In recent months, researchers have investigated and analyzed chest X-ray images using deep learning algorithms to detect COVID-19. First, the images are preprocessed using the CNN technique for extracting better features, which are fed in deep learning algorithms for image classification.

Ahammed et al. [29] proposed a deep neural network based system where CNN provided high accuracy (94.03%). The authors trained the system with normal, pneumonia and COVID-19 patient’s chest X-ray images. The limitation of the work was that a dataset with only 285 images was used for developing the system, and this small number of data was not perfect for training a deep learning-based system for the COVID-19 prediction.

Chowdhury et al. [30] worked with chest X-ray images to develop a novel framework named PDCOVIDNet based on parallel-dilated CNN. In the proposed method, the authors used a dilated convolution in the parallel stack that could capture and stretch necessary features for obtaining a detection accuracy of 96.58%.

Abbas et al. [31] proposed and validated a deep convolutional neural network called decompose, transfer, and compose (DeTraC) to detect COVID-19 patients from their chest X-ray images. They proposed a decomposition mechanism to check irregularities from the dataset by investigating class boundaries for obtaining a high accuracy (93.1%) and sensitivity (100%).

Azemin et al. [32] used a deep learning method based on the ResNet-101 CNN model. In their proposed method, thousands of images were used in the pre-trained phase to recognize meaningful objects and retrained to detect abnormality in the chest X-ray images. The accuracy of this method was only 71.9%.

El-Rashidy et al. [33] introduced a framework consisted of three layers: patient layer, cloud layer and hospital layer. A set of data was collected from the patient layer using some wearable sensors and a mobile app. A neural network-based deep learning model was used to detect COVID-19 using the patient X-ray images. The proposed model achieved 97.9% accuracy and 98.85% specificity.

Khan et al. [34] developed a new architecture for the diagnosis of X-ray images as the COVID-19 or normal using pre-trained deep learning models like ResNet50, VGG16, VGG19 and DensNet121, where VGG16 and VGG19 showed the best accuracies. The proposed model consisted of two phases like preprocessing and data augmentation, and transfer learning, and finally showed 99.3% accuracy.

In the proposed model by Loey et al. [35], three deep transfer models like AlexNet, GoogleNet and ResNet18 were employed on a dataset of 307 images with four different types of classes: COVID-19, normal, pneumonia bacterial and pneumonia virus. The research work was distributed into three scenarios to reduce memory consumption and execution time. At the last deep transfer model, GoogleNet achieved 100% testing accuracy and 99.9% validation accuracy.

Minaee et al. [36] reported a deep learning-based framework to detect COVID-19 from chest X-ray images using four tuning models like ResNet18, ResNet50, SqueezeNet and DensNet-121. The proposed method took advantage of data augmentation to create a transformed version of the COVID-19 images, which increased the number of samples and finally achieved 98% sensitivity and 90% specificity.

Sekeroglu et al. [37] developed a model using deep learning and machine learning classifiers where a total of 38 experiments was conducted by CNN for the detection of the COVID-19 using the chest X-ray images with high accuracy. Among them, 10 experiments were performed using 5 different machine-learning algorithms, and 14 experiments were carried out by the state-of-the-art pre-trained network for transfer learning. The system demonstrated 98.50% accuracy, 99.18% specificity and 93.84% sensitivity. They concluded that the system developed by CNN was capable of achieving COVID-19 detection from a limited number of images without any preprocessing and with minimized layers.

Wang et al. [38] developed a model using ResNet-101 and ResNet-151 with fusion effects to enhance their weight ratio dynamically. Classification of the chest X-ray images was carried out based on three classes, such as normal, COVID-19 and viral pneumonia. Performance accuracy of 96.1% was achieved during the testing phase.

Yoo et al. [39] applied chest X-ray radiography (CXR) images to classify using a deep learning-based decision-tree classifier for detecting COVID-19. This classifier compared three binary decision trees based on the PyTorch frame. The decision tree classified CXR images as normal or abnormal, where the third decision tree achieved an average accuracy of 95%.

Khalifa et al. [40] developed a classification approach for the treatment purposes of coronavirus on a single human cell-based on treatment type and treatment concentration level using deep learning and machine learning (ML) methods. Numerical features of the data sets were converted to images for building the DCNN model. The testing accuracy of treatment classification obtained by the model was as high as 98.05% compared to the other traditional ML methods, including support vector machine (SVM) and decision tree (DT). However, the proposed DCNN model showed less testing accuracy (98.2%) compared to the DT (98.5%) for the prediction of treatment concentration level. Deep transfer models (i.e., Alexnet) have not been employed in their study.

Wang et al. [41] have developed a transfer learning method (Xception model) using deep learning models for diagnosing COVID-19. The proposed method showed 96.75% diagnostics accuracy. Furthermore, Deep features and machine learning classification (Xception + SVM) were also employed to develop an efficient diagnostic method for improving the accuracy of the Xception model by 2.58%. From the result, the authors claimed that their proposed method attained higher classification accuracy and efficient diagnostic performance of the COVID-19. However, the authors have not compared their results with the existing similar works.

Sahlol et al. [42] proposed an improved hybrid classification approach using CNNs and marine predators algorithm for classifying COVID-19 images, which were obtained from international cardiothoracic radiologists. Inception architecture of CNNs was employed to extract features, and a swarm-based marine predators algorithm was used to select the most relevant features from the images. However, the research work did not consider any fusion approach to improve the classification and feature extraction of the COVID-19 images.

Most of the reported work in the literature has used chest X-ray images to diagnose COVID-19, and this highlights the importance of chest X-ray image analysis as an indisputable tool for doctors and radiographers. However, imbalance in data manipulation and lack of necessary extracted features from the images sometimes cannot provide expected accuracy in the classification result. To overcome these limitations, this work proposed CNN for improving the detection accuracy of the COVID-19.