The Implementation of ConvNet technique for Automatic Detection of SARS-CoV-2

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Abstract

In the case of covid19 outbreak, most of the patients infected into their lungs started with pneumonia and throat infections with short of breathing. SARS-CoV-2 can negatively impact the lung, the gastrointestinal system, the brain, and the musculoskeletal system. It is basically can be a full body illness. The diagnosis of all such symptoms is possible with imaging technology like x-ray of chest which a radiologist can analyze to understand the severity of the infection. The researchers in Oman are trying to understand epidemiological trends to generate new Artificial Intelligence Algorithms to assist with covid19 disease detection, differentiation from other pneumonia and quantification of lung for therapy planning in advance. Predicting the SARS-CoV-2 disease in advance offers healthcare providers the opportunity to apply preventative measure that might improve patient safety, and quality of care, while lowering medical costs (Jarod Ferguson 2013). A group of researchers in some study concluded that the deep learning model showed comparable levels of performance with expert radiologists, and greatly improve the efficiency of radiologists in clinical practice (Elise Mak 2020). One type of deep learning, known as convolutional neural network, is particularly well suited to analyzing images, such as magnetic resonance imaging results or x-rays, it designed to operate more efficiently and handle larger images. Artificial Intelligence in medical imaging and diagnostics can conduct a comparative analysis of multiple x-ray scan images of the same patient and measure the changes in infections. That helps doctors to track the development of the disease, evaluate the treatment of the covid19 patients speedily and effectively. This paper presents a convolutional neural network to detect coronavirus in chest x-ray imagery with high accuracy and it is relevant to the conference theme of AI techniques to predict, prevent covid19, and other pandemics. Many studies showed that the covid-19 detection neural network scored high marks for diagnosing coronavirus infection with more than 92% accuracy.

Keywords: SARS-CoV-2, Deep Learning, Convolutional Neural Network, Chest x-ray.

Introduction

Covid19 coronavirus is an illness caused by a new virus that is spreading rapidly across the world. It can effect on breathing system, lungs and airways. It can spread from person to person through germs that end up on the hands and on surfaces when infected persons are coughing or sneezing. Many people will recover after experiencing a period of sickness lasting between one to two weeks, but some people are highly risk and may get seriously ill from covid19. The virus hits different people very differently. Both the particular mix of symptoms, and their severity, can very a lot from one person to the next. One person might barely notice their case, and another might die. Pneumonia, respiratory disappointment, and death may all result from the infection. A condition known as cytokine discharge disorder can cause numerous covid19 complications. This is the stage at which an illness causes the immune system to flood the circulatory system with pro-inflammatory proteins known as cytokines. They have the ability to kill tissue and destroy organs in the patient body. On computer tomography images, a deep learning-based model is used to detect covid19. Some researchers have also created public databases of covid19 patients' chest x-ray images. For the diagnosis of covid19, a tool called COVID-Net was developed and applied to these public datasets (J. P. Cohen et al. 2020). Deep learning is being used to diagnose chest X-ray images, and the results are promising. For medical image processing, deep learning models are commonly used. Convolution neural networks are used to detect pneumonia, according to D. Varshni et al. (2019). In the literature section, there are numerous techniques for diagnosing covid19 using machine learning techniques on radiological images.

Problem statement

Pandemics are mostly caused by influenza viruses. Since these viruses' behavior varies with the seasons, it is essential to predict their behavior in order to avoid infection. Some viruses have unusual characteristics that make them difficult to predict. These viruses cause pandemics because humans lack the immunity to fight them. Covid19 is the most recent coronavirus outbreak, it has emerged and spread rapidly. After its discovery in Wuhan, China, in December 2019, the disease has spread to more than 199 countries and regions. A. C. Walls et al. (2020) mentioned that covid19 is caused by the coronavirus 2 of the severe acute respiratory syndrome. The virus is a ribonucleic acid virus from the Coronavirus group, which causes the common cold in the majority of people. The disease is infectious, and the virus is passed from person to person through respiratory droplets, and physical contact (J. F. W. Chan et al. 2020). Fever, dry cough, and respiratory problems such as shortness of breath, muscle soreness, and fatigue are all common covid19 symptoms. Diarrhoea and vomiting have also been recorded in some cases. The intensity of the illness varies, ranging from a mild case of the flu to pneumonia that causes respiratory problems. The disease progresses to the point that organ failure and acute respiratory distress syndrome occur, resulting in the patients' deaths. The covid19 virus doesn't cause symptoms on its own, but the RNA in its capsule is engineered to get the other autoimmune disease going in a big way. To begin with, it suppresses the immune system, lowering T-cell counts, reprograming the host, and so on, allowing other viruses in the host to rise and cause symptoms. They were previously inactive, but the arrival of the general covid19 virus has changed everything. Some patients may also have a runny nose, which is unusual in this situation and may indicate the existence of a different virus. Others claim to have lost their senses of taste and smell. Approximately 80% of people who get covid19 have a mild case and recover without any special care. However, one out of every six people develops a serious illness. Covid19 poses a greater risk of serious illness to the elderly and those with underlying medical conditions such as high blood pressure, heart disease, diabetes, or chronic respiratory conditions. Antibiotics are ineffective against covid19 since it is a viral pneumonia. Antiviral medications are ineffective against flu, and there is currently no reliable vaccine. The strength of a person's immune system determines how quickly they recover.

Literature Review

Krishna et al. (2021) discussed about the diagnosis of covid19 from chest x-ray images using wavelets-based depthwise convolution network. The paper proposed an automated method to diagnose the covid19 from chest x ray by using an improved depthwise convolution neural network. The network is trained to classify the input image into three categories: normal, viral pneumonia, and covid19. Covid19 chest X-ray images, viral pneumonia patients, and healthy individuals made up the dataset that used in the research. The dataset contains a total of 1439 images from the three classes. There are 132 images of covid19, 629 images of viral pneumonia, and 678 images of a normal case. For diagnosis, the model's predicted output is combined with Grad-CAM visualization. For multiresolution analysis, the input images are segmented using Haar wavelet. A comparative analysis is also carried out to assess the proposed method's performance. Through chest x ray images, the study has revealed that the proposed method outperforms current methodologies and can therefore be used for accurate disease diagnosis and control of it.

A study about “predicting covid19 pneumonia severity on chest x-ray with deep learning” has presented an intensity score prediction model for covid19 pneumonia for chest x-ray images. Such a tool can be used to assess the seriousness of covid19 lung infections like pneumonia and can be used to guide treatment escalation and de-escalation as well as track treatment effectiveness, particularly in the Intensive care unit. Over time, an automated tool can be used to objectively and quantitatively monitor disease development and treatment response in patients. Three experts prospectively rated images from a public covid19 database in terms of the level of lung activity as well as the level of opacity. The features for covid19 images that are informative for this task are constructed using a neural network model that was pre-trained on massive non-covid19 chest X-ray datasets. They used a DenseNet model from the TorchXRayVision library in this study. Models based on DenseNet have been shown to accurately predict pneumonia. For the training, images were resized to 224x224 pixels, with a middle crop applied if the aspect ratio was irregular, and the pixel values were scaled to -1024, 1024. Based on CXRs, the studied model can predict the severity of covid19 pneumonia which can be used as a tool to help manage patient care.

Another article about “Predicting covid19 from Chest X-Ray Images Using Deep Transfer Learning” has prepared a dataset for covid19 detection of 5,000 images with binary labels for the research community to use it as a reference. They also used this dataset to train four successful deep learning models and evaluate their output on a test set of 3,000 images. The top-performing model had a sensitivity rate of 97.5 percent and a specificity rate of 95 percent. They conducted a thorough analysis into the models' performance in terms of sensitivity, specificity, ROC curve, region under the curve, and uncertainty matrix. They use a machine learning algorithm to predict covid19 from X-ray images of the chest and end-to-end deep learning architecture that directly predicts the disease from raw images without the need for feature extraction. In recent years, deep learning-based models, primarily convolutional neural networks, were shown to surpass traditional AI approaches in most machine learning and medical image analysis tasks, and have been applied to a variety of problems ranging from classification, segmentation, and face recognition and image processing. In this study, two strategies were used to address the covid19 image scarcity problem. Firstly, to increase the number of samples by a factor of four, they use data augmentation to create transformed versions of covid19 images, such as flipping, small rotation, and inserting small amounts of distortions. Secondly, they refine the last layer of the pre-trained edition of these models on ImageNet rather than training them from scratch. As a result, the model can be trained with fewer samples from each class that have been classified.

Method

The ResNet-18 model will be used to train the covid19 radiography dataset which awarded by Kaggle community. The training dataset consist of 10,192 normal images, 3616 covid19 images, and 1345 viral pneumonia images. The whole images are in PNG file format (portable network graphics), and the resolution are 299*299 pixels. The main focus of deep network is to predict infection in x-ray images and create image classification model. So the model can predict the chest radiography images belong to one of these classes with high accuracy: normal, covid19, and viral pneumonia.

Results

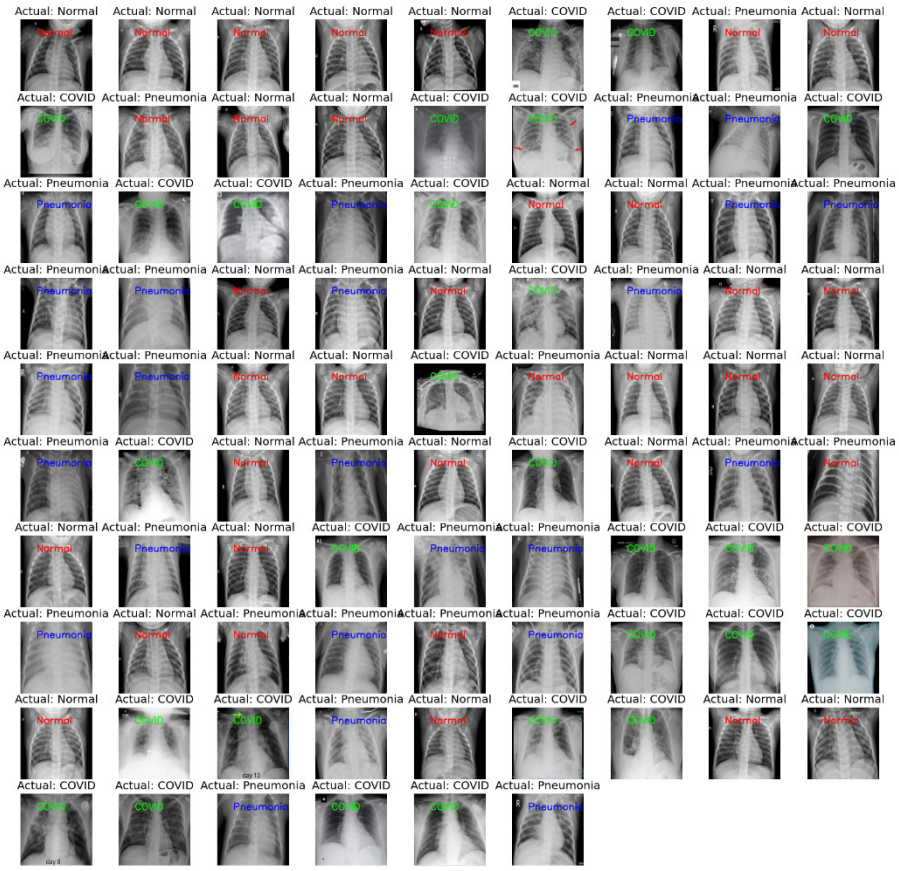

Figure 4: A classificatory of covid19, normal & viral pneumonia's chest x-rays.

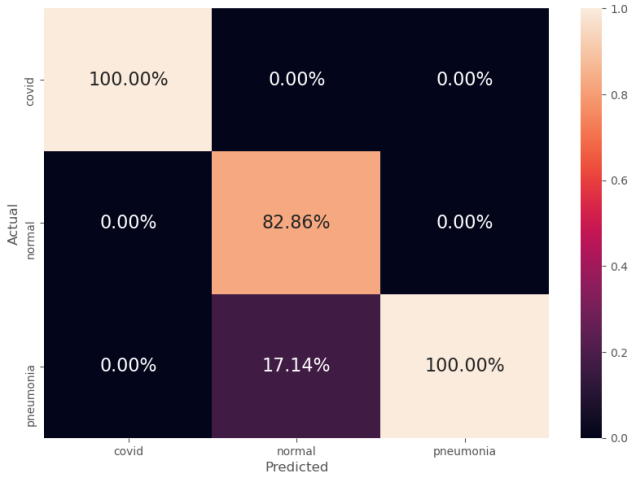

Figure 5: heat map

Discussion

I. Differentiate between covid19 & viral pneumonia in chest x-ray images

Figure 1: Covid19

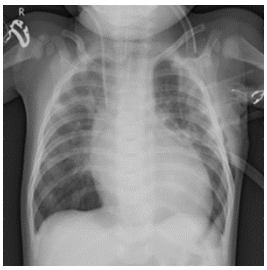

Figure 2: Viral Pneumonia

Figure 3: Normal

Figure 1, Figure 2, Figure 3 are sample images from dataset which descriptive examples of chest x-rays in patients with covid19 and viral pneumonia. The normal chest x-ray image in the right panel represents clear lungs without any areas of abnormal opacification. The viral pneumonia chest x-ray in the middle shows with a more diffuse and bilateral pattern in both lungs. At covid19 x-ray chest, the ground glass opacities **GGOs** are bilateral with posterior/ peripheral lungs.

II. CNN model selection (VGG16, ResNet-18)

In their first convolutional layer, a convolutional neural network begins to detect features including color and edges. The network can learn to detect more complicated features in deeper convolutional layers. Included steps:

- Install new libraries.
- Import all the libraries which are useful for the classification.
- Exploratory data analysis of covid dataset.
- Create dataset.
- Show x-ray images in list for each category (covid19, viral pneumonia, and normal).
- Data preprocessing (resize the image to 244*244 pixels).

- Make the model VGG16
- Train the loss and accuracy for classification between three categories.
- Evaluate the model.

Conclusion

Deep learning can be a very viable technique in the healthcare industry for disease detection simply by processing chest x-ray images and loading them into the model as an input. The chest x-rays are divided into categories such as normal, pneumonia, and covid19 at first. Expert radiologists have struggled to distinguish pneumonia from covid-infected x-rays, so making it feasible by deep learning was a huge accomplishment. With proposed models that offered by scientists, mass testing of people for covid19 can be performed efficiently. It will help produce quicker and more reliable results while still being more expense than the other method. This method can be used on a state level as well as in rural communities where sufficient services are lacking. The article illustrated various approaches that are used in covid19 diagnoses by review other studies and articles.

Acknowledgment

Author would like to thank the supervisor of project planning Mr. Jitendra Pandey who supported me by giving useful instructions and tips for the research article.

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