AIMS Human and Media Laboratory Project

COVID-19 Detection Using CNN

Chonnam National University, South Korea

Mentor: Hang Phuong; Mentee : Nurdiansyah Faisal

1. Introduction

CNN is a type of DNN, inspired by the visual system of the human brain, and is most commonly used in the analysis of visual imagery. This project used CNN with extra layers to improve the COVID-19 X-ray image classification accuracy. In neural networks, the CNN structure is specially designed to process the two-dimensional image tasks although it can also be used in one- and three-dimensional data. The convolutional layer, considered a main layer of a CNN, performs the operation called “convolution” which gives CNN its name. Kernels in the convolutional layer are applied to the layer inputs. All the outputs of the convolutional layers are convolved as a feature map. In this study, the Rectified Linear Unit (ReLU) has been used in the activation function with a convolutional layer which is helpful to increase the nonlinearity in the input image, as the images are fundamentally nonlinear in nature.

2. Method

In the experiments of this study, a primary dataset containing 288 X-ray images has been used as a base dataset. Of 288 images, 144 X-ray images belonged to confirmed COVID-19 patients, and the other 144 images belonged to normal or people with other diseases like pneumonia. The dataset used is available on Kaggle.

The proposed CNN model used are including convolutional (Conv2D), max-pooling layers, dropout layers, activation function layers, batch normalization layers, flatten layers, and fully connected layers. In this study, max pooling has been used because others may not identify the sharp features easily as compared to max pooling. In addition, the batch normalization layer has been used in this study as it involved the training of a very deep neural network.

3. Results

After preprocessing of the dataset, the final dataset consisted of a total of 367 X-ray images. For training and testing the proposed CNN, the dataset was partitioned into two subsets. The training dataset contained 144 COVID-19 X-ray images and 144 normal X-ray images, making a total of 288 X-ray images. The CNN model thus achieved an extraordinary performance with an accuracy of 97% with the test data subset used from the processed dataset of this study with a precision of 0.974, with the model parameter values given in Figure 3.4

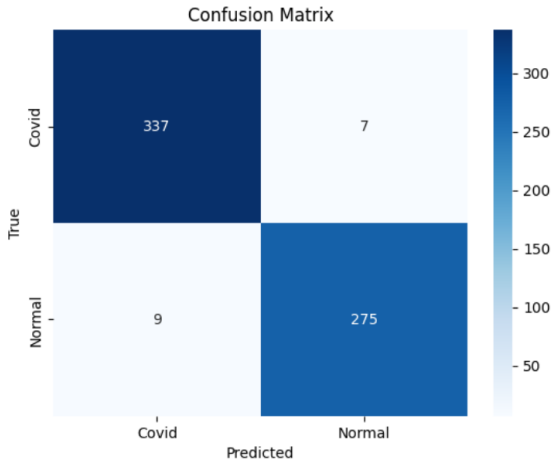

Figure 3.1 Confusion Matrix of CNN model

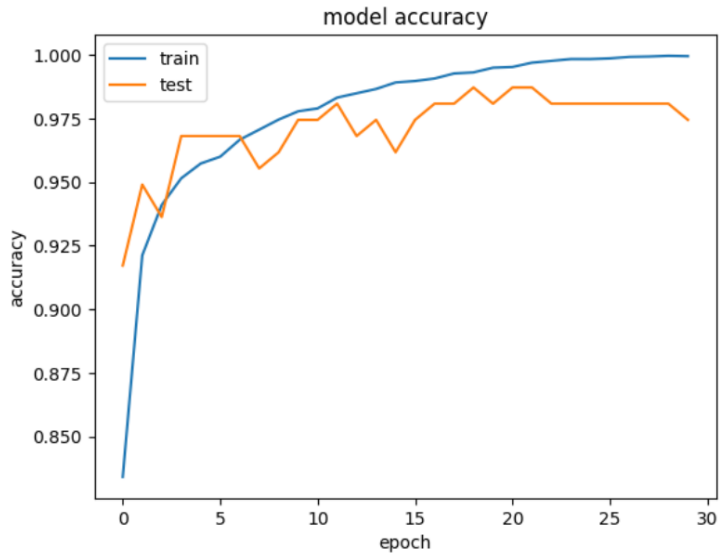

Figure 3.2 Training and testing accuracy plot achieved by the CNN model

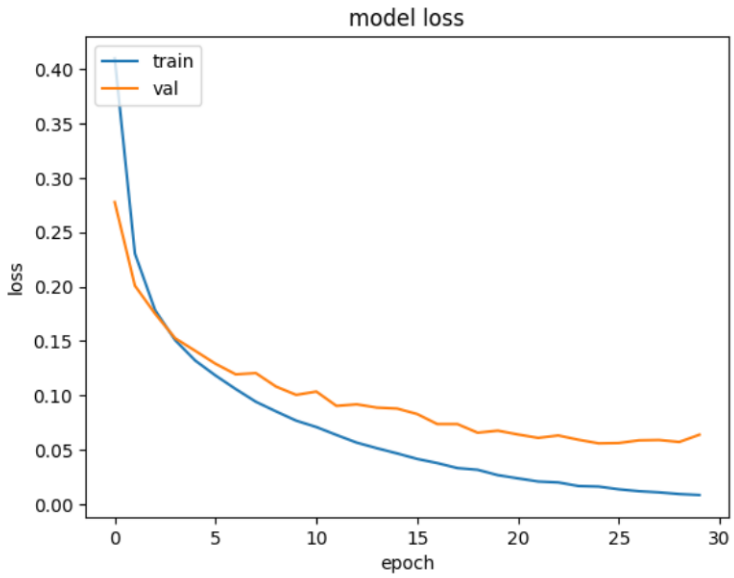

Figure 3.3 Training and testing loss plot by the CNN

	precision	recall	f1-score	support
Covid	0.97	0.98	0.98	344
Normal	0.98	0.97	0.97	284
accuracy			0.97	628
macro avg	0.97	0.97	0.97	628
weighted avg	0.97	0.97	0.97	628

Accuracy: 0.9745222929936306

Figure 3.4 The accuracy score of CNN

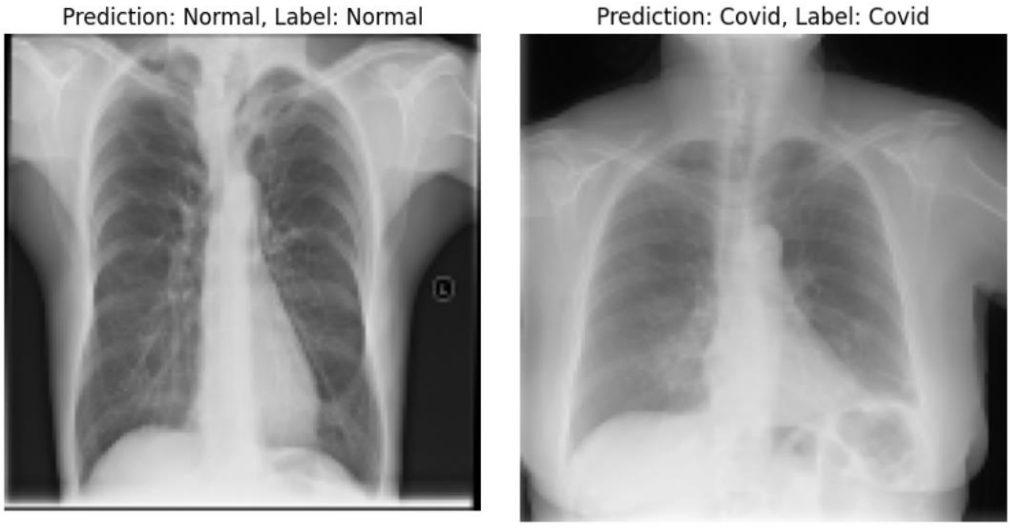

Figure 3.5 The prediction and label of the COVID-19 detection

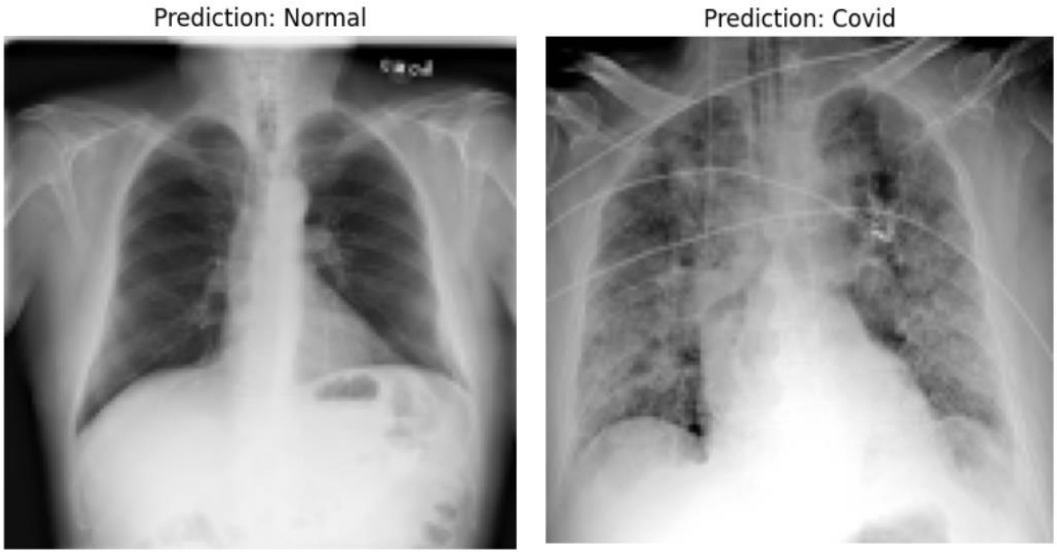

Figure 3.6 The prediction results of the COVID-19 detection

4. Discussion

Due to the very promising results provided by CNNs in medical image analysis and classification, they are considered de facto standards in this domain. CNN has been used for a variety of classification tasks related to medical diagnoses such as lung disease, detection of malarial parasites in images of a thin blood smear, breast cancer detection, wireless endoscopy images, interstitial lung disease, CAD-based diagnosis in chest radiography, diagnosis of skin cancer by classification, and automatic diagnosis of various chest diseases using chest X-ray image classification.

In medical imaging, besides detecting COVID-19 CNN is valuable in better accuracy in identifying tumors or other anomalies in X-ray and MRI images. Based on previously processed similar images by CNN networks, CNN models may analyze an image of a human body part, such as the lungs, and pinpoint where there might be a tumor and other anomalies like broken bones in X-ray images. Similarly, medical images like CT scans and mammograms can be used to diagnose cancer. In order to determine whether any indicators within a picture indicate malignancy or damage to cells owing to both hereditary and environmental factors, such as smoking habits, CNN models compare the image of a patient with database images that include comparable features.

References

B. Kayalibay, G. Jensen, and P. van der Smagt, “CNN-based segmentation of medical imaging data,” 2017, http://arxiv.org/abs/1701.03056.

J. P. Cohen, “Github Covid19 X-ray dataset,” 2020, https://github.com/ieee8023/covid-chestxray-dataset, 2020. Online.

M. Sharif, M. Attique Khan, M. Rashid, M. Yasmin, F. Afza, and U. J. Tanik, “Deep CNN and geometric features-based gastrointestinal tract diseases detection and classification from wireless capsule endoscopy images,” Journal of Experimental & Theoretical Artificial Intelligence, pp. 1–23, 2019.

M. Umer, S. Sadiq, M. Ahmad, S. Ullah, G. S. Choi, and A. Mehmood, “A novel stacked CNN for malarial parasite detection in Thin blood smear images,” IEEE Access, vol. 8, pp. 93782–93792, 2020.

N. Asada, K. Doi, H. MacMahon et al., “Potential usefulness of an artificial neural network for differential diagnosis of interstitial lung diseases: pilot study,” Radiology, vol. 177, no. 3, pp. 857–860, 1990.

Q. Li, W. Cai, X. Wang, Y. Zhou, D. D. Feng, and M. Chen, “Medical image classification with convolutional neural network,” in Proceedings of the 2014 13th International Conference on Control Automation Robotics & Vision (ICARCV), pp. 844–848, Singapore, December 2014.

R. Rouhi, M. Jafari, S. Kasaei, and P. Keshavarzian, “Benign and malignant breast tumors classification based on region growing and CNN segmentation,” Expert Systems with Applications, vol. 42, no. 3, pp. 990–1002, 2015.