**Detection of COVID-19 Using Deep Learning**

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**Abstract**

The outbreak of COVID-19 has caused distress and chaos in the entire world with the exponential growth of cases. Priority calls for social distancing and quarantine, the only ways of preventing the spread of the disease. It has been observed that the RT-PCR testing of COVID-19 is not only resulting in many false results but is also time-consuming. Therefore, immediate and efficient testing of COVID-19 is essential with the widespread disease over all the continents. Alternative detection techniques are the need of the hour to combat the disease. In this paper, an automated detection system is built to detect COVID-19 using Chest X-rays Images with the aid of Convolutional Neural Network (CNN). The CNN model has given the accuracy of 97% in the detection of COVID-19 and Normal Chest X-ray Images.

Keywords: COVID-19, RT-PCR, Chest X-rays, Convolutional Neural Network.

**Introduction**

The recent outbreak of a transmissible disease known as COVID-19 has caused a global alarm. COVID-19 is an infectious disease caused by a recently discovered coronavirus. The outbreak commenced in December 2019 in the city of Wuhan, China which soon turned into a pandemic due to its contagious nature. It is also called as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). **[web1]**

Coronaviruses (CoV) are a family of hundreds of viruses that usually infect animals like chickens, bats, camels, cats. These viruses within the animals can mutate permitting them to transmit the virus within them to other species leading to a spill-over **[web2].** It has been observed that the virus is mainly attacking the respiratory system in humans, ranging from the common cold to more deadly diseases like Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS).

The symptoms of COVID-19 can be very mild; some people may not show any symptoms at all but can infect other people. It is not as deadly as SARS and MERS **[paper1].** The most common symptoms of COVID-19 are fever, dry cough, and fatigue. Other symptoms that are less common in nature are headaches, nasal congestion, sore throat, loss of taste and smell, conjunctivitis, and discolouration of fingers or toes. Usually, older people having other underlying medical problems like high blood pressure, heart and lung problems, diabetes, or cancer are at a higher risk of developing a severe illness. However, anyone can get the virus and get seriously ill.

In many developed countries, the health system has come to the point of collapse due to the increasing demand for intensive care units simultaneously **[paper2].** Intensive care units are filled with patients who get worse with COVID-19 pneumonia. Coronavirus is continuing its spread across the world, with more than 11 million confirmed cases in 188 countries. At least half a million people have lost their lives, as per 7th July, 2020 **[web5].**

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The disease has spread across the globe in the first few months of 2020, reaching 10 million cases. Europe and North America saw the first major outbreaks in April but as they began to ease, Latin America and Asia started seeing an increase in cases. North America has seen a resurgence of infections in recent weeks, mostly driven by new outbreaks in the US, but Mexico has also seen an increasing number of cases.

Not only this, COVID-19 has brought economic activity in the entire world at a standstill. The economic damage is evident. This pandemic is one of the largest economic shock the world has experienced in decades. Recent data shows that the service industry has been hit the hardest. Tourism and global trade have been massively disrupted in every region of the world. The World Trade Organization (WTO) expects global trade to fall up to 32% this year due to the coronavirus pandemic **[paper5].** The deep recession triggered by the pandemic are expected to leave ever lasting scars through lower investment, an erosion of human capital and fragmentation of global trade and supply linkages.

SARS, which was first detected in November 2002, bears several similarities to COVID-19. Both the coronaviruses are believed to have originated from bats, jumping to humans via an intermediate animal host **[web2].** According to the WHO, SARS punched holes in the lungs, giving them “a honeycomb-like appearance” **[paper2]** —and these lesions are present in those afflicted by a novel coronavirus, too. However, the mortality rates for SARS are higher. In 2012, there was another outbreak of a newly found coronavirus called the Middle East Respiratory Syndrome (MERS). The very first case was found in Saudi Arabia. The difference between SARS, MERS, and COVID-19 is that R0 for SARS is 3, R0 for MERS is less than one, but the R0 for COVID-19 is 5, meaning that every infected person is likely to infect five other people. This shows how the infectious nature of COVID-19 **[web2].**

COVID-19 begins and ends in patients’ lungs, because like the flu, coronaviruses are respiratory diseases. They spread typically when an infected person coughs or sneezes, spraying droplets that can transmit the virus to anyone in close contact. Coronaviruses also cause flu-like symptoms: Patients might start with a fever and cough that progresses to pneumonia or worse **[web3].**

COVID-19 is detected in the upper and lower respiratory specimens of the individuals with the help of RT-PCR (real-time transcription-polymerase chain reaction) test. Since the origin of the outbreak, the availability and quantity of the testing kits have been low. The stability and reproducibility if the detection kits are being questioned. These factors play a determinant role in the accuracy of test results. In several areas, the accuracy of the kits has found to be only 80% and has to be hence repeated several times before the cases can be confirmed. There are questions being raised about quality and stability of the detection kits **[web4].**

X-ray images of the chest can be used to diagnose COVID-19 with technological advancements made in the field of machine learning. One of the most vital methods of machine learning is deep learning. Deep learning focuses on extracting features and classifies images which are applied in detecting objects or in medical cases, classification of tasks. Machine learning and deep learning have become established disciplines in applying artificial intelligence to mine, analyze, and recognize patterns from data **[paper3].**

With the recent innovation in Artificial Intelligence (AI), COVID-19 can be detected, quantified, and monitored and making it easier to isolate patients who have been infected for faster treatment. Chest x-rays scan the infections present in the lungs of the patient. It is a faster, easier, cheaper, and less harmful method of testing patients and hence must be used. With the increasing mortality rates all thanks to COVID-19, Chest X-rays must be implemented by all countries on an urgent basis. Although this technological advancement seems helpful, the images of various types of pneumonia are similar and overlap with other infectious and inflammatory lung diseases making it difficult to distinguish between COVID-19 from other viral cases of pneumonia **[paper2].**

In the study, a prediction of the COVID-19 detector will be modelled using Convolutional Neural Network (CNN) based on Chest x-rays images. CNN helps in the extraction of the features by enhancing low-light images with the help of training data. In the early stages of COVID-19, bilateral distribution of patchy shadows and ground-glass opacity has been observed which are similar to the viral pneumonia symptoms with slight differences **[paper1].** With the aid of the CNN model, unique features can be identified which are difficult for visual recognition. After the model is trained on the dataset, performance of this classification model is evaluated on the validation dataset using a Confusion Matrix.

**Literature Review**

Convolutional neural network (CNN) is one of the most popular and effective approaches in the diagnosis of COVD-19 from digitised images. Several reviews have been carried out to highlight recent contributions to COVID-19 detection.

In Shuai et al. study, based on the COVID-19 radiographic changes from CT images, they have developed a deep learning method that can extract the graphical features of COVID-19 to provide clinical diagnosis prior to pathogenic testing and thus save critical time for the disease diagnosis **[paper1].**

In a study by Apostolopoulos et al., a dataset of X-ray images from patients with pneumonia, confirmed Covid-19 disease, and normal incidents, was used to evaluate the performance of state-of-the-art convolutional neural network architectures proposed previously for medical image classification. The study suggested that transfer learning can extract significant biomarkers related to the Covid-19 disease **[paper4]**.

In a study by Narin et al., pre-trained models like ResNet50, InceptionV3 and Inception-ResNetV2 are used on a chest x-ray dataset to distinguish between COVID-19 and normal images **[paper2].**

In a study by Abbas et all., a detection system has been made using the DeTraC deep convolutional neural network to classify images of Normal, COVID-19 and SARS chest x-ray images **[paper6].**

In a study by Basu et al., a detection system has been built to differentiate between CPVID-19 and Pneumonia chest x-ray images using Domain Extension Transfer Learning and Thoracic Imaging. They have also detected the regions in which the infection has spread in the chest x-rays using Gradient Class Activation Map (Grad-CAM) **[paper7].**

In a study by Fei et al., they developed a deep learning-based system for automatic segmentation of all lung and infection sites using chest CT **[paper9]**.

Xiaowei et al. aimed to establish an early screening model to distinguish COVID-19 pneumonia and Influenza-A viral pneumonia from healthy cases using pulmonary CT images and deep learning techniques **[paper8].**

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