International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 4 Volume No.6 July – 2022
DOI:10.46647/ijetms.2022.v06i04.0027 ISSN: 2581-4621

Deep Chest: Computer Vision and Deep Learning for Lung Disease Detection

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Abstract
Lung disease is one of the most common medical conditions in the world. Pulmonary diseases happen when there are problems with any part of the lungs. Lung infections can affect the air ways of respiratory function, and it may affect the ability to breathe and the good functionality of the human respiratory system. Studying different lung diseases and categorizing them is one of the most interesting areas of research in recent years. Deep learning techniques in the field of computer vision along with medical engineering have recently achieved impressive results. In this work we used three deep learning models for classifying the lung diseases and analyzed the result to find the best model among them. The obtained result shows higher validation accuracy for the deep learning models and this lead to conclude that the method is suitable for predicting Lung diseases.

Keywords— Deep Learning, Medical Engineering, Lung Diseases, Human Respiratory System.

1. Introduction

As of the end of December 2019, a new coronary heart disease (COVID-19) 2019 has been confirmed and it caused severe lung damage and difficulty breathing. Pneumonia, a form of lung disease, is also possible due to the virus that causes COVID-19 or may be due to another viral or bacterial infection. Artificial intelligence is rapidly entering radiology, and possibly AI-based algorithms are suitable for tasks such as pattern identification on chest CT images. This study proposes an in-depth classification method for detecting COVID-19, pneumonia, and lung cancer from CT images.

Medical images are very often contaminated by noises due to increasing forms of intrusion including that of the procedure of imaging and data collection. As a consequence, a visual assessment of them could become more challenging [1].

1.1 Proposed System

Climate change is linked to many health problems, such as reduced lung function, asthma, and an increase in premature death. The unhealthy life ways of humans increase the risk of diseases to people. One of the major diseases we focus on in this study is a lung disease. Lung diseases are the leading cause of death worldwide, causing 3.23 million deaths in 2019. The ambient exposure to tobacco smoke, and the incineration of internal and all kinds, of smoke, and chemicals are important risk factors for lung diseases.

The major symptoms of lung disease including coughing, dyspnoea, and chest pain—may be added several others. Physical examination of the chest remains important, as it may reveal the

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presence of an area of inflammation, a pleural effusion, or an airway obstruction. Methods of examination include physical inspection and palpation for masses, tender areas, and abnormal breathing patterns. The most common methods are shown in Figure 1.

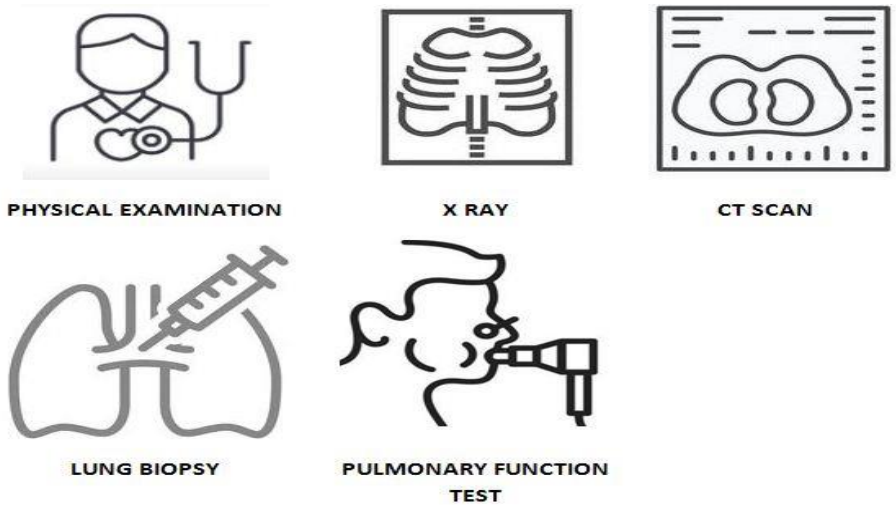

Figure 1: Common Methods for Ling disease Diagnosis

A computer and technological equipment are used to fuel AI.Disease detection has become easier because of the power of machines. It can help spot risks early and more precisely. Earlier detection of diseases can save human lives.

2. Related Works

As discussed in the previous section, lung diseases cause difficulty in breathing. It is essential to implement efficient automatic diagnosing systems to detect these diseases. Several studies and researches are going on in this area. Generally, DCNNs perform better in a greater database than a database which is comparatively smaller. Transfer learning is useful in such frameworks of CNN which have a relatively limited collection of data.[1] Transfer learning is a type of machine learning, where a method already generated for a task is replicated as a starting point for a specific task[2].

A chest CT scan test is very common and is a cost-effective medical imaging technique. Lungs CT clinical diagnosis can be of high demand. Hence, there is a scarcity of resourceful public datasets. In the medical image processing as usual amount of data is not large enough, especially for the positive case. Thus, it is also essential to use appropriate data augmentation techniques [3]. Deep learning is an emergent and influential method which is used for feature learning and pattern recognition. [4].Chest X-ray and computed tomography (CT) images are quite easy to obtain for patients and are a low-cost procedure, which makes using them in the recognition of COVID-19 applicable in most countries [5].Also most of the studies performed earlier is a binary classification of diseases. Hence we are focusing on multi-classification for lung diseases using deep learning models.

3. Methodology

Deep Learning models have proven to yield better accuracy when dealing with large volumes

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of dataset. They learn to perform classification tasks directly from images, text or sound. It can achieve state-of-the-art precision, sometimes exceeding human level performance. These models are trained using a large set of labeled data and neural network architectures that contain many layers. This was made possible because of transfer learning, where models trained from large data sets like ImageNet with modified optimizers was used.

We trained our proposed model based on the publicly available chest CT scan datasets from TCIA and Kaggle repositories. The open source python libraries like Keras and Tensor flow were used to train the deep learning models to discriminate features for the classification of Lung disease from chest CT images.

3.1 Dataset Description

A more reliable database other than GitHubs is the very popular database of "Kaggle".We collected CT images consisting of Normal, Pneumonia, COVID 19 and Lung Cancer with varying resolutions from the Kaggle repositories. It was further subdivided into training, testing and validation set with each containing Lung Cancer ,Pneumonia, COVID 19 and Normal images.

3.2 Dataset Pre-processing

The Lung CT datasets are first augmented to excess the number of the used images and to balance between the four types of datasets. Then, these images are used as input for the data pre-processing stage. To make the model more robust, rescaling and normalization was used. Furthermore, images were randomly rotated at 40° during training and flipped both vertically and horizontally by 20° etc…

3.3 Deep Learning Proposed Models

In this work, several types of supervised deep learning techniques are utilized for developing the proposed three deep-chest classification models. This study aim to explore their performance in detecting the four considered lung diseases and concluding the best of them.

ResNet-101 is a convolutional neural network that is 101 layers deep. The core idea of ResNet is introducing a so-called "identity shortcut connection" that skips one or more layers. One of the problems ResNets solve is the famous known vanishing gradient. ResNet improves the efficiency of deep neural networks with more neural layers while minimizing the percentage of errors. [15]

VGG-19 is a convolutional neural network that is trained on more than a million images from the ImageNet database.VGG19 has19 weight layers consisting of 16 convolutional layers with 3 fully connected layers and same 5 pooling layers. There consists of two Fully Connected layers. The Last fully connected layer uses softmax layer for classification purpose. [16]

The Inception V3 is a deep learning model based on Convolutional Neural Networks, which is used for image classification. The model itself is made up of symmetric and asymmetric building blocks, including convolutions, average pooling, max pooling, concatenations, dropouts, and fully

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connected layers.[17]

3.4 Proposed Architecture

The model block diagram is shown in Figure 2. As clearly seen from the figure, the model consists of three main stages: data pre processing, deep learning models for feature extraction, and classification. The proposed model uses chest images from CT and as inputs and the final output is the classification of the input image into one of the five classes: COVID-19, Normal, Pneumonia and Lung Cancer.

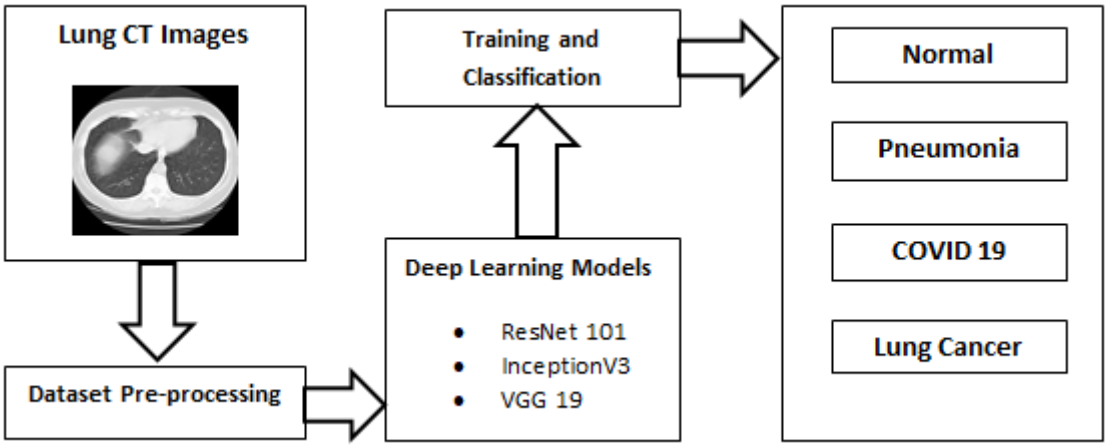

Figure 2. Block diagram of Deep-Chest Model

4. Results and Discussion

The results were based on conducting experiments using VGG-19, Inception V3 and ResNet101, pre-trained models to discriminate Pneumonia, Lung cancer and Covid 19 images from Normal CT images at high resolution. As a standard technique, the image was reduced into smaller sizes which are then passed into the convolutional neural network for classification. The validation accuracy of our model was slightly higher when compared to other conventional approaches due to the efficiency of using pre-trained models.

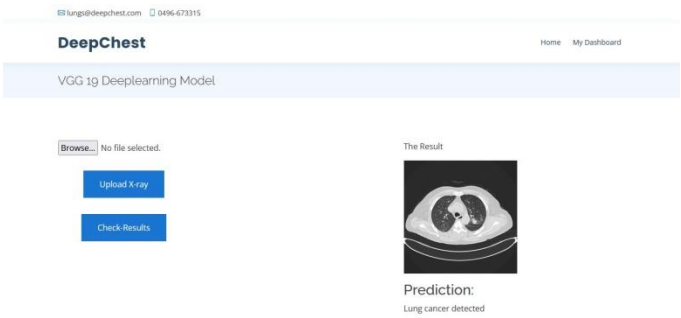

Figure 3. VGG 19 Model Lung Cancer CT Prediction.

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Our findings on using pre-trained models such as VGG-19, Inception V3 and ResNet-101 trained on same datasets, gave better results as compared to training from scratch. Further, to validate the performance of our approach, a comparative analysis was done using state-of-the arts models.

The performance of our models when compared against three approaches, which in most cases VGG 19, outperforms the other two robust pre-trained models. The VGG 19 models shows 88% accuracy, ResNet 101 shows 86 % and Inception V3 shows 82% accuracy.

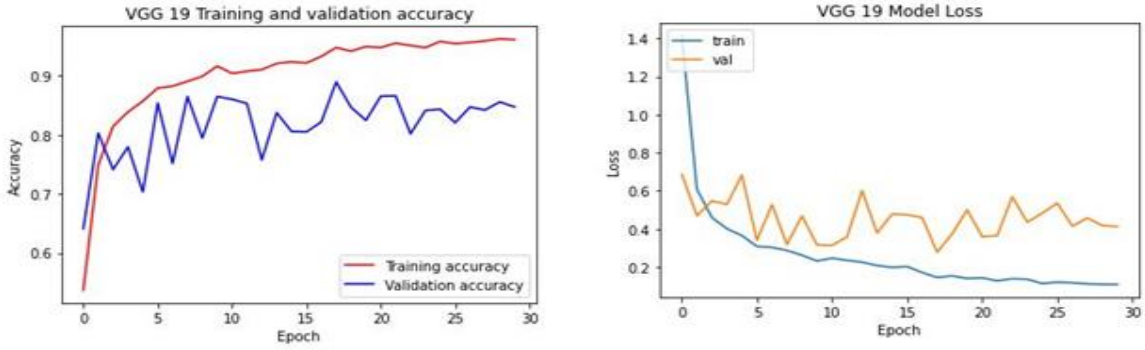

Figure 7 . VGG 19 Model Validation Accuracy and Loss.

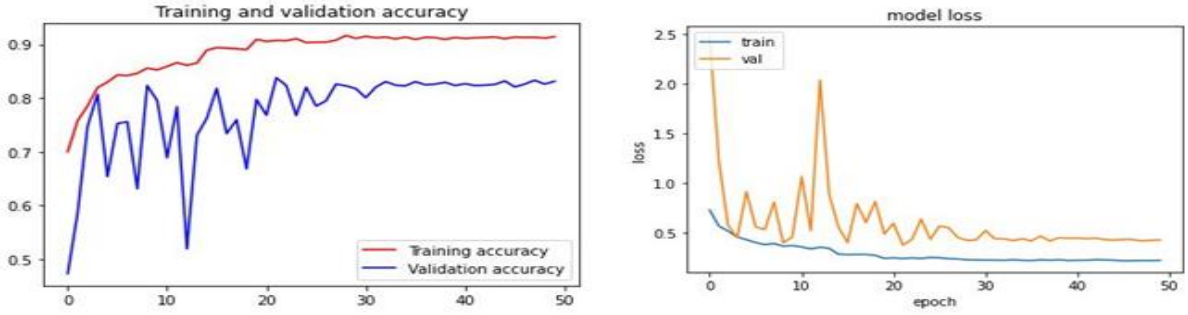

Figure 8: ResNet 101 Model Validation Accuracy and Loss.

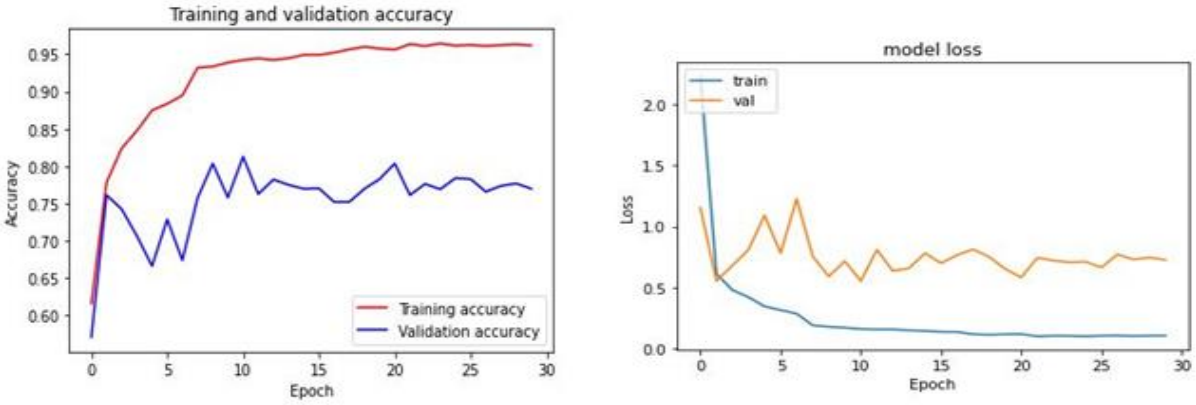

Figure 9: Inception V3 Model Validation Accuracy and Loss.

5.Conclusion

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There are many diseases that may attack the human lung system. The most commonly used diagnosis methods for these three diseases are chest X-ray and computed tomography (CT) images. In this study, a multi-classification deep learning model was designed and evaluated for detecting lung diseases from chest CT images. This work to classify the four chest diseases in a single model. It is important to correctly diagnose these diseases early to determine the proper treatment. Three deep learning architectures for lung disease detection and diagnosis in the human lung system are proposed.

In this work, a multi-classification deep learning model for diagnosing COVID-19, pneumonia and lung cancer from chest CT images is proposed and developed. The CT scan of the chest is useful even before symptoms appear, and CT scan can precisely detect the abnormal features that are identified in images. The obtained results lead to conclude that the method is suitable to integrate clinical decision support systems for pulmonary screening and diagnosis.

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