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CLASSIFICATION OF COVID19 CT SCAN IMAGE USING CONVOLUTIONAL NEURAL NETWORK

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ABSTRACT

Deep learning is a new machine learning technology that plays a significant role in different classification techniques. Image classification is a very important application of the deep neural network technique. We have used a deep learning technique in this research work to classify COVID19 CT scan images. The deep learning technique plays a vital role in developing a robust model for classifying the COVID19 CT Scan images. This research work proposed a special type of deep learning technique that is a convolutional neural network (CNN) to classify the COVID19 CT scan images. The main contribtion of this reserch work is to select the relevant tuning parameter of CNN which gives better accuracy for classifying COVID19 CT scan images. We analyzed the CNN model with different tuning parameters and compared the performance of the proposed CNN model with Relu, Sigmoid, and Tanh activation functions. The proposed CNN model achieved 88.24% accuracy under the condition of the Relu activation function.

Keywords: *Classification, CT Scan Image, Convolutional Neural Network, Deep Learning, Activation function.*

1. Introduction

COVID 19 disease is an infectious virus that affects the different people in different ways. COVID19 pandemic is a very challenging task for medical science, including doctors and medical students. COVID19 [1] pandemic began in Wuhan, Hubei province of China, on December 31, 2019. Almost all countries have faced the problem of COVID19 pandemic that caused the death of many people and decreased the economic growth in the world. The COVID19 virus spread in China from Wuhan in 1 month [2]. The USA found the first seven cases on January 2020 [3]. Most coronaviruses are transmitted from animals to humans because of their zoonotic nature. There is some most common techniques used to check the COVID19 symptoms. This research has proposed a tuned convolutional neural network technique for classifying COVID19 CT Scan images.

Many researchers used deep learning techniques and machine learning to classify the COVID19 CT scan images, but CNN play major role to classify the image classification like CT scan images. CNN is used to reduce the size of high dimensional images without loss of information as well as improve the quality of images and enhance the performance. Authors [5] have proposed deep learning techniques for detecting COVID19 disease using chest X-Ray

pictures. They suggested two models, ResNet-101 and ResNet-152, with the best outcomes for fusion based on accuracy and loss value. Researchers [6] proposed a new model using VGG-16, DenseNet-161, and ResNet-18 for the classification of COVID19 disease with chest X-ray images and achieved better accuracy. Authors [7] proposed a deep learning technique for detecting COVID19 disease with a chest X-ray image dataset. They have suggested the DenseNet121 and VGG16 models and compared the performance of both, where DenseNet121 model achieved better accuracy. Authors [8] reviewed COVID19 chest X-ray classification using a deep learning approach. They discussed the source of images and deep learning models as well as their performances. They also explored the challenges and future scopes on COVID19 chest X-rays. Author has proposed Region Proposal Network (RPN) to perform image classification. They also reduce the dimension of images and computationally increase the performance of the model [9]. Researchers [10] proposed deep convolutional neural networks (CNN) to classify chest radiograph images. The proposed CNN model achieved satisfactory accuracy for the classification of normal versus abnormal chest radiograph images. Authors [11] proposed Deep learning, Machine Learning, and a Convolutional Neural Network-based approach for predicting COVID19 positive and normal patients using Chest X-Ray images. Researchers [12] suggested the VGG16 model for the classification of COVID19 disease with chest X-ray images. The proposed model achieved a satisfactory 89.3% of accuracy. Researchers [13]explored the convolutional neural network (CNN) based algorithm on a chest X-ray dataset to classify pneumonia. CNN based transfer learning is the best methodin all three ways. Authors [14] explored the application of artificial intelligence in the X-ray and CT scans of COVID19 patients. The proposed AI-based techniques will help to detect and diagnose of COVID19 disease. Erdem and Aydın [15] proposed model that is combination of CNN and SVM for classifying COVID19 disease. They compared the performance of proposed model with other techniques where proposed model achieved better performance as 85.86% accuracy. Khan A. I. [16] proposed CoroNet deep CNN model for classification of COVID19 disease using chest X-ray images. The overall performance of proposed model achieved 89.6% accuracy.

2. MATHODS AND MATERIALS

Methods and materials play a very important role in the field of research work. This section explored the architecture of the proposed CNN model and COVID19 CT scan image-based dataset.

2.1 Convolutional neural networks (CNN)

Convolutional neural networks (CNN) [4]are biologically inspired networks that are widely used in image classification, object detection, and text classification. CNN is a famous and successful type of artificial neural network. CNN is a type of deep learning technique that contains multiple layers to extract valuable features and supply the relevant features to a fully connected network. In the convolutional neural network architecture, each layer of the network is 3-dimensional, which has a spatial extent and a depth corresponding to the number of features. CNN is used in the dimensional reduction technique to reduce the image's size, decrease the computational time and time complexity, and improve performance. Figure 1

shows the typical neural network architecture containing convolutional, pooling, and fully connected layers.

2.2 Activation Function

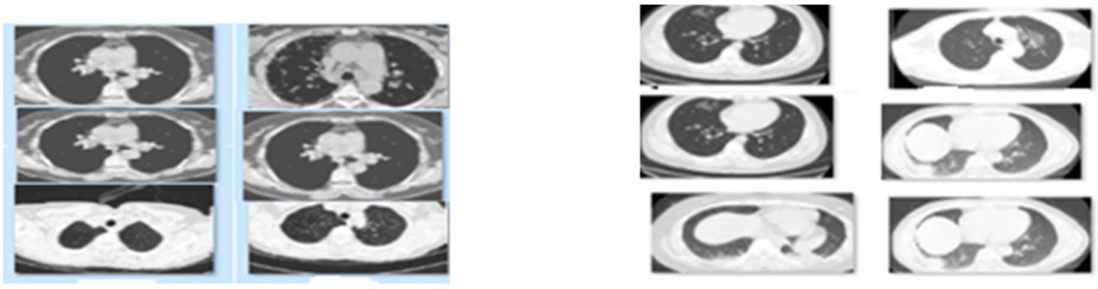
An activation function determines if a neuron should be activated or not activated. This research work specially focused on activation function used in deep neural network. We have used the three most popular activation functions like sigmoid, Tanh and Relu activation function.

- **Sigmoid Activation Function:** It is non linear activation function. It looks like S shap and smooth step function**.** Unlike linear activation function, sigmoid activation function output is bounded in range 0 to 1 [17]. The sigmoid activation function basically used in binary classification problem and also gives to raise a problem of vanishing gradients.
- **Tanh Activation function:** All characteristics and looks are similar to sigmoid activation function. The output of Tanh activation function is bounded in range -1 to +1. When we compared the Tanh and sigmoid activation function, Tanh is preferable ove sigmoid function and gives optimization solution [17]. The Tanh activation function gives to raise a problem of vanishing gradients.
- **Relu Activation Function: Relu** actuivation fuction is very popular and it is not purely linear bit it consists of linear segments. The output is bounded in range 0 to infinity [17]. It solves the problem of vanishing gradients.

Figure 1: Architecture of convolutional neural network

2.3 Data Set

In this research work, we used the COVID19 CT scan image dataset collected from www.github.com repository. The original dataset contains 746 images where 349 belong to COVID19 CT scan images and 397 belong Non-COVID19 images. In this reserch work , we have randomly selected the 105 images of COVID19 CT sacn images and 120 images of Non –COVID19 CT scan images. The samples of Non-COVID19 CT images and COVID19 CT images as shown in Figure2.



(a) Non COVID19 CT scan Image (b) COVID19 CT scan Image

Figure 2: Samples of COVID19 and Non COVID 19 CT scan Image

3. EXPERIMENTAL RESULT

The experiment is carried out in a Windows 10 environment with python software. This research work focused on identifying and classifying COVID19 CT scan images. In this research work, we have used CNN as a classifier for the COVID19 CT scan image classification in the case of three different activation functions with a different number of epochs. The research work depicted the training and testing accuracy with different epochs where a difference of data in each epoch is 50. The main reason to show the training and testing accuracy with difference of 50 epoch is that when decreases the epochs difference then slightly changes in training and testing accuracy. We have divided the dataset into 70% of the training and 30% of the testing samples.

Case 1: The proposed CNN classifier was trained and tested with the Relu activation function. The proposed CNN classifier is trained and experimented with the different number of epochs, as shown in table1. The proposed CNN classifier achieved the best training and testing classification accuracy of 100% and 88.24% respectively in the case of 100 epochs. Figure 3 (a), (b), (c) , (d), (e), and (f) show the training and testing accuracy with 50 epochs, 100 epochs, 150 epochs, 200 epochs, 250 epochs, and 300 epochs respectively.

Table 1 : Accuracy (In %) of proposed CNN with Relu activation function

Number of Epochs	Training Accuracy	Testing Accuracy
50	93.63	77.94
100	**100**	**88.24**
150	98.73	80.88
200	95.54	77.94
250	98.09	77.94
300	98.73	75.00

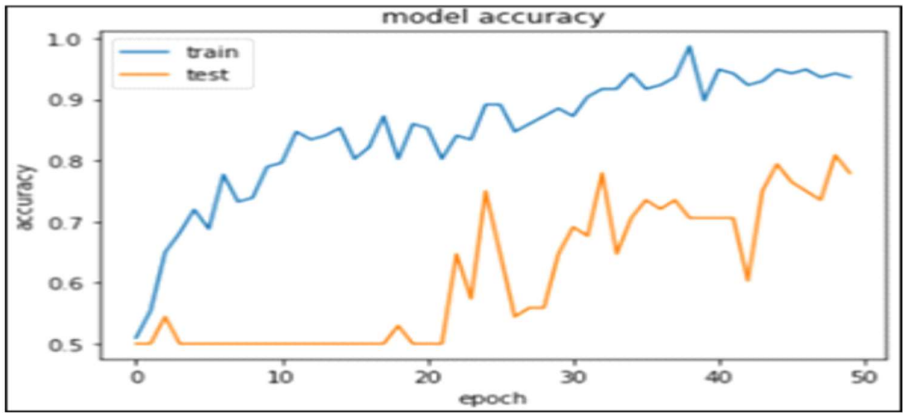


Figure 3 (a) **:** Training and testing accuracy with 50 epochs

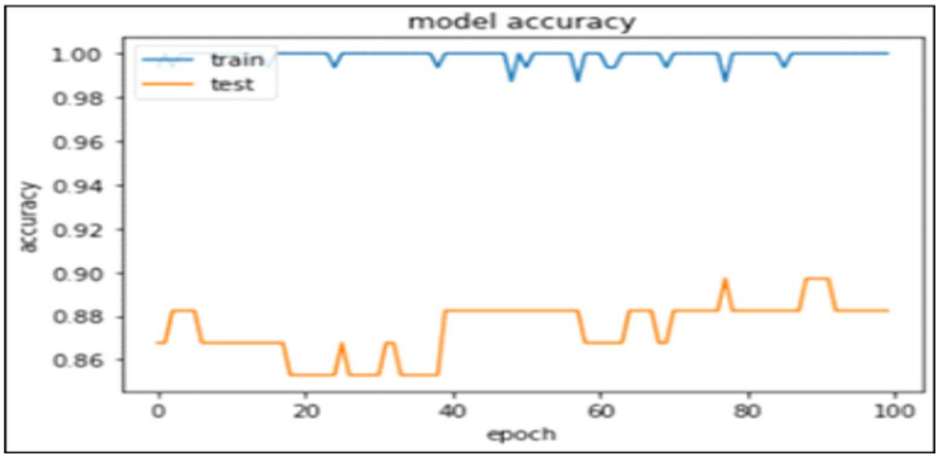


Figure 3(b) : Training and testing accuracy with 100 epochs

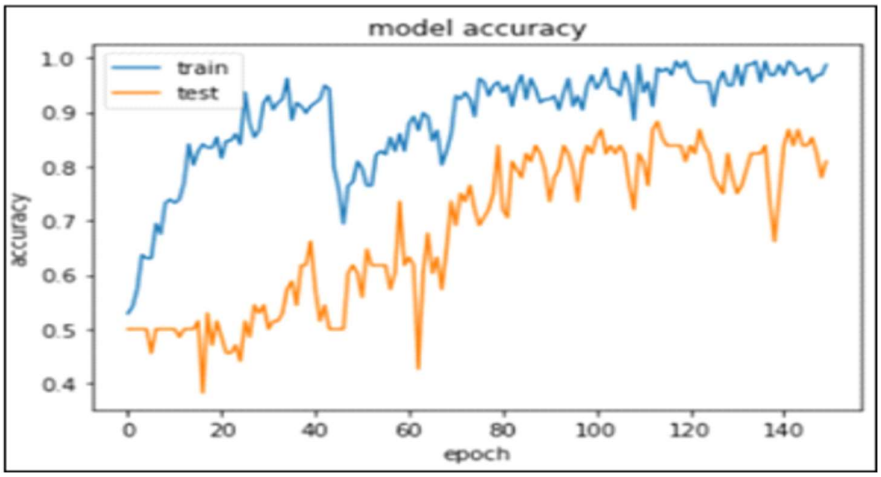


Figure 3(c) : Training and testing accuracy with 150 epochs

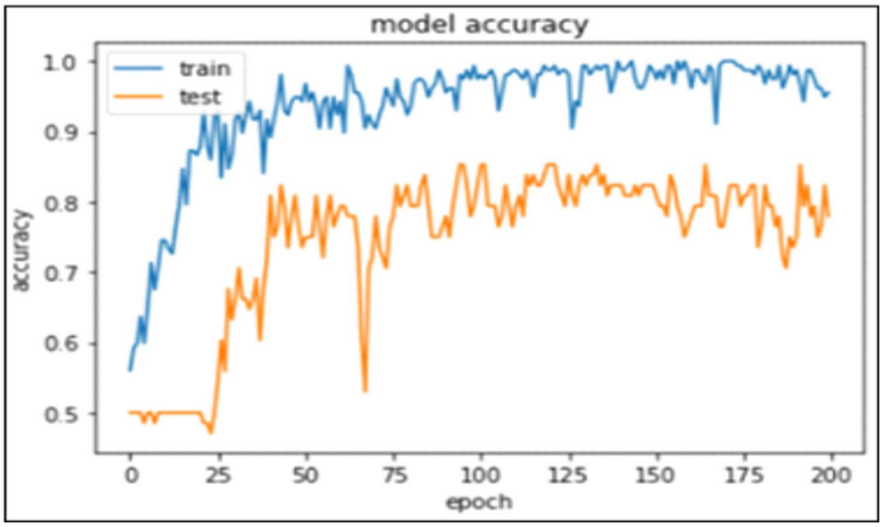


Figure 3(d) : Training and testing accuracy with 200 epochs

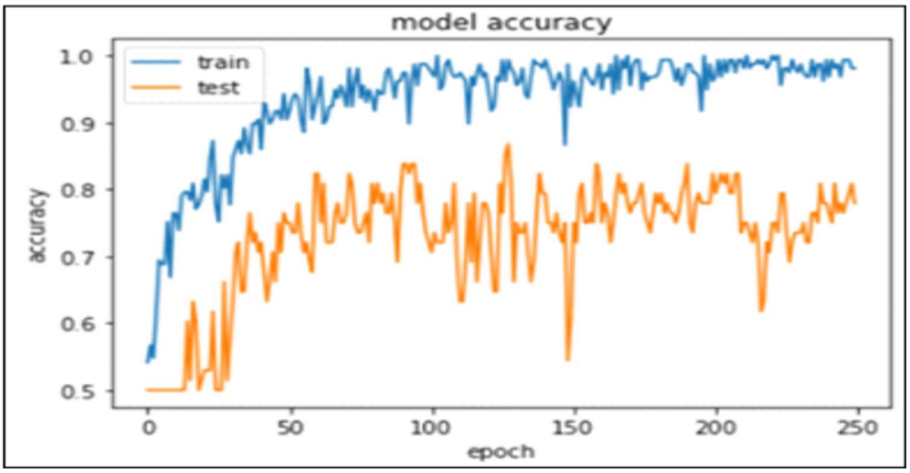


Figure 3(e) **:** Training and testing accuracy with 250 epochs

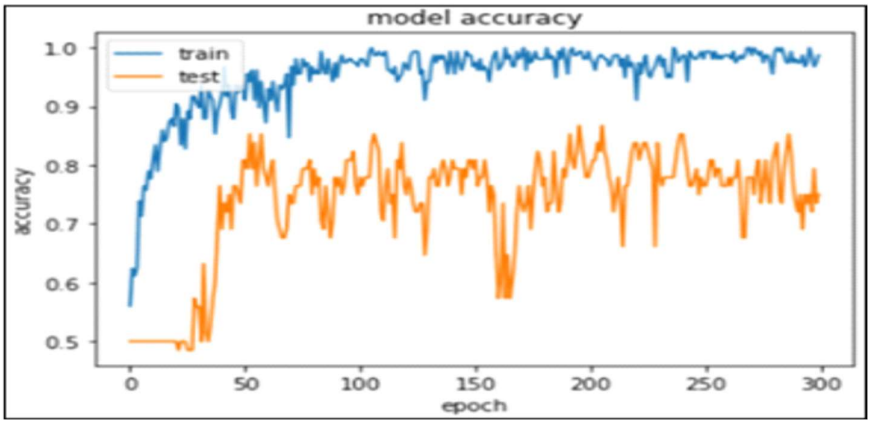


Figure 3(f) **:** Training and testing accuracy with 300 epochs

Case 2: The proposed CNN classifier was trained and tested with a sigmoidactivation function. The proposed CNN classifier is trained and tested with a different number of epochs, as shown in Table 2. The proposed CNN classifier achieves the best testing accuracy of 83.82% in the case of 200 epochs. Figure 4 (a), (b), (c) , (d), (e), and (f) show the training and testing accuracy with 50 epochs, 100 epochs, 150 epochs, 200 epochs, 250 epochs, and 300 epochs respectively.

Table 2 : Accuracy (In %) of CNN with Sigmoid activation function

Number of Epocs	Training Accuracy	Testing Accuracy
50	94.90	63.24
100	91.72	67.65
150	96.82	76.47
200	**98.73**	**83.82**
250	96.18	77.94
300	99.36	69.12

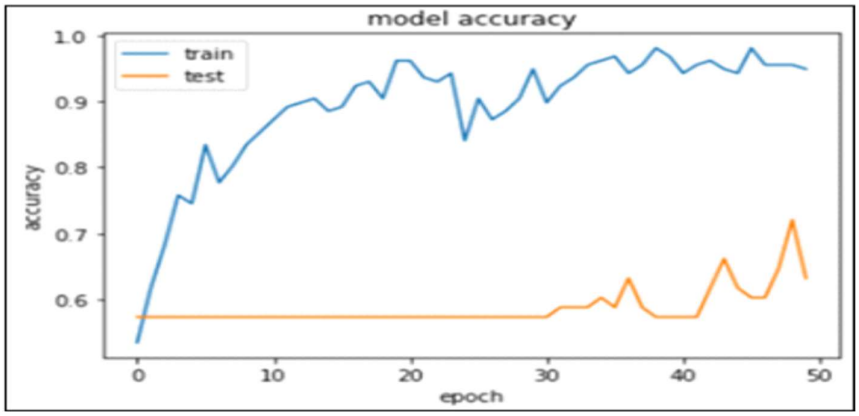


Figure 4(a) : Training and testing accuracy with 50 epochs

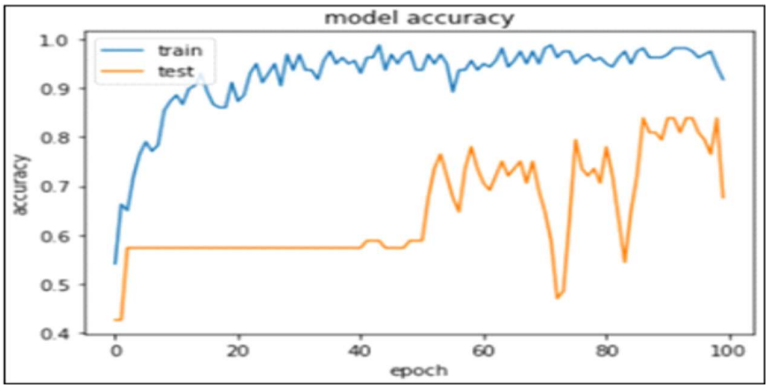


Figure 4(b) : Training and testing accuracy with 100 epochs

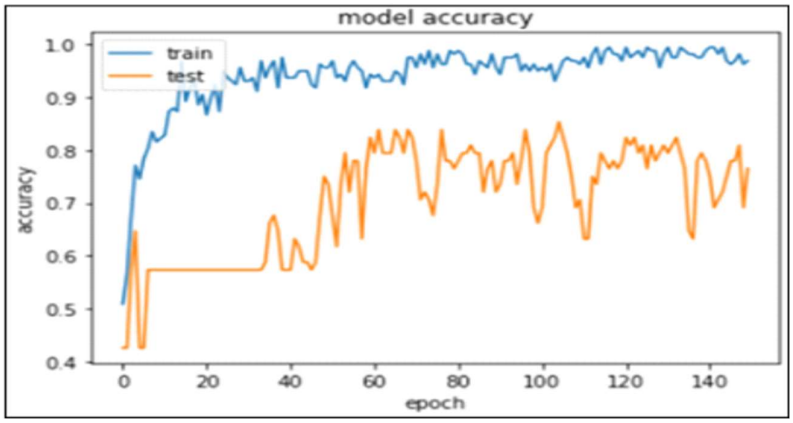


Figure 4(c) : Training and testing accuracy with 150 epochs

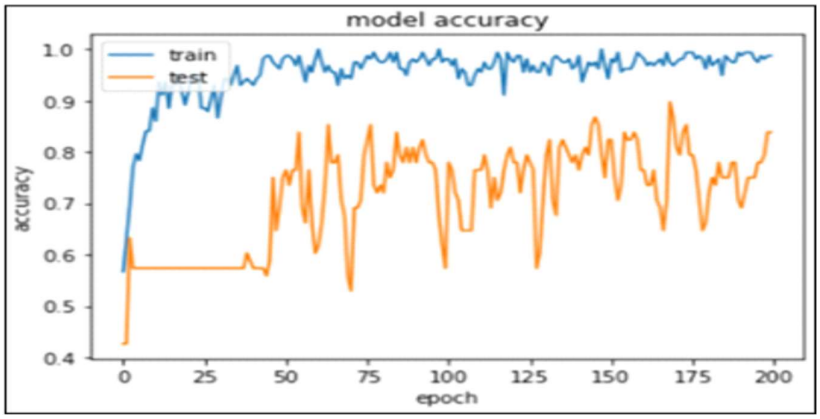


Figure 4(d) : Training and testing accuracy with 200 epochs

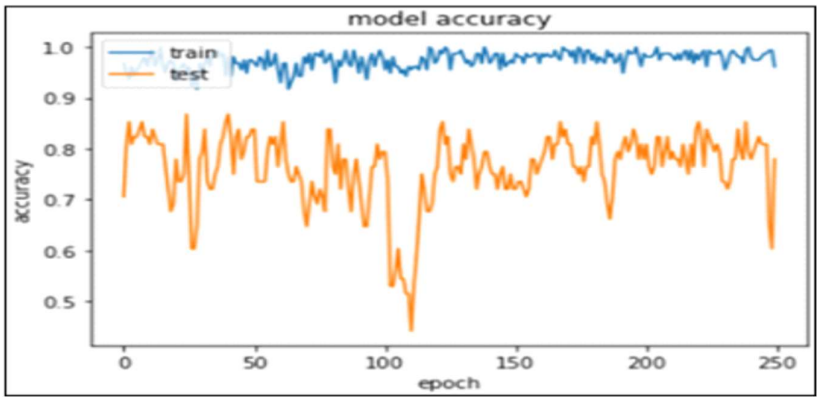


Figure 4(e) : Training and testing accuracy with 250 epochs

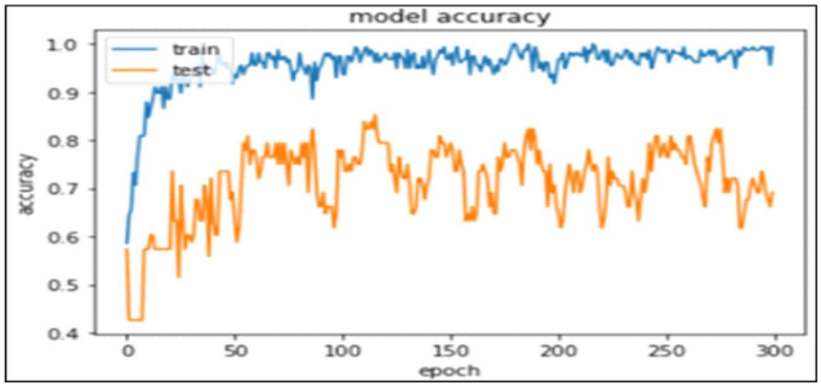


Figure 4(f) : Training and testing accuracy with 300 epochs

Case 3: The proposed CNN classifier was trained and tested with the Tanh activation function. The proposed CNN classifier is trained and tested with a different number of epochs, as shown in Table 3. The proposed CNN classifier achieves the best testing accuracy of 73.53% in the case of 250 epochs. Figure 5 (a), (b), (c) , (d), (e), and (f) show the training and testing accuracy with 50 epochs, 100 epochs, 150 epochs, 200 epochs, 250 epochs, and 300 epochs respectively.

Table 3 : Accuracy (In %) of CNN with Tanh activation function

Number of Epochs	Conv2D Layer	Training Accuracy	Testing Accuracy
50	3	82.17	72.06
100	3	66.88	55.88
150	3	67.52	70.59
200	3	78.34	69.12
250	**3**	**82.17**	**73.53**
300	3	80.89	72.06

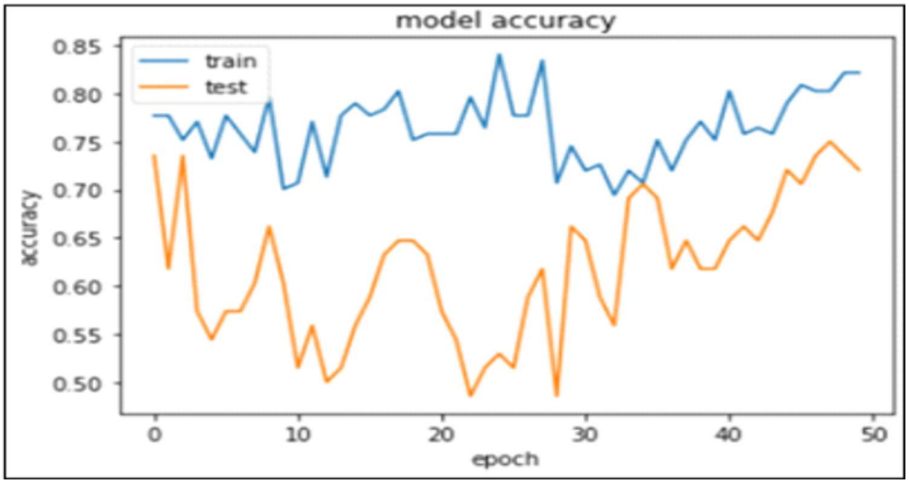


Figure 5(a) **:** Training and testing accuracy with 50 epochs

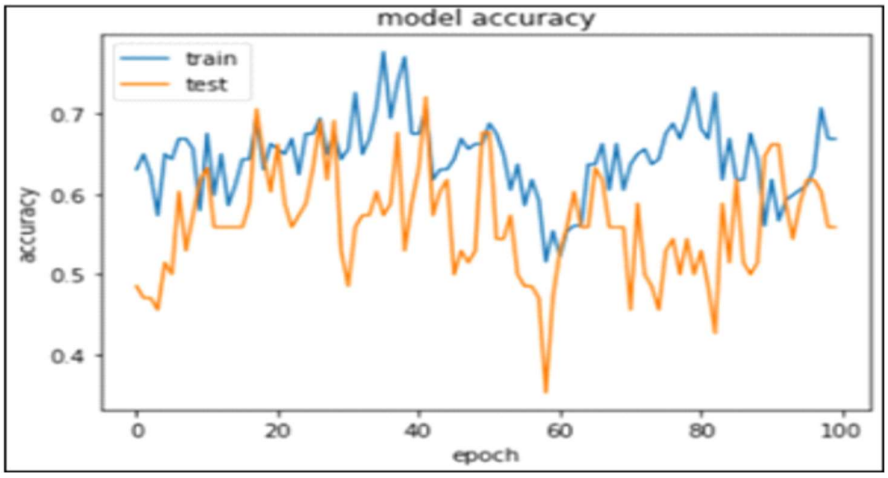


Figure 5(b) **:** Training and testing accuracy with 100 epochs

(b)

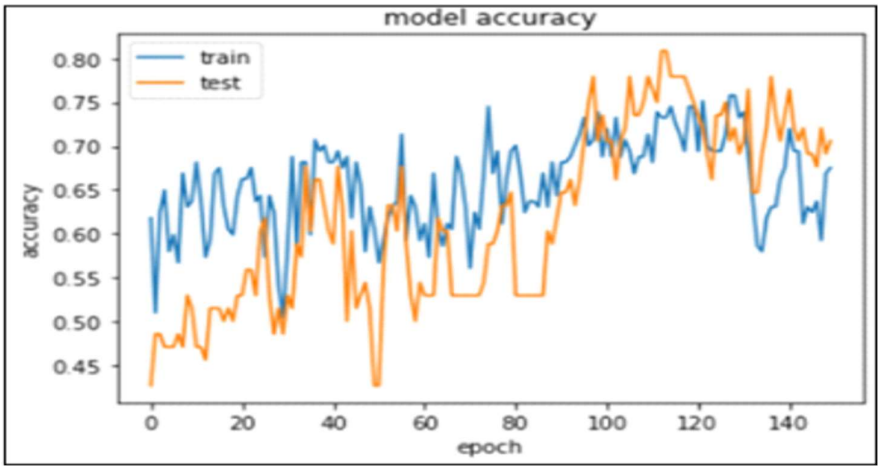


Figure 5(c) : Training and testing accuracy with 150 epochs

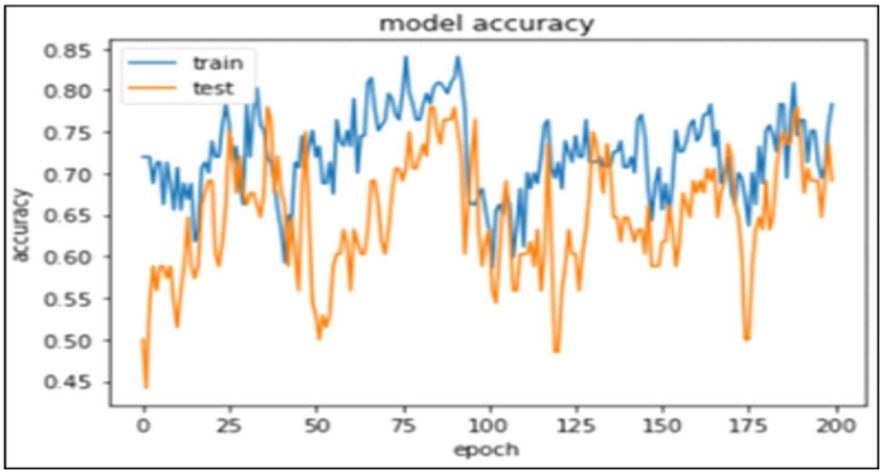


Figure 5(d) : Training and testing accuracy with 200 epochs

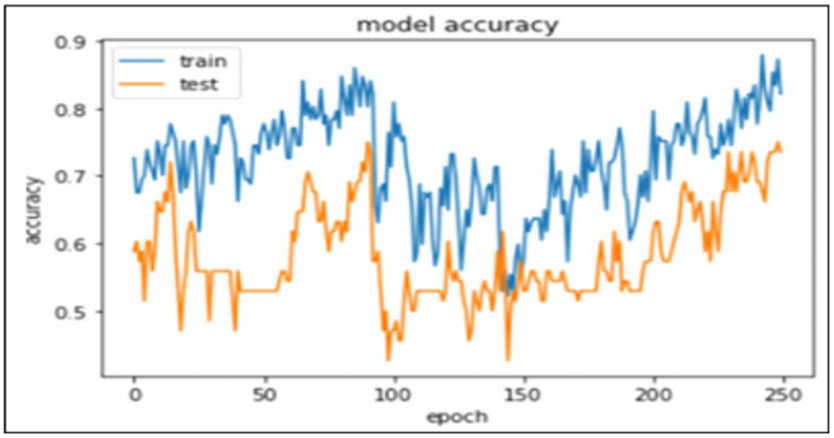


Figure 5(e) : Training and testing accuracy with 250 epochs

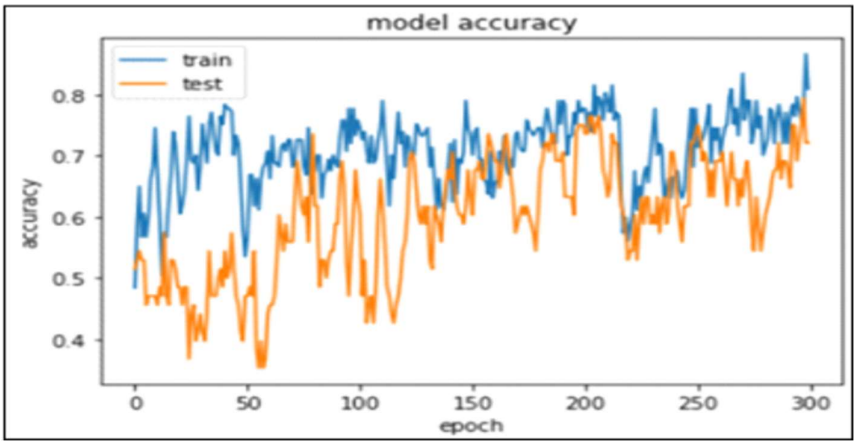


Figure 5(f) : Training and testing accuracy with 300 epochs

4. Analysis of Result

This research work has compared the accuracy of proposed CNN model with existing model developed by some authors. The proposed (CNN+Relu+epochs-100) model achieved 100% of training and 88.24% of testing accuracy. The proposed CNN model gives better accuracy as compared to proposed model with 85.86% accuracy by Erdem and Aydın [15] and our proposed CNN model gives approximate similar accuracy as compared to model developed by Khan A. I. [16] . Finally our proposed CNN model with highly tune parameter gives satisfactory results for classification of COVID19 CT scan images.

5. CONCLUSION

This research paper explored the three different cases of CNN to classify the COVID19 diseases with CT scan X-ray images. The proposed CNN used three activation functions such as Relu, sigmoid, and Tanh, with different numbers of epochs. The proposed CNN model with the Relu activation function and 100 epoch is recommended for classifying COVID19 CT Scan images. The recommended CNN model achieves the training and testing accuracy 100% and 88.24% respectively. In the future, we will develop a robust model using advanced deep learning techniques like VGGNet, VGG16, and other optimization techniques to obtain high classification accuracy.

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