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Research Article

A Review of Approaches and Difficulties in the Use of Deep Learning Techniques for COVID-19 Disease Diagnosis on Chest X-Rays

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ABSTRACT

The global community's healthcare system has faced significant challenges as a result of the COVID-19 outbreak, which has increased demand for prompt and accurate diagnosis. Of these techniques, deep learning-based (DL-based) models have shown a great deal of promise in identifying COVID-19 from medical imaging techniques, especially CT and chest X-ray scans. The latest developments in COVID-19 detection using chest X-ray images are presented in this survey paper. As discussed, various deep learning architectures, including CNN, ResNet, Xception, and hybrid models, have shown promise in accurately classifying cases of COVID-19, pneumonia, and normal lung disease. Furthermore, a comparison is made between the accuracy, sensitivity, specificity, and F1-score level of each individual ADA and ADA with each model. Along with highlighting current drawbacks like data imbalance and overfitting, the paper suggests future development directions to give the model resilience and a range of applications.

1. INTRODUCTION

Early detection is crucial because the COVID-19 virus, which caused a global health crisis and paralyzed health systems, first surfaced in late 2019. The virus can be stopped from spreading if it is discovered in time and treated right away. Other quicker detection techniques are being researched because PCR testing and other conventional diagnostic methods can be time-consuming and resource-intensive. Medical imaging, especially CT scans and chest X-rays, is one of the options and a helpful diagnostic tool.

In recent years, the analysis of medical images using deep learning (DL) models has transformed the diagnosis of diseases, particularly COVID-19. The accuracy of the four image-processing models used in this study most notably the Convolutional Neural Network (CNN) in identifying COVID-19 in chest X-ray images is novel. One of these models' main advantages is that it eliminates the need for manual feature extraction by automatically learning discriminative features from the images. Furthermore, larger performance gains with fewer labeled data have been brought about by transfer learning and pre-trained models.

In this paper, we provide an overview of current research trends, with a focus on deep learning models that have been applied to the identification of COVID-19 from chest X-ray images. It also examines the difficulties, such as overfitting and imbalances in the dataset, and talks about possible avenues for further study.

2. LITERATURE REVIEW

In this paper, few related methods are addressed for detecting Covid-19. Various deep-learning-based approaches have been established for coronavirus and viral pneumonia detection.

The author [1] splits the two different approaches to combine multiple feature selection algorithms into two groups [data fusion and decision fusion]. The data fusion technique aggregates the solutions generated by each feature selection method based on a voting scheme to generate a single output solution. This method of feature selection is to essentially aggregate the data derived from multiple feature selection methods. Reduced datasets are used in a decision fusion strategy by feature selection algorithms. They performed an experimental analysis to test the efficiency of these proposed techniques, since

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the analysis in depth demanded an implementation of the methodologies proposed [21, 23] in addition to the PCA methodology and unmodified data [24, 22], namely, features have not been extracted, and this was achieved on 10 sets of datasets [25]. Three classification algorithms are used, namely decision tree, Naive Baes, and K- Nearest Neighbors and the results showed that the merging process performed better than most datasets merging and PCA on the datasets. Additionally, it out-performs raw data uncombinably in most data sets without requiring any feature extraction.

Task 4: Authors [2] employed AI techniques to evaluate chest X-ray photographs to spot COVID-19-positive people. Expedient Image Classification Approaches such as CNN, SoftMax, SVM, Random Forest & K- Nearest Neesbours First method, by using SoftMax classification directly on the images, and secondly, by extracting features from the images using CNN instead of any feature-processing method, and classifying them by using the classification methods mentioned above. The performance of every method was assessed to calculate the optimal algorithm and they observed that all classifiers had a very good performance, where accuracy, sensitivity, and specificity rates were all over 98%. The results show that methods of artificial intelligence are capable of detecting COVID-19 diseases, from chest X-ray images, successfully.

Coronet, a deep learning network designed to automate the detection of COVID-19 infection from chest X-ray images was introduced by the authors [3] in their study. The model is built on the ImageNet-pretrained Xception architecture and is trained on chest X-ray images for COVID-19 and other pneumonia types from two publicly available databases. In the experiments, the overall accuracy of the proposed approach (CoroNet) is 89.6% with 95% classification accuracy (for 3-class classification i.e., COVID-19 vs Pneumonia vs normal).

Using transfer learning method they developed a state-of-the-art convolutional neural network (CNN) architecture for the automatic detection and diagnosis of Coronavirus disease using X-ray images from COVID-19-positive patients, as well as common bacterial pneumonia patients and normal incidents. Authors [4] used the dataset from X-ray images from patients with common bacterial pneumonia, confirmed COVID-19 disease, and normal incidents. The goal of the study was to theoretically construct and research the performance of these architectures for MD classification task in this case for detecting the COVID-19 disease. They propose that Deep Learning with X-ray images may extract important COVID-19-related imaging biomarkers, and the maximum accuracies, sensitivity, and specificity achieved were 96.78%, 98.66%, and 96.46% (i.e., the high accuracy). The results indicate that the addition of the X-ray method to the diagnosis of COVID-19 disease can be a recommended way such that the X-ray approach in some aspects can be discussed further on future studies.

Multi-image data augmentation for improved COVID-19 detection on chest X-Ray and chest CT scan images of coronavirus suspected cases based on a multi-image CNN solution [5] In the proposed method, to boost the number of effective examples for training CNN model, it makes use of the information based on discontinuity which is extracted in the filtered images. The proposed model attains nearly 95.38% classification accuracy for CT and X-ray images, respectively, as per the experimental results. Tested on publicly available databases of chest-X-ray and CT images, their model achieved other metrics and also enabled a comparison against the ResNet-50 and VGG-16 models. Our proposed model outperformed others in terms of sensitivity and specificity in CT and X-ray images. The approach can help in screening of COVID-19 with the chest X-ray and CT scan of suspected corona infected person.

Authors [6] conduct study on how to make use of deep learning methods to classify X-ray images into three classes; Normal, Pneumonia and COVID-19 respectively. They trained a few deep convolutional networks with two publicly available datasets. DATASETS DETAIL These datasets include 180 X-ray images of humans suffering from COVID-19. Moreover, the authors introduced lots of training techniques to improve the learning process of the network in an imbalanced dataset, characterized by a lack of COVID-19 events, with respect to the other classes. They propose the best accuracy by use of a neural network that sequentially merges features extracted from two strong networks namely, Xception and ResNet50V2.

Deep learning models for COVID-19 diagnosis from chest X-ray images detailed by the authors [7]. The authors proposed a hybrid architecture with features from Resnet50 in addition to novel layers and achieved a Top-1 accuracy of 96.30%. Authors evaluated and compared performance of AlexNet, Resnet50, GoogLeNet, VGG16 and the hybrid architecture using both COVID-19 Chest X-Ray dataset and Chest X-Ray Images (Pneumonia) datasets. The hybrid model achieved better results than the other deep learning architectures, and the authors recommended that it could be used within computer-aided systems for diagnosing COVID-19 disease.

Example taking from [8] Authors used reliable pre-trained deep learning algorithms for automatic detection of pneumonia induced by COVID-19 from digital chest X-ray images. It was designed to features the performance of state-of-the-art neural architectures suggested for classification of medical images in the last couple of years. Data set: The data set used in the experiments contained274 COVID-19 cases, 380 viral pneumonia, and 380 healthy casestaken from some open sources of X-Rays available in the Internet. It is observed from the results that overall and based-class score wise Model vgg16 is better than other models. Study Results The results of the study indicate that deep learning using X-ray imaging is effective in rapid collection of biomarkers relevant to COVID-19 infection, and further the additional information this imaging modality can provide can serve to greatly enhance the speed and accuracy of diagnosis. An immense amount of patient data particularly related to COVID-19 is needed, but it should be noted that training deep neural networks may lead to overfitting on limited data, the study said. The results demonstrate the prospective role of deep learning for clinical applications in medical image analysis and diagnosis and provide avenues for future work.

Deep learning techniques are utilized to accurately detect the COVID-19 in COVID-19 chest CT images [9]. In particular, retraining the GoogleNet CNN architecture with the COVIDCT-Dataset, from a total of 349 CT images (with clinical findings of COVID-19). The time to train the retrained model was 74 minutes and 37s meanwhile the validation accuracy was 82.14%.

Deep features with support machines (SVM) may be applied to X-ray images to identify Coronavirus infected patients [10]. The dataset required to train and validate the model is huge, because of which a deep learning-based classifier is not implemented and instead SVM is used. SVM: SVM is employed for classification on the deep features that have extracted from the CNN fully connected layer. The approach has three groups of X-ray pictures which are COVID-19, pneumonia, and typical. Feature extraction done by 13 different models of CNN is used to evaluate the performance of SVM in predicting COVID-19. The best results were attained by SVM whilst utilising deep features from ResNet50. To detect COVID-19, ResNet50 with SVM which is a classification model achieved 95.33% Accuracy, 95.33% Sensitivity, 2.33% FPR, and 95.34% f1-score (IFSARS, IFMERS, and IFARDS were not included).

Study conducted inAuthors [11] designed a new approach relying on deep features fusion and ranking to finding COVID-19 in early stage. Sub-datasets were created by extracting patches of size 16x16 and 32x32 from 150 CT images, and around 3000 patch images were labelled either as COVID-19 or No finding, with which the proposed method was trained and tested. They used feature fusion and ranking approaches for enhancing the efficiency of the method and the built processed data was classified using Support Vector Machine (SVM).

A method for COVID-19 detection using chest X-ray images has been proposed based on deep-learning techniques by the authors [12]. The authors have prepared a dataset of three classes which was normal, COVID−19, and pneumonia images. They extracted deep learning features and classification using ResNet50 and SVM, respectively; achieving 94 % accuracy on the given dataset of Normal, Corona virus and Pneumonia images. The performance accuracy and other evaluation matrix shown better than VGG16 by using our proposed method. The hybrid model was ResNet50+SVM which was specified as the best one in the case of both balanced and imbalanced class datasets. But according to the authors, more could be done with class-balancing machine learning approaches to ensure the model accuracy on the second dataset is even better. to conclude, the model proposed can be promising for covid-19 detection using artificial.

Using a deep-learning algorithm built on a dataset of chest CT images, the authors [13] was able to identify COVID-19 infected patients. The standards of the model applied to the image's validation reached 0.732 and 0.700 accuracy, whereas the standards in the images test were 0.819 and 0.760 accuracy. These findings suggest that the model may assist radiologists in identifying disease. The model achieved a sensitivity and specificity of 0.730 and 0.615, respectively in validation images. Such output indicates that the model may produce false positive and false negative results. Despite this limitation, the model is still more sensitive and specific in the independent set of test images with a sensitivity of 0.811 and specificity of 0.615. This basically establishes that with more time and development deep learning algorithms can dedicate to finding Covid-19 positive victims.

The 23-based team sought to provide a safe, reliable way of readings COVID 19 from CT scans of the chest that also monitored how well the drugs they suggest might perform in practice. Over the research, a total of 202 people were diagnosed with Covid19.HealthTree [16] is their tool. Their statisticians used the Desktop Manager statistical software package to complete all of the pattern-matching and multiple - regression. Besides those features identified with this article's classification of Covid-19 severity from pre-trained deep models, there could be a difference maker in whether lesions were malignant or not. Exceptions validation, tenfold cross-validation, and leave-one-out were three validation routines employed to judge pipelines proposed. Final results from the experiment showed that classified feature from pre-trained deep models for COVID-19 severity screening applications has made good progress. Through tenfold cross-validation we obtained the best classification accuracy of 95.20 percent, while it was 95.34% under leave-one-out. In general, DenseNet-201 with cubic SVM model had shown particular gain.

Some authors [14] propose the use of pre-trained models based on convolutional neural networks for identifying coronavirus pneumonia and thus assessing infected patients with chest X-ray radiographs. Based on three binary categories and four kinds of 5-fold cross-validation were used to evaluate the performance of the models. According to the results, the pre-trained ResNet50 model showed the highest classification performance of the four models, with an accuracy of 96.1%. They also discuss how deep transfer learning methods could help detect COVID-19 at an early stage. The authors suggest increasing the dataset of COVID-19 chest X-rays so as to test the classification accuracy of different CNN models in future research.

Research [15] was carried out on detecting SARS-CoV-2 directly from chest X-rays. The basic classifiers consist of chest CT and CXR images, with transfer learning models used to complement these. After separating the data set into training and testing sets. The proposed method, Xception + Choquet Fuzzy, can achieve the highest accuracy of 99.57%. Nevertheless, a small part of test data (0.43%) was misclassified, perhaps due to the effectiveness of individual transfer learning models. In future research, however, it may be necessary to improve individual models or add up classification methods so as achieve accuracy. Given the scarcity of healthcare resources as well as possible dangers from emerging variants Rapid and accurate testing for COVID-19 is important.

Recognizing the golden rule of style, we'll begin by following it. [16].The authors use transfer learning to join pre-trained CNNs, devising a model that has accuracy rarely achieved before. They collected a data set on which to train and evaluate this new system: normal, viral pneumonia, tuberculosis and COVID-19 patients. The research shows that AI methods such as transfer learning and sequence modeling are effective and accurate methods for providing aid systems Helpful to diagnose coronavirus disease from chest X-rays.

The authors [17] showed that by making minor modifications on ResNet101, such as adjusting the hyperparameters the principle and inventing CO-ResNet a new AP task-oriented network designed to spot COVID-19, pneumonia, or normal lung conditions. They sampled a data set of 5935 X-ray images from two public datasets. In the case of CO-ResNet, the authors made use of a number of different methods in order to increase its efficiency. These included scaling of the data, augmentation and normalization. The authors concluded that the CO-ResNet algorithm can correctly identify coronaviruses and pneumonia. As a result, this technology could possibly lead to better algorithms for medical image analysis, by way of DL methods more exact and effective than what currently exist.

The authors [18] evaluated use of pre-trained convolutional neural networks (CNNs) for COVID-19 classification with chest X-rays. They showed that pre-trained (CNNs), including AlexNet, GoogleNet, and SqueezeNet, achieved excellent results in classification performance compared to those of accuracy, sensitivity, specificity, precision and the F1 score as well as the plot unique. They also mentioned that these networks take the shortest time to train than any other pre-trained (DL) model. The results also showed that it is quite difficult to achieve excellent classification results without data augmentation and when the training parameters are well chosen. The results of this study we believe are important because they demonstrate the effectiveness of using pre-trained (CNN) combined with artificial intelligence (AI) methods for rapid and cost-effective detection of COVID-19 through chest X-ray data. As these networks are available to the public, this may be just what we need to deal with a major emergency like that seen down at Fangcang Hospital.

The authors [19] investigated using deep learning (DL) techniques in diagnosing coronavirus (COVID-19) by analyzing chest X-ray (CXR) images. They used a pre-trained neural network model (ResNet-50) to detect coronavirus (COVID-19). The paper presents two distinct DL methodologies, in the pre-processing stage, where CXR images are enlarged, enhanced, normalized, and resized to a pre-defined size. The proposed (DL) method for identifying chest X-ray (CXR) images consists of an ensemble approach in which several iterations of a modified Resnet-50 model. Using two publicly accessible benchmark datasets – the COVID-19 image dataset (IDC) and CXR images (pneumonia) – evaluation is conducted on the performance of the proposed system.

The authors [20] suggest two distinct methodologies to classify people with COVID-19, pneumonia patients, and healthy individuals using X-ray images. Method I is achieved by first training the (CNN) with (SVM) model with the COVID-19 dataset and then testing the results against other classifiers. Method II employs a pre-trained Mobile Net model type to test how well the results came out doing this. By proving that the CNN model with SVM, trained using the COVID-19 data set, was more accurate at determining people's category than other methods for classification Their study obtained the highest accuracy level in distinguishing the three classes of people from each other. compared to using pre-trained deep networks that were trained on different types of images The results are better using a (CNN) model that is not trained on other types of images but specifically trained for X-ray. Their study emphasizes the importance of using sufficient training data for image classification tasks and also underscores this point by proving the need for models tailored to each distinct image class.

TABLE I: PERFORMANCE COMPARISON LITERATURE ABOUT COVID-19 DIAGNOSTIC METHODS USING CHEST X-RAY IMAGES.

Previous Study	**Data Type**	**No. of data**	**Number of Classes**	**Methods / Classifier**	**Accuracy (%)**
Mohammad Rahimzadeh and Abolfazl Attar (2020)	X-rays Images	11302	normal, pneumonia, and COVID-19	concatenation of the Xception and ResNet50V2	91.4%
Umut Ozkaya1 et al. (2020)	CT images	3000	COVID-19 and No Findings Patches	Feature fusion (VGG-16, GoogleNet and ResNet-50) + SVM	98.27%
Kiran Purohit, et al (2020)	X-Ray and chest CT scan images	412	normal, pneumonia, and COVID-19	convolutional neural network (CNN) based multi-image augmentation technique	around 95.38% and 98.97%
Vamsidhar Enireddy et al. (2020)	X-rays Images	458	normal, corona virus, and pneumonia images	VGG16 InceptionV3 ResNet50 ResNet50 and SVM	94%
Oussama El Gannour et al. (2021)	X-rays Images	10,399	normal, viral-pneumonia, tuberculosis, and COVID-19	Modified Pre-Trained Models Based on TL Technique (Xception, Inception V3, InceptionResNet V2, ResNet50 V2, MobileNet V2, and DenseNet201)	99.71%
Walaa Gouda et al. (2021)	CXR images	2790	normal, corona virus, and pneumonia	first and second proposed versions of Resnet-50)	99.63%
Subrato Bharati et al. (2021)	X-ray images	5,935	normal, corona virus, and pneumonia	CO-ResNet with ResNet101 backbone	98.74%

Previous Study	Data Type	No. of data	Number of Classes	Methods / Classifier	Accuracy (%)
Xiangjun Wu et al. (2020)	CT images	495	normal, corona virus, and pneumonia	Single view Multi-view	0.620 0.760
Ali Narin et al. (2021)	X-ray images	7065	COVID-19, normal (healthy), viral pneumonia and bacterial pneumonia)	ResNet50, ResNet101, ResNet152, InceptionV3 and Inception-ResNetV2	99.7%
Ali Mohammad Alqudah et al. (2020)	CXR images	930	COVID-19 and Non-COVID-19	SVM, RFF, and KNN	98%
Asif Iqbal Khan et al. (2020)	chest X-rays	1251	COVID, Pneumonia, normal	CoroNet based on Xception architecture pre-trained	89.6%
Nesreen Alsharman and Ibrahim Jawarneh (2020)	CT-images	349	COVID-19 and non-COVID-19	GoogleNet	82.14%

3. CONCLUSION:

To sum up, the chest X-ray image based deep learning model for COVID-19 detection seems to be highly effective in delivering fast and accurate diagnostic approaches in an automated way. Different Deep learning architectures such as CNN, ResNet and hybrid models have been utilized with high rates of success. As collecting training data can be very expensive, transfer learning techniques that take advantage of pre-trained models have particularly improved performance by alleviating the need for large datasets. Recent studies show high accuracy, sensitivity, and specificity of these results, which makes them well suited for practical use in a clinical setting.

However, there are multiple challenges that still need to be overcome despite the success. Things like data imbalance, overfitting and generalizability of models in different datasets need further focus. Finally, the strength and reliability of these models may be enhanced using multi-modal data integration of X-rays with clinical data (eg, demographics, lab testing, histology). Further efforts need to be made in data curation (larger and more heterogeneous datasets), model architectures, and developing systems that can be easily incorporated into clinical workflows.

Moreover, the development of AI-fueled diagnostic tools has the opportunity to greatly enhance COVID-19 identification and aid clinicians to make faster, more accurate choices, especially in resource-poor environments.

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Conflicts of Interest:

The authors declare no potential conflicts of interest.

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