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Detection of COVID-19 using Modified VGG Architectures

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ABSTRACT: COVID-19 has created havoc in the world. This paper aims to study and understand the performance of modified VGG-16 and VGG-19 architectures in detecting COVID-19 using the concept of transfer learning. The algorithm has been validated using a private dataset with normal and COVID-19 positive chest X-ray images.

KEYWORDS: COVID-19, CNN, Deep learning, Transfer learning, X-ray.

INTRODUCTION

The ongoing COVID-19 pandemic has globally affected lung conditions, resulting in many pneumonia cases. Therefore, accurate diagnosis and monitoring of lung diseases are global concerns. Since the number of cases with COVID-19 continues to increase, researchers are looking for alternative deep learning-based approaches to speed up the assessment of these patients. The proposed model proposed in this paper is a modified CNN architecture and a VGG-16 model with the transfer learning approach. The model reduces the task of designing the algorithm from scratch. Further, the performance of this model is compared by replacing VGG-16 with VGG-19.

RELATED WORK

Table-I gives the literature review for COVID-19.

Table I. Review of Literature

Sl. No.	Methods	Year	Accuracy
1	CNN, VGG-16 [1]	2021	90.54
2	CNN, transfer learning, VGG-19, DenseNet121, Xception, ResNet-50 [2]	2021	86.8
3	Deep CNN [3]	2021	94
4	GAN, transfer learning [4]	2021	94.5
5	VGG-19, transfer learning [5]	2021	97.11

PROPOSED MODEL

Section A, B, C, and D explain VGG-16, VGG-19, transfer learning, and the proposed algorithm.

A. VGG-16

VGG-16 stands for Visual Geometry Group (the University of Oxford in 2014), 16 in VGG-16 refers to 16 layers with weights, and it follows the CNN architecture (shown in Figure 1). It has approx. 138 million parameters.

B. VGG-19

The concept of the VGG19 (shown in Figure 2) is the same as the VGG16, except the network is 19 layers deep. However, the convolutional neural network is used for analyzing the object of the image. The "16" and "19" stand for the number of weight layers in the model (convolutional layers). This means that VGG19 has three more convolutional layers than VGG16.

C. Transfer Learning

Transfer learning is a research problem in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem (wiki).

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D. Proposed Algorithm

A pre-trained model (VGG-16) is used, and the concept of transfer learning is applied to pass the knowledge to the proposed model (Figure 3). Data augmentation, normalization, and resize operations are performed to the training set. The final CNN layers are fine-tuned; training is performed only with the fully connected layers. The steps followed are (Figure 4):

i. The weights are loaded from the VGG-16.
ii. The weights are frozen.
iii. The final convolutional layer is fine-tuned.
iv. The final layers are modified with the customized classifier.
v. The customized classifier layers are only trained, saving a lot of computational power and time.

The entire process is repeated with VGG-19, and the performance of both models is evaluated.

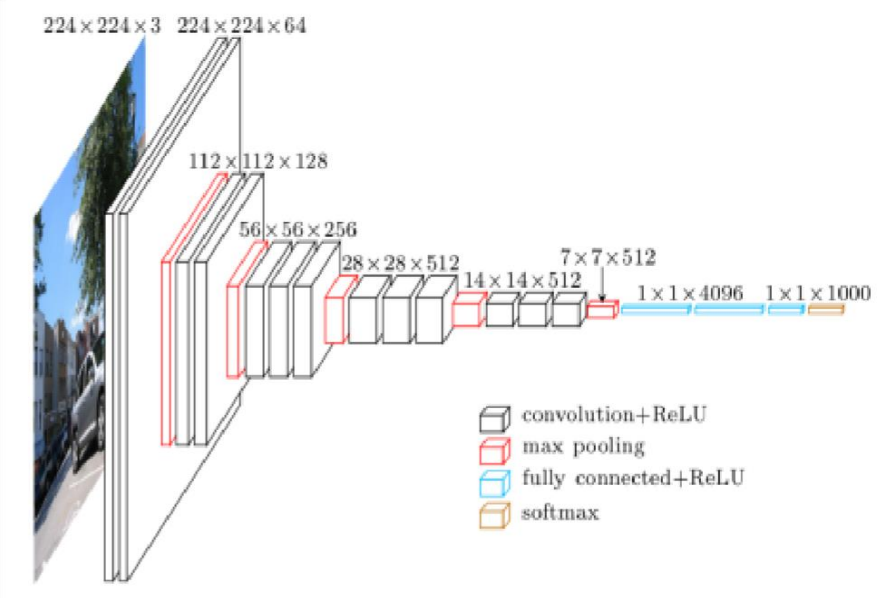

Figure 1: VGG-16 architecture [source: neurohive]

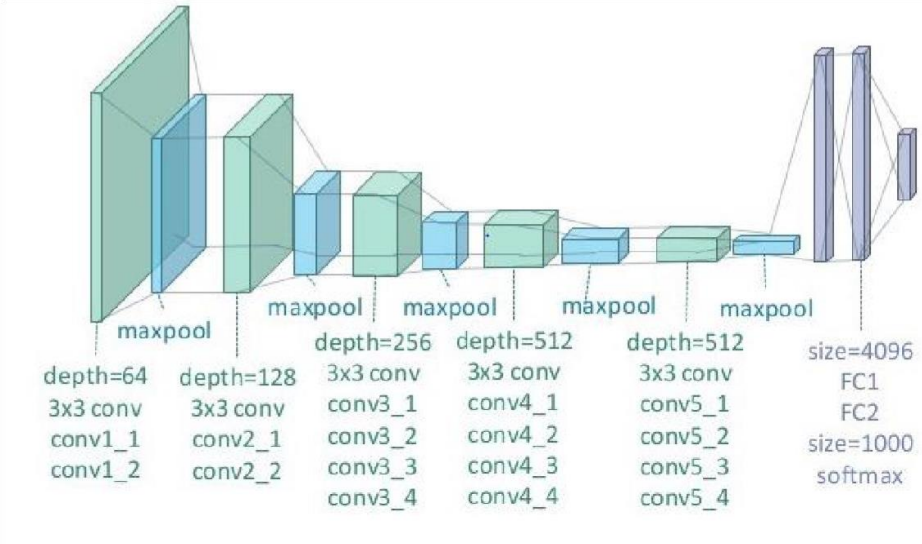

Figure 2: VGG-19 architecture

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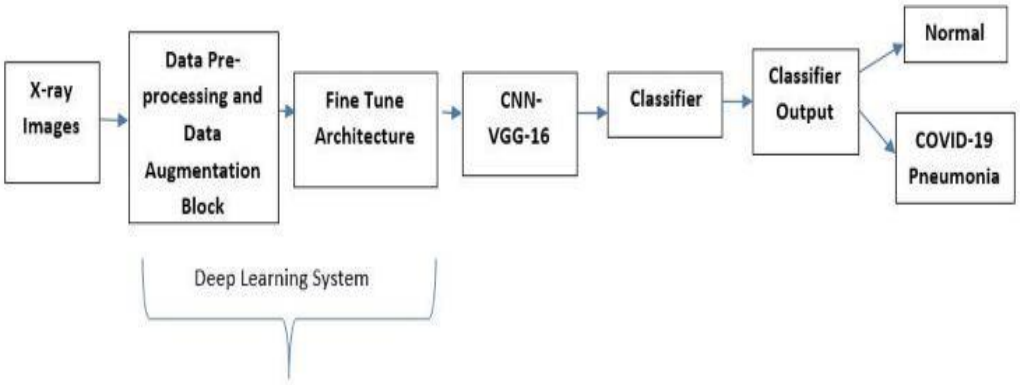

Figure 3: Block diagram of the proposed system

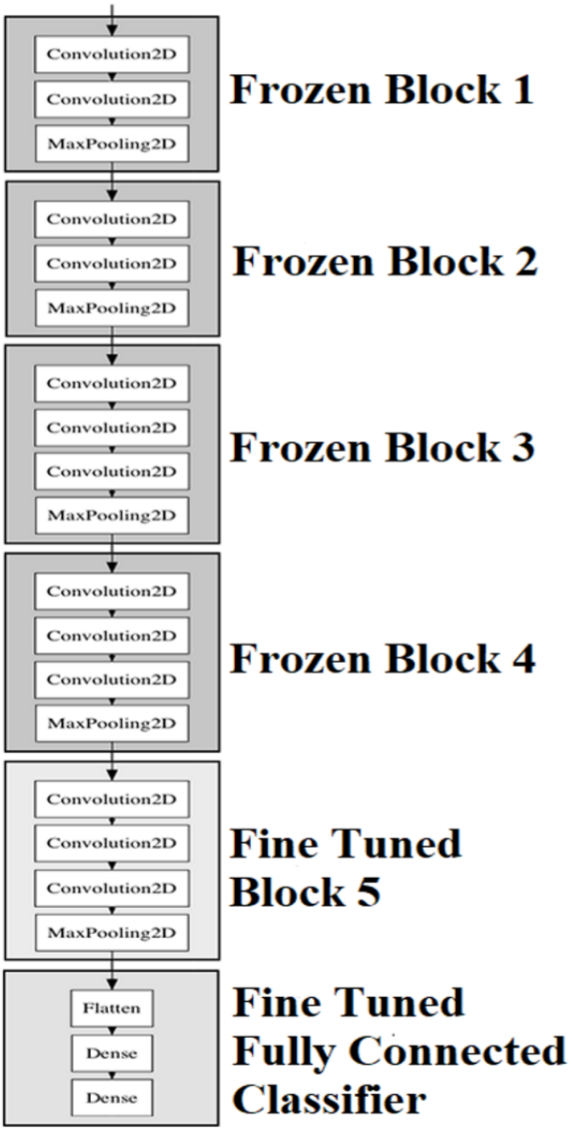

Figure 4: Block diagram of the modified CNN-VGG-16 methodology

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EXPERIMENT AND RESULTS

Training and testing are done in Google Colab. Pre-processing of the X-ray images includes data resizing, shear, zoom, horizontal flip, and normalization. The model is trained using the training data, and the training accuracy and loss are calculated after each epoch. Also, the validation accuracy and loss are measured. Two hundred twenty-four chest x-ray images are collected from a private hospital, with 112 COVID-19 and 112 normal images for training. For the validation step, 30 COVID-19 and 30 normal images are taken.

Table II. shows the result of the proposed modified VGG-16 and VGG-19 models. Figures 5 & 6 show the Accuracy and Loss graphs for the modified VGG-16 model. Figures 7 & 8 display the Accuracy and Loss graphs for the modified VGG-19 model.

Table II: Proposed Modified Vgg-16 and Vgg-19 Results

Models	Validation Accuracy %	Recall %	Specificity %	Precision %	F1 Score %
Modified VGG-16	97	96.77	96.55	96.77	96.77
Modified VGG-19	98	98.4	97.9	98.43	98.43

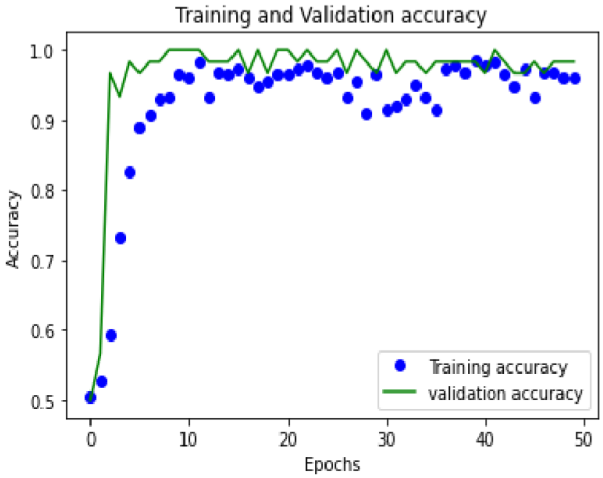

Figure 5: Accuracy vs. No. of epochs for modified VGG-16

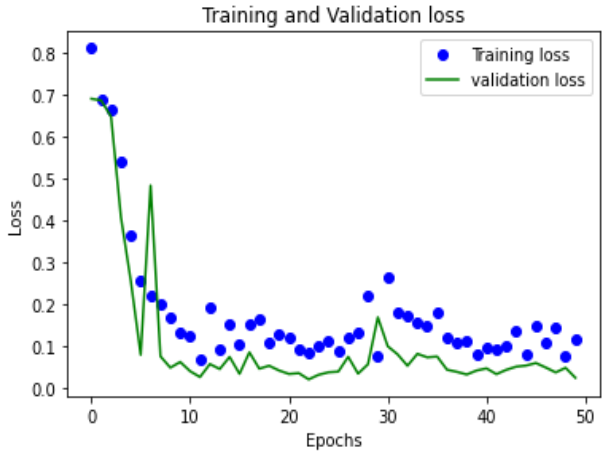

Figure 6: Loss vs. No. of epochs for modified VGG-16

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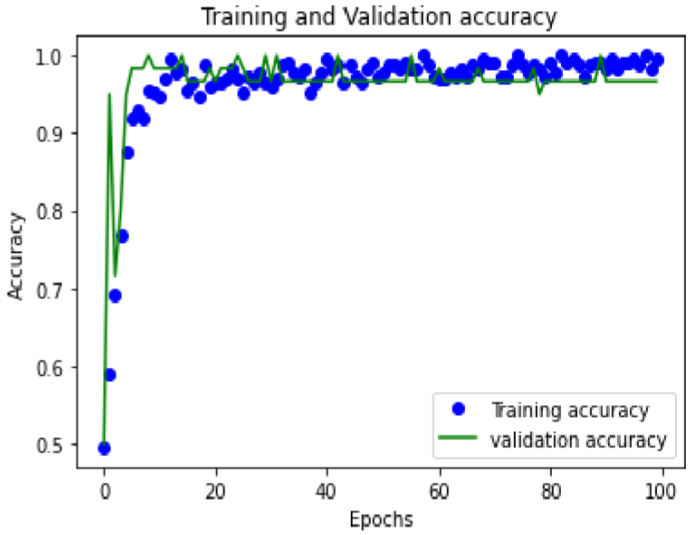

Figure 7: Accuracy vs. No. of epochs for modified VGG-19

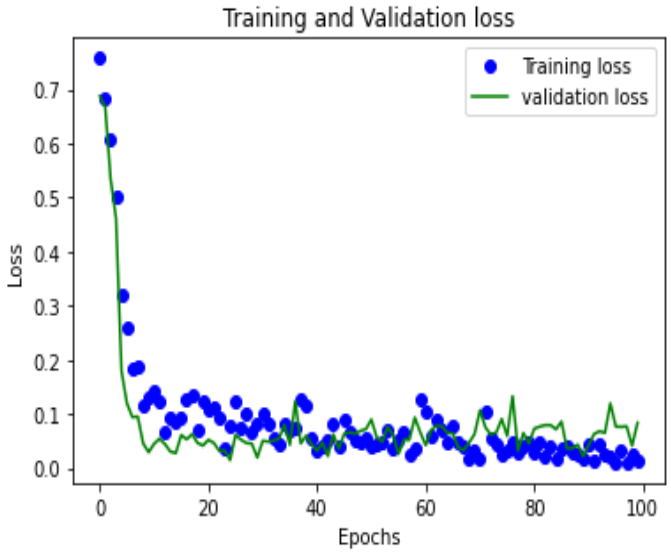

Figure 8: Loss vs. No. of epochs for modified VGG-16

Comparative Analysis: Table III gives a comparison with some related works.

Table III. Shows the Comparison Of Our Model

Sl. No.	Methods	Year	Accuracy
1	CNN, VGG-16 [1]	2021	90.54
2	CNN, transfer learning, VGG-19, DenseNet121, Xception, ResNet-50 [2]	2021	86.8
3	Deep CNN [3]	2021	94
4	GAN, transfer learning [4]	2021	94.5
5	VGG-19, transfer learning [5]	2021	97.11
6	**Modified VGG-16**	**2022**	**97**
7	**Modified VGG-19**	**2022**	**98**

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CONCLUSION

A comparison of VGG-16 and VGG-19 is drawn for detecting COVID-19 disease. It is observed that the proposed modified VGG-19 model (98% validation accuracy) outperforms the modified VGG-16 model (97% validation accuracy). Also, it can be concluded that the pre-trained model successfully transferred its knowledge from larger datasets to smaller ones.

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