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An Artificial Intelligence Driven Review of Literature on the Detection of COVID-19 Disease from Radiographic Images

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Abstract: Pandemic of COVID-19 has attained significance in the field of research and innovation. After the arrival of various variants of covid 19, it demands more research for the identification and analysis of features. Medical investigations are found to be risky and costly. And so, the use of artificial intelligence techniques become more popular for the classification of covid 19 features. Such AI techniques perform recognition with accuracy and time effective in order to control diagnosis. The use of AI for COVID-19 detection has emerged as a promising solution. The proposed review of literature performs the analysis of the effectiveness of the AI models such as CNN and Inception-ResNet-V2, for the identification of COVID-19 from the radiographic scans. While these models have shown promising results, it is important to use them as an additional tool to assist medical professionals, rather than as a replacement. Ethical considerations such as reliability, transparency, and fairness must also be considered in the development of these models. Additionally, the data used to train and test these models should be diverse, representative, and validated to avoid potential biases and improve generalization capabilities. Further research and collaboration between medical professionals and AI experts are needed to advance the management and deployment of AI models for the detection of COVID-19.
Keywords: Convolutional Neural Network (CNN), RT-PCR, Artificial Intelligence, Computed Tomography (CT).

I. INTRODUCTION

Coronavirus has caused for the occurrence of COVID-19 contamination that affects human lung adversely. The contamination caused by COVID-19 is declared as pandemic that has been affected the millions of lives and become the center for research. Medical experts have performed various clinical based researches for the detection and diagnosis of COVID-19. The task seems to be very risky because of the spread of the virus in the air. The virus is used to spread very fast among individuals. And so, it become more challenging to do research under the controlled environment. Exposure of an individual in the virus can cause the infection to spread in the body. The identification task for the COVID-19 virus is also challenging as is requires time duration from 24 to 48 hours during the clinical investigation. The symptoms of the infected body resemble with the other common diseases. The early detection of this virus become very crucial to save thousands of lives. To get the rid of these challenges coming in medical investigations, the field of artificial intelligence have gain popularity in order to make fast identification of COVID-19. Researchers have used artificial intelligence model in order to classify the features obtained from digital dataset. The work is based on computer vision technique in which analysis of patient's radiographic datasets have been applied by using artificial intelligence techniques. Radiographic datasets are the medical images contain X-ray and CT scan of lung images of patients. Image processing and digital feature analysis have been made in the AI model in which variation of intensity level of the pixel features are investigated through every neuron (fundamental functional unit of AI model). The specificity and the sensitivity of the AI model is higher than medical investigation tools. The AI model can monitor the spread of contaminated portion of the lung dataset by analyzing feature vector from image pixel. Other datasets such as patient's symptoms, demographic information, travel data, speech signal etc. have been also utilized with AI model by the various researcher for the identification of COVID-19. The AI model make prediction using fuzzy logics that tries the fit the relevant features in the likelihood of classification. Researchers have made attempts to refine the AI model and so, such model establishes the critical role in controlling and mitigating the extent of contamination caused by COVID-19.

AI is also being used to detect and track COVID-19 variants. COVID-19 has numerous variants, and each variant can have unique features that impact its transmission and virulence. Therefore, identifying and tracking these variants is important to understand the extend and impact of the contamination and to develop effective treatments and vaccines.

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AI can be used to analyze genomic data from COVID-19 samples to identify mutations that distinguish different variants of the virus. Investigators have applied models based on deep learning techniques that can analyze these genomic sequences and identify the presence of specific mutations associated with different variants of COVID-19.

Tools of AI have been seen in monitoring of extent of variants of covid-19 from various digital sources such as patient's audio, CT scan and other radiographic data. Some more data sources have been utilized in the existing works such as clinical data, genomic information, epidemiological information etc. AI algorithms have been developed to recognize the patterns of contamination in such data sources in order to track the extent of contamination caused by COVID-19. Furthermore, AI can also be used to analyze the belongingness of different variants of COVID-19 emerging in the future. By analysing patterns in viral evolution and transmission, AI models can help researchers anticipate the emergence of new variants and develop strategies to mitigate their impact. AI is a powerful tool for detecting and tracking COVID-19 variants, which is crucial for understanding the evolution and spread of the infection and developing effective strategies to control it. Figure 1 shows a general process of COVID check.

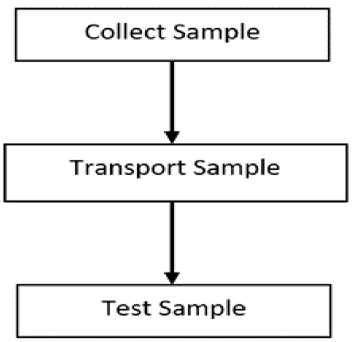
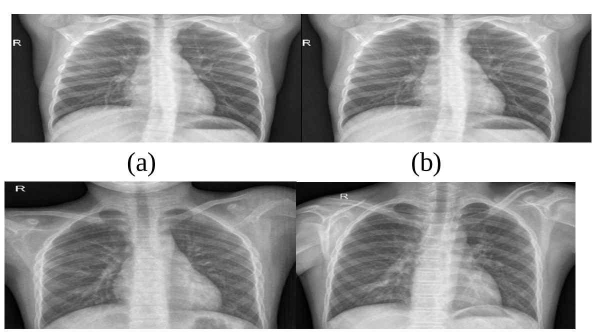


Fig.1. RT-PCR Process [1]

Radiographic images can provide important information about the presence and severity of lung damage caused by the virus. Here are some of the features that radiographic images can show that are used for the detection of COVID-19:

1) *Ground-glass Opacities:* These are areas of hazy or cloudy opacity in the lungs that are seen on radiographic images. Ground-glass opacities are a common finding in COVID-19 patients, and they are often seen in the periphery of the lungs.
2) *Consolidation:* Consolidation refers to an area of the lung that appears more solid on radiographic images, usually due to fluid or other material filling the air spaces. Consolidation is a common feature of COVID-19 pneumonia.
3) *Bilateral Involvement:* COVID-19 pneumonia often affects both lungs, and radiographic images can show bilateral involvement with ground-glass opacities and consolidation in both lungs.
4) *Progression Over Time:* Radiographic images can be used to track the progression of lung damage over time, which can help healthcare professionals monitor the course of the disease and adjust treatment as needed.

Machine learning algorithms can be trained to analyze these features in radiographic images and identify patterns that are associated with COVID-19 pneumonia. By analyzing large volumes of radiographic images, these algorithms can help healthcare professionals make faster and more accurate diagnoses, which is critical for controlling the spread of the disease. Fig 2 depicts the sample of radiographic images [4].



(a) (b)

(c) (d)

Fig.2. Sample of radiographic images (a) Normal (b) Pneumonia (c) COVID image (d) General viral

AI is being used for the recognition of COVID-19 variants by analyzing genomic data from COVID-19 samples. Here are some of the ways AI is being used for COVID-19 variant recognition:

a) *Sequence Analysis:* AI models can analyze the genomic sequence of COVID-19 samples and identify mutations that are associated with different variants of the virus. Machine learning algorithms can identify patterns in these mutations that are characteristic of specific variants.
b) *Classification:* Machine learning algorithms can be trained to classify COVID-19 samples based on the presence of specific mutations. By analyzing large volumes of genomic data, these algorithms can identify patterns that are associated with different variants of the virus.
c) *Cluster Analysis:* AI models can analyze genomic data to identify clusters of related COVID-19 samples. By analyzing patterns of mutation and transmission, these algorithms can identify clusters that are associated with specific variants of the virus.
d) *Prediction:* AI models can be used to predict the likelihood of new COVID-19 variants emerging in the future. By analyzing patterns in viral evolution and transmission, machine learning algorithms can help researchers anticipate the emergence of new variants and develop strategies to mitigate their impact.

AI is a powerful tool for the recognition of COVID-19 variants, which is essential for understanding the evolution and spread of the disease and developing effective strategies to control it that are associated with different variants of the virus, which can help healthcare professionals and public health officials respond quickly to outbreaks and contain the spread of the disease.

II. RELATED WORK

AI has emerged as a viable technique for the diagnosis and management of COVID-19, which has spread globally. There is a review of articles on COVID-19 AI identification: In the research, "Deep Learning-Based Detection for COVID-19 from Chest CT using Weak Label" (2020), COVID-19 was identified employing an extensive learning-based technique. The research demonstrated that the suggested method had a high level of success in detecting COVID-19 instances. In "COVID-Net: A Fitted Wide Convolutional Neural Network Layout for Identification of COVID-19 Cases from Chest Radiography Images" (2020), a design of deep convolutional neural networks identified as COVID-Net was suggested for the identification of COVID-19 cases from chest radiography pictures. According to the research, COVID-Net identified COVID-19 instances with an excellent level of precision. In "COVID-19 Detection Using Deep Learning Models to Exploit Social Mimic Optimisation and Organised X-Ray Chest Scans Utilising Fuzzy Colour and Droplet Characteristics" (2021), an advanced deep training-based method for COVID-19 Detection employing organised X-ray images of the chest has been put forward. The investigation revealed that the suggested method had an excellent degree of success in detecting COVID-19 instances. "Identification of COVID-19 from Chest MRI Scans Employing Transfer Learning Techniques with Deep Convolutional Neural Networks" (2020) - The present study recommended a transfer learning strategy employing powerful convolutional neural networks for identifying of COVID-19 cases from chest CT images.

According to the research, COVID-Net identified COVID-19 instances with an excellent level of precision. In "COVID-19 Detection Using Deep Learning Models to Exploit Social Mimic Optimisation and Organised X-Ray Chest Scans Utilising Fuzzy Colour and Droplet Characteristics" (2021), an advanced deep training-based method for COVID-19 Detection employing organised chest X-ray images has been put forward. The investigation revealed that the suggested method had an excellent degree of success in detecting COVID-19 instances. "Identification of COVID-19 from X-Ray Chest Scans Employing Transfer Learning Techniques with Deep Convolutional Neural Networks" (2020) - The present study recommended a transfer learning strategy employing powerful convolutional neural networks for identifying of COVID-19 cases from chest CT images. Table 1 contain the literature review of the existing works.

Table: 1.During the literature survey, we collected some of the information about CNN Model that currently being used:

Study	Year	Method	Data	Results
Limited Label Deep Learning-Based COVID-19 identification from CT Imaging of the Chest	2020	Deep learning	Chest CT scans	High accuracy in detecting COVID-19 cases

A Customised Convolutional Neural Network with Deep Learning for Screening COVID-19 Infections from Lung Imaging is called COVID-Net.	2020	Deep learning	Chest radiography images	High accuracy in detecting COVID-19 cases
Hierarchical Chest X-Ray Pictures employing Droplet Features for COVID-19 Detection Utilising Artificial Intelligence Algorithms to Gain Benefits of Societal Imitation Optimisation	2021	Deep learning	Structured chest X-ray images	High accuracy in detecting COVID-19 cases
Deep Convolutional Neural Networks and Transfer Learning for COVID-19 prediction from digital images	2020	Transfer learning with deep convolutional neural networks	Chest X-ray images	High accuracy in detecting COVID-19 cases
A Deep Learning Strategy towards the Immediate Assessment of COVID-19 Using a clinical traits	2020	Deep learning	Radiological and clinical features	High accuracy in early detection of COVID-19 cases

The quantity of investigation on COVID-19 verification employing artificial intelligence (AI) techniques grows. These are several illustrations: "Forecasting of COVID-19 Incidence and Mortality using Artificial Intelligence Techniques: A Research" (2021) - This summary essay compiles current studies that employed artificial intelligence (AI) methods to forecast COVID-19 cases and fatalities. The prospective use of artificial intelligence algorithms for forecasting COVID-19 spread and creating successful remedies is highlighted by the authors. "Covid-19 recognition employing neural networks: A research" (2021) - This brief paper provides a summary of current research that employed artificial intelligence for COVID-19 finding, covering methodologies employing chest X-rays, computed tomography (CT) scan and patient records.

The researchers talk about how deep learning may be used to discover COVID-19 instances earlier and enhance the results for patients. A summary of predictive modelling strategies for COVID-19 evaluation and management, comprising methods based on chest scans, medical records, and genetic information, is given in the article of review "A Detailed Assessment of Artificial Intelligence Strategies for COVID-19 Assessment and Medication" (2021). The researchers talk about how artificial intelligence could lead to better COVID-19 evaluation and therapy results.

A thorough overview of predictive modelling techniques for COVID-19 identification and evaluation employing images from chest X-rays is given in the research publication "Machine Learning Algorithms for COVID-19 Detection and Interpretation Using Chest MRI Images: A Assessment" (2021). The researchers talk on how machine learning could help with early COVID-19 case diagnosis and impact reduction.

III. METHODOLOGY DISCUSSION

A. Dataset

There are a number of datasets that are freely accessible for COVID-19 identification using artificial intelligence methods.

These are a some instances:

1) *COVID-19 CT segmentation Dataset:* This dataset consists of chest CT scans from COVID-19 positive and negative patients. The dataset includes both annotated and unannotated CT images.
2) *COVID-19 Image Data Collection:* This dataset contains chest X-ray and CT images from COVID-19 positive and negative patients. The dataset is publicly available on GitHub and includes over 5,000 images.
3) *X-ray chest pictures* from pneumonia patients, including COVID-19, are part of the RSNA Pneumonia Identification Competition collection. The dataset includes over 30,000 images and is available on Kaggle.
4) *COVIDx Dataset:* This dataset consists of chest X-ray images from COVID-19 positive and negative patients. The dataset includes over 13,000 images and is publicly available on GitHub.
5) *Mendeley Data COVID-19 SARS-CoV-2 Labeled Optical Microscopy Images Dataset:* This dataset contains optical microscopy images of SARS-CoV-2, the virus that causes COVID-19. The dataset includes over 100 images and is publicly available on Mendeley Data.

Models based on machine learning for COVID-19 detection are able to be trained and tested using these types of datasets. It's crucial to remember that certain datasets could have restrictions, such as short numbers of samples or unbalanced classes, which might influence how well machine learning models perform.

B. Convolutional neural network (CNN)

For the purpose of identifying of COVID-19, convolutional neural networks, also known as CNNs, have been extensively used. CNNs are a subset of neural network algorithms that are capable of categorizing new images by learning attributes from existing ones.

The usual processes in training a CNN to identify COVID-19 are listed below:

- *Data Preprocessing:* The dataset of chest X-ray or CT images is preprocessed by normalizing pixel values, resizing images, and removing artifacts.
- *Data Augmentation:* The dataset is augmented to increase the size and diversity of the training set. Common techniques include rotation, scaling, and flipping.
- *Model Architecture:* The CNN architecture is designed by choosing the number of layers, type of layers (e.g., convolutional, pooling, and fully connected layers), and activation functions.
- *Training:* The CNN is trained on the training set using backpropagation to adjust the weights of the network. The loss function used for COVID-19 detection typically includes cross-entropy and binary cross-entropy.
- *Evaluation:* On the examination set, the experienced performance of CNN is evaluated. Accuracy, sensitivity, specificity, and AUC constitute standard metrics for assessment.

For COVID-19 identification, there are a number of publically accessible pre-trained CNN models that can be used, including VGG, ResNet, Inception, and DenseNet.

The amount of training data needed can also be decreased and model performance can be increased by employing transfer learning, which entails using a pre-trained CNN model and retraining only the final layers for the COVID-19 identification job. The operation of the convolutional neural network is shown in Figure 3.

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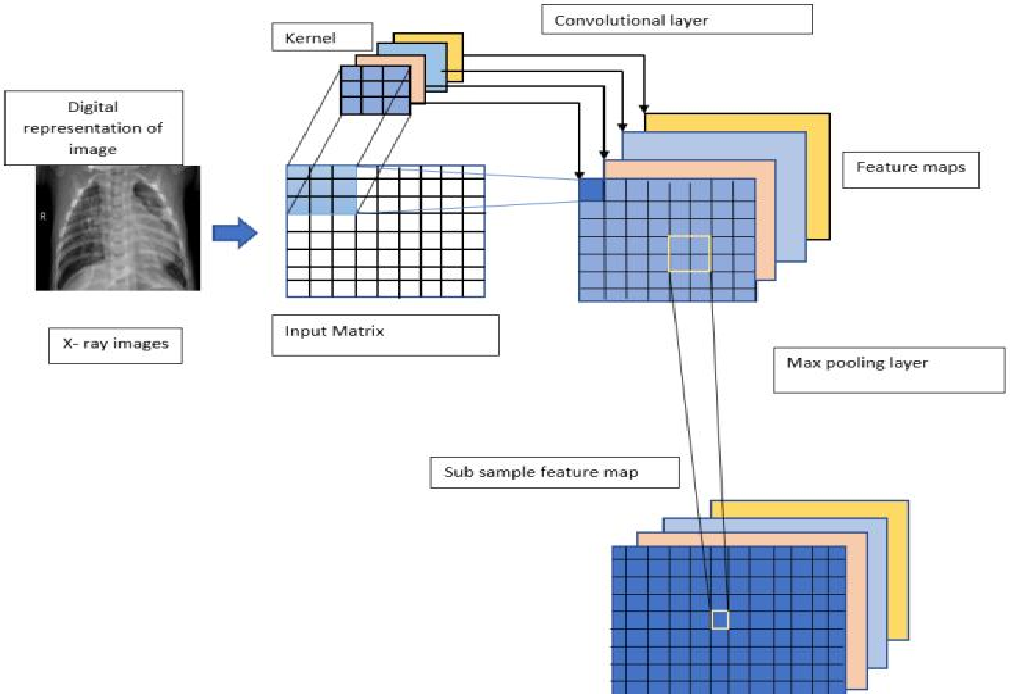

Fig.3. Feature extraction using CNN [16]

1) Convolutional Layer:

An essential component of convolutional neural network networks (CNNs), which are used for image categorization, object detection, and other computer vision applications, is the convolutional layer. The convolutional layer is a layer that applies a series of filters that are learnable to the input image using the mathematical action of convolution to produce a set of result map features.

The convolutional layer consists of several elements:

a) Filters or Kernels: These are compact matrices of trainable weights that conduct the convolution operation by gliding over the input image. Any filter produces a single value in the output feature map by being applied to a limited area of the input image.

b) Stride: The filter adjusts the input image by this many pixels at each step over the input image. Smaller output feature maps are produced when the stride is larger.

c) Padding: To maintain the size of the input image during convolution, extra pixels are added to the edges of the image. Convolutional layers frequently employ zero padding.

d) Activation Function: To add non-linearity to the model, this non-linear function is applied to each filter's output. The ReLU, sigmoid, and tanh activation functions are frequently used. .

The convolutional layer's output feature maps are then sent into the CNN's subsequent layer, which might either be another convolutional layer or a pooling layer. Using backpropagation and gradient descent, the convolutional layer's filter weights are learned during training.

Convolutional layers have several key benefits when used in CNNs, including the capacity to learn hierarchy of characteristics from the image being processed, translational invariance, and the capacity to reduce the number of parameters in the model by sharing weights across various areas of the image being processed.

$$F(a,b) = (k * L)(a, b) = \sum_{0p}^{q} P * q \sum_{q}^{p} F\, K(a+p, b+q) L\,(p,q)$$

Where K= Input matrix (image),

L = 2D filter of size (p x q)

F defines the output 2D featured map.

K is convolved with the filter L gives feature map F as the result. Convolution operation is given as K ∗L.

Assume that the input image has the following dimensions: W = width, H = height, and C = number of channels (e.g., 1 for grayscale, 3 for RGB). Let K be the number of filters in the convolutional layer, with F x F x C as their individual dimensions. A set of K feature maps of dimensions W' x H' x 1, where W' and H' depend on the filter size, stride, and padding applied, will be the output of the convolutional layer.
The convolution operation is defined as follows:

For each filter k:

- The filter is slid over the input image in strides of size S, computing the dot product between the filter and the input pixels at each location.
- The result of the dot product at each location is summed to produce a single scalar value for the corresponding location in the output feature map.
- The process is repeated for each location in the input image, producing a complete feature map.
- The output feature map is then passed through an activation function to introduce non-linearity.

y[n] = (f * g)[n] = sum_{k=-inf}^{inf} f[k] * g[n-k]

where f stands for the input picture, g for the filter, n for the output feature map index, and * for convolution. The filter g and a local area of the input image f centred at index n are multiplied element-by-element to produce the output feature map y[n]. The filter size determines the size of the local zone, and the stride and padding parameters control how the filter is applied to the input picture. Convolutional layer output feature maps can be processed through an activation function to provide nonlinearity to the model. Rectified Linear Unit (ReLU), which is referred to as the most popular activation function, is defined as:

ReLU(x) = max(0, x)

where x is the activation function's input value. Positive input values are left unaltered while negative input values are set to zero by the ReLU function. Backpropagation and gradient descent are used to learn the weights of the filters in the convolutional layer during training. The goal is to reduce a loss function, which calculates the discrepancy between the output that was anticipated and the actual output. By using the loss function's negative gradient with respect to the weights as a starting point, the weights are iteratively updated.

2) Subsampling

Subsampling is basically a method by which we can reduce image size by selecting a part of the original image. It specifies by selecting a parameter a, specifying that every a^{th} parameter has to be extracted. It reduces the size by removing all the information together.

3) Fully Connected Layer

Each neuron in a layer that is completely connected frequently referred to as a dense layer or dense kind of layer in the context of a neural network, is connected to every neuron in the previous layer. Each neuron in a fully connected layer produces a weighted average of its inputs, which is then followed by an activation function that is nonlinear. Backpropagation is a technique used to learn the weights in a fully linked layer during training. The technique known as backpropagation changes the layer's values to reduce the discrepancy among the output that was anticipated and the final result. Artificial intelligence algorithms frequently employ layers that are completely interconnected for applications like image classification and natural language processing. In the classification of images, the output of a convolutional layer, which extracts features from the input image, serves as the source to the fully connected layer. The characteristics are subsequently translated to a set of class probabilities by the layer that is completely linked. Fully connected layers are frequently combined with recurrent neural networks (RNNs) or convolutional neural networks (CNNs) in the use of natural language processing to model the connections between elements in an expression. In order for models based on deep learning to learn complicated correlations between both inputs and outcomes, fully connected layers play a crucial role.

$$Z^p = \frac{e^{y^p}}{\sum_{i=1}^{n} n\, e^{y^n}}$$

Where y is denoted as the input vector and Z is the vector that will be given as the output. Adding all the outputs we will get 1. Figure 4 shows the method for the classification.

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IV. CLASSIFICATION MODEL

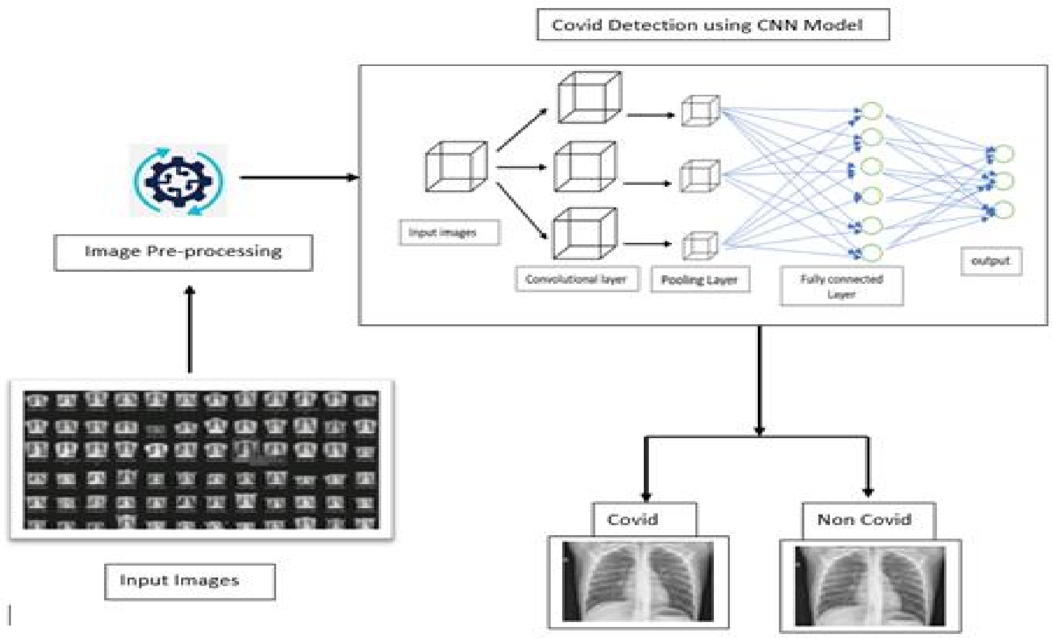

Fig.4. General method for covid-19 detection

S. Albahli et al.[6] used Inception NetV3, Inception-ResNet-V2 and NASNetLarge models for classification. In this experiment models were trained with and without data augmentation. In data augmentation the rotation performed was 15 degrees. The activation functions used were "Softmax" and "Relu". It was found that NASNetLarge performed better than all, but as the dataset size increases Inception-ResNetV2 will perform better.

A. NASNetlarge

Like other sophisticated neural network layouts, NASNetlarge can be applied to a range of tasks related to computer vision, such as the evaluation of medical images for COVID-19 recognizing. nevertheless, wouldn't be best to use a network that has been trained like NASNetlarge directly for COVID-19 detection because the characteristics the network has learnt could not be particular to the distinctive properties of COVID-19 in healthcare photos. It would be necessary to improve NASNetlarge on a collection that includes medical pictures unique to COVID-19 in order to use it for COVID-19 identification. Training the algorithm with the COVID-19 datasets and an altered final component for categorization could be required. The implementation of machine learning algorithms for COVID-19 detection individuals a number of difficulties, involving the accessibility and calibre of healthcare pictures, the requirement for sizable and diverse information sets for training and validation, and the requirement for interpretability of the models in order to verify that the models' conclusions are clinically applicable and helpful. In order to optimise and confirm these algorithms for clinical usage, more investigation is required even though NASNetlarge and other deep learning models show promising for COVID-19 diagnosis.

B. InceptionNet-V3

A sophisticated neural network design called InceptionNet-V3 was recently extensively applied to a variety of computer vision tasks, particularly the processing for healthcare images. InceptionNet-V3 has the ability to be employed for COVID-19 identification for healthcare pictures, just like other models based on deep learning. InceptionNet-V3 would require to be trained on a collection of medical pictures associated with COVID-19 in order to be used for COVID-19 detection. In order to do this, the artificial neural network must be trained using a modified final layer for categorization on a COVID-19 database. InceptionNet-V3 has been utilized in multiple investigations to identify COVID-19 in chest computed tomography images. For instance, an article that appeared in the IEEE Journal of Access in 2020 recognized COVID-19 and non-COVID-19 instances from chest X-ray pictures with a precision of 98.75% and a power coefficient of 0.997 by using InceptionNet-V3.

The precision, specificity, and sensitivity of InceptionNet-V3 were utilized for identifying COVID-19 cases from lung CT scans in an additional study that was published in the Journal of Medical Systems in 2021. While InceptionNet-V3 and other deep learning models seem promising for COVID-19 identification from healthcare pictures, it's crucial to remember that before being applied in healthcare environments, these algorithms need to be verified on a variety of relevant datasets.

C. Inception-ResNet-V2

A deep learning model called Aurora-ResNet-V2 blends the design of Inception with connections that remain. This framework has demonstrated significant performance in a range of applications involving computer vision, such as categorization, recognising objects, and recognition of images. According to certain studies, COVID-19 instances can be discovered from chest X-rays as well as CT scans by using models that use deep learning, including Inception-ResNet-V2. The precision and responsiveness of these research' findings are encouraging. It is essential to observe that deep learning models, including Inception-ResNet-V2, should not be considered as a replacement for medical diagnosis by a qualified healthcare professional. The use of these models should be considered as an additional tool to assist in the diagnostic process and not as a standalone solution. Moreover, the development and deployment of such models should be done with caution and following ethical guidelines to ensure their reliability, transparency, and fairness. Additionally, the data used to train and test these models should be diverse, representative, and validated to avoid potential biases and improve generalization capabilities.

V. CONCLUSION

In conclusion, the use of AI for COVID-19 detection has shown promising results. Deep learning models such as Inception-ResNet-V2 have been explored to identify COVID-19 cases from chest X-rays and CT scans. However, it is important to note that these models should not replace medical diagnosis by a qualified healthcare professional, and should be used as an additional tool to assist in the diagnostic process. Furthermore, the development and deployment of such models should be done with caution and following ethical guidelines to ensure their reliability, transparency, and fairness. Additionally, the data used to train and test these models should be diverse, representative, and validated to avoid potential biases and improve generalization capabilities. Further research and collaboration between medical professionals and AI experts are needed to advance the development and use of AI for COVID-19 detection.

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