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Diagnosis Of COVID-19 From Chest X-Ray Images Using Deep Learning Approach

[1]A. V. Gaikwad, [2] Dr. S. W. Mohod

[1] ME Student, [2] Professor, Electronics And Telecommunication Dept.. PRMITR ,Badnera
[1]Department of Electronics And Telecommunication PRMITR, Badnera ,
[1] PRMITR, Badnera, Amravati, India

Abstract: The rapidly spread of Coronavirus is still the leading cause of death worldwide. The numbers of COVID-19 test unit are accessible in emergency clinics as the cases are expanding daily. Hence, it is essential to implement an automatic detection and classification system as a fast elective finding choice to predict COVID-19 spreading among the people. Medical images analysis is one of the most promising research areas, it offers the facilities for analysis and making decisions of a number of diseases such as Coronavirus. This paper conducts a comparative study of the use of the recent deep learning model that deal with detection and classification of coronavirus pneumonia. The experiments were conducted using chest X-ray dataset of images (images of bacterial pneumonia, of coronavirus and normal) AI technique detect the COVID-19 patients using X-Ray images in an automated manner, where radiologists are not available, and help make the pro-posed testing technology scalable.

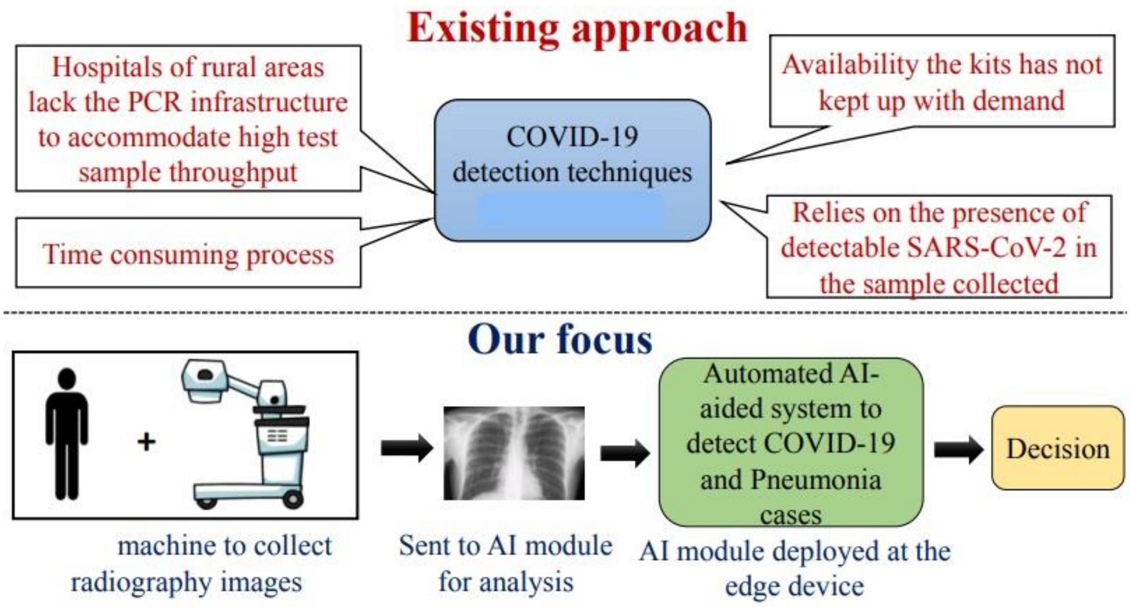
***Index Terms* - AI techniques, COVID-19 Detection, Chest X-Ray**.

I. INTRODUCTION

COVID-19 virus spread across the world has affected human's health as well as international economy. The rate of viral spread predicted in cites will be according to previous pandemic state. The patients above the age of 50 years with chronic diseases are at the highest risk and should therefore take special precautions. The rapid circulation of COVID-19 is one of the main fears. Till now, no specific treatment has been recommended for COVID-19. The preventive recommendations to avoid the spread of this coronavirus are Regular hand-washing, wearing of mask, keeping proper social distance, and avoiding close contact with infected people **[1]**

One of the standard diagnostic techniques is the reverse transcription-polymerase chain reaction (RT-PCR) method **[2].** Although RT-PCR can detect the severe acute respiratory syndrome coronavirus that causes COVID-19, in some cases, it created negative test results and also there is a shortage of required material and specialized personnel to perform these tests. Hence some studies have recommended the use of X-rays rather than RT-PCR. The symptoms detection of COVID-19 in the lower parts of the lungs has a higher accuracy when using X-rays. Chest X-ray is a very common, fast and cheap clinical method **[2]**. The chest X-ray gives the patient a lower radiation dose as compared to CT and MRI **[3].** Due and lower cost and radiation X-rays are part of routine patient care and are still the primary imaging test. For the diagnosis of COVID-19, Radiological imaging considered an important screening method. In this paper, we considered the use of Deep Learning to find COVID-19 cases and diagnose COVID-19 patients via chest X-ray images.

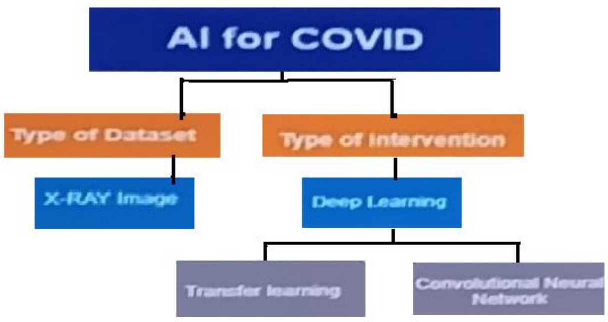
II. Model Diagram



III. About Deep Learning

To assist radiologists and to overcome the challenges of X-rays, we need to improve the speed of the technique. This can be achieved by designing advanced diagnostic systems by using artificial intelligence (AI) tools. . Artificial intelligence (AI) tools have provided successful results in analyzing data in a medical context. The machines have already been manufactured with AI models that perform likewise to experts in specific valuation tasks [4, 5].

Convolutional neural network (CNN)-based models are developed to detect normal and infected patients differentiating the infected for COVID-19 and pneumonia infections via radiological images (i.e., CXR available from open databases)



3.1 Comparison: Deep Learning and Machine Learning

Use of artificial intelligence methods are increasing due to its ability to handle with huge datasets exceeding human potential in the field of medical services [6]. Adding CAD methods into radiologist diagnostic systems really decreases the workload of doctors and increases reliability, accuracy and quantitative analysis [7].

3.2 Overview of CNN

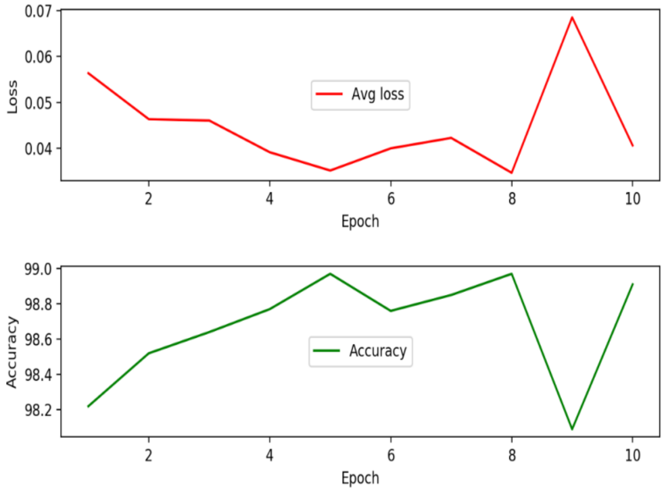
To detect meaningful patterns in data automatically and to solve problems, Machine learning (ML) and Deep learning (DL) are included in the field of computational learning which are impractical by explicit algorithms [8].

Hierarchical architectures of DL acquire high-level abstractions in data [9].Multiple layers of nodes are combined to build up more abstract representations of the data. The achievement of DL is directly associated with the spread of cheap, GPU (Graphics Processing Units) that decrease the training time for creating a DL model increase the speed of that model[10].

3.3 Model Performance

CNN is used in pattern recognition with superior feature learning capabilities, being a suitable model to deal with image data [11]. Really, CNN is a leading architecture of DL for image classification and can competing human accuracies in many tasks [12]. Due to its ability to extract information from visual features, CNN can be applied to the task of detecting COVID-19 in patients, based on chest X-ray images.

A large set of training samples are the requirement of a CNN based model to achieve good generalization capabilities. The hierarchical layers of tiled convolutional filters are the part of CNN model.



3.4 CNN Architecture

The sequence of the basic structure of CNN is represented as Input Layer -- convolutional layer—Pooling layer —Fully Connected Layer as shown in Fig. maybe with other intermediate layers for normalization and/or dropout.

3.5 The Input Layer

Mainly depends on the dimension of the images. In the network, all images must have the same dimension. Presented as a single colour channel image. It will hold the raw pixel values of the images.

3.6 Convolutional Layer

Convolutions are the main building blocks of a CNN, used to extract the numerous features from the input images. By sliding the Filter kernels over the image and for each position, the dot product of the filter kernel and the image covered by the kernel is taken [13]. The size of filter kernels used in this layer is 3×3 pixels. The output is in term of the Feature map which gives the information about the image such as the corners and edges. This feature map is then fed to other layers to learn several different features of the input image.

3.7 Pooling Layer

As shown in Fig. Convolutional Layer is followed by a Pooling Layer. it takes the larger size feature maps (produced after convolution operations), and shrinks them to lower sized feature maps. This is achieved by shrinking the connections between layers and independently operates on each feature map.
Different types of pooling techniques are used in different pooling layers such as max pooling, average pooling, sum pooling etc. From feature map, the largest element is taken in Max Pooling. The average of the elements in a predefined sized Image section is calculated in Average pooling. In the predefined section the total sum of the elements is computed in Sum Pooling.
The main drawback of pooling layer is that it sometimes decreases the overall performance of CNN. As the pooling layer helps CNN to find whether a specific feature is present or not in the given input image by avoiding about the correct position of that feature.

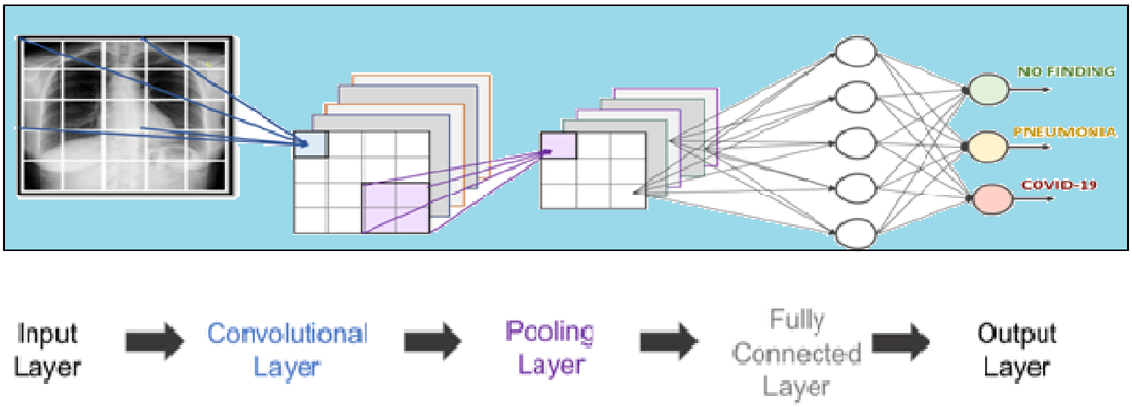
3.8 Fully Connected Layer

In a fully-connected layer (also known as dense Layer) each node is directly connected to every node in the previous and in the next layer as shown in Fig. The each of the nodes in the last frames in the pooling layer are connected as a vector to the first layer from the fully-connected layer. In this the input image from the pooling layers are flattened and fed to the FC layers. The flattened vector then goes through few more FC layers .Usually the mathematical operations take place there. The process of classification begins in this stage.

3.9 Drop Out

FC Layers consist of lot of parameters that need complex computational work in training dataset, it can cause over fitting in the training dataset, is the drawback of this layer. To overcome this drawback a dropout layer is used in which a few neurons are dropped from the neural network during training process resulting in thinner than the original neural net. This increases the resistance of model to over fitting and makes training faster [14]. Activation Functions

The last parameter of the CNN model is the activation function. It decides which information of the model should be forwarded and which ones should not be at the end of the network. ReLU, Softmax, tanH and the Sigmoid functions are some e.g. of activation function and has a particular usage., sigmoid and softmax functions are preferred for a binary classification CNN model whereas for a multi-class classification, usually softmax is used.



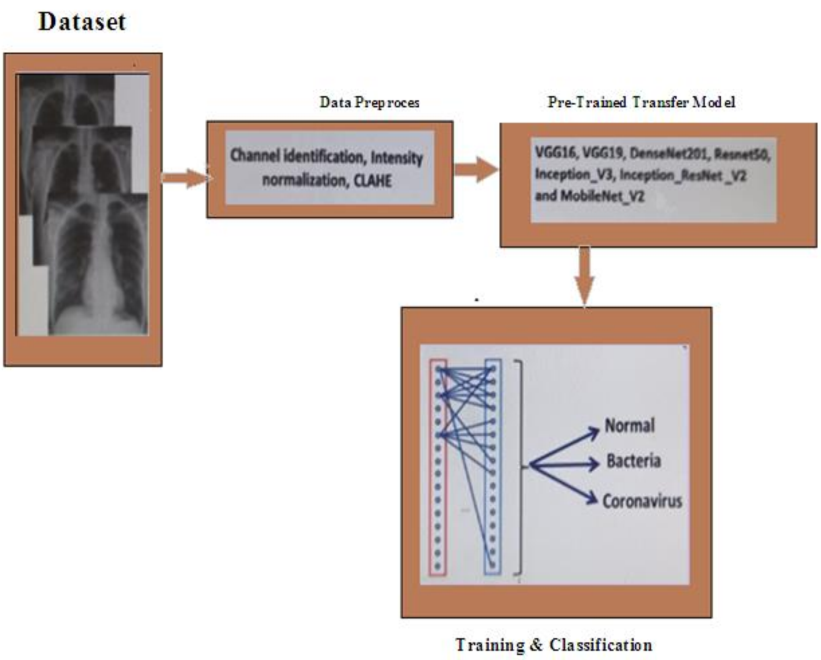
Thus the CNN Network converts the input image by transforming it through layer by layer from the original pixel values to the final class values. Some layers contain parameters and other doesn't. Particularly the FC layers perform transformations which are a function of the activations in the input volume, as well as the parameters (the weights and biases of the neurons). The Pooling layers will perform a fixed function.

IV. Related Work

This Work (diagnosis of COVID-19 using chest X-rays) consist of binary or multiple classifications. In Some studies raw data are preferred while others uses feature extraction process. The data used in studies also varies. Most of the studies preferred convolutional neural network method (CNN. With transfer learning, the detection of various abnormalities in small medical image datasets is an achievable goal, often with remarkable results) [15].Hemdan et al. used VGG19 and DenseNet models to diagnose COVID-19 from X-ray images [16]. Uçar and Korkmaz worked on X-ray images for COVID-19 diagnosis and supported the Squeeze Net model with Bayesian optimization [17]. Sahinbas an Catak used X-ray images for the diagnosis of COVID-19 and worked on VGG16, VGG19, Res Net, DenseNet and InceptionV3 models [18]. Medhi et al. used X-ray images as feature extraction and segmentation in their study, then COVID-19 was positively and normally classified using CNN [19] During the classification process, 2-fold, 5-fold, and 10-fold cross-validation methods were used [20]. Punn and Agarwal worked on X-ray images and used Res Net, InceptionV3, Inception Res Net models to diagnose COVID-19 [21].

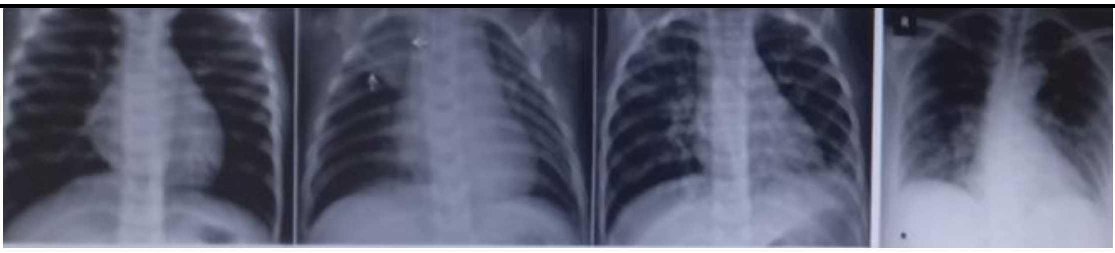
V. Methodology

In this study, we built our contribution for automatic multiclass classification on new publicly available image datasets chest X-rays. The diagram shows the main proposed methodology. As shown in Fig. , the entire work is mainly divided into four steps: dataset, data pre-processing, pre-trained transfer models, and training and classification.



VI. Dataset

This present work introduces publicly available image datasets that contain X-rays and has three classes (normal, bacterial pneumonia and coronavirus (viral pneumonia, covid19)). Figure shows an example of chest X-rays in patients with Fig (a) Shows a Normal, Figure (b) shows a Bacterial Pneumonia Figure (c) shows Viral Pneumonia While Figure (d) Shows an image of patient infected by covid19.



(a) Normal (b) Bacterial Pneumonia (c) Viral Pneumonia (d) Covid-19

6.1 Data Pre-Processing

The input images are pre –processes in next stage using different pre-processing techniques, to improve the quality of visual information of each input image by eliminating or decreasing the noise present in the original input image, increasing contrast, deleting the low or high frequencies, etc. The dataset was randomly split with 80% of the images for training and 20% of the images for validation. The images chosen for validation are not used during training in order to perform successfully the classification task.

6.2 Pre-Trained Transfer Models

In this study, we implemented the present contribution for automatic multiclass classification based VGG16, VGG19, DenseNet201, Inception_ResNet_V2, Inception_V3, Resnet50, and MobileNet_V2 models for the classification of Chest X-ray images to normal, bacteria ,viral and coronavirus classes. A Large amount of training data is the requirement of deep learning models, which is yet not available in this field of applications. To overcome the situation of no availability of medical imaging dataset the present work is going to apply transfer learning technique

6.3 Training and Classification

After data pre-processing the training dataset is ready to be passed to the proposed models in order to extract the appropriate and relevant features which then are flattened together to create the victories feature draws. Now this victories feature is passed to a multilayer perceptron to classify each image into corresponding classes.

In real life, we always prefer to come up with medical diagnosis based on multiple medical expert views. Combined opinion of the medical experts help in reaching to a more reliable conclusion. Following the same philosophy, multiple benchmarks ANN models have been adopted in our proposed work. To make independent predictions. They have been trained individually Then the models are combined, using a new method of weighted average ensemble technique, to predict a class value. This new proposed assembling method is expected to make the prediction more robust.

VII. Research Objectives

1) To maintain the correctness with enhanced accuracy by analyzing radio images of COVID-19 patients using suggested computational Intelligence techniques.

2) A'small try' to contribute to combat this hard situation of COVID-19 using AI.

Conclusion

Thus this study shows the success of DL techniques for the identification of COVID-19 cases using chest X-Ray images. In future, with the use of DL in the equipment of radiology canters, it will be possible to achieve a faster, cheaper, and safer diagnosis of this disease. It can be a powerful tool for radiologists to decrease human error and to make decisions in critical conditions... Even though DL is the powerful computing tools in detection of COVID-19, care should be taken by the developers to avoid over fitting and usefulness of COVID-19 DL diagnostic models; models must be trained on large, various datasets to cover all the available data use.

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