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Covid-19 Detection using X-ray

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ABSTRACT

COVID-19 is considered to be the most dangerous and deadly disease for the human body caused by the novel coronavirus. To compact this disease, it is necessary to screen the affected patients in a fast and inexpensive way. With limited testing kits, it is impossible for every patient with respiratory illness to be tested using conventional techniques (RT-PCR). So, Chest X-ray being the most inexpensive and easily available option. Chest X-ray images are primarily used for the diagnosis of this disease. This research has proposed a machine vision approach to detect COVID-19 from the chest X-ray images. The features extracted by the convolutional neural network (CNN) from X-ray images to develop the classification model through training by CNN. Chest X-Ray being the most easily available and least expensive option. In this project, we have proposed a Deep Convolutional Neural Network-based solution which can detect the COVID-19 +ve patients using chest X-Ray images. Multiple state-of-the-art CNN models, have been adopted in the proposed work. They have been trained individually to make independent predictions. Then the models are combined, using a new method. To test the efficiency of the solution we have used publicly available chest X-ray images of COVID "+ve" and "–ve" cases. We have developed a GUI-based application for public use. This application can be used on any computer by any medical personnel to detect COVID +ve patients using Chest X-Ray images within a few seconds.

Keywords: Deep Learning, CNN, Image Processing

I. INTRODUCTION

The COVID-19 is a deadly disease caused by the newly recognized coronavirus. In December 2019, coronavirus (SARS-COV-2) infected the human body for the first time, and it can spread principally among humans through the droplets formed by the infected persons when they speak, cough or sneeze. As the droplets are too heavy to travel far, they cannot spread person-to-person without coming in close contact. Although the exact time is not yet known, a new study has estimated that the COVID-19 can be viable in the air for up to 3 hours, on copper for 4 hours and up to 72 hours on plastic and stainless steel.

However, the exact answers to these questions are still not agreed upon by the general health research community and currently under investigation. COVID-19 attacks the lung and damages the tissues of an infected person. At the early-stage, some people may not find any symptoms where most of the people had fever and cough as the core symptoms. Other secondary symptoms could be body aches, sore throat, and a headache could be all possible.

At present, COVID-19 disease is increasing daily due to the lack of quick detection methods. All over the world, a huge number of people died of this disease in 2020. The respiratory tract and lungs are the media where the virus can spread easily. As a result, inflammation occurs, and air sacs can be filled with fluid and discharge. The process is responsible for creating an obstacle in oxygen intake. Quick and accurate detection of the virus is a major challenge for doctors and health professionals around the world in order to reduce the death rate caused by this virus. Due to the global climate changes, people have already been suffering from many other diseases, and the impact created by the COVID-19 is immeasurable. Currently, the virus has spread to almost every country in the world. Recently, all over the world, America, South-East Asia, and Europe have the uppermost number of confirmed COVID-19 cases.

At present, further research on an effective screening process is required for diagnosing the virus cases and segregating the affected people. Health professionals and scientists of many countries in the world are attempting to improve their treatment plan and capacity of test through implementing multifunctional testing to stop spreading the virus and for protecting themselves from the deadly virus

A) AIM

COVID-19 is a highly infectious disease, which is caused by the SARS-Corona virus. In March 2020 and after spreading to more than 100 countries and leading to several thousands of cases, the World Health Organization (WHO) officially declared the outbreak of the new coronavirus as a pandemic.

So, our motive is to provide a model (web application) to the medical field to detect the Covid 19 using the recent development of technology in deep learning and medical image processing.

The main contribution of this work is in proposing a novel deep neural network-based model for highly accurate detection of COVID-19 infection from the chest X-Ray images of the patients.

II. OBJECTIVES

- To design and develop a covid-19 detection system which can help in quick and accurate results.
- To establish an early screening model to distinguish COVID-19 positive and negative cases.
- Early detection of the COVID-19 in a faster, easier, and cheaper way can help in saving lives and reduce the burden on healthcare professionals.
- To overcome the problem of a lack of specialized physicians in remote villages.

III. LITERATURE REVIEW

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.

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, and finally showed 99.3% accuracy.

IV. REQUIRED ANALYSIS

Using the relevant datasets of chest X-ray images for the COVID-19 detection is a laborious task. The researchers used different pre-processing techniques, feature extraction techniques and classification methods. Now, it is difficult to suggest a promising technique or combination of techniques that are more effective in diagnosing COVID-19 from the chest X-ray image. In most of the cases, an accuracy above 90% was reported, and from a statistical point of view, this a very high level of accuracy. However, the goal would be increasing the accuracy level as close to 100% as misdiagnosis, even in a small number of cases, is not quite acceptable. It is fairly clear that the proposed technique produced a better classification accuracy in detecting COVID-19 compared to the other techniques proposed in the literature. The proposed method showed better accuracy using CNN classifier.

CNN provides a good result as a binary classifier for the chest X-ray dataset. However, when the classification was carried out with features extracted either by CNN individually, the accuracies were much lower compared to the reported values. HOG was the worst among the three, with an accuracy of 92.73%. Similarly, only SVM (97.16%) showed accuracy higher than 95% compared to the other two classification techniques, such as ANN (89.21%) and KNN (90.67%).

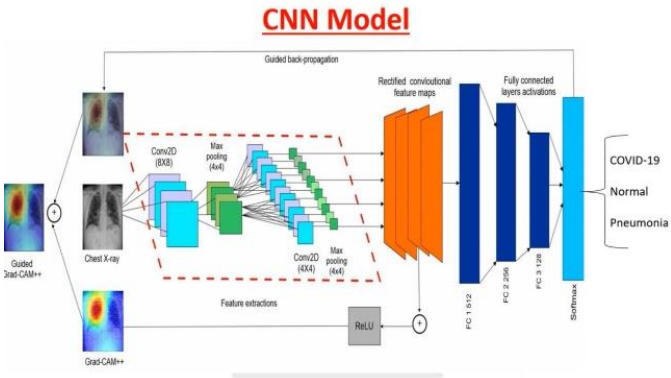
In this study, even though the image size was reduced by more than half of the original sizes, the system still demonstrated its robustness in correctly diagnosing COVID-19 cases. This could be attributed to the higher number of distinctive features obtained by CNN.

The proposed technique suggests a robust way in the feature extraction and noise removal phase. The proposed system used speckle-attacked and low-quality chest X-ray images in the testing phase. The results of the study demonstrated that the proposed approach could diagnose COVID-19 very quickly and accurately and help the clinicians to take the necessary actions for saving the lives of COVID-19-affected people

V. PROJECT DESIGN

A) The Proposed approach

The proposed system considered input of the X-ray images to identify COVID-19. First of all, this system converted images from RGB to grayscale and identified the region of interest (ROI) by removing the unwanted regions. The CNN method was used to extract feature vector from the images. This was used as the input to train the classification model. The number of features extracted by one technique was not large enough to accurately identify COVID-19.



For the purpose of this project, we propose to implement a model based on Convolutional Neural Network (CNN).

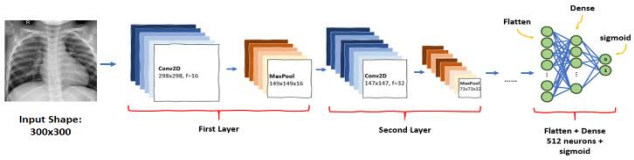
A Convolutional Neural Network (CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other.

The pre-processing required in a CNN is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, CNN have the ability to learn these filters/characteristics.

The architecture of a CNN is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex.

Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field.

A collection of such fields overlaps to cover the entire visual area.



B) The Proposed Solution:-

Web Application where user (doctors) will upload Chest X-Ray Image of patients and as a result user get is the given X-Ray image is of COVID-19 person or of Pneumonia person or else of Normal person.

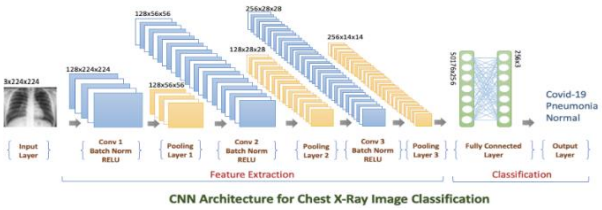
Advantages:

1. Shipping the test or the sample is one of the shortcomings of PCR tests whereas X-ray machines can solve the problem.
2. If a situation comes when the radiologists & doctors get affected, AI can generate preliminary diagnosis to understand if a patient is affected/not.

VI. DESIGN IMPLEMENTATION

A) CNN :-

A Convolutional Neural Network (CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other.



In the CNN model, we have convolutional layer, maxpooling layer, batch normalization and relu activation function. At the end we have two fully connected layer.

Convolutional layer is base of CNN, responsible for feature extraction and pattern recognition of input image. Image form trained dataset are passed through a filter consisting of feature maps and kernels, which helps CNN to extract low level and high level feature.

After feature extraction, there appropriate position related to other is much more important. Pooling layer is also called as sampling layer. It is used to reduce the dimension of the feature.

Batch normalization is a layer that allows every layer of the network to do learning independently. It is used to prevent and regulate overfitting, making model more efficient.

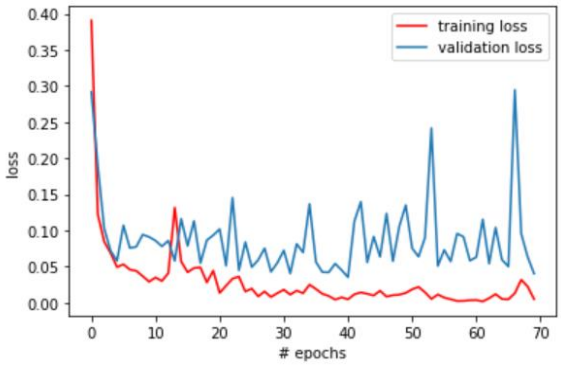
The relu activation and its variant function is used for their ability to overcome the vanishing gradient problem which arises frequently in CNN model.

Fully connected layer is used at end of the deep CNN network for classification and it is the most important layer of CNN.

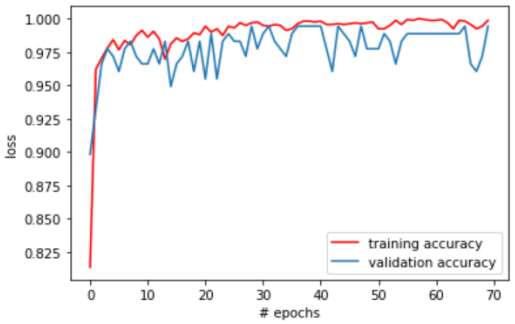
The function is global operation like multi-perceptron.

Neurons in fully connected layer have full connections to all activation functions in previous layer.

The below graph shows the difference between training loss and validation loss. And which is not showing the evidence for overfitting, so this is quite good model. As per the graph below, loss is decreased with the epochs. Even we can increase the epochs to get the less loss.



The below graph shows the difference between the training accuracy and validation accuracy. As per the graph the accuracy of model in increasing with epochs.



The testing accuracy, we have tested the CNN model using the test data and target data and we got the accuracy of 0.98 and the loss of 0.04.

B) WEB APPLICATION

We have deploy the previously trained CNN model in a web application using a Python backend with a Flask web development framework. The frontend of the website is created with HTML and JavaScript.

Firstly folder named as web app is created and all the files used for the web application including the CNN model are stored together. We have .html file in the templates folder and the CNN model is in the model folder and the Python code which is used for the backend is saved as app.py in the folder.

Then we need to run the folder to make the web application work. So, we used the command prompt to host our web application on a local host which is given on the last line after we run the app.py file. After this we have copy pasted the URL in any web

browser such as chrome and we will get the web application running on the local host.

VII. TECHNOLOGIES USED

We have used CNN Classifier for the classification.
We have used Python and TensorFlow for the implementation of CNN. Google Colab platform is used for the training of the model.
The deep learning library of TensorFlow is used, and the training and the testing procedures are done on the GUI with Sublime text.
For the web application, we have used HTML, CSS and JavaScript for the frontend and Python for the backed.
We have used flask web development framework.
We have used the following libraries: -
Flask
Keras
jupyter
Pillow
numpy
scikit-learn
matplotlib

VIII. RESULT AND DISCUSSION

The coronavirus pandemic has stretched the healthcare systems in every country in the world to its limit as they had to deal with a large number of deaths. Early detection of the COVID-19 in a faster, easier, and cheaper way can help in saving lives and reduce the burden on healthcare professionals. Artificial intelligence can play a big role in identifying COVID-19 by applying image processing techniques to X-ray images. This work designed and developed an intelligent system for the COVID-19 identification with high accuracy and minimum complexity. Suitable feature selection and classification are absolutely vital in the COVID-19 detection using chest X-ray images. Chest X-ray images were entered into the system in order to produce the output of the marked lung significant region, which was used to identify COVID-19. The proposed feature CNN model showed a higher classification **Accuracy (0.98)**.

The goal of this project is to provide a model to medical field to detect covid 19 using Chest X-ray and main contribution of this work is in proposing a novel deep neural network-based model for highly accurate Detection of covid-19. First Model is loaded and input is given to the model. The model will predict the result and output will be in the form of an array. This model will classify the given image whether the given x-ray image is of COVID-19 Positive person or of COVID-19 Negative person. And we will display the output with help of GUI to the user.

IX. CONCLUSION

COVID-19 is a highly infectious disease, which is caused by the SARS-Corona virus. In March 2020 and after spreading to more than 100 countries and leading to several thousands of cases, the World Health Organization (WHO) officially declared the outbreak of the new coronavirus as a pandemic.
So, our motive is to provide a model to the medical field to detect the Covid 19 using the recent development of technology in deep learning and medical image processing.
The main contribution of this work is in proposing a novel deep neural network-based model for highly accurate detection of COVID-19 infection from the chest X-Ray images of the patients.

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