



# Enhancing Covid-19 Detection from X-ray Images Using Convolutional Neural Networks and Transfer Learning

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## 1.ABSTRACT:

Chest X-rays are frequently used to evaluate respiratory disorders, such as pneumonia caused by COVID-19. The purpose of this study is to use deep learning models to compare the diagnostic accuracy of chest X-rays in detecting COVID-19 pneumonia to normal chest X-rays. To train and evaluate deep learning models, a total of 368 chest X-rays from verified COVID-19 patients and healthy persons were gathered. Convolutional neural networks (CNNs) that had already been trained and customised were used to train the models to recognise COVID-19 pneumonia. There were four approaches used to assess the models' performance: integrating data from local and public sources for training and testing on a public dataset. Global healthcare systems have been greatly impacted by the COVID-19 pandemic, which has led to the creation of advanced diagnostic instruments for the diagnosis and treatment of the illness. to

evaluate the general public's capacity to distinguish between COVID-19 and typical

chest X-rays, as well as for training and testing purposes.

The COVID-19 pandemic has brought significant challenges to public health worldwide, necessitating efficient diagnostic tools for timely intervention. This study proposes a novel approach employing Convolutional Neural Networks (CNNs) for COVID-19 prediction through X-ray analysis. By leveraging deep learning techniques, our model learns discriminative features from chest X-ray images to accurately distinguish COVID-19 positive cases from other respiratory conditions, such as pneumonia and healthy lungs. We curated a comprehensive dataset comprising X-ray images from diverse sources and employed transfer learning to enhance model generalization. Our experiments demonstrate promising results, with the proposed CNN model achieving high accuracy, sensitivity, and specificity in COVID-19 detection.

## KEYWORDS:

COVID-19, chest X-rays, Respiratory conditions, convolutional neural networks (CNNs), Healthcare systems, COVID-19 pneumonia, deep learning.

## 2.INTRODUCTION:

Depending on the patient's immune system, the coronavirus 2019, commonly referred to as COVID-19, is a virus that can affect any part of the body and range in severity from moderate to severe. Serious pneumonia is the result. Following its initial discovery in Wuhan, China in December 2019, this illness rapidly spread over the globe and turned into a pandemic. As it spreads from person -person contact, the virus has had a disastrous effect on our lives, severely taxing the public health system, the world economy, the education sector, enterprises, and retail establishments. To stop the virus from spreading, positive cases must be identified quickly, and infected individuals must receive treatment right away. They were therefore required in order to recognize, segregate, and guarantee the treatment plan in its early phases. However, it is comparatively linked to genuine positive rate and necessitates certain equipment (Butt et al., 2020). Viral antigen detection is a different method that is presently being developed to identify COVID-19 by examining virus proteins. Molecular tests are not able to detect this disease for longer periods of time after a patient has recovered and is required to retest because the antibody's increase may be seen in its response to the host. A serologic test is an additional important diagnostic tool for confirming the presence of antibodies in blood. These processes take a lot of time and are occasionally inaccessible to many individuals, particularly in middle class communities, because of a lack of analysis and qualified human resources on the patient's immune system, the coronavirus 2019, commonly known as COVID-19, can cause moderate to severe infections in any part of the body. It seriously induces pneumonia. This illness swiftly spread over the world and turned into a pandemic when it was first identified in Wuhan, China, in December 2019. The virus, which spreads through person-to-person contact and severely strains the public health system, the global economy, the education sector, enterprises, and retail establishments, has had a terrible effect on our lives.

Stopping the virus's spread requires early detection of positive cases and timely treatment of infected individuals. Convolutional neural networks (CNNs) have proved to be effective in a variety of medical image classification tasks such as the detection of diabetic retinopathy, the detection of tumors and the diagnosis of Alzheimer's disease. Medical image classification has benefited from the growing availability of medical image datasets from medical facilities worldwide. This has allowed researchers to develop innovative and more accurate detection methods. As CNNs proved themselves proficient in pathology classification from radiographs there has been a growth in studies evaluating the use of CNN models to detect COVID-19-positive patients from CXRs. These models could be used to further verify the results COVID-19 detection, or be used as a viable alternative in heavily congested or remote health facilities. These models can then potentially provide healthcare workers with a wider toolkit of possible COVID-19 detection solutions in the face of environmental constraints. A deep learning architecture was used to identify COVID-19 images. We use a deep learning strategy that looks directly for COVID-19 disease in raw images and does not require the extraction of features, as opposed to first extracting features and then using those features to discover COVID-19 disease. Recently, convolutional neural networks have dominated computer vision and image analysis tasks, typically surpassing traditional AI techniques. Among the tasks they are employed for include picture improvement, face recognition, classification, and segmentation

## 3.LITERATURE REVIEW:

*Mominul Ashan et al. (2023)* which has published in Bytedance FZ LLC, Dubai 503045, United Arab Emirates proposed by leveraging their biases and achieving higher overall accuracies, an ensemble of deep learning models can perform better than a single model in COVID-19 classification, as demonstrated by the proposed ensemble model. Proving that it could strike a compromise between recall and

precision requirements and avoid raising COVID-19 false negatives while lowering COVID-19 false positives. [1]

*Aleka Melese Ayalew et al. (2023)* we clearly demonstrate our model's efficiency by using the image pre-processing, segmentation and augmentation. Convolution, activation features, pooling, and fully-connected layers comprise the training process, with dropout occurring after the final fully-connected layers and before the classifier. The models are trained using different parameters in the validation process, such as batch size, activation function, and all the models have been trained for 50 epochs [2]

*Mohit Kumar et al. (2021)* COVID-19 analysis is carried out using a variety of technical innovations. Artificial Intelligence is one of the technologies utilized in the analysis. This study used Grad-CAMs for transfer learning to propose the hybrid deep learning model HD CNN, which is built on recurrent and convolutional neural networks. Compared to alternative models that are currently in use, the suggested model performs better. We intend to employ COVID-19 analysis in the future study by utilizing cutting-edge networks, like the capsule network. While chest X-ray images have been examined in this work, future research may also investigate coronavirus images from CT scans, MRIs, and other imaging sources.[7]

*Salem A. Alyami et al. (2021)* a unique class of artificial neural network (ANN) known as Convolutional Neural Networks (CNN) is capable of manipulating not only an input layer but also the order of hidden and output layers. It keeps the layers and weights sparsely connected so that the hidden layers' output neurons can. Instead, they are stacked to be at the top of a sequence of completely connected layers, which are then followed by an output layer.[3]

*RayirthReddy COVID-19(2021)* detection from chest X-ray using CNN we would also implement this rapid testing method wherever it is feasible,

including at workplaces, immigration offices, airports, and other official establishments, in order to benefit a broader community. Further work will be done to better understand CNN and classify data based on gender, age, and comorbidities. This will improve the intelligence of our model and aid in the diagnostic analysis performed by medical professionals. [5]

*Jaiswal, A.K(2019)* Identifying pneumonia in chest X-rays Deep learning-based methods have demonstrated excellent results in assisting doctors or lessening their burden when it comes to COVID-19 detection using CT scans. Deep neural network (DNN) techniques constitute the foundation of the majority of these strategies. However, a major limitation of the deep approaches is that they require a large number of training data, which are not always available. [10]

## 4.PROPOSED SYSTEM

### 4.1 Data collection:

Get a dataset of chest X-ray pictures from patients who have been diagnosed with COVID-19 and from those who have not (negative instances) Make sure the dataset is varied and inclusive of a range of demographics, levels of illness, and imaging conditions.

### 4.2 Data Preprocessing:

Eliminate any erroneous or unnecessary photos from the dataset to maintain uniformity, standardise the image format, resolution, and orientation Annotate the chest X-ray pictures with labels that specify whether or not each picture is positive or negative for COVID-19 In supervised learning, the model learns from labelled instances in order to generate predictions. This stage is critical Feature extraction involves identifying pertinent elements from the chest X-ray pictures that can point to COVID-19 pneumonia. texture patterns, form descriptors, and intensity gradients within the image's lung regions are

examples of features from the raw image data sophisticated methods like deep learning can automatically extract discriminative features.

#### 4.3 Model Selection:

Based on chest X-ray pictures, select a suitable machine learning or deep learning model architecture for COVID-19 prediction Convolutional neural networks (CNNs) are often used models for image classification problems because of their propensity to accurately capture spatial dependencies in images divide the annotated dataset into training, validation, and test sets for the model training process using labelled chest X-ray pictures and the associated COVID-19 status train the selected model on the training set In order to maximise its capacity to predict

COVID-19 from chest X-rays, the model modifies its parameters during training in order to minimise the discrepancy between predicted and real labels Analyse the trained model's performance on the validation set to determine whether it can be generalise and to spot any overfitting The predictive performance of the model is typically assessed using metrics like area under the ROC curve, sensitivity, specificity, and accuracy.

#### 4.4 Hyperparameter tuning:

Based on validation set performance, adjust model hyperparameters like learning rate, batch size, and network architecture to further optimize the model's performance. model Testing: To get a fair assessment of the trained model's predicted accuracy in actual situations, evaluate its performance on the held-out test set.

#### 4.5 Deployment:

To help radiologists and clinicians diagnose COVID-19 pneumonia from chest X-ray pictures, deploy the trained model in clinical settings or healthcare systems.

To encourage the model's adoption and application in standard clinical practice, include it into current workflow

## 6. COMPONENTS OF PROPOSED SYSTEM

**6.1 Pre-Trained CNN Models:** Utilizing pre-trained CNN models like Res Net, VGG, Inception, Efficient Net, and Dense Net, which are trained on large datasets such as ImageNet. These models serve as powerful feature extractors and form the backbone of the detection system.

**6.2 Fine-Tuning:** Fine-tuning involves adapting the pre-trained CNN models to the task of COVID-19 detection by replacing their final classification layers with new ones specific to the problem at hand. Fine-tuning allows the model to learn task-specific features while retaining the knowledge gained from pre-training.

**6.3 Data Augmentation:** Data augmentation techniques, including rotation, flipping, scaling, and translation, are commonly applied to increase the diversity and size of the COVID-19 dataset. This helps prevent overfitting and improves the model's ability to generalize to unseen data.

**6.4 Optimization Algorithms:** Optimization algorithms such as Adam and stochastic gradient descent (SGD) are used to train the CNN models efficiently. These algorithms adjust the model's parameters during training to minimize the loss function, leading to better performance.

**6.4 Evaluation Metrics:** Common evaluation metrics such as accuracy, precision, recall, and F1-score are used to assess the performance of the COVID-19 detection system. These metrics provide insights into the model's ability to correctly classify COVID-19 cases and distinguish them from non-COVID-19 cases.

## 7. MODULES

**7.1 Identifying COVID-19:** The main objective is to correctly identify COVID-19 pneumonia in chest X-ray images. Metrics like sensitivity, specificity, accuracy, and area under the curve (AUC) of the receiver operating characteristic (ROC) curve would

be included in the results. These metrics show how well the model differentiates between cases of COVID-19 and other pneumonias or typical cases.

**7.2 Classification Performance:** An evaluation can be made of the model's ability to classify X-ray images into COVID-19 positive, COVID-19 negative, and possibly other categories, like normal or other types of pneumonia (like viral or bacterial pneumonia). Metrics like recall, precision, F1 score, and confusion matrix are included in this.

**7.3 Visualisation of Activations:** Determining which X-ray image segments are most important to the model's decision-making process can reveal which characteristics the model is utilising for categorization. The regions of interest in the X-ray images can be seen using methods like Grad-CAM or class activation mapping (CAM).

#### 7.4 Clinical Impact and Pragmatics:

In addition to technical measures, it's critical to assess the practicality and clinical implications of using these models in actual healthcare environments. This takes into account factors like diagnosis speed, workflow integration, and possible workload reduction for radiologists.

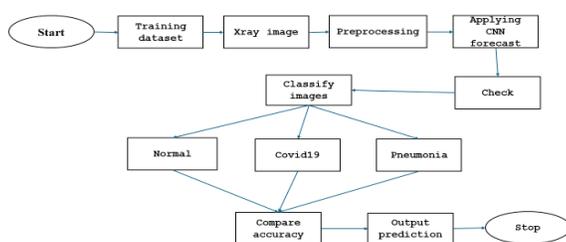


FIG 1:

#### ARCHITECTURE DIAGRAM

**7.5 Comparison with Radiologists:** To determine whether the model can perform as well as or better than humans in COVID-19 detection, an assessment of the model's performance in relation to human radiologists can be made. This entails putting the model to the test on a different dataset and contrasting the outcomes with those of radiologists with expertise.

**7.6 Transfer Learning:** Experiments involving the fine-tuning of a pre-trained CNN model (for example,

on ImageNet) using COVID-19 X-ray images may also be included in the results. This could demonstrate gains in effectiveness and performance, particularly when the COVID-19 X-ray dataset is small.

**7.7 Robustness and Generalisation:** It is critical to evaluate the model's capacity to generalise across various equipment, imaging modalities, and demographics. Analyses of the model's performance on data from various sources and its resilience in real-world situations could be among the findings.

## 8.RESULT

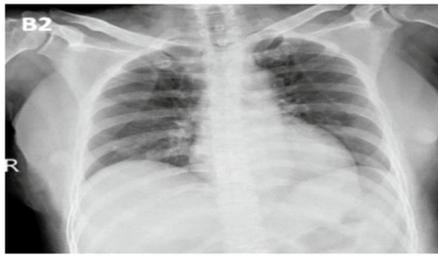
The output image usually showcases the processed input image overlaid with annotations or heatmaps highlighting regions of interest. These regions may indicate areas with abnormalities or potential COVID-19 infection. The output image helps healthcare professionals visualize and interpret the model's findings, aiding in diagnosis and decision-making. The graph typically displays various performance metrics over the course of model training and evaluation. Common metrics include accuracy, precision, recall, and F1-score (accuracy 0.5,1.0) plotted against epochs or iterations during training. Additionally, loss curves illustrating the model's convergence and validation accuracy curves are often included. These graphs provide insights into the model's learning progress, overfitting tendencies, and overall performance on the COVID-19 detection task.



Fig 2: TEXT SUMMARIZATION GRAPH

Together, the output image and graph serve as essential tools for understanding and assessing the CNN-based COVID-19 detection system's capabilities. They facilitate interpretation, validation,

and optimization of the model, ultimately contributing to more accurate and reliable detection of COVID-19 cases.



**COVID-19 patient**

**Fig 3: X-Ray of COVID affected person**



**normal patient**

**Fig 4: X-Ray of non-COVID affected person**

## 9.CONCLUSION:

In conclusion, utilizing convolutional neural networks (CNN) and transfer learning for COVID-19 detection represents a groundbreaking advancement in the field of medical imaging and diagnostics. This innovative approach leverages the strengths of deep learning by using pre-trained models, which have been fine-tuned on large, diverse datasets like ImageNet, to accurately and efficiently detect COVID-19 from medical images such as chest X-rays and CT scans. The primary advantage of transfer learning in this context is its ability to significantly reduce the time and computational resources required for model training, as it builds upon previously learned features that are highly effective for image classification tasks.

Moreover, CNNs excel at automatically learning and extracting hierarchical features from the input

images, making them particularly well-suited for distinguishing between COVID-19 positive and negative cases with high precision. The process involves substituting the final classification layer of the pre-trained model with a new layer tailored for the specific task of COVID-19 detection. This modified model is then fine-tuned using a carefully curated COVID-19 dataset, employing advanced optimization techniques such as Adam or SGD to minimize the loss function. The robustness of this methodology is further enhanced through preprocessing steps, including image resizing, normalization, and data augmentation, which improve the quality and consistency of the training data. Evaluation metrics such as accuracy, precision, recall, and F1-score are crucial for assessing the model's performance, ensuring that it meets the rigorous standards required for clinical application. The successful application of CNNs and transfer learning in COVID-19 detection not only provides a powerful tool for early diagnosis and treatment but also exemplifies the potential of deep learning technologies to address urgent medical challenges. This approach facilitates rapid deployment in clinical settings, contributing to more effective patient management and helping to alleviate the burden on healthcare systems. Overall, the integration of CNNs and transfer learning marks a significant milestone in medical AI, paving the way for future innovations in disease detection and healthcare delivery.

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