Project Report

Course Name: Artificial Intelligence Lab
Course Code: CSE-316

Course Teacher
Name: Md. Arid Hasan(MAHN)
Department of CSE
Daffodil International University

Submitted By
Name: Md. Aiyub Ali
ID: 193-15-13456
Name: Md. Sourov Mia
ID: 193-15-13536
Name: Rabeya Boshri
ID: 193-15-13483
Section: N
Program: Day
Department: CSE
Daffodil International University

Date of Submission: 13.04.2022

Covid-19 Detection from X-ray images using Convolutional neural network

ABSTRACT

The emergence of Coronavirus Disease 2019 (COVID-19) in early December 2019 has caused immense damage to health and global well-being. Currently, there are approximately five million confirmed cases and the novel virus is still spreading rapidly all over the world. The chest X-ray images along with emerging Artificial Intelligence (AI) methodologies, in particular, Deep Learning (DL) algorithms have recently become a worthy choice for early COVID-19 screening. This work proposes a DL-assisted automated method using X-ray images for the early diagnosis of COVID-19 infection. We evaluate the effectiveness of the pre-trained Convolutional Neural Network (CNN) model. The model has been validated on publicly available chest X-ray images and it is obtained by CNN with an accuracy of 97.26%. This study will be useful for researchers to think about the design of more effective CNN-based models for early COVID-19 detection.

KEYWORDS: Human Diseases. CNN, Chest X-ray, Covid-19

INTRODUCTION

The new coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has spread all over the world and has become a global public health issue[1]. COVID-19 that has been declared as a pandemic by World Health Organization (WHO) on 11th March 2020 leads clinical symptoms such as acute respiratory disorder, fever, cough, sore throat, headache, fatigue, muscle pain, and shortness of breath[2]. According to the statistical reports, it has been reported that one of the most crucial step in the fight against the COVID-19 is early identifying the infected individuals and commencement of treatment procedures in severe cases as well as quarantine procedures to mitigate the spread.[3] The conventional diagnosis process has become relatively faster but still causes a high risk for medical staff. Moreover, it is costly and there exists a limited number of diagnostic test kits. On the other hand, medical imaging techniques (X-ray and CT) based screening are relatively safe, faster, and easily accessible[4]. Compared to CT imaging, X-ray imaging has been extensively used for COVID-19 screening as it requires less imaging time, lower cost, and X-ray scanners are widely available even in rural areas. Recently, [5]CNN has been successfully applied to detect pneumonia in chest X-ray images. A chest radiology image-based detection system can have many advantages over a conventional method. [6] It can be fast, analyze multiple cases simultaneously, have greater availability and more importantly, such a system can be very useful in hospitals with no or a limited number of testing kits and resources. Moreover, given the importance of radiography in the modern health care system, radiology imaging systems are available in every hospital, thus making radiography-based approach more convenient and easily available. Today, researchers

from all around the world, from various different fields are working day and night to fight this pandemic. Many researchers have published a series of preprint papers demonstrating approaches for Covid-19 detection from chest radiography images. These approaches have achieved promising results on a small dataset but by no means are production-ready solutions. These approaches still need rigorous testing and improvement before putting them into use. Subsequently, a large number of researchers and data scientists are working together to build highly accurate and reliable deep learning-based approaches for the detection and management of Covid-19 disease. Researchers are focusing on deep learning techniques to detect any specific features from chest radiography images of Covid-19 patients. In the recent past, [7]deep learning has been very successful in various visual tasks which include medical image analysis as well. Deep learning has revolutionized automatic disease diagnosis and management by accurately analyzing, identifying, and classifying patterns in medical images. The reason behind such success is that deep learning techniques do not rely on manual handcrafted features but these algorithms learn features automatically from the data itself. In the past, [7]deep learning has had success in disease classification using chest radiography images. CNN is a deep neural network model that detects covid-19 from chest x-ray images. Convolutional neural networks achieved exceptional results exceeding average radiologist performance.

In this study, we present a deep learning-based approach to detecting Covid-19 infection from chest x-ray images. We propose a deep convolutional neural network (CNN) model to classify two types of normal and Covid-19. The proposed model is called CNN and will help us identifying the difference between two types of infections and how Covid-19 is different from other infections. A model that can identify Covid-19 infection from chest radiography images can be very helpful to doctors in the triage, quantification and follow-up of positive cases. Even if this model does not completely replace the existing testing method, it can still be used to bring down the number of cases that need immediate testing or further review from experts.

METHODOLOGY

Convolutional Neural Network also known as CNN is a deep learning technique that consists of multiple layers stacked together and uses local connections known as local receptive field and weight-sharing for better performance and efficiency. The deep architecture helps these networks learn many different and complex features which a simple neural network cannot learn. CNN's have shown excellent performance on several applications such as image classification, object detection, speech recognition, natural language processing, and medical image analysis[8].

The convolution layer is the core building block of a Convolutional Neural Network which uses convolution operation (represented by *) in place of general matrix multiplication[9]. Its parameters consist of a set of learnable filters also known as kernels. The main task of the convolutional layer is to detect features found within local regions of the input image that are common throughout the dataset and map their appearance to a feature map.

The convolution operation is given as:

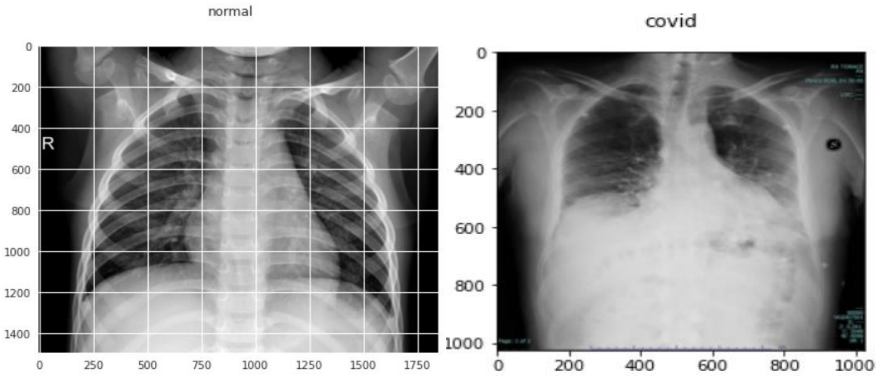
$$F(i,j) = (I * K)(i,j) = \sum\sum I(i + m, j + n)K(m, n)$$

Where I is the input matrix (image), K is the 2D filter of size m x n, and F represents the output 2D feature map. Here the input I is convolved with the filter K and produces the feature map F[10]. This convolution operation is denoted by I*K. The output of each convolutional layer is fed to an activation function. The activation function takes the feature map produced by the convolutional layer and generates the activation map as its output. Activation functions are used to introduce non-linearity to the network. There are number of activation functions available but the one which is recognized for deep learning is Rectified Linear Unit (ReLU). ReLU simply computes the activation by thresholding the input at zero[11]. In other words, ReLU outputs 0 if the input is less than 0, and raw output otherwise. It is mathematically given as:

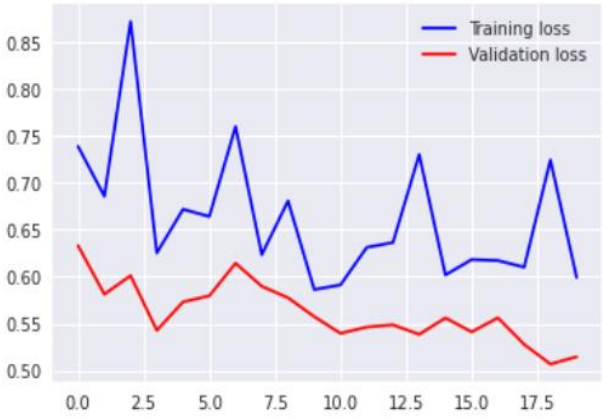
$$f(x) = \max(0, x)$$

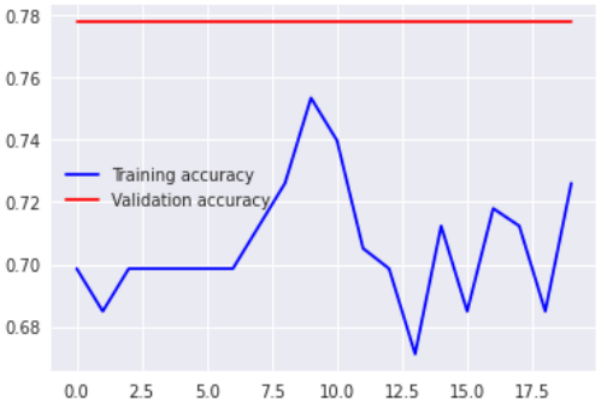
Rectified linear unit activation function produces a graph which is zero when $x < 0$ and linear with slope 1 when $x > 0$.

In CNN, the sequence of convolution layer is followed by an optional pooling or downsampling layer to reduce the spatial size of the input and thus reduce the number of parameters in the network. A pooling layer takes each feature map output from the [12] convolutional layer and downsamples it pooling layer summarizes a region of neurons in the convolution layer. There most common pooling technique is Max Pooling which simply outputs the maximum value in the input region. Other [13] pooling options are average pooling and maximum pooling. The task of Convolution and pooling layers is to detect features from the input. The next step is to make a decision based on these detected features. In case of classification problem, the task is to compute the class scores. This is done by adding one or more fully connected layers at the end. In a fully connected layer each neuron from previous layer is connected to every neuron in the next layer and every value contributes in predicting how strongly a value matches a particular class[14]. The output of the last fully connected layer is then forwarded to an activation function which outputs the class scores. Sigmoid is the main classifier used in CNN. Sigmoid function which computes the probability distribution of the 2 output classes.



The proposed model, CNN was implemented in Keras on top of Tensorflow. The model was pre-trained on Imagedataset and then retrained end-to-end on the prepared dataset using rmsprop optimizer with a learning, epoch value of 20. All the experiment and training was done on Kaggle. Plots of accuracy and loss on the training and validation datasets over training epochs.





RESULT

The experimental result of the proposed model on the prepared dataset is presented in the form of training and validation plot above. The aforementioned performance metrics are the top metrics used to measure the performance of classification algorithms. The proposed model CNN achieved an overall accuracy of up to 95%, while the accuracy of the CNN model is 97.26%.

CONCLUSION

As the cases of the Covid-19 pandemic are increasing daily, many countries are facing a shortage of resources. During this health emergency, it is important that not even a single positive case goes unidentified. With this thing in mind, we proposed a deep learning approach to detect Covid-19 cases from chest radiography images. The proposed method (CNN) is a convolutional neural network designed to identify Covid-19 cases using chest x-ray images. The model has been trained in two cases and covid-19 cases from different publically available databases. CNN is computationally less expensive and achieved promising results on the prepared dataset. The performance can further be improved once more training data becomes available. Notwithstanding the encouraging results, CNN still needs clinical study and testing but with higher accuracy and sensitivity for Covid-19 cases, CNN can still be beneficial for radiologists and health experts to gain deeper understanding into critical aspects associated with COVID-19 cases.

REFERENCES

[1] T. Zebin and S. Rezvy, "COVID-19 detection and disease progression visualization: Deep learning on chest X-rays for classification and coarse localization," *Appl. Intell.*, vol. 51, no. 2, pp. 1010–1021, Feb. 2021, doi: 10.1007/S10489-020-01867-1.

[2] H. Mukherjee, S. Ghosh, A. Dhar, S. M. Obaidullah, K. C. Santosh, and K. Roy, "Deep neural network to detect COVID-19: one architecture for both CT Scans and Chest X-rays," *Appl. Intell.*, vol. 51, no. 5, pp. 2777–2789, May 2021, doi: 10.1007/S10489-020-01943-6.

[3] S. Jhajharia, S. Verma, and R. Kumar, "A cross-platform evaluation of various decision tree algorithms for prognostic analysis of breast cancer data," *Proc. Int. Conf. Inven. Comput. Technol. ICICT 2016*, vol. 2016, 2016, doi: 10.1109/INVENTIVE.2016.7830107.

[4] M. Farooq and A. Hafeez, "COVID-ResNet: A Deep Learning Framework for Screening of COVID19 from Radiographs," Mar. 2020, Accessed: Apr. 04, 2022. [Online]. Available: http://arxiv.org/abs/2003.14395.

[5] M. Toğaçar, B. Ergen, Z. C.-C. in biology and medicine, and undefined 2020, "COVID-19 detection using deep learning models to exploit Social Mimic Optimization and structured chest X-ray images using fuzzy color and stacking approaches," *Elsevier*, Accessed: Apr. 04, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0010482520301736.

[6] L. Wang, Z. Lin, A. W.-S. Reports, and undefined 2020, "Covid-net: A tailored deep convolutional neural network design for detection of covid-19 cases from chest x-ray images," *nature.com*, Accessed: Apr. 04, 2022. [Online]. Available: https://www.nature.com/articles/s41598-020-76550-z.

[7] E. E.-D. Hemdan, M. A. Shouman, and M. E. Karar, "COVIDX-Net: A Framework of Deep Learning Classifiers to Diagnose COVID-19 in X-Ray Images," Mar. 2020, Accessed: Apr. 04, 2022. [Online]. Available: http://arxiv.org/abs/2003.11055.

[8] X. Gu, L. Pan, H. Liang, and R. Yang, "Classification of bacterial and viral childhood pneumonia using deep learning in chest radiography," *ACM Int. Conf. Proceeding Ser.*, pp. 88–93, Mar. 2018, doi: 10.1145/3195588.3195597.

[9] T. Ozturk, M. Talo, E. Yildirim, … U. B.-C. in biology, and undefined 2020, "Automated detection of COVID-19 cases using deep neural networks with X-ray images," *Elsevier*, Accessed: Apr. 04, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0010482520301621.

[10] Y. Oh, S. Park, J. Y.-I. transactions on medical imaging, and undefined 2020, "Deep learning COVID-19 features on CXR using limited training data sets," *ieeexplore.ieee.org*, Accessed: Apr. 04, 2022. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/9090149/.

[11] M. Islam, M. Islam, A. A.-I. in medicine unlocked, and undefined 2020, "A combined

deep CNN-LSTM network for the detection of novel coronavirus (COVID-19) using X-ray images," *Elsevier*, Accessed: Apr. 11, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2352914820305621.

[12] S. Hassantabar, M. Ahmadi, A. S.- Chaos, S. & Fractals, and undefined 2020, "Diagnosis and detection of infected tissue of COVID-19 patients based on lung X-ray image using convolutional neural network approaches," *Elsevier*, Accessed: Apr. 11, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S096007792030566X.

[13] M. Aslan, M. Unlersen, K. Sabanci, A. D.-A. S. Computing, and undefined 2021, "CNN-based transfer learning–BiLSTM network: A novel approach for COVID-19 infection detection," *Elsevier*, Accessed: Apr. 11, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1568494620308504.

[14] G. Gilanie, U. Bajwa, M. Waraich, … M. A.-… S. P. and, and undefined 2021, "Coronavirus (COVID-19) detection from chest radiology images using convolutional neural networks," *Elsevier*, Accessed: Apr. 11, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1746809421000872.