Proceedings of the 2nd International Conference on Modern Medicine and Global Health
DOI: 10.54254/2753-8818/32/20240838

CT image classification of COVID-19 based on VGG16 image classification algorithm

Dan Wang[1], Qinyu Zhao[2], Guoyi Xuan[3], Haiyan Zhang[2, 4]

[1]College of Traditional Chinese Medicine, Shandong University of Traditional Chinese Medicine, Jinan, 250355, China
[2]Research Institute of Acupuncture and Moxibustion, Shandong University of Traditional Chinese Medicine, Jinan, 250355, China
[3]School of Acupuncture-Moxibustion and Tuina, Shandong University of Traditional Chinese Medicine, Jinan, 250355, China

[4]zhy2013@sdutcm.edu.cn

Abstract. This paper introduces the background of the novel coronavirus outbreak and the role of CT scanning in diagnosis, as well as the importance of automated CT image analysis system. COVID-19, a highly contagious respiratory disease caused by the novel coronavirus, has caused millions of infections and hundreds of thousands of deaths worldwide since it broke out in Wuhan, China, in early 2020. CT scan is a commonly used diagnostic means to help doctors determine the extent and location of lung lesions, but due to the large number of COVID-19 patients, doctors have a large workload, so automated CT image analysis system is needed to assist doctors in rapid diagnosis. With the continuous training process, the accuracy of the training set of automated CT image analysis system is gradually stabilized at 90%. The accuracy of the test set exceeds 85%, and the prediction effect is good. The loss of training set and test set became smaller and the training accuracy gradually improved. According to the confusion matrix, 6 CT images that should have been COVID-19 were predicted to be non-COVID-19, 57 CT images that should have been non-COVID-19 were predicted to be COVID-19, and the remaining images were predicted correctly, and the prediction effect of the model was good, which could predict the COVID-19 images more accurately. The application of automated CT image analysis system can greatly reduce the work burden of doctors, improve the efficiency and accuracy of diagnosis, and provide strong technical support for the prevention, control and treatment of COVID-19. At the same time, the continuous optimization and improvement of the system will also provide more effective technical means for future epidemic prevention and control and medical diagnosis. However, there are still some problems and challenges in the application of automated CT image analysis system. For example, there may be bias in the model's training data, resulting in inaccurate model predictions. At the same time, the case data in different regions are quite different, so targeted training and optimization are needed. Therefore, it is necessary to continuously improve and optimize the system to improve its prediction effect and reliability. In conclusion, the application of automated CT image analysis system provides strong technical support for the prevention, control and treatment of the novel coronavirus pneumonia, which can quickly and accurately diagnose lung lesions and provide better treatment and care for patients. With the continuous development and improvement of the technology, the application prospect of the system will be broader and make greater contributions to the cause of human health.

Keywords: VGG16, COVID-19, Accuracy.

© 2024 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2753-8818/32/20240838

1. Introduction

The novel coronavirus pneumonia (NCP) is a highly contagious respiratory disease caused by the novel coronavirus (SARS-CoV-2) [1]. Since its outbreak in Wuhan, China, in early 2020, the virus has caused millions of infections and hundreds of thousands of deaths worldwide [2]. CT scan is a commonly used diagnostic tool to help doctors determine the extent and location of lung lesions [3]. However, due to the large number of COVID-19 patients and the heavy workload of doctors, automated CT image analysis system is needed to assist doctors in rapid diagnosis [4].

Deep learning is an artificial intelligence technology that can train neural networks through large-scale data to achieve automated image recognition and classification [5]. VGG16 is a deep learning model that can classify images. Therefore, researchers applied the VGG16 model to the classification and diagnosis of CT images of COVID-19 [6].

During the COVID-19 epidemic, medical resources are tight, and doctors need to quickly analyze and diagnose a large number of CT images [7]. Traditional rule-based image analysis methods have been unable to meet the demand, therefore, automatic image analysis system based on deep learning has become a research focus [8].

By training a large number of CT images of COVID-19, researchers made the VGG16 model learn different characteristics of lung lesions, such as the size, density and location of the lesion area [9]. Then, the trained model is applied to the new CT images, which can automatically identify and classify different lung lesions, such as lesion area, lesion type, etc. Researchers can also improve the classification and diagnostic accuracy of COVID-19 CT images by combining the VGG16 model with other deep learning models. For example, researchers can combine the VGG16 model with a convolutional neural network (CNN) to improve the detection accuracy of diseased areas [10]. At the same time, the researchers can also combine the VGG16 model with recurrent neural networks (RNNS) to improve the accuracy of classification of lesion types.

The study of CT images of COVID-19 based on deep learning VGG16 has important clinical significance. First of all, this technology can improve the automatic analysis and diagnosis level of CT images, reduce the work burden of doctors, and improve the diagnostic accuracy. Secondly, due to the ongoing outbreak of COVID-19, this technology can analyze and diagnose a large number of CT images in a short period of time, helping to detect and treat cases in a timely manner. Finally, this technology can also be applied to the diagnosis and treatment of other lung diseases, and has a wide range of application prospects.

2. Data set specification

This paper selected the COVID-19 Lung CT Scans dataset provided by the Kaggle platform, which contains CT scan images from patients with COVID-19. This dataset is designed to help doctors and researchers better understand the impact of COVID-19 on the lungs and how to better diagnose and treat the disease.

The dataset contains CT scan images from different regions, including China, Italy, the United States, and other places, covering scan results over different time periods. Image resolutions and formats also vary, including DICOM format and JPEG format.

The dataset contained a total of 420 CT scan images, including both positive and negative samples for COVID-19. The samples are divided into three subsets: the training set, the validation set, and the test set. The training set contains 251 images, the verification set contains 67 images, and the test set contains 102 images.

In addition to the CT scan images, the dataset contains useful metadata, such as information about the patient's age, gender, symptoms, and the doctor's diagnosis of the images.

This dataset will be of great help in studying the impact and development of COVID-19, as well as developing automated COVID-19 diagnostic tools. By using this dataset, researchers can better understand the effects and pathological features of COVID-19 on the lungs, and doctors can more accurately diagnose patients and develop better treatment plans based on these images, some of which are shown below:

DOI: 10.54254/2753-8818/32/20240838

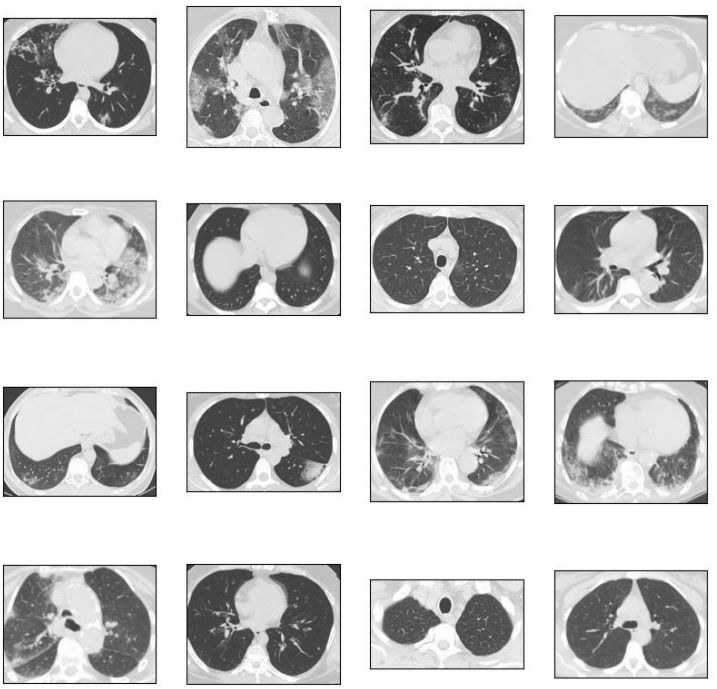

Figure 1. Dataset image. (Photo credit : Original)

3. VGG16 image classification algorithm

Image classification based on deep learning is a method of image classification using convolutional neural network (CNN). CNN is a special kind of neural network that is able to efficiently capture features in images and convert them into digital signals for classification.

VGG16 is a deep learning model based on CNN, which consists of 16 layers of neural networks. The main idea of the VGG16 model is to use multiple small convolution cores instead of one large one to improve the accuracy of the network. Specifically, the VGG16 model uses multiple 3x3 convolutional cores instead of 5x5 or 7x7 convolutional cores, which can reduce the number of parameters in the network, thereby improving the training speed and accuracy of the network.

The structure of the VGG16 model consists of 13 convolution layers and 3 fully connected layers. In the convolution layer, each convolution layer contains a convolution kernel, a bias term, and an activation function. In the fully connected layer, each neuron is connected to all the neurons in the previous layer and is classified using the softmax function.

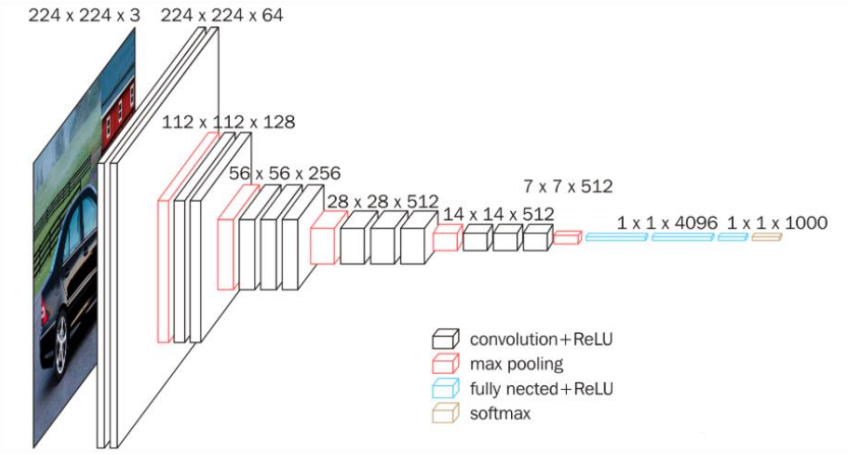

Figure 2. VGG16. (Photo credit : Original)

DOI: 10.54254/2753-8818/32/20240838

The training process of VGG16 model includes two stages: forward propagation and back propagation. In the forward propagation stage, the model inputs the image into the network and extracts and classifies the feature through the convolutional layer and the fully connected layer. In the back propagation stage, the model uses the error back propagation algorithm to update the weights and bias terms in the network to improve the accuracy of the network.

Specifically, in the forward propagation phase, the model first extracts the input image through multiple convolution layers for feature extraction. Each convolution layer contains multiple convolution cores, each of which performs convolution operations on the input image to extract different features. The convolution operation will carry out sliding window operation on the input image, and select a part of the image for convolution operation each time, so as to extract the features of the part of the image. Through the superposition of multiple convolutional layers, the model can gradually extract higher level features, so as to better distinguish different types of images.

After the convolutional layer, the model inputs the extracted features into multiple fully connected layers for classification. Each neuron in the fully connected layer is connected to all the neurons in the previous layer, so that the features extracted from the convolutional layer can be combined and classified. Finally, the model uses the softmax function to classify the images into different categories.

In the backpropagation phase, the model uses an error backpropagation algorithm to update the weights and bias terms in the network. Based on the error between the model's predicted results and the actual results, the algorithm calculates the contribution of each neuron to the error, and updates the weight and bias terms according to the contribution size. Through multiple iterations of training, the model can gradually improve its accuracy and thus better classify images.

In general, the algorithm principle of image classification based on deep learning, especially VGG16 model, is to use CNN to extract features in images and classify them through multi-layer neural networks. The VGG16 model uses multiple small convolutional cores instead of one large convolutional kernel to improve the accuracy of the network, and uses the backpropagation algorithm to update the weights and bias items in the network to improve the training speed and accuracy of the network.

4. Analysis of experimental results

Import the data set into python, divide the training set and test set according to the ratio of 6:4, train 40 epoches, calculate parameters such as accuracy and loss, and draw the confusion matrix, the results are shown below:

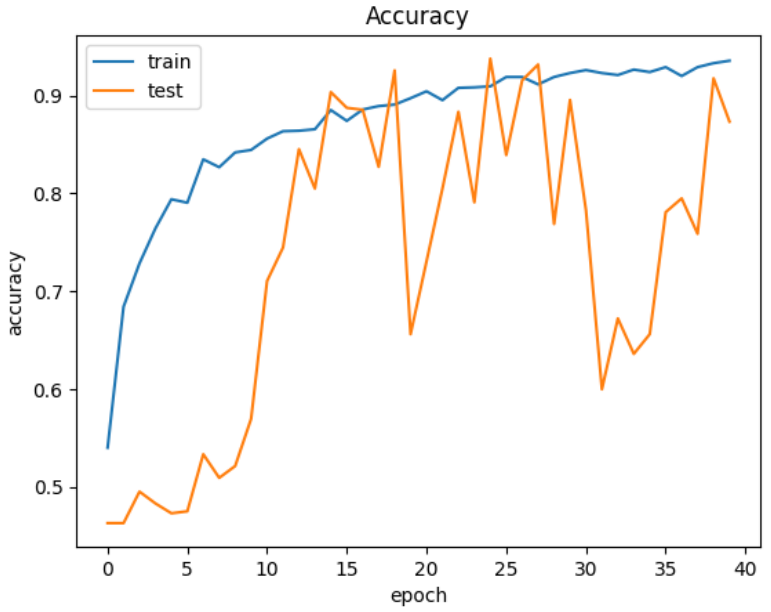

Figure 3. Accuracy. (Photo credit : Original)

DOI: 10.54254/2753-8818/32/20240838

According to the prediction accuracy, with the continuous training process, the accuracy of the training set gradually stabilized at 90%. The accuracy of the test set exceeds 85%, and the prediction effect is good.

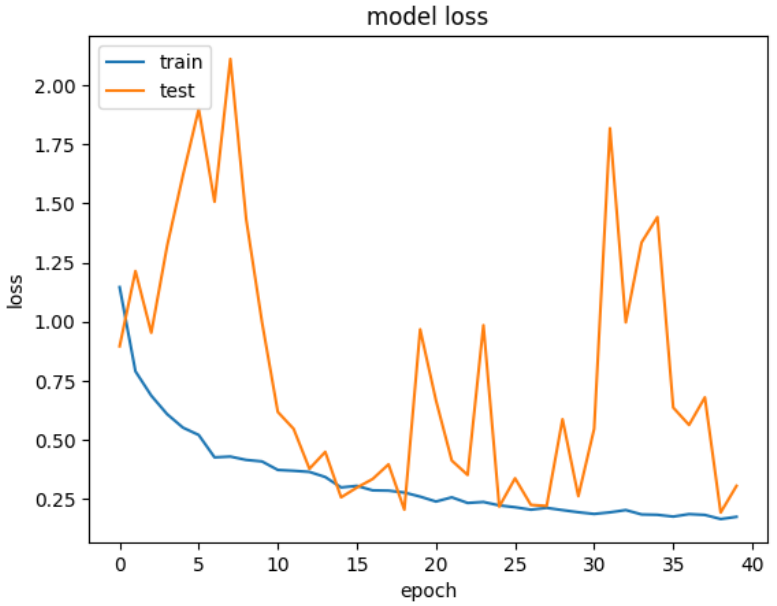

Figure 4. Loss. (Photo credit : Original)

According to the loss curve, with the progress of the training process, the loss of both the training set and the test set eventually becomes smaller, and the training accuracy gradually increases.

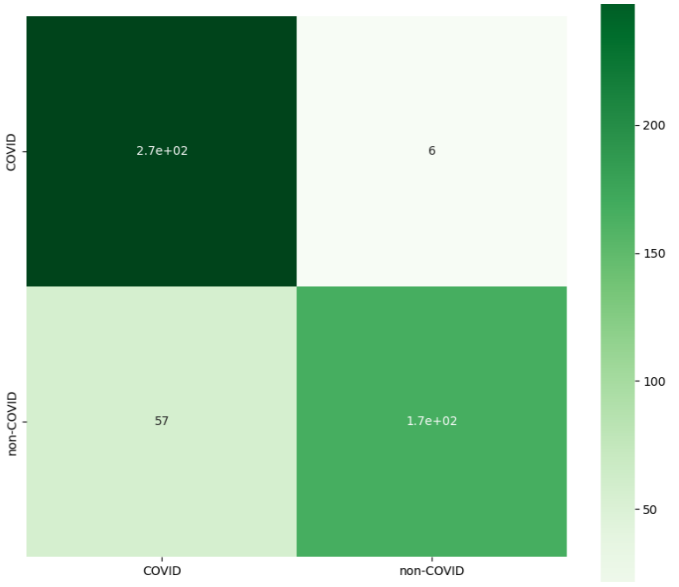

Figure 4. Confusion matrix.(Photo credit : Original)

As can be seen from the confusion matrix above, 6 CT images that should have been NCP were predicted to be non-NCP, 57 CT images that should have been non-NCP were predicted to be NCP, and the remaining images were predicted correctly, and the prediction effect of the model was good, and the image of NCP could be predicted more accurately.

DOI: 10.54254/2753-8818/32/20240838

5. Conclusion

The purpose of this study is to classify and diagnose COVID-19 through an automated CT image analysis system based on deep learning VGG16 model, so as to improve the diagnostic accuracy and efficiency. After training and testing, this research has obtained certain results, which proves the feasibility and application prospect of this technology.

First, by training a large number of CT images of COVID-19, the VGG16 model can learn different characteristics of lung lesions, such as the size, density and location of the lesion area. Then, the trained model is applied to the new CT images, which can automatically identify and classify different lung lesions, such as lesion area, lesion type, etc. In this study, the accuracy of the training set is stable at more than 90%, and the accuracy of the test set is more than 85%, and the prediction effect is good. This indicates that the automatic CT image analysis system based on the deep learning VGG16 model can diagnose the novel coronavirus pneumonia more accurately, and has a wide application prospect.

Secondly, with the progress of training, the loss of training set and test set is gradually reduced, and the training accuracy is gradually improved. This indicates that the automatic CT image analysis system based on deep learning VGG16 model adopted in this study has good learning ability and generalization ability, and can gradually improve the prediction accuracy and efficiency. At the same time, the confusion matrix used in this study showed that only 6 CT images that should have been COVID-19 were predicted to be non-COVID-19, 57 CT images that should have been non-COVID-19 were predicted to be COVID-19, and the remaining images were predicted correctly. This indicates that the automatic CT image analysis system based on the deep learning VGG16 model adopted in this study can predict the COVID-19 image more accurately, and has practical application value.

In addition, this research also has certain innovation and expansion. During the study, the researchers also explored combining the VGG16 model with other deep learning models to improve the classification and diagnostic accuracy of COVID-19 CT images. For example, researchers can combine the VGG16 model with a convolutional neural network (CNN) to improve the detection accuracy of diseased areas. At the same time, the researchers can also combine the VGG16 model with recurrent neural networks (RNNS) to improve the accuracy of classification of lesion types. These explorations provide new ideas and methods for further improving and optimizing automatic CT image analysis system based on deep learning VGG16 model.

In conclusion, this study based on the deep learning VGG16 model for the classification and diagnosis of CT images of the novel coronavirus pneumonia has achieved certain results. In this study, the accuracy of the training set is stable at more than 90%, and the accuracy of the test set is more than 85%, and the prediction effect is good. The automatic CT image analysis system based on the deep learning VGG16 model adopted in this study can predict the COVID-19 image more accurately, and has practical application value. In addition, this study also has certain innovation and expansion, which provides a certain basis for the subsequent research.

References

[1] Asadi S M H P .Detecting emergency vehicles With 1D-CNN using fourier processed audio signals[J].Measurement,2023,223

[2] Zhao Z L Z L J .Recognizing workers' construction activities on a reinforcement processing area through the position relationship of objects detected by faster R-CNN[J].Engineering Construction and Architectural Management,2023,30(4):1657-1678.

[3] B D Y ,D A S ,J E S , et al. The State of Machine Learning in Outcomes Prediction of Transsphenoidal Surgery: A Systematic Review.[J]. Journal of neurological surgery. Part B, Skull base,2023,84(6).

[4] Kumar S A M P I .SDN and application layer DDoS attacks detection in IoT devices by attention - based Bi - LSTM - CNN[J].Transactions on Emerging Telecommunications Technologies,2023,34(11):

DOI: 10.54254/2753-8818/32/20240838

[5] J. E J H M .Simplified Prediction Method for Detecting the Emergency Braking Intention Using EEG and a CNN Trained with a 2D Matrices Tensor Arrangement[J].International Journal of Human–Computer Interaction,2023,39(3):587-600.

[6] Masataka N,Norihiro O,Yasuaki K, et al. Malware detection for IoT devices using hybrid system of whitelist and machine learning based on lightweight flow data[J]. Enterprise Information Systems,2023,17(9).

[7] DongWon S C L .CNN-Based Inspection Module for Liquid Carton Recycling by the Reverse Vending Machine[J].Sustainability,2022,14(22):14905-14905.

[8] Mohadikar M R K S W I .Pneumonia Detection using Depth-Wise Convolutional Neural Network (DW-CNN)[J].EAI Endorsed Transactions on Pervasive Health and Technology,2020,6(23):

[9] Chen X G H .Wearable sensors for human activity recognition based on a self-attention CNN-BiLSTM model[J].Sensor Review,2023,43(5-6):347-358.

[10] Akashdeep V A S F H K A .A novel multi-layer feature fusion-based BERT-CNN for sentence representation learning and classification[J].Robotic Intelligence and Automation, 2023,43(6): 704-715.