CCC, IIIT Allahabad - Computer Vision Research Internship

Automatic Detection of Coronavirus Disease (COVID-19) Using Chest X-ray Images and Deep Convolutional Neural Networks

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1) **Topic :** Automatic Detection of Coronavirus Disease (COVID-19) Using Chest X-ray Images and Deep Convolutional Neural Networks

2) ## Literature Survey :

Recently, researchers have perceived the imaging patterns on chest CT for detecting the COVID-19 in chest CT . Fang et al. studied the sensitivity of RT-PCR and chest CT during the detection of COVID-19. They analyzed the travel history and symptoms of 2 patients and found that the sensitivity of chest CT for detection of COVID-19 is much higher than RT-PCR. Xie et al. also reported that the 3% of 167 patients had negative RT-PCR for COVID-19 detection. However, chest CT has better sensitivity of detection of COVID-19 over RT-PCR. Berheim et al. studied 121 infected patients' chest CT from four different centers of China. The relationship between CT scan and symptom onset is established. They found that the severity of disease increased with time from onset of symptoms and designated the signs of disease. Recently, deep learning techniques have been widely used in detection of acute pneumonia in chest CT images . Li et al. developed a deep learning model named as COVNet to extract visual features from chest CT for detection of COVID-19. They used visual features to distinguish between community acquired pneumonia and other nonpneumonia lung diseases. However, COVNet is unable to categorize the severity of this disease. Gozes et al. developed an artificial intelligence-based CT analysis tool for detecting and quantification of COVID-19. The system extracted slice of opacities in the lungs automatically. The developed system achieved 98.2% sensitivity and 92.2% specificity. The output of system provides quantitative opacity measure and 3D volume display for opacities. The system is robust against pixel spacing and slice thickness .Shan et al.

developed a deep learning-based system named VB-net for automatic segmentation of all the lung and infection sites using chest CT. Xu et al. developed a prediction model to discriminate COVID-19 pneumonia and influenza-A viral pneumonia using deep learning techniques. The CNN model was used for prediction. The maximum accuracy obtained from prediction model was 86.7%. Wang et al. investigated the radiographic changes in CT images of infected patients. They developed a deep learning-based prediction model that utilizes the modified inception transfer learning technique. The features are extracted from CT images for prior diagnosis. The accuracy of 89.5% obtained from this method is better than Xu's model and saved time for diagnosis. Narin et al. proposed an automatic deep convolution neural network– based transfer models for prediction of COVID-19 in chest Xray images. They used InceptionV3, Inception-ResNetV2, and ResNet50 models for better prediction. The ResNet50 pre-trained model produced accuracy of 98%, which is higher than . Sethy et al. developed a deep learning model for detecting COVID-19 from X-ray images. They extracted deep features and transferred them to support vector machine for classification. The accuracy of 95.38% obtained from the proposed model, which is better than. From the extensive review, it has been found that the chest CT images can be used for early classification of COVID-19- infected patients .Therefore, in this paper, computational models are used to classify COVID-19 patients from chest CT images.

3) Dataset :

In this study, chest X-ray images of 50 COVID-19 patients have been obtained from the open source GitHub repository shared by Dr. Joseph Cohen. This repository is consisting chest X-ray / CT images of mainly patients with acute respiratory distress syndrome (ARDS), COVID-19, Middle East respiratory syndrome (MERS), pneumonia, severe acute respiratory syndrome (SARS). In addition, 50 normal chest X-ray images were selected from Kaggle repository called "Chest X-Ray Images (Pneumonia)" . Our experiments have

been based on a created dataset with chest X-ray images of 50 normal and 50 COVID-19 patients (100 images in total). All images in this dataset were resized to 224x224 pixel size. In Figure 2 and Figure 3, representative chest X-ray images of normal and COVID-19 patients are given, respectively.

CoronaHack-Chest X-Ray Dataset:https://www.kaggle.com/praveengovi/coronahack-chest-xraydataset?

4) Methodology

Deep Transfer Learning

Deep learning is a sub-branch of the machine learning field, inspired by the structure of the brain. Deep learning techniques used in recent years continue to show an impressive performance in the field of medical image processing, as in many fields. By applying deep learning techniques to medical data, it is tried to draw meaningful results from medical data.

Deep learning models have been used successfully in many areas such as classification, segmentation and lesion detection of medical data. Analysis of image and signal data obtained with medical imaging techniques such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and X-ray with the help of deep learning models. As a result of these analyzes, detection and diagnosis of diseases such as diabetes mellitus, brain tumor, skin cancer and breast cancer are provided with convenience.

In the analysis of medical data, one of the biggest difficulties faced by researchers is the limited number of available datasets. Deep learning models often need a lot of data. Labeling this data by experts is both costly

and time consuming. The biggest advantage of using transfer learning method is that it allows the training of data with fewer datasets and requires less calculation costs. With the transfer learning method, which is widely used in the field of deep learning, the information gained by the pre-trained model on a large dataset is transferred to the model to be trained.

In this study, we built deep convolutional neural network (CNN) based ResNet50, InceptionV3 and Inception-ResNetV2 models for the classification of COVID-19 Chest X-ray images to normal and COVID-19 classes. In addition, we applied transfer learning technique that was realized by using ImageNet data to overcome the insufficient data and training time. The schematic representation of conventional CNN including pre-trained ResNet50, InceptionV3 and Inception ResNetV2 models for the prediction of COVID-19 patients and normal were depicted in Figure 4.

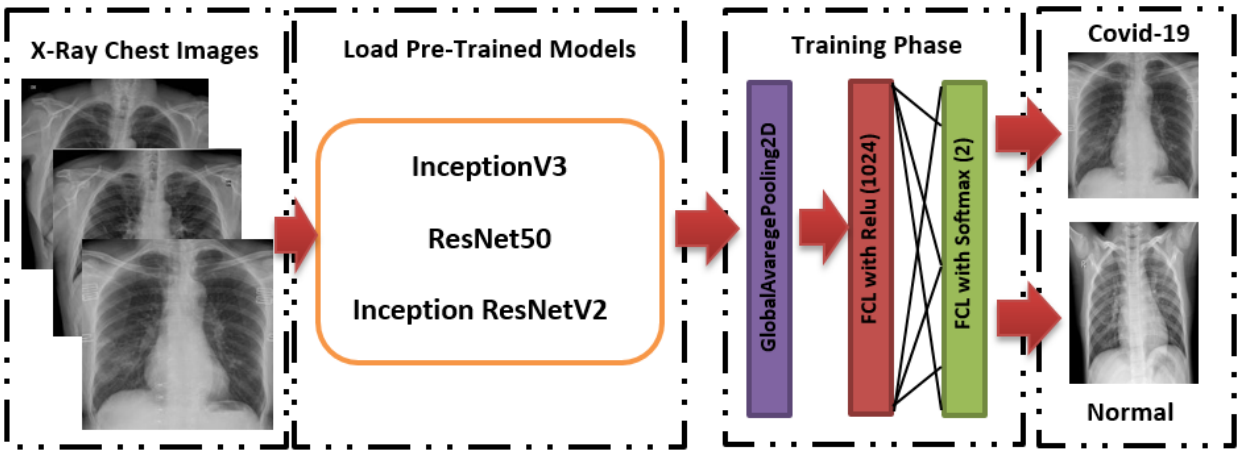

Figure 4. Schematic representation of pre-trained models for the prediction of COVID-19 patients and normal

Residual neural network (ResNet) model is an improved version of convolutional neural network (CNN). ResNet adds shortcuts between layers to solve a problem. Thanks to this, it prevents the distortion that occurs as the network gets deeper and more complex. In addition, bottleneck blocks are used to make training faster in the ResNet model. ResNet50 is a 50-layer network trained on the ImageNet dataset.

ImageNet is an image database with more than 14 million images belonging to more than 20 thousand categories created for image recognition competitions. InceptionV3 is a kind of convolutional neural network model. It consists of numerous convolution and maximum pooling steps. In the last stage, it contains a fully connected neural network. As with the ResNet50 model, the network is trained with ImageNet dataset. The model consists of a deep convolutional network using the Inception ResNetV2 architecture that was trained on the ImageNet-2012 dataset. The input to the model is a 299×299 image, and the output is a list of estimated class probabilities.

5) Software Used

Software:

- **Language Used:** Python 3.0
- **Tools Used:** Anaconda 3.0
- **Libraries Used:** Chainer, numpy, cupy, cuda,OpenCV
- **Dataset Used:** CoronaHack-Chest X-Ray Dataset(Kaggle)

6) References

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