULTS AND DISCUSSION

RMSprop optimizer is used to train the model, as it restricts the oscillation in the vertical direction, resulting fast convergence. It also chooses different learning rate for each parameter. The model was trained for 48 epochs with the batch size of 28. After the training and validation, the result obtained from the classifier is given below.

Optimiser	Batch size	Epochs	Accuracy
RMSprop	28	48	96%

Table 2: Hyper parameters and results

V. CONCLUSION

In this work, CoronaHack- Chest- X-Ray-dataset is being used to evaluate and train our proposed classifier. In order to make the imbalanced data set stable and suitable to use, we performed several image transformation techniques like geometric transformation, colour based transformation, and neural style transfer based augmentation that helped to increase the number of samples of the Covid-19 class. The accuracy of the proposed model is 96%. This experiment shows that our work is more beneficial and competitive than previous works in Covid-19 classification.

REFERENCES

- [1] Joseph Paul Cohen, Paul Morrison, Lan Dao, Karsten Roth, Tim Q Duong, Marzyeh Ghassemi, "COVID-19 Image Data Collection: Prospective Predictions Are the Future," arXiv,2006, Available at: <https://github.com/ieee8023/covid-chestxray-dataset>, 2020
- [2] Khanday, A.M.U.D., Rabani, S.T., Khan, Q.R. et al., "Machine learning based approaches for Detecting COVID-19 using Clinical Data," International Journal of Information Technology, vol.12, pp. 731-739, 2020.
- [3] Moutaz Alazab¹ , Albara Awajan¹ , Abdelwadood Mesleh¹ , Ajith Abraham² , Vansh Jatana³ , Salah AlhyariYassin, " COVID-19 Detection and Prediction using Deep Learning," International Journal of Computer Information Systems and Industrial Management Applications, vol. 12, pp. 168-181, 2020.
- [4] Mohamed Abd Elaziz, Khalid M. Hosny , Ahmad Salah, Mohamed M. Darwish, Songfeng Lu, Ahmed T. Sahlol, "New Machine Learning Methods for Image-Based Diagnosis of COVID-19," PLOS ONE, vol. 15, pp. 1-18, 2020.
- [5] Mohd Zulfaezal Che Azemin,¹ Radhiana Hassan,² Mohd Izzuddin Mohd Tamrin,³ and Mohd Adli Md Al, "COVID-19 Deep Learning Prediction Model Using Publicly Available Radiologist-Adjudicated Chest X-Ray Images as Training Data: Preliminary Findings," Hindawi, vol. 2020, 2020.
- [6] Ozturk, Tulin et al. "Automated Detection of COVID-19 cases using deep neural networks with X-ray images," Computers in biology and medicine, vol. 121, 2020.
- [7] Panwar, Harsh et al. "Application of deep learning for fast detection of COVID-19 in X-Rays using nCOVnet," Chaos, solitons, and fractals, vol. 138, 2020.
- [8] Mohammed (Behdad) Jamshidi et al., "Artificial Intelligence and COVID-19: Deep Learning Approaches for Diagnosis and Treatment," IEEE Access, vol. 8, pp. 109581- 109595, 2020.



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