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Covid-19 Detection Using Chest X-Ray

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Abstract

COVID-19 is spreading rapidly throughout the world. As of 14 April 2020, 128,000 people died of COVID-19. As the virus spreads at a very high rate, there is a huge shortage of medical testing kits all over the world. The respiratory system is the part of the human body most affected by the virus, so the use of X- rays of the chest may prove to be a more efficient way than the thermal screening of the human body. In this paper, we are trying to develop a method that uses radiology, i.e. X-rays for detecting the novel corona virus. Along with the paper, we also release a dataset for the research community and further development extracted from various medical research hospital facilities treating COVID- 19 patients. This may be useful in an inpatient setting where the present systems are struggling to decide whether to keep the patient in the ward along with other patients or isolate them in COVID-19 areas. It would also help in identifying patients with high likelihood of COVID with a false negative RT-PCR who would need repeat testing. Further, we propose the use of modern AI techniques to detect the COVID-19 patients using X-Ray images in an automated manner, particularly in settings where radiologists are not available, and help make the pro- posed testing technology scalable. We present CovidAID: COVID-19 AI Detector, a novel deep neural network based model to triage patients for appropriate testing. On the publicly available covid-chestxray-dataset [2] dataset, our model gives 90.5% accuracy with 100% sensitivity (recall) for the COVID- 19 infection. We significantly improve upon the results of Covid- Net [10] on the samedatabase

Keywords—COVID-19, Computer Vision, Radiology, Deep learning

I INTRODUCTION

The sudden spike in the number of patients with COVID-19, a new respiratory virus has put unprecedented load over healthcare systems across the world.

The main contribution of our project is in proposing a novel deep neural network based model for highly

accurate detection of COVID-19 infection from the chest X-Ray images of patients.The designed system also differentiates the patients suffering from pneumonia and COVID-19 as both 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. In our project we will implement by larger datasets so that accuracy and efficiency will b more. For that purpose, we are suing data augmentation along with transfer learning to achieve outstanding results. We are using RESNET architecture for training data purpose & for better accuracy.

II SPECIFICATION

Our project is entirely Software and we were used PyTorch Framework for our project.

1. Easy Interface: PyTorch offers easy to use API; hence it is considered to be very simple to operate and runs onPython.

The code execution in this framework is quite easy.

2. Python Usage: This library is considered to be Pythonic which smoothly integrates with the Python data sciencestack.

Thus, it can leverage all the services and functionalities offered by the Python environment.

3. Computational Graphs:PyTorch provides an excellent platform which provides dynamic computational graphs. Thus, user can change them duringruntime.

4. PyTorch is known for having 3 levels ofabstraction:

- Tensor: Imperative n-dimensional array which runson GPU.
- Variable: Node in computational graph. This stores data and gradient.
- Module: Neural network layer which will store stateor learnable weights.

III METHODOLOGY

If persons carry their chest X-ray with them thenthis technique can be used for the first screening at:

1. Airports 2.Hotels 3.Shoppingcenters

Right now, Cancer care center in Bengaluru hasstarted using chest X-Ray method on pilotbasic.

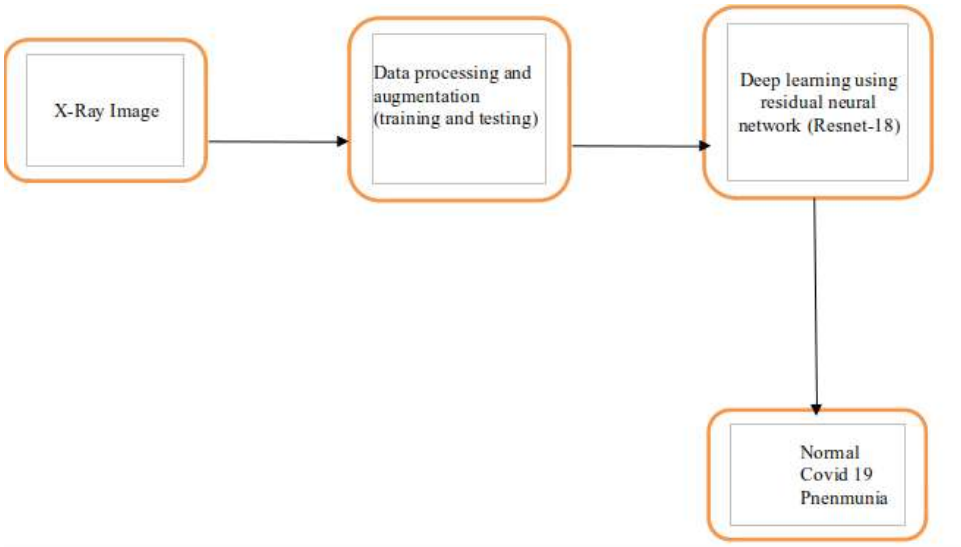

Fig. 1 "Block Diagram"

First we took row images (X-ray image) from the dataset. Then we used data processing to convert the row data into the clean data set because when data is collected from different sources it is collected in raw format which is not feasible for the analysis.

As the number of collected images are very less we further applied data augmentation such as rotating all images to 45 degree, zooming images to 30% and height shifting. With a factor of 0.2. It will improve diversity and will improve quality of prediction. Next, we loaded the pretrained model using PyTorch. In training phase we used data to train machine.

Using machine learning algorithm and deep learning finally we predicted the X-ray image is of either covid-19 or pneumonia patient or the normal person.

IV DETAILDESIGN

1) For the image classification tasks, Residual Network (ResNet) outperformed previous classification networks like CNN, etc. but these deep neural networks need a significant amount of data to train and will produce state-of - the art performance.

2) In addition to the numbers, hyper-parameters such as learning rate, drop-out values will play a key role in delivering the best results in a shorter period of time and mitigating the over-fitting problem on the other hand picking a random value for the hit hyper-parameter and the test will be tricky and inefficient value of learning rate will play a significant role, while too low a value will be inefficient and time-consuming for the training of the neural networks, on the other hand a value too high will cause divergent behavior in the loss function

3) Our methodology is inspired by ADADELTA to select a good learning rate value and avoid hit and trial. We will be training a batch of 128 images is and computing the loss on defined neural networkarchitecture.

4) Adding more layers and increasing the number ofparameters in Residual Network architecture will help in improving the accuracy of the overallclassification.

5) For the basic image preprocessing, augmentation and manipulation OpenCV and python programming language, along with the PyTorch framework, will be used.

6) Experimentations will be performed on a Linux workstation with NvidiaGPUs.

7) Pre-Trained ResNet-18 models will be initialized with random weights and further trained with AdamOptimizer.

A) Input : X-ray ofchests

B) Output : Prediction of covid, normal andPneumonia

IV.A RESNET 18:

TheinitialResNet18modelissuitableforthecolorimages, while the modified ResNet18 is more appropriate for the grayscale images which are used to diagnose infections in this study. The average pooling layer of the original ResNet18 is replaced with the GlobalAverage

Pooling layer (GAP) and two compression layers areadded to support the image rating after aglobalaverage pooling layer..

The model achieves the performance likelihood after the convolutionary layer of each form of label. The cross-entropy loss function is used in this work, to prevent the issue of sluggish learning:

$$\text{Loss(L)} = \frac{1}{d}\sum_{z}[y \ln \propto +(1-y)\ln(1-\propto)]$$

wheredisthetotalnumberoftrainingdata.Thesummation is performed on all inputs of training, y, z,and their respective target output. The modified network is shown in Fig. 5 and its structure is as follows:

1 InputLayer

It contains image data, and image data are denoted by a 3D matrix. And this needs to be resized in to one column. Example: 28 × 28 image is transformed into 784 × 1 before inputs to the system.

2 ConvolutionalLayer

TheconvolutionallayerperformsanimportantroleintheCNN model.Insidethislayer,thefeaturesoftheimagegetextracted. Convolution conserves the contiguous correlation in between elements by reading image features getting help from little pores of feeding images. Numbers of filters are used for the convolution process and an activation map is generated to be feed as input to the next layer ofCN

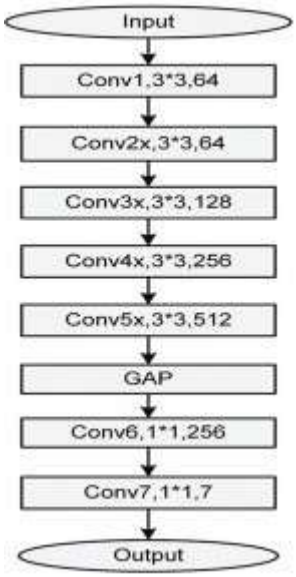

Fig. 2 "Flow Chart"

Fig. 3 "Output"

3 PoolingLayer

The pooling layer is used to reduce the size after the convolution of feeding images. It can be used in between two convolutional layers. If applying a fully connected layer after two convolutional layers without applying average or max pooling, then the computations and amount of the parameters will be very high. The pooling layer provides better results against certain transformations.

4 Fully ConnectedLayer

Afullyconnectedlayercontainskernels,weights,andbiases.It generally relates a one-layer kernel with a kernel of the next corresponding layer. It is used to categorize images in between certain types via training. A fully connected layer can be referred to as finishing the pooling layer input the features to the ReLU or Softmax activation function(classifier).

5 LogisticLayer

It is the final layer of the CNN model that is placed at the last of the fully connected layer.

6 OutputLayer

This is the output layer of CNN and it includes the tag thatwill be in the shape of single-hard encoded. The used hyper- parameters for training are as follows: learning rates = 0.001, beta = 0.9, and batch size =6.

V RESULT

We installed Jupyter notebook for implementation of our project.Weimported requiredlibraries.Weprepared the training and datasets.

We created the custom dataset and applied Image Transformation.

Further we prepared data loader and applieddata visualizationNext we created a the model and trained that mode using RESNET18. We got the final result I e. classification of images into3

classes 1.Covid 2. Normal Pneumonia 3. Normal People

V.A. DATA VALIDATION

We used 2 datasets in our project. In first dataset there are 3886 images. Out of that 1314 are normal,1345 are viral and 1200 are covid examples. In second dataset total images are 15,153. Out of this 10,192 are normal, 1345 are viral and 3616 are covid examples.

A. Observations

1. For dataset 1: TP=14, FN=7
   TN=61, FP=2 P=21, N=63
2. For dataset 2: TP=17, FN=3
   TN=30, FP=4 P=20, N=34

$$\text{Classification accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Sensitivity} = \frac{TP}{TP + FN}$$

$$F1\ \text{Score} = \frac{2 \times \text{sensitivity} \times \text{precision}}{\text{sensitivity} + \text{precision}}$$

Sr. No.	Observations		
	Parameters	*Dataset 1*	*Dataset 2*
1.	Sensitivity	66.66	85.18
2.	F1 Score	87.5	80.95
3.	Accuracy	89.28	87.03

VI CONCLUSION

We used Resnet18 here and got efficiency upto 95%.Inthisprojectwe implemented a new methodology which also differentiates the patients suffering from pneumonia and COVID-19 as both have the same symptoms. Detecting COVID-19 using chest X-Ray is much cheaper than the medical COVID-19 test kit. This method is as fast as the current thermal imaging technique.WecanincreaseaccuracyofCOVID-19detectionbyincreasingthe dataset. The main drawback of our project is the lack of dataset. The presently available data collection is too limited to obtain state-of-the-art performance and to replace the thermal imaging technique. If person's chest X-Ray is available with her/him then it took less time but person do not carry chest X- RaythenitcantakehalfanhourfordoingchestX-Rayprocess.

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