International Journal of Science and Research Archive

eISSN: 2582-8185 CODEN (USA): IJSRO2

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Diagnosis of COVID-19 cases on X-Ray images using CNN

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International Journal of Science and Research Archive, 2022, 08(01), 031–037

Publication history: Received on 15 November 2022; revised on 25 December 2022; accepted on 28 December 2022

Article DOI: https://doi.org/10.30574/ijsra.2023.8.1.0338

Abstract

COVID-19 is a viral disease that has killed more than 10 million people worldwide and infected millions of people. Therefore, it has become necessary to screen large numbers of people to detect infected individuals and reduce the spread of the disease. Maximum spread for confirming a virus is estimated with RT-PCR test. PCR (Polymerize Chain Response) is a popular device for predicting pathological examination. A key issue with real-time RT-PCR testing is the risk of generating false-negative and false-positive results. As an adjunct to RT-PCR, Computed Tomography (CT) can be used to diagnose COVID-19. In this article, using CXR scans, we proposed a deep-layered convolutional neural network (CNN) for accurate COVID-19 detection. Our model yields 97% accuracy.

Keywords: Coronavirus (COVID-19); CNN; Radiological images; Classification

1. Introduction

Several countries' healthcare systems have collapsed due to a lack of diagnostic tools and adequate ventilation equipment. To stop the virus's spread, several nations have been compelled to implement nationwide curfews and lockdowns. RT-PCR testing is the most widely used standard for virus validation. However, this method yields false-negative results if the viral load is insufficient. Alternatively, radiologists would like toclassify radiological scans, chest x-rays, or computed tomography images based on certain visual characteristics. Additionally, finding COVID-19 on a chest x-ray is a difficult process, even with an experienced radiologist. For example, an experienced radiologist diagnosis the pathology correctly while a less experienced radiologist diagnoses it with abnormalities.

Figure 1 Sample chest x-ray picture for COVID-19 patients

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Figure 2 Sample chest x-ray image for non-COVID 19 patients

This study aims to examine patterns seen inchest radiographs of patients infected with the COVID- 19 virus**.** In the field of medical imaging, a deep neural network approach is used with a large number of neurons in each layer to help with classification [1]**.** The sample chest x- ray picture for COVID-19 patients is shown in Figure 1, and the sample image for non-COVID-19 patients is shown in Figure 2. The source is taken to be JPEG images.

The following of the paper examines several linked works. The CNN algorithm installation used in this research is then discussed. The process is then described. The experimental results are shown and analyzed in section 4. The final portion goes over the conclusions and future measures.

2. Related work

Support early detection of disease by extracting knowledge from medical data [2]. In the CNN method [3], many researchers have focused on medical images. To automatically detect diabetic retinopathy and diabetic macular edema in retinal fundus images, Gulshan et al. [4]used large data sets to develop deep learning algorithms that outperformed medical professionals on a variety of medical imaging tasks. This neural network is known as adeep convolutional neural network.

This study demonstrates the feasibility of detecting early detection of coronavirus infection using a deep learning algorithm, which is an accurate way to help doctors identify COVID-19 patients using X-rays. Thepurpose is to determine whether it will lead to the development of a more efficient calculation method.

Apostolopoulos and Mpesiana [5] used a dataset of 1,427 X-ray images, including 700 pneumonia patients, 224 COVID-19 disease patients, and 504 normal patients, pre-trained using a convolutional neural network. model (transfer learning). The purpose of this study is to evaluate how well convolutional neural network architectures perform in practice in classifying medical images. The highest accuracy (98.66%) was found in deep learning using his X-ray imaging results of the disease COVID-19.

To assess the effectiveness of care provided in the ICU and to determine when care should be escalated or de- escalated, Cohen et al. [6] compared general pneumonia severity with COVID-19 chest radiographs. We created a neural network model to predict and evaluate.

Computed tomography (CT) scans were reported by Barstugan et al. [7] To identify coronavirus early usingmachine learning techniques. A wavelet transform approachwas used to extract and classify features with SVM, achieving a scoring accuracy of 99.68%. The feature extraction process was applied with modifications toimprove classification performance.

This article proposes a method to automatically identify COVID-19 from chest X-rays. A better CNN model is used for chest X-ray analysis. The network is provided with all inputs for analyzing disease. As input the network was builtto predict whether the XRAY measurements will be COVID or normal. This approach is most suitable for the situationat hand and can be used to accurately diagnose the disease.

3. Method

This section describes the stages of the CNN model used for COVID-19 detection. Figure 3 shows the topology of a convolutional neural network. The input format is 224*224*3, followed by a bypass layer, a fully connected layer containing the relu activation function, and an output layer to classify the images.

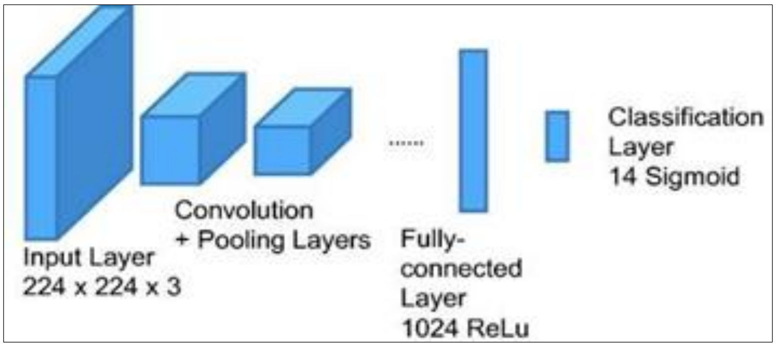


Figure 3 Convolutional neural network constructed based on DenseNet-121

The phases are shown in Figure 4 and discussed hereafter.

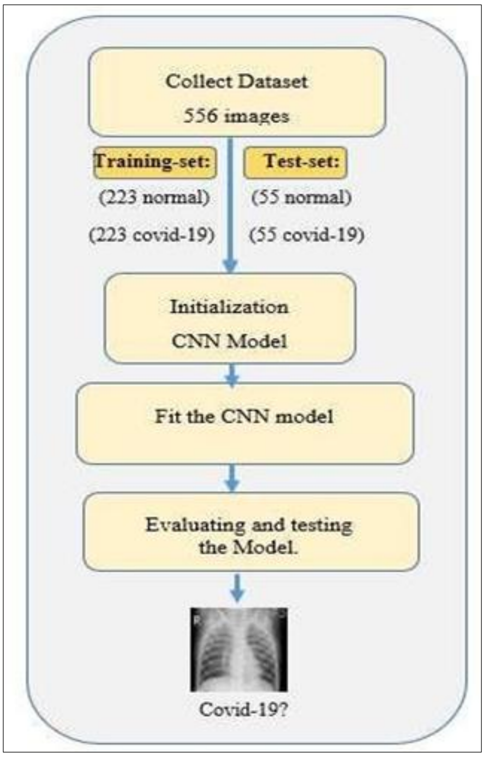


Figure 4 The proposed CNN prediction model for COVID-19

3.1. Dataset

The collected chest X-ray dataset contains a total of 2157 X-ray images, of which 1726 (or 80%) are used for training and 433 (or 20%) are used for testing. The Keras library was imported into Google Colab [8] after downloading X-ray images from the Kaggle website.

3.2. Initialization

- Adding first layer (Convolution 2D): Convolution 2D is added as the first layer.Use 64 output filters in a convolutional 3*3 filter matrix. Multiply this to produce an inputimage of RGB size 64*64 and use activation = relu.
- Apply the following to each image: (MaxPooling2D), Process, Hidden Layer 1 (rotate 2*2 matrix, skew). Add dropout layer. Repeat steps 1 and 2 twice.
- Add Flattening: Flattening is the step of converting a matrix into a single array.
- Adding full connection (128 final layer ofoutputs, activation= relu & dropout layer & Dense layer, activation= sigmoid).

The CNN architectural layers are shown in Figure 5 and the CNN overview is shown in Table 1.

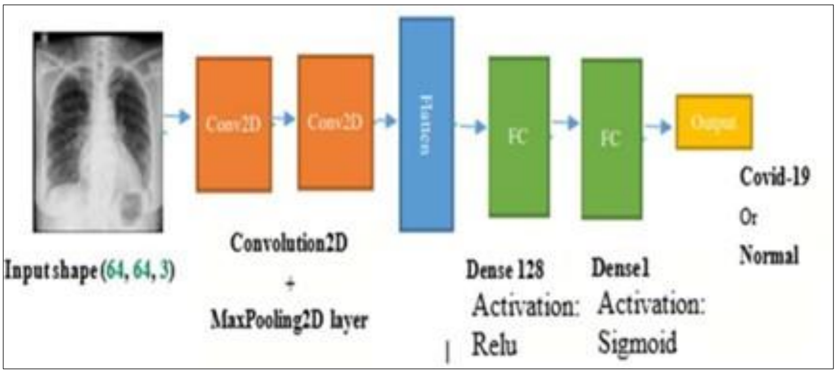


Figure 5 The layer of CNN architecture

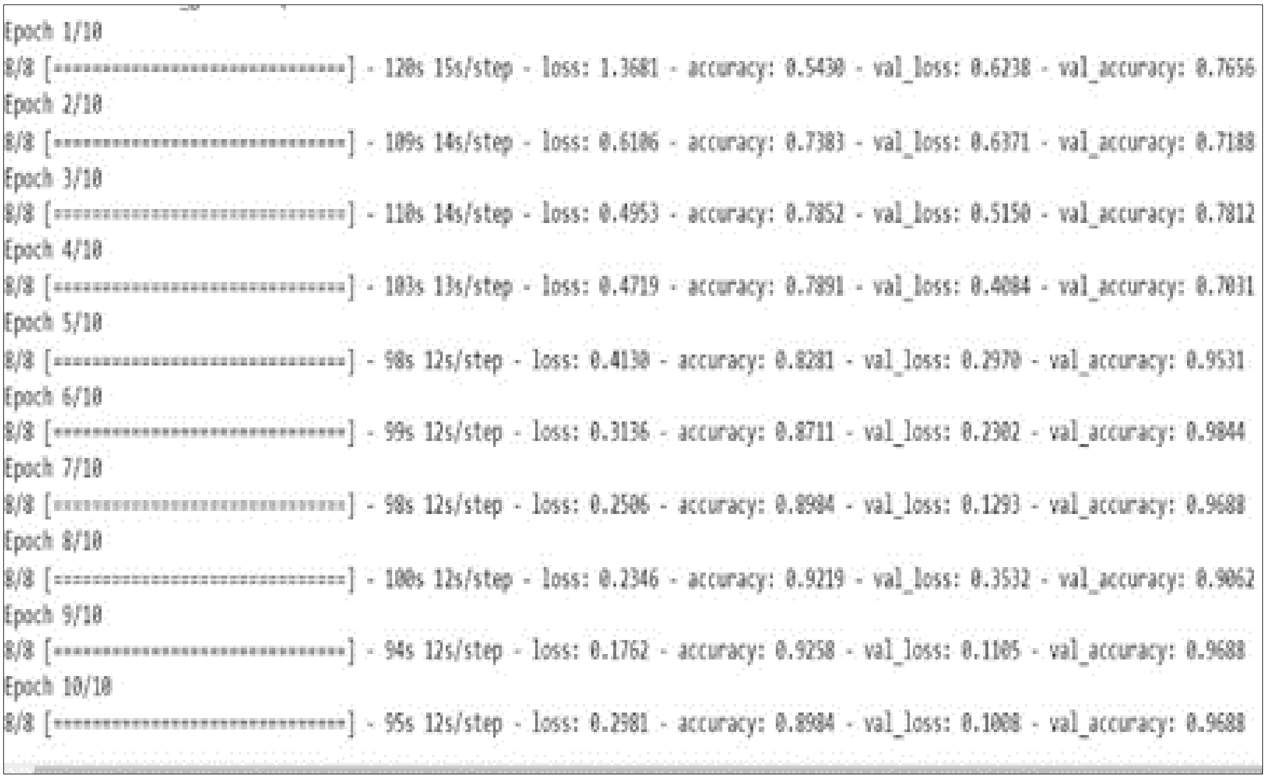
Table 1 CNN model summary

Layer (type)	Output shape	Param#
Conv2d_4 (conv2D)	(None, 222, 222, 32)	896
Conv2d_5 (conv2D)	(None, 220, 220, 64)	18496
Max_pooling2d_3 (MaxPOOLING2D)	(None, 110, 110, 64)	0
Dropout_4 (dropout)	(None, 110, 110, 64)	0
Conv2d_6 (dropout)	(None, 108, 108, 64)	36128
Max_pooling2d_4 (maxpooling2d)	(None, 54, 54, 64)	0
Dropout_5 (dropout)	(None, 54, 54, 64)	0
Conv2d_7 (conv2D)	(None, 52, 52, 128)	73856
Max_pooling2d_5 (maxpooling2d)	(None, 26, 26, 128)	0
Dropout_6 (dropout)	(None, 26, 26, 128)	0
Flatten_1 (flatten)	(None, 86528)	0
Dense_2 (dense)	(None, 64)	5537856
Dropout_7 (dropout)	(None, 64)	0
Dense_3 (dense)	(None, 1)	65

Total params: 5,668,097; Trainable params: 5,668,097; Non-trainable params: 0

3.3. Fit the CNN model

Adam's algorithm gives good results quickly and is widely used in deep learning because it is an optimization technique that updates weights in iterative networks basedon training data instead of traditional random gradientdescent [9].



```
Epoch 1/10
8/8 [==============================] - 120s 15s/step - loss: 1.3681 - accuracy: 0.5430 - val_loss: 0.6238 - val_accuracy: 0.7656
Epoch 2/10
8/8 [==============================] - 109s 14s/step - loss: 0.6106 - accuracy: 0.7383 - val_loss: 0.6371 - val_accuracy: 0.7188
Epoch 3/10
8/8 [==============================] - 110s 14s/step - loss: 0.4953 - accuracy: 0.7852 - val_loss: 0.5150 - val_accuracy: 0.7812
Epoch 4/10
8/8 [==============================] - 103s 13s/step - loss: 0.4719 - accuracy: 0.7891 - val_loss: 0.4084 - val_accuracy: 0.7031
Epoch 5/10
8/8 [==============================] - 98s 12s/step - loss: 0.4130 - accuracy: 0.8281 - val_loss: 0.2970 - val_accuracy: 0.9531
Epoch 6/10
8/8 [==============================] - 99s 12s/step - loss: 0.3136 - accuracy: 0.8711 - val_loss: 0.2302 - val_accuracy: 0.9844
Epoch 7/10
8/8 [==============================] - 98s 12s/step - loss: 0.2506 - accuracy: 0.8984 - val_loss: 0.1293 - val_accuracy: 0.9688
Epoch 8/10
8/8 [==============================] - 100s 12s/step - loss: 0.2346 - accuracy: 0.9219 - val_loss: 0.3532 - val_accuracy: 0.9062
Epoch 9/10
8/8 [==============================] - 94s 12s/step - loss: 0.1762 - accuracy: 0.9258 - val_loss: 0.1105 - val_accuracy: 0.9688
Epoch 10/10
8/8 [==============================] - 95s 12s/step - loss: 0.2981 - accuracy: 0.8984 - val_loss: 0.1008 - val_accuracy: 0.9688
```

Figure 6 Result of model training in 10 Epoch

The Adam optimizer is an efficient version of gradient descent and typically does not require manual tuning of the learning rate. The optimizer uses the loss gradient throughout training to try to minimize ("optimize") the errorin the model output by changing parameters.

Apply fitting to the training set (train_generator,steps_per_epoch=8, epochs = 10, validation_data = test_generator, validation_steps=2

Figure 6 shows the results of model training for 10 Epochs.

3.4. Evaluating and testing the Model.

Several cell samples will be provided to identify COVID-19 and validate the model. The images were loaded and converted to an array so the model could determine if a particular image was her COVID-19. Figure 7 shows a model of testing for new X-Ray images.

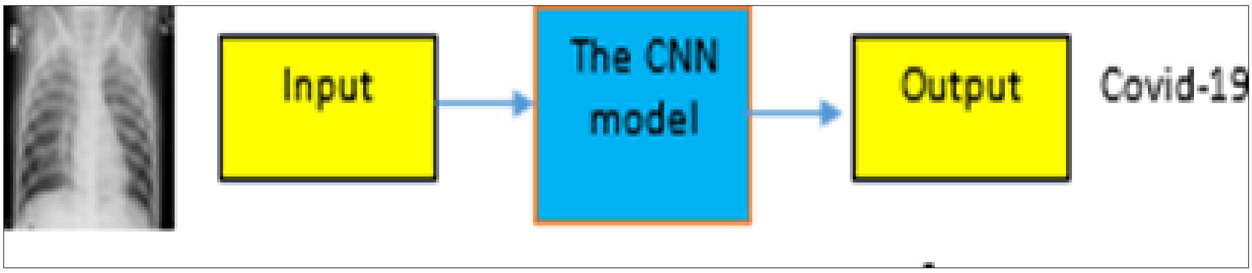


Figure 7 New prediction

4. Results and discussion

In the first experiment, a dataset of 2157 chest X-rays wasused for training and testing, with 1726 images for training (80%) and 433 images for testing (20%). The model was trained on a set of 1726 chest radiographs of 460 COVID-19 infected and 1266 normal persons and a test set of 433 chestradiographs of 116 COVID-19 infected and 317 non-infected people. To improve the learning process, the same neural network must receive the entire dataset many times. The CNN model weights are updated after 10 intervals. The results showed a loss of 21.5% and an accuracy rate of 92.3%.

In a second experiment, 188 x-ray images were collected from Kaggle [10],[11] and added to the first dataset to create 2345 images. The model was then rerun (80% trained, 20% tested) with 96.3% accuracy and 13.7% accuracy. loss. Table 2 shows the results using the CNN model on the input dataset.

Experience has demonstrated that some algorithms can identify COVID-19 in human samples more accurately with a larger training sample, enabling the identification of the patient.

Table 2 Results of CNN model

No. images	No. epoch	loos	accuracy
2157	10	21.5%	92.3%
2345	10	13.7%	96.3%

5. Conclusion

As a result of this innovative study, it is possible to quickly identify patients using a highly accurate AI algorithm, which may be helpful and efficient in the current COVID-19 outbreak.

We are almost certain that it is possible for the proposed CNN model, which exhibits the highest score for the accuracy of a specialized chest radiologist, to represent avery effective examination tool for the rapid diagnosis of many infectious diseases, such as the COVID-19 epidemic, that do not necessitate the introduction of a radiologist or physical examinations.

We recommend that future research address other issues such as outbreak escalation and explore different approaches to convolutional neural networks, such as improving the interpretation of deep learning and CNN models.

Compliance with ethical standards

Acknowledgments

We would like to convey our immense gratitude for Mr. Meeravali Shaik, Project Guide, Assistant Professor, Department of Computer Science and Engineering who gave us constant motivation, innovative ideas and suggestions throughout the research work. Under his guidance, we were able to complete the research promptly. We are highly obliged to him for his help and guidance. He has not only helped us in our research but has also been great mentor to us.

Disclosure of conflict of interest

No conflict of interest

Author's declaration

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