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Efficient Detection of corona virus using deep learning in human lung's X-ray images

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***Abstract*—The most trending issue today is the virus covid-19 also called as corona virus as this has become a worldwide medical emergency. The best method to stop the spread of illness is to find the virus early with lowest possible cost. The aim of this review is to find if the patient is infected with covid - 19 or pneumonia or normal using a deep learning model. It also detects and highlights the virus infected in the lung image. There are two folders available train data set and test data set. Within the test setup, the solution provided will create quality classification accuracy results. Here, GUI (Graphical User Interface) application is created for areas related to medical examinations. Any medical examiner or technician can use this GUI application to detect Corona Virus positive patients using radiography X-ray images. It can be used on any computer. In this project we use CNN architecture for detecting the virus. This application provides or displays the result very rapidly, in just a few seconds. The accuracy of detecting the virus from the patient's body is around 98%. And the time taken to process is also very less.**

Keywords—Corona virus detection, chest X-rays, CNN, Deep-learning, Pneumonia, GUI

I. Introduction

The global consequence of the covid-19 patient population increase is catastrophic for healthcare system. It'll be difficult to test every patient with a respiratory illness using standard means due to a lack of test kits(RTPCR), while test results are really being awaited, high risk individuals may benefit from being quarantined if probable covid-19 infection are detected on chest x-ray and CT images. To minimize the turnaround time by using an image analysis model that uses the CNN model to identify and classify the chest X-ray and CT images into Normal, Viral Pneumonia, and COVID-19. The segmentation of the lung X-ray data was performed using a seeded region growing algorithm. The efficiency of the algorithm depends on choosing the right seed points. On the basis of a similar standard, the areas spread outward from their beginning locations to nearby points. The COVID-19 has been calculated using an equation after segmenting the lung portion. The properties of the lung are extracted by the proposed technique, which also uses it to enhance the input's resolution and efficiency. In this case, it gives the precise level of a density and also detects all supplements in the lung. It provides high resolution to determine the degree of a COVID-19 when locating a COVID-19 and fracture. It is an integrated

Lung feature extraction process. Pre-processing, feature selection, feature extraction, classification. Since late December 2019, Wuhan, China, has been the site of an outbreak of a novel corona virus disease (also known as COVID-19), which subsequently spread widely. Regardless of the fact that COVID-19 is an acutely treatable illness, there is a possibility that it will be fatal, with the risk of death being 4.03 percent in China and 13.04 percent in Algeria and 12.67 percent in Italy etc. As a result of severe alveolar injury and developing respiratory failure, the development of a major sickness may result in death. The gold standard for clinical diagnosis is laboratory testing, such Real-time reverse transcriptase-polymerase chain reaction (RT-PCR), yet the tests can often result in false negatives. Additionally, in a pandemic situation, a lack of RT-PCR testing capacity could postpone the subsequent clinical decision. The project's prime objective is to use X-ray images to identify COVID 19 symptoms in patients.To Classify COVID 19 Infections CNN architecture is used. Upload X-ray images: The system should be able to collect the X-ray images from users which will be used by CNN architecture, Detection of covid-19: The system ought to be able to recognize the COVID in the submitted X-ray images, Display results: The system must be able to provide information that the user can understand and use to their advantage. Not all of the positive COVID-19 data that are published online have undergone the same pre-processing. Due to the fact that the entire X-ray occupies most of the screen and has black bars on the sides, this becomes a problem. To fix this problem, write a script to delete the black pixels from the samples taken from the sides of the photos. Following are the steps in this methodology: chest X-ray picture preprocessing, data augmentation, transfer learning using neural networks such as DenseNet121, VGG16, MobileNet, InceptionV3, Xception, and VGG19, feature extraction, and ensemble classification.

1) CNN is well suited to training very large medical datasets with numerous parameters but few samples and the over fitting should not be the issue. To speed up training on a selected typical value, the number of parameters that a straightforward network must learn has been decreased. For image classification, a feed-forward network is directly fed pixels from the input image. Compared to classic fully connected networks, CNN models operate more quickly.

2) Vision Pro Deep Method does not require any image preparation, in contrast to the majority of conventional deep learning designs. Before beginning to train the model, the software automatically preprocesses the photos that are fed into the GUI.

II. METHODOLOGY

A. *Flow chart for data acquisition and testing*

There are 2 files of data sets are available they are train data set and test dataset as shown in fig 1. Each of these data sets have images of x-ray were few are effected with covid-19, pneumonia and also with no infection.

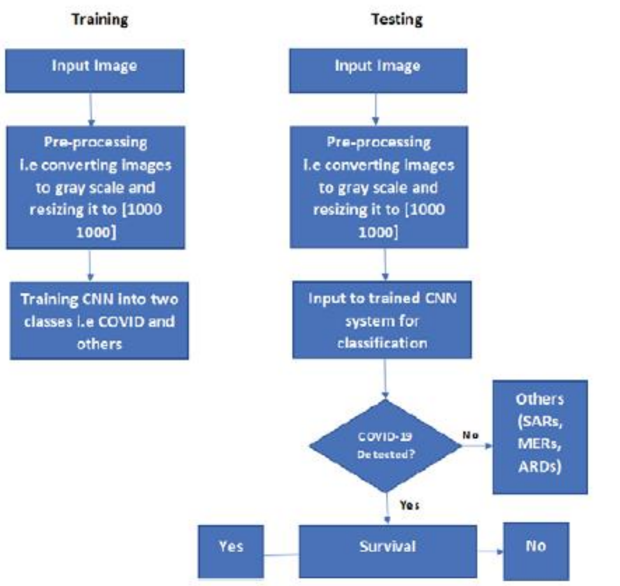

Fig 1: Data acquisition and testing

CNN algorithm is used to differentiate between these infections. The 1st step is to pre-process the data were the image is converted from RGB to gray scale image. By using a formula, image resizing, image preprocessing in CNN, feature selection in CNN, feature extraction in CNN classifying using CNN, output prediction.

B. *The proposed method follows these stages:*

1)Data set: The training dataset is provided by the Database Resource Initiative (IDRI) and the Lung Image Database Consortium (LIDC). 1000 CT scans of large and small tumours, recorded in the Digital Imaging and Communications in Medicine (DICOM) format are available from LIDC and IDRI.

2)Image Segmentation: When a image is segmented, the visual image is divided into a number of sections. Usually, this makes it easier to recognise boundaries and artefacts. The goal of segmentation is to make it easier to translate an abstract image into a concrete image that can be quickly and easily evaluated.

3)Pre-processing: The median filter is used in the preprocessing stage to restore the tested image by reducing the impacts of acquisition degradations. There is discussion of several preprocessing and segmentation methods for lung nodules. The median filter simply replaces the value of each pixel with the median of its neighbours, which includes itself. As a result, pixels whose values differ markedly from those of their neighbours will be eliminated.

4) CNN: Convolutional layer, RELU, pooling, and fully connected normalised layers are among the many hidden layers that make up a CNN, a type of DNN. In order to improve network performance and reduce memory usage, Weight values in the convolution layer of CNN are shared. The common weights, local connections, and 3D volumes of the neurons are the key characteristics of CNN. A convolution layer creates a feature map by combining various input picture sub regions with a learnt kernel. When the error is small, a non-linear activation function is then applied through the ReLu layer to enhance the convergence properties. To reduce a 2x2 or 3x3 grid to a single scalar value, a portion of the picture or feature map is selected, and the pixel with the highest among them or the average value is selected as the particular pixel. As a result, the sample size is significantly reduced.

III. PREPROCESSING AND FEATURE EXTRACTION

1) Converting RGB image to gray scale image: The image is changed from RGB to Grayscale as the first step in the pre-processing process. By applying below we can convert RGB to gray image.

$$0.2989*R+0.5870*G+0.1140*B \quad (1)$$

In a RGB image there 3 colors red, green and blue each pixel values are taken from R,G and B and then those values are substituted in the above formula then an gray scale image is as shown in fig 2.

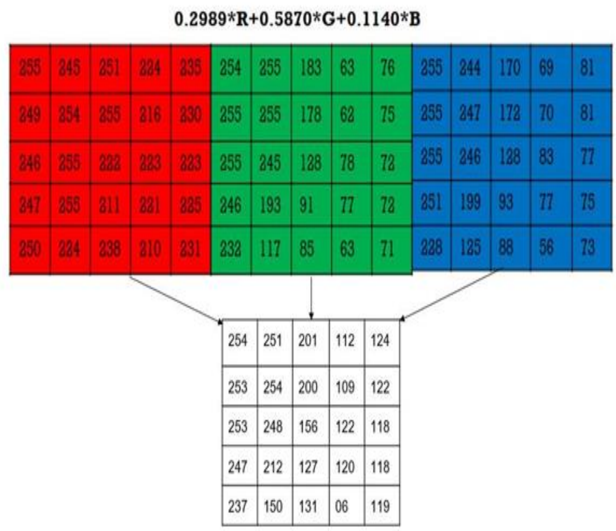

Fig 2: RGB to gray scale

2) Noise removal: In order to remove or reduce noise from an image, a noise reduction algorithm is used. The algorithms for noise reduction smooth out the entire image, leaving areas close to Contrast boundaries. This reduces or eliminates the visibility of noise. Next step of data pre-processing is noise removal. Gray scale image that was obtained in the preceding stage is used as input in this case. Here, we're using a noise-removal technique called a median filter. A non-linear digital filtering method called the median filter is frequently used to eliminate noise from an image or signal. The matrix, which represents the grey scale image, is appended with 0's at the edges and corners. Arrange the elements of each 3 x 3 matrix in arrange it in ascending order, then choose the median or center element out of 9 elements, then write the value to that specific pixel spot as shown in fig 3.

254	251	201	112	124
253	254	200	109	122
253	248	156	122	118
247	212	127	120	118
237	150	131	6	119

a) Original gray scale image

0	0	0	0	0	0	0
0	254	251	201	112	124	0
0	253	254	200	109	122	0
0	253	248	156	122	118	0
0	247	212	127	120	118	0
0	237	150	131	6	119	0
0	0	0	0	0	0	0

b) Padding for gray scale image

0	246	246	237	0
202	246	246	211	132
202	202	153	132	120
112	123	121	120	116
0	112	116	116	0

c) Enhanced matrix

Fig 3: Noise removal using median filter

3) Fundamental global threshold: Threshold is a sort of segmenting the image in which it can modify a picture's pixel composition to facilitate analysis. Keep A(i,j) if it exceeds or is equal to the threshold T. If not, substitute 0 for the value. At this case, the value of T can be changed in the front end to accommodate the various requirements of various images. Here, we employ the approach of trial and error to find the threshold value that might be most appropriate for us. Figur 4 displays thresholding utilizing fundamental global thresholding.

Suppose Threshold= 150

0	246	246	237	0
202	246	246	211	132
202	202	153	132	120
112	123	121	120	116
0	112	116	116	0

a) Enhanced matrix

0	246	246	237	0
202	246	246	211	0
202	202	153	0	0
0	0	0	0	0
0	0	0	0	0

b) Thresholded image

Fig 4: Basic global threshold

High pass filter: An image can appear crisper by using a high-pass filter. These filters draw attention to the image's. The 3*3 matrix of the input elements is multiplied with the filter matrix which is also written as A(1,1)*B(1,1), in the same way all the matrix are multiplied and there sum is divided bt 9,this will give the position of perticular pixel. The value of each pixel point are determined in the same manner. Since there is no such thing as negative lighting, the negative values are taken to be zero as shown in fig 5.

0	0	246	24	237	0	0
0	0	246	246	237	0	0
202	202	246	246	211	0	0
202	202	202	153	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

a) Bounday extention at edge and corner

-1/9	-1/9	-1/9
-1/9	8/9	-1/9
-1/9	-1/9	-1/9

b) High pass filter

-127	60	6	79	-76
35	52	47	90	-76
62	63	35	-68	-23
-67	-62	-39	-17	0
0	0	0	0	0

c) Filtered matrix

0	60	6	79	0
35	32	47	90	0
62	63	36	0	0
0	0	0	0	0
0	0	0	0	0

d) After rejecting negatives

FIG 5: Image sharpning using high pass filter

A) Flow chart for feature extraction using HOG:

Gy is calculated as Gy=top value - left value, and Gx is calculated as Gx = right value - left value as shown in fig 6.

0	0	0	0	0	0	0
0	0	60	6	79	0	0
0	35	32	47	90	0	0
0	62	63	36	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

a)Padding to sharped image

60	6	19	-6	79
52	12	38	-47	-90
63	-27	-63	-35	0
0	0	0	0	0
0	0	0	0	0

b) G_X values

-35	-52	-47	-90	0
-62	-3	-29	79	0
35	52	47	90	0
62	63	35	0	0
0	0	0	0	0

c) G_y values

Fig 6: G_X and G_y in HOG

Calculations are made for magnitude and direction. In below figure 7, feature extraction using HOG is depicted. Magnitude is brightness, and degree of orientation is orientation angle. Following the calculation of the orientation angle, the frequency of the angles for the specific intervals are documented and provided as input for the classifier. Here, zeroes are not taken into account while calculating frequency. For instance, we write the frequency as 2 because there are 2 occurrences for the range of 40 to 59.

Magnitude $=\sqrt{[G_X^2+G_Y^2]}$ (2)

$\varnothing = \tan^{-1}(G_y/G_x)$ (3)

69.5	52.3	50.7	90.2	79
80.9	12.4	47.8	91.9	90
72	58.6	78	96.6	0
62	63	35	0	0
0	0	0	0	0

a)Magnitude $=\sqrt{[G_X^2+G_Y^2]}$

30.25	83.42	67.99	86.19	0
50.01	14.04	37.34	59.25	0
29.05	62.56	36.72	68.74	0
0	0	0	0	0
0	0	0	0	0

b) $\varnothing = \tan^{-1}(G_y/G_x)$

f	1	4	2	3	2	0	0	0	0	0
Bin	0	20	40	60	80	100	120	140	160	180

Fig 7: Feature Extraction using HOG

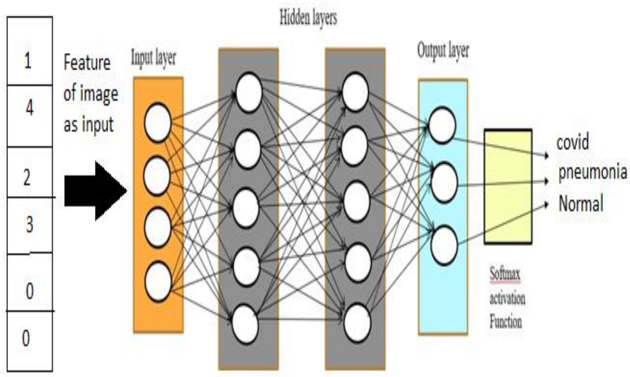

Fig 8: Features of image is input for CNN classification

Using the SoftMax Activation Function in this instance, the classifier utilizes this output to determine whether covid is present in the image or not as shown in fig 8.

IV. IMPLEMENTATION

A. *Steps for implementation:*

1) Front end development using python Tkinter: User-friendly computer programmers' are available today. Console-based I/O is not the only form of user interaction. They have faster CPUs and more potent graphics hardware, which contribute to its more ergonomic graphical user interface (GUI). These programs can take mouse clicks as input and let the user select options with the aid of radio buttons, dropdown lists, and other GUI components.

2)Tkinter programming: Tkinter is the name of Python's built-in GUI library. GUI application development is rapid and easy thanks to Python and Tkinter. Tkinter offers an efficient object-oriented interface for the Tk GUI toolkit. Tkinter has a number of advantages. The same code runs on Windows, macOS, and Linux since it is cross-platform. Because Tkinter uses native operating system components to produce visual elements, applications created with this framework look like they belong to the platform being used to run them. The following are the implementation objectives:

- Reduce the amount of memory needed
- Increase readability of outputs
- Improve the read ability of source text
- Keep the amount of source statement to minimum
- Shorten the development period

V. TESTING

TABLE 1: Test case 1

Test case	1
Module being tested	Covid detection
Sample input	X-ray
Expected output	Covid detection
Observed output	Covid detection
Error observed	nil

TABLE 2: Test case 2

Test case	2
Module being tested	normal
Sample input	X-ray
Expected output	normal
Observed output	normal
Error observed	nil

TABLE 3: Test case 3

Test case	3
Module being tested	Pneumonia detection
Sample input	X-ray
Expected output	Pneumonia detection
Observed output	Pneumonia detected
Error observed	nil

TABLE 4: Test case 4

Test case	4
Module being tested	Covid detection
Sample input	X-ray
Expected output	Covid detection
Observed output	Pneumonia detected
Error observed	Model predicted the result wrong.

VI. RESULTS AND DISCUSSION

The result of this project it has the accuracy of 98%. A convolution layer uses convolution to extract the input images features and then produces feature maps. It is made up of a number of convolution kernels, which are fixed-size filters that are employed in convolution operations on image data to create feature maps. The following images differentiate between covid-affected x-rays versus standard x-rays.

A. COVID-19 Detection:

Fig 9: Input covid -19 infected X-ray

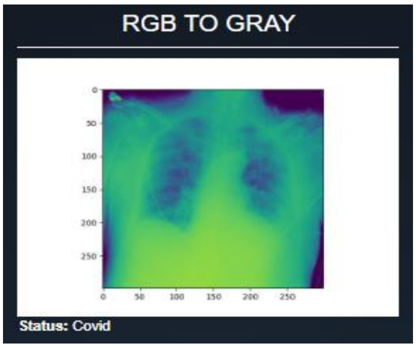

Fig 10: RGB converted to gray scale

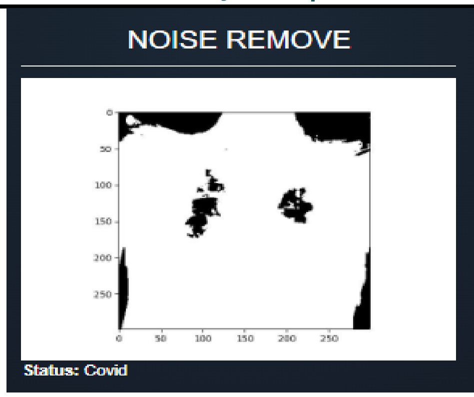

Fig 11: Noise removal process

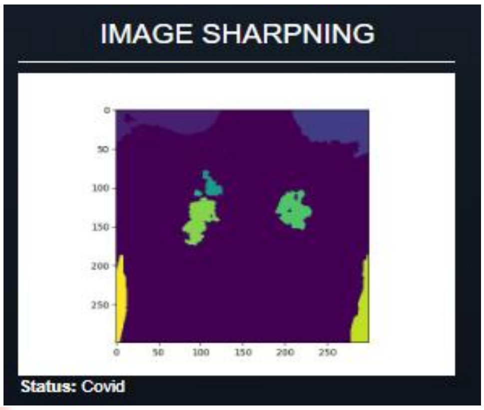

Fig 12: Image sharpening

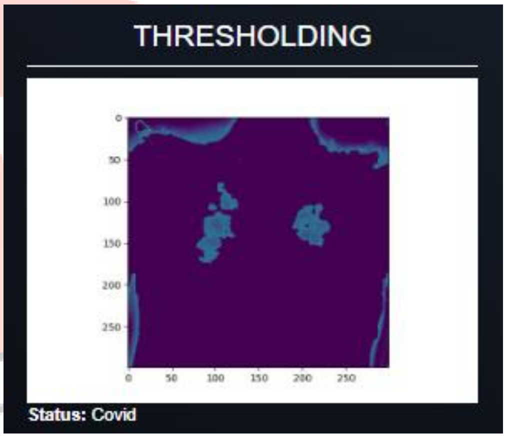

Fig 13: Threshold image

B. Pneumonia Detection

Fig 14: Pneumonia infected x-ray

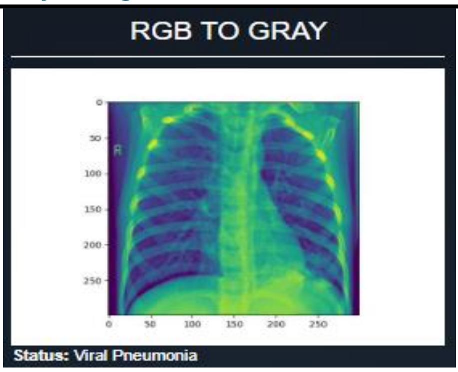

Fig 15: RGB converted to gray scale

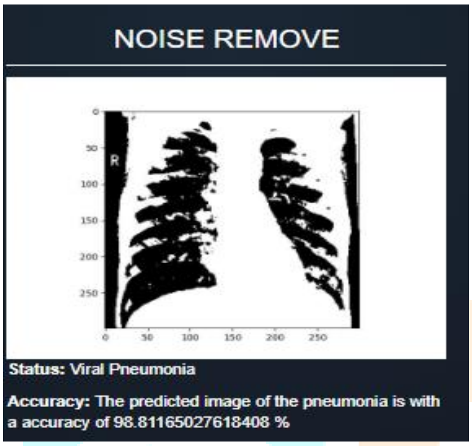

Fig 16: Noise removal process

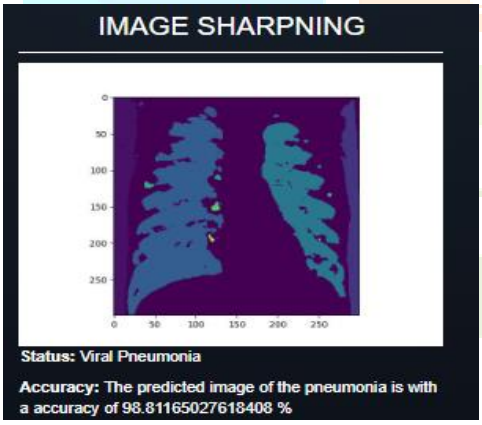

Fig 17: Image sharpening

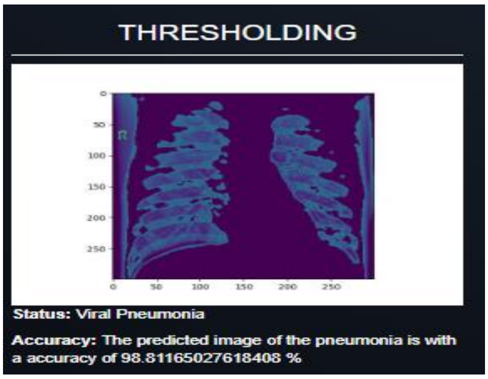

Fig 18: Threshold image

C. No infection in lungs:

Fig 19: Normal X-ray

VII CONCLUSION

By using CAD tool the efficiency of the output can be increased. The Deep CNN model that has been proposed is more accurate and performs better. The outcomes reveal that transfer learning was a successful, reliable, and easily implementable method for COVID -19 identification. By using chest X-ray radiographs, corona virus , pneumonia infected patients can be identified with a classification accuracy of more than 98%.

A. Future enhancement:

Lack of a comprehensive database with widespread public availability is one of the difficulties in creating a reliable and accurate Corona virus diagnostic system. We fervently believe that academics will be able to explore better DL models and correctly forecast COVID19 in the future with the aid of freely accessible resources. Second challenge is to have an accurate ground reality. The work is summarized in terms of classification, division, and prediction. In this study, we successfully identified covid-19 in vgg16 among inceptionv3, ResNet50, Vgg16, and Vgg19 with high accuracy. Due to our higher accuracy and performance, our research will aid doctors in reaching an accurate conclusion. This paper provides a good understanding of the many deep transfer learning techniques that can be applied if we want to contain this sickness as soon as possible. We think that by doing this, we can more effectively stop the Corona virus and lower the number of deaths brought on by it.

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