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“An ensemble deep transfer-learning approach to identify COVID-19 cases from chest X-ray images”

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Overview

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Introduction

- A novel Coronavirus or COVID-19 is an infectious virus that has been transmitted through a set of all animals. Later, it has affected people too. Since December 2019, various examples of severe viral pneumonia identified in the seafood wholesale market in Wuhan City, China. A Novel coronavirus affected people severely was officially affirmed on January 6, 2020.

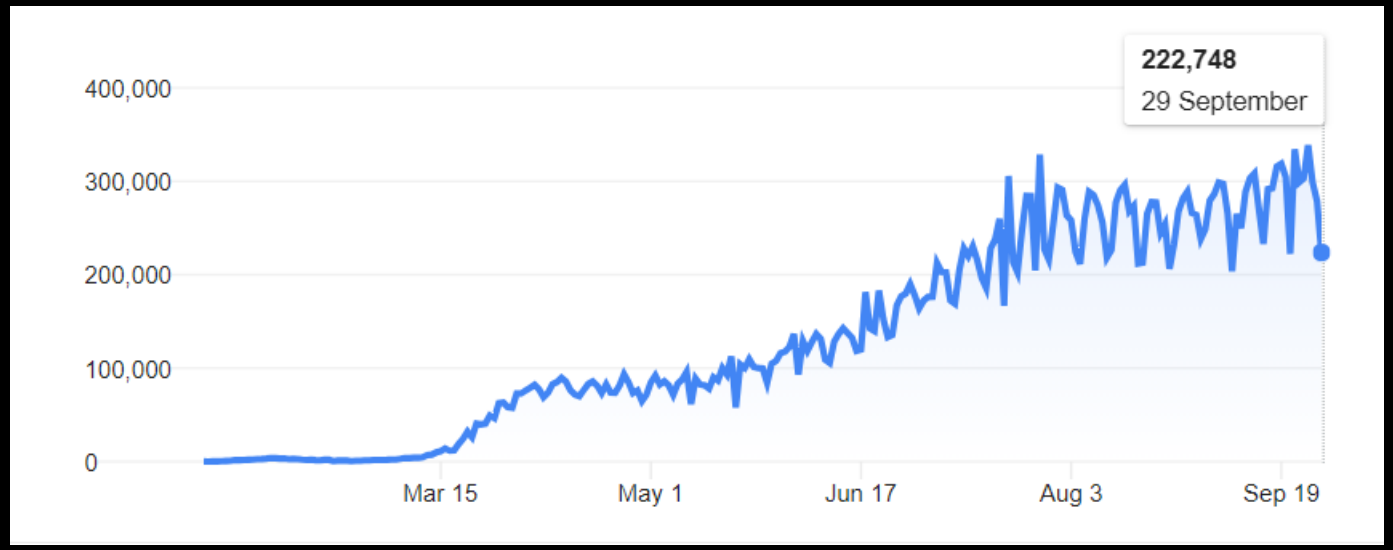
- At initial transmissions, it caused severe pneumonia to the patients.

- Around 15-20% of the patients fall into a serious medical condition, which means they require oxygenation as a major aspect of treatment.

- More than 35 millions of people are affected in COVID-19 worldwide and 1 million people died.

Introduction

- A recent statistics of daily COVID-19 affected people globally.



Daily affected people in COVID-19 (Source: Internet)

Introduction

- While investigating images-based problems, Deep Convolutional Neural Network can comprehend more effectively by its state-of-art architecture. Deep neural-based frameworks can classify images or related problems more precisely and productively by its powerful algorithmic strength.

- To tackle the classification problem more accurately, the author combines two pre-trained ResNet-152 and DenseNet- 121 architectures to achieve the best possible result on the chest x-ray dataset.

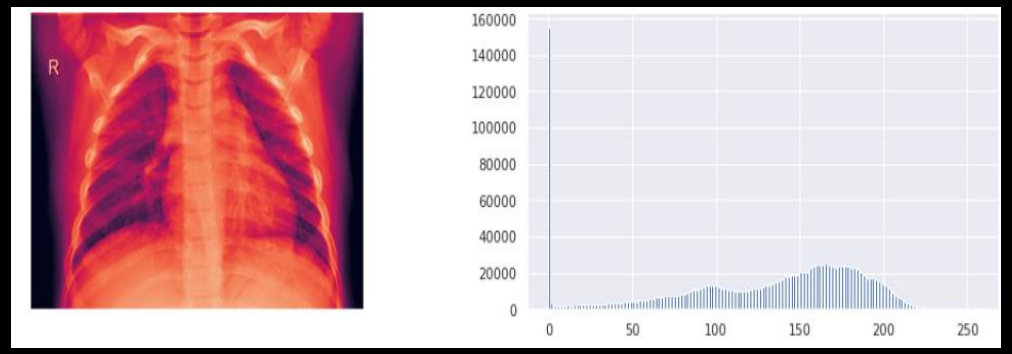
Objective

- As some patients with COVID-19 have severe pneumonia. And RT-PCR is the only method of detecting COVID-19 cases. And this method is costly and time consuming. So a deep learning-based low cost method can be applied to overcome this drawback.

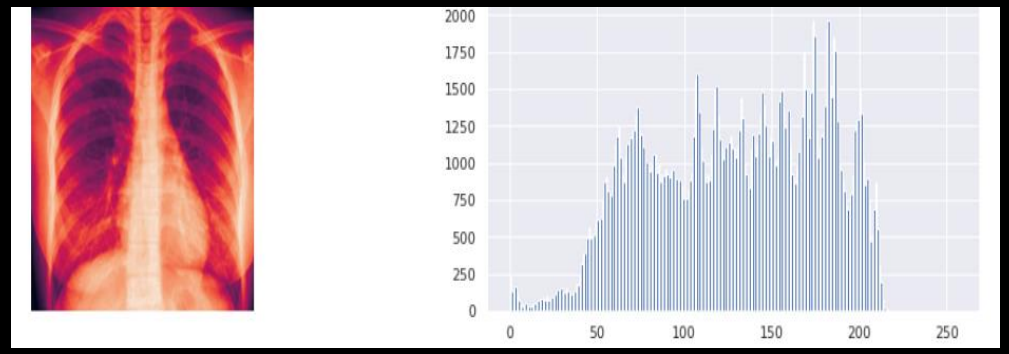
- Deep learning algorithms in the image-based medical diagnosis is currently carried out an enormous importance in medical community. There are several state-of-art deep learning algorithms are employed in this case to detect disease more accurately and low cost.

Methodology

- A publicly open source dataset has used in this study.
- Only data augmentation has been done for the dataset.
- Data visualization has done utilizing image histogram to get better intuition of the dataset.



Normal X-Ray



COVID-19 X-Ray

Methodology (Cont.)

- Implemented ResNet-152, DenseNet-121 and ensemble of these architectures in the dataset.
- No prior image-pre-processing has been done except data augmentation.
- 20 epochs are taken for the ensemble model to train and 20 epochs are taken for each model.
- The batch size is 24.
- Pre-trained weights are utilized to ensure faster concurrence.

Dataset

- The dataset is open-sourced publicly available dataset.
- It has 5907 images of different classes.
- Where 5283 images are for training and 624 images are for testing.
- For this experiment, 1409 images are considered of two classes such as normal and COVID-19.
- 987 images are for training and 422 images for testing.

Proposed Model

- Proposed model is an ensemble of ResNet and DenseNet architectures.
- In the proposed model, a combination of ResNet-152 and DesneNet-121 architectures have been utilized.
- Adam optimizer has been used in the individual models for optimization.
- But the main work of this ensemble has used SGD for optimization.
- Softmax activation function is used in the output layer of the proposed model.

Proposed Model (Cont.)

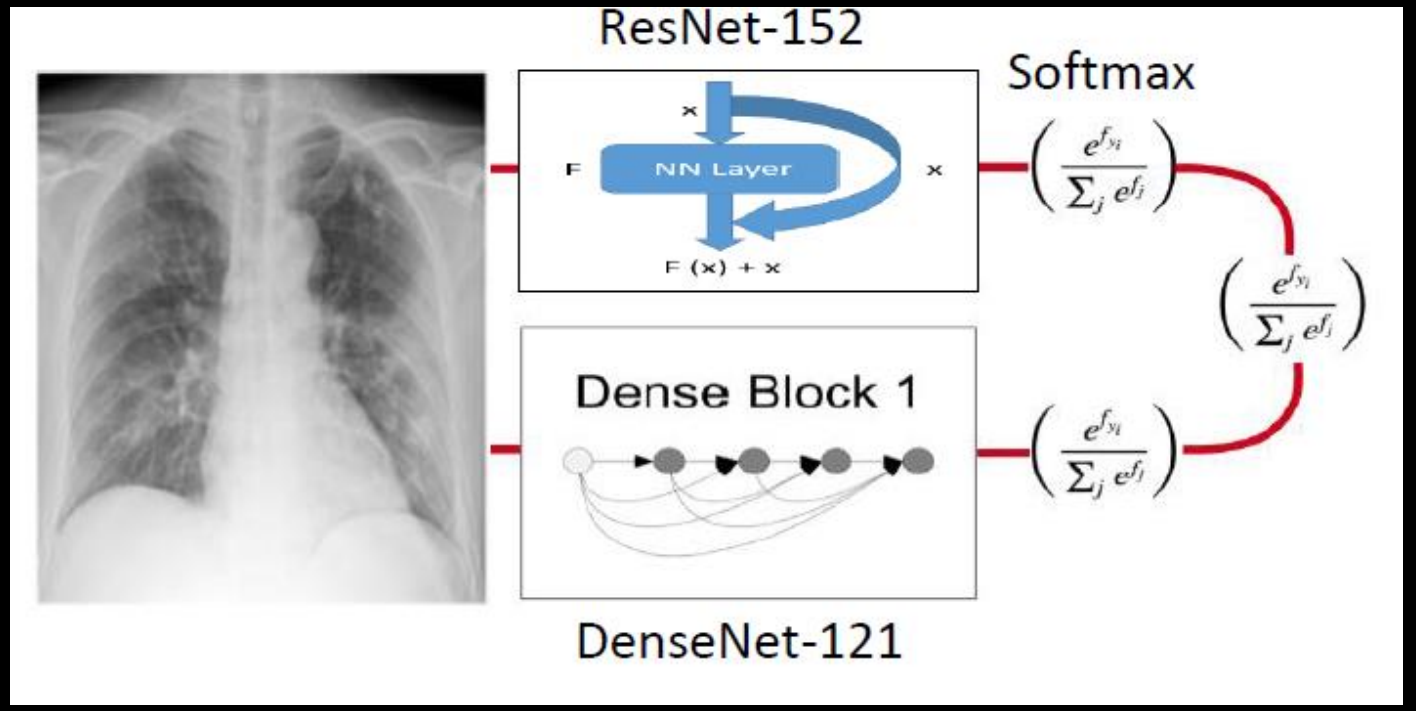


Fig: An illustration of Residual Network and Densely Connected Network Ensemble Model

Experimental Results

Algorithms	Accuracy (%)	Specificity (%)	Sensitivity (%)
DenseNet-121	87.50	83.96	91.29
ResNet-152	94.33	95.72	94.92
Proposed	**98.43**	**99.23**	**98.71**

Performance Graphs of Proposed Model

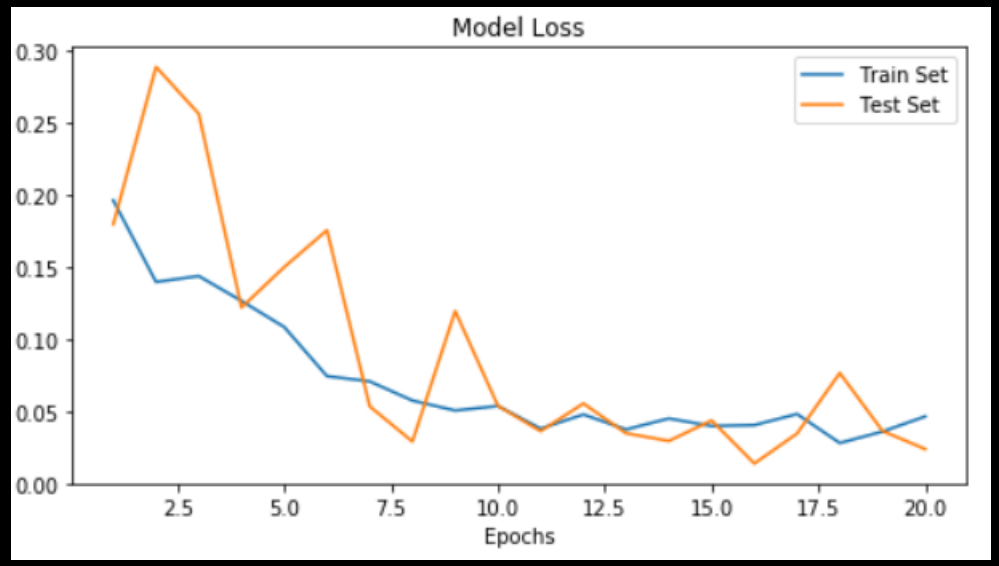


Fig: From left side, (a) Model accuracy of proposed ensemble model and (b) Model loss of proposed ensemble model.

Comparison of Proposed Architecture

Algorithms	Accuracy (%)	Dataset
Inception + ResNet V2 [11]	92.18	Open Source
VGG – 19 [12]	97.75	Open Source
DeTrac [14]	95.12	Open Source
Xception + ResNet-50 [15]	91.40	Open Source
ResNet-50 [16]	98.00	Open Source
Proposed	**98.43**	**Open Source**

Limitations

- Due to time and computational power limitations, the author could not run the k-fold validation in this experiment.

- This research has some limitations, because of the significant changes in symptoms to the patients. Some patients have not been affected by severe pneumonia, even after they have affected by COVID-19.

- So this research is not suitable for all generic patients to determine COVID-19.

Conclusion

- The main objective of this study is to identify COVID-19 affected individuals and limit the transmission as it is a viral disease.
- The author introduces a deep ensemble model for COVID-19 case detection, the ensemble model is a combination of ResNet-152 and DenseNet-121 architectures.
- The proposed model has an accuracy, specificity, and sensitivity of 98.43%, 99.23%, and 98.71% respectively.

Thank You!