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Corona Virus Detection using Digital Image Processing

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ABSTRACT
The Corona Virus epidemic has thrown the entire world into chaos, bringing life to a screeching halt and taking thousands of lives. It continues to pose a serious hazard to public health. The COVID-19 pandemic's global expansion has resulted in considerable losses. The fact that the corona virus was detected quickly is one of the most crucial challenges that medical and healthcare departments are dealing with. As a result, it's critical to confirm the suspected case's diagnosis, not only to make the following step easier for the patients, but also to limit the number of infected persons. In image identification, the deep convolutional neural network has made tremendous progress, particularly in the field of auxiliary medical diagnosis technologies. Neural networks have been effectively utilized to identify pneumonia from CT scans, with results that outperform radiologists. As a result, deep learning has played a critical part in the response to the COVID-19 outbreak, making it possible to appropriately judge and respond to the outbreak. This project presents a model that employs the Convolutional Neural Network (CNN) deep learning algorithm with some basic layers. The proposed method applies deep learning's analytical and diagnostic capabilities to CT scan images, presenting an image classifier based on the CNN and VGG16 models to classify chest CT scan images. The goal of this model is to transfer learning, model integration, and classification of these images into two categories: normal and Covid19-positive.

Keywords:*-Corona virus detection, deep learning, machine learning, CT scan, CNN.*

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in Wuhan, China, and quickly spread over the world. The COVID-19 epidemic has thrown the entire planet into chaos, bringing life to a screeching halt and taking countless of lives. Corona virus has a negative impact on people's health, especially senior adults and those with underlying medical disorders and low immunity. By mid-July 2020, the COVID-19 pandemic had claimed the lives of over 570,000 people, with over 13 million cases of corona virus infection. One of the most important steps in combating the pandemic is to find COVID19-infected people as soon as feasible so that they can receive proper care and treatment. Early diagnosis of the corona virus is also critical for determining which patients should be isolated to prevent the sickness from spreading throughout the population.

Being thoroughly informed on the COVID-19 virus, the disease it produces, and how it transmits is the greatest strategy to avoid and slow down transmission. Clean up every now and again or utilize a liquor based rub to shield yourself as well as other people from disease, and try not to contact your face. However, given the COVID-19's recent proliferation, reliable detection remains a difficult undertaking, particularly in regions with minimal medical services. While reverse transcription polymerase chain reaction (RT-PCR) test kits have emerged as the primary method for diagnosing COVID-19, many countries are increasingly considering chest X-rays, computed tomography (CT) scans, and biomarkers (i.e. high C-reactive protein (CRP), low pro-calcitonin (PCT), low lymphocyte counts, elevated Interleukin-6 (IL6), and Interleukin-10 (IL10)) to aid diagnosis and/or provide evidence of more severe disease progression.

Considering the recent spreading trend of the COVID-19, an effective detection remains a challenging task, particularly in communities with limited medical resources. As in most cases, the virus is affecting the lungs of the infected person, we can use chest radiographs to detect the health of the patient's lungs. CT Scans play a pivotal role in COVID-19 patient screening and disease detection. The deep convolutional neural network has achieved unprecedented development in image recognition, especially in the field of auxiliary medical diagnosis technology.

The current system for detecting COVID-19 employing the aforementioned viral and antibody testing modalities is time consuming and requires additional resources and approval, that are not always attainable in disadvantaged areas. As a result, various researchers and publications advise using a chest radiograph to check for COVID19. Utilizing non-invasive modalities such as CT scans or chest X-rays, radiologists can observe COVID-19 infected lung features. COVID-19-induced characteristics, on the other hand, are difficult to distinguish from those of community-acquired bacterial pneumonia. As a result, for many patients, human evaluation of radiograph data and precise decision making might be burdensome for radiologists, necessitating the development of an automated categorization system. Furthermore, radiologists may become infected and require isolation, which may have an impact on remote populations with fewer hospitals, radiologists, and caregivers.

The objective of this research is to construct a deep learning model that can discriminate COVID-19 cases from normal cases with high accuracy, in order to automate COVID-19 detection using CT Scan pictures.
The following goals are at the forefront of the project:

- Compared to RT-PCR, chest CT Scan imaging is thought to be a more reliable, practicable, and quick method of diagnosing and assessing Covid-19. It is a more efficient and straightforward way.
- CNN is a deep learning technique that is commonly used for document and image analysis. CNN is effective for detecting a variety of illnesses, including Covid-19. In order to detect Covid-19 from chest CT scan pictures, CNN is required. In real-world circumstances, it has showed promising results.

LITERATURE SURVEY

1. For the detection of Covid-19 virus, proposed method employs a 2D CNN network for feature and classification of chest x-rays. Fine-grained visual qualities such as texture and clarity are examined while detecting the virus in x-ray pictures. The feed forward network for image categorization uses the image pixels straight from the input images. In the output convolution layer, the pooling layer is critical for lowering feature dimension. It is coupled to categorization by fully connected layers and softmax layers. The REW layer is the element-by-element activation function. A pooling layer is put between the convolution layers on a regular basis. Dropout layer with reduced density is developed for better

optimization.
Fit Model is used to train the model, which includes both training and test data in an 80:20 ratio. Because the dataset is split into two categories: Covid-19 positive and normal, the approach uses binary classification. The dataset includes 60 photographs, 30 of which are normal and 30 of which are positive for Covid19. The restricted dataset provided to train and test the model is the paper's key shortcoming.

2. For the detection of Covid-19 virus in chest CT scan pictures, this method presents a semi-supervised methodology. A CNN model called ResNet+ is utilized to extract spatial characteristics from the CT scan picture by combining a lung segmentation mask with the appropriate CT volume. Modules are used to refine the feature maps channel and spatial attention in an end-to-end manner. The spatial characteristics are then transformed into spatial-axial features using a bidirectional LSTM. To improve the quality of slices, two enhancement algorithms are used: stochastic sampling and tone mapping. Slice attention is used to facilitate in the identification of the infected lung region. A fully connected layer is used for the final slice and volume level prediction.
The model is trained and tested using a total of 302 CT volumes, 29 of which are Covid19 positive instances. The total number of positive and negative slices is 3520 positive and 19353 negative slices. The dataset is split into 80:120 training and test datasets.

3. To detect COVID-19, this research suggested a weakly supervised technique. The creation of this technique was prompted by a lack of RT-PCR kits, which caused the treatment of covid-19 to be delayed. As a conclusion, for detecting covid-19, a weakly supervised deep learning technique was presented. This study includes 150 covid-19 3D volumetric chest CT scans from CAP and NP patients. A deep neural network for lung segmentation was trained using an open dataset. To standardize data for pre-processing, various scanners and centers are used. The researchers used a setup that used small convolution filters stacked with nonlinearity injected in between to boost CNN depth.

Both a 3-way classification and three binary classification tasks were used to train the suggested model. This model can pinpoint the specific location of lesions and inflammation, assisting in determining the infection's severity. The results of the experiments showed that this model has a high level of detection accuracy and provides clear visualizations of the lesions.

4. With the use of deep nets, this research offered a de-mystify method for detecting the Covid-19. It diagnoses the Covid-19 virus using CXR pictures. Covid-19 is distinguished from other respiratory infections such as MERS, SARS, and ARDS using this approach. Two publicly accessible data sets were used to train the model. The first data comprises of 320 chest x-ray images, whilst the second comprises 3347 images. In this research, a total of 3606 images were used. The model is trained on 80% of the images, with the remaining 20% being employed for testing. 259 images of Covid-19 positive individuals are included in the total of 3306 images, while the remaining 3347 images are related to other diseases such as MERS and SARS.

This study’s approach is as follows: The chest x-ray images are first taken and then grouped in order to detect Covid-19 and other disorders. All of the images were first converted to grayscale before being divided into two categories: Covid-19 and other disorders. If a patient tests positive for Covid-19, CNN with seven layers is applied to further classify them in order to determine their survival rate.

5. To identify Covid-19 patients from pneumonia and other normal cases, this research presents a deep learning-based algorithm. It makes use of an x-ray dataset that includes the posteroanterior chest image for Covid-19, pneumonia, and normal cases. This approach presents a DARI (Data Augmentation of Radiograph Images) algorithm, which generates synthetic chest x-ray data for Covid-19 infected lungs, due to the low dataset available for Covid-19 cases. The suggested DL-CRC framework is split into 2 parts:
   The DARI algorithm: In this stage, we check if the proposed CNN model has enough training data. If not, we prepare a robust dataset for Covid-19 infected lungs using the DARI method. The dataset is generated using a Generative Adversarial Network (GAN) and many data augmentation techniques such as rotate and zoom.
   CNN's model is as follows: The suggested model is a two-dimensional CNN. The above-mentioned dataset is fed into the model as input. The chest x-ray images are then classified as Covid-19 infected, pneumonia, or normal cases using this approach.
   The suggested model correctly detects Covid-19 patients' 93.94 percent of the time, normal cases 95.91 percent of the time, and pneumonia cases 88.52 percent of the time. The paper's biggest downfall was that this model was only tested on X-ray images of the lungs and was applied to a fairly small dataset of Covid-19 cases.

6. The implementation and design of convolutional neural networks (CNN) to detect the presence of Covid-19 in chest x-ray images are discussed in this research. There are no huge data sets available for Covid-19 because it is a relatively new ailment. As a result, to deal with the limited data set, this model employs two approaches: transfer learning and data augmentation. In transfer learning, a previously trained CNN is employed, and the layers closest to the output unit are fine-tuned before being used as feature detectors. This strategy is low-cost and does not necessitate a large dataset. Data augmentation creates multiple instances from a single instance by making minor changes to it. On the dataset supplied, the model employed in this paper is a DenseNet 121 pre-trained model. The final layer of the CNN is retained to estimate the probability of positive or negative COVID-19 viral cases using transfer learning.

   On top of the base network, two layers are added to detect Covid-19. The first layer is a pooling layer that takes the average of the most recent convolution layer from the DenseNet 121 model. The second layer is a densely linked layer that is activated using the sigmoid function. Due to the little dataset, a micro batch gradient descent with a few epochs is used. In a frontal view chest radiograph, this technique can detect the Covid-19 virus.
   The restricted dataset available to train the model is the model's fundamental flaw.

7. This research provides a weakly-supervised deep learning method for covid-19 detection and lesion localization using 3D CT imaging. To detect covid-19 from CT volumes, a 3D deep convolutional neural network

(DeCoVNet) was developed. As input, DeCoVNet used a CT volume and lung mask generated by a pre-trained UNet. The 3DCC approach was applied to the CT image for weakly supervised lesion localization, and regions sensitive to the 3DCC algorithm were used for lesion localization. Before training the 2D UNet for lung segmentation, all CT volumes were pre-processed in a consistent manner, and data augmentation was used to avoid overfitting.

The DeCoVNet was built using the PyTorch framework, which was trained from start to finish. Without labelling the lesions in the CT volumes, the weakly supervised deep learning system obtained accurate results in recognizing covid-19 and decent lesion localization outcomes. This well-trained and high-performance deep algorithm aids in the rapid detection of covid-19 and hence the global eradication of this disease.

8. By combining the principles of automatic voice recognition with deep learning algorithms, artificial intelligence has made a significant contribution to the identification of covid-19. Using a recurrent neural network, the importance of speech signal processing in the early diagnosis of covid-19 is demonstrated (RNN). The long short-term memory architecture of the RNN is utilized to analyze features such as cough, respiration, and voice of the patients. Using machine learning algorithms, three main sounds such as coughing, breathing, and speaking are examined to determine the health state of a human body. Speech corpus from 60 healthy people and 20 covid-19 sufferers were collected to test and train the system. Spectral centroid, spectral roll-off, zero-crossing rate, and Mel –frequency cepstral coefficient were among the speech variables extracted from the dataset that influence system accuracy.

   Using previous data samples, RNN was employed to forecast the future data sequence. By storing data for a longer length of time, LSTM was utilized to address the vanishing gradient problem of RNN. Only cough samples were used to acquire precise findings, and it was discovered that the MFCC characteristics produced the highest frequency. Breathing and coughing samples yielded more accurate findings than the patient's voice.

9. Using medical expertise and deep convolutional neural networks, this research proposes an artificial intelligence-based technique for detecting covid-19 using X RAY pictures (CNNs). A chest X-ray is a simple approach to detect abnormalities in the chest, such as lung inflammation. CNN is a feedforward artificial neural network that uses less pre-processing than other techniques in image/video processing. To mitigate the effect of overfitting, the suggested CNN employs data augmentation. The suggested approach is compared to recent deep learning work on the covid-19 detection method. The CNN model was found to outperform the other baselines in detecting covid-19. Expert radiologists validated the suggested CNN model, which obtained 96 percent accuracy.

   Because the results are accurate, medical professionals can implement this method to quickly detect covid-19. The only stumbling block to covid-19-related research is the scarcity of case data, which can be alleviated by maintaining close contact with hospitals that can supply additional information.

10. This research provides a method for detecting covid-19 in patients using CT images that combines deep learning target identification and picture

classification. In this case, artificial intelligence is employed to determine covid-19's traits and symptoms in CT images. The CT pictures of 721 covid-19 patients and 600 images as training data for the detection model are studied in this research. Covid-19's CT lesions detection approach consists of three parts: target region selection, object identification model, and particular convolutional layers for spatiotemporal feature extraction. The segmentation of lung areas is the first stage in lesion detection, followed by geometric morphology operations to locate the relevant region. Multiple continuous convolutional layers and pooling layers were used to create a 2D lung regions segmentation model in encoder-decoder mode. This method minimizes the number of undesired areas for lesion diagnosis while also increasing model efficiency. The spatial semantic convolutional layer and the time semantic convolutional layer were two sophisticated feature extractors in the lesion detection model.

Faster RCNN, YOLO3, SSD, and an algorithm model based on space-time sequence convolution were among the algorithms examined. The detection methods in this paper can acquire more accurate findings by comparing them to these algorithm models. The time spatial sequence convolution approach can produce results that are both faster and more efficient.

DATASET DESCRIPTION

The raw data obtained from numerous databases remains in the form of statements, numbers, and qualitative expressions. There are errors, discrepancies, and contradictions in the raw data. It is vital to make modifications after a comprehensive examination of the data gathered. The processing of primary data entails the following phases. Kaggle is a popular website for data scientists and machine learning experts. Kaggle is a web-based data science platform that allows users to explore and construct models as well as search for and publish data sets. The dataset employed in the proposed model consists of two labels: Covid-19 positive and Normal. The model at the end classifies the input image based on the two above mentioned labels.

Following that, the dataset is divided into two categories: training data and test data. We divided the dataset in an 80:20 ratio in the suggested model, with 80% of the data being used to train the model and 20% being used to test the model.

METHODOLOGY

The proposed model with the different layers and pre-trained models has been thoroughly detailed in the following parts. The developed model is based on deep learning, which uses several hyper parameters for training and maximizes these parameters using a loss function and an Adam optimizer during training.

A loss function is a technique of evaluating how well a certain algorithm mimics the available data for machines to learn. With the help of an optimization function, the loss function gradually learns to decrease the prediction error. The Adam Optimizer is a noisy problem optimization technique that can regulate sparse gradients. It also combines the best features of the AdaGrad and RMSProp algorithms to provide the best results.

The initial stage in training the Convolutional Neural Network (CNN) model is to feed training data to the various layers of the CNN model. The CNN model is the model artefact that emerges from the training process. The training data must include the correct response, often known as a target or target characteristic. The images present in the training dataset were utilized in training the model into classifying the images into either normal or Covid-19 positive cases.

The complete flowchart of the for detecting COVID-19 with CNN is depicted in the figure below.

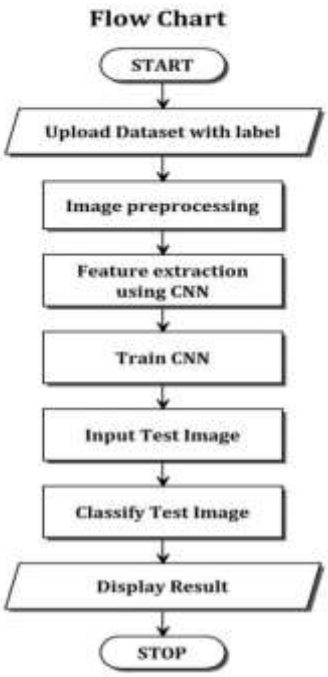

Fig.1:-*Flowchart*

PROPOSED CNN MODEL

CNN is an Artificial Neural Network (ANN) based profound learning calculation which has filled fundamentally lately. CNN depends on the standard of human sensory system particularly human minds which is framed of billions of neurons. CNN is shaped of fake neurons which have the property of self-enhancement with learning like the cerebrum neurons. Because of this self-improving property, it can separate and arrange the highlights removed from pictures more definitively than some other calculation. Besides, it needs extremely restricted preprocessing of the information however it yields profoundly exact and exact outcomes. CNN is inconceivably utilized in object discovery and picture grouping including clinical imaging.

The proposed model is a CNN model with basic layers for classifying CT Scan images into Covid-19 positive or normal cases. The CNN structure is utilized to learn the discriminating patterns automatically from the CT Scan images.

The Convolutional-2D layer is the first layer of the proposed CNN model. It is connected to the next Convolutional-2D layer from this layer. The next layer is the max-pooling layer, which reduces the size of the convolved feature map in order to reduce computational costs. It also extracts the maximum value from the convolutional layers' resulting matrix. Next, we have the dropout layer, it removes the connections between 1 convolutional 2D layer and another convolutional 2D layer.

This prevents overfitting in the proposed model. The value retrieved by the max-pooling layer is passed on to the next hidden layer which includes the convolutional 2D, max-pooling and dropout layers. After this the flatten layer is applied. This layer converts the multi-dimensional array, to a single dimensional array. It is used to convert a matrix into a vector. This vector is given as input to the dense layer where it is classified as either Covid-19 positive or Normal.

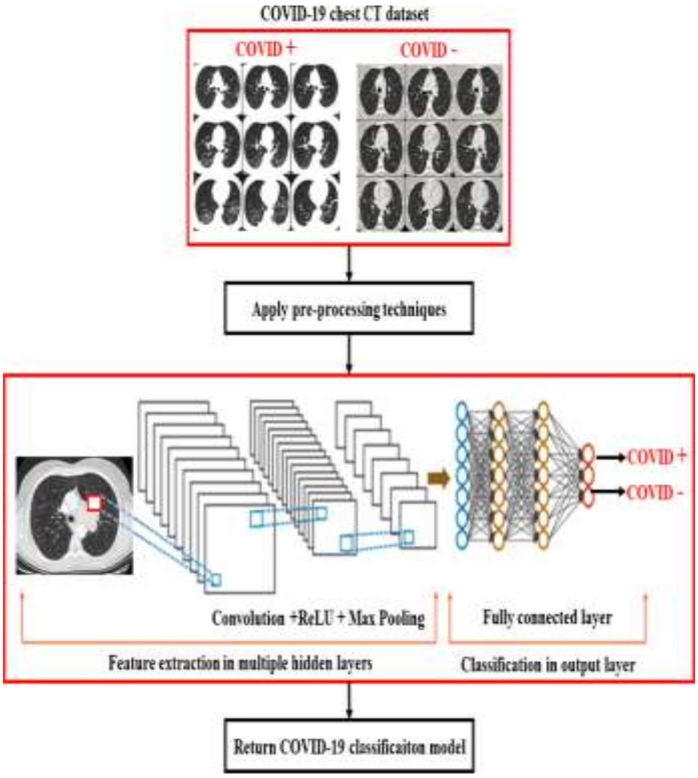

Fig.2:*-Proposed CNN Model*

PRE-TRAINED VGG-16 MODEL

The most interesting thing about VGG16 is that as opposed to having countless hyper-boundaries, they zeroed in on having convolution layers of 3x3 channel with a step 1 and consistently utilized same cushioning and max-pool layer of 2x2 channel of step 2. It follows this course of action of convolution and max pool layers reliably all through the entire engineering. In the end it has 2 FC(fully associated layers) trailed by a softmax for yield. The 16 in VGG16 alludes to it has 16 layers that have loads. This organization is a really huge organization and it has around 138 million boundaries.

The layers in the VGG-16 model portrayed in the underneath chart are: the initial two layers have 64 channels of 3*3 channel size and same cushioning. Then, at that point, after a maximum pooling layer of step (2, 2), two layers which have convolution layers of 256 channel size and channel size (3, 3).

This followed by a maximum pooling layer of step (2, 2) which is same as past layer. Then, at that point, there are 2 convolution layers of channel size (3, 3) and 256 channels. After that there are 2 arrangements of 3 convolution layer and a maximum pool layer. Each have 512 channels of (3, 3) size with same cushioning. The picture is then passed to the heap of two convolution layers. In these convolution and max pooling layers, the channels that are utilized are of size 3*3.

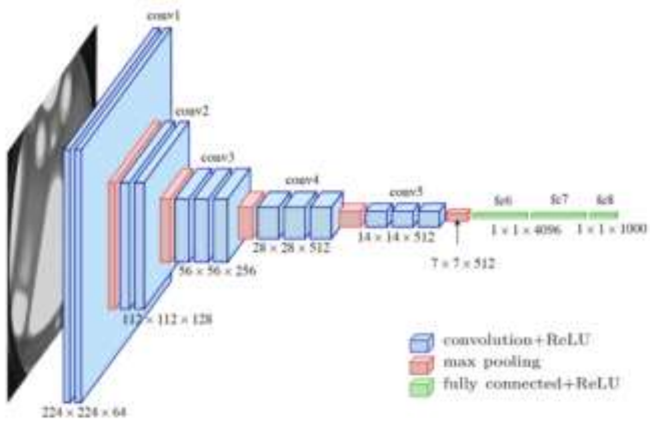

Fig.3:-*Pre-Trained VGG-16 Model*

IMPLEMENTATION

In response to the outbreak of COVID-19, deep learning has played an indispensable role, which makes it possible to accurately judge and respond to the epidemic. The proposed system would have the analytical and diagnostic capabilities of deep learning on computerized tomography chest CT SCAN images and present an image classifier based on the CNN. This model aims to classify the result as normal or COVID-19.

The whole system for detection of Covid-19 from chest CT scan image consists of the following important steps:

- The first step is to acquire the dataset required to train and test the proposed model. The dataset is then classified based on two labels: Covid-19 positive and normal. The dataset is divided into two parts: Training dataset and test dataset. In this project, the data is divided in the ratio 80:20 with 80% of data being utilized for training the model.
- Preprocessing alludes to every one of the changes on the crude information before it is taken care of to the AI or profound learning calculation. Pictures come in various shapes and sizes. They additionally come through various sources. Thinking about this multitude of varieties, pre-handling should be performed on any picture information. Initial step of information pre-handling is to make the pictures of a similar size.
- The biggest advantage of Deep Learning is that we do not need to manually extract features from the image. The network learns to extract features while training using its Convolution kernels; the image is just needed to be fed to the network (pixel values).
- For classifying CT Scan images into Covid-19 positive or normal instances, the suggested model is a CNN model with fundamental layers The CNN structure is used to automatically learn discriminating patterns from CT Scan images. The postulated CNN model's first layer is the Convolutional-2D layer. This layer's succeeding Convolutional-2D layer is related to it. The max-pooling layer is the following layer, which minimizes the size of the convolved feature map to conserve time and money. It also retrieves the maximum value from the output matrix of the convolutional layers. The dropout layer then breaks the links between one convolutional 2D layer and another convolutional 2D layer This prevents the developed framework from overfitting. The value obtained by the max-pooling layer is

passed on to the convolutional 2D, max-pooling, and dropout layers in the subsequent hidden layer. The flatten layer is then placed after that. The multi-dimensional array is processed to a single-dimensional array via this layer. It's a tool for converting a matrix to a vector. This vector is fed into the dense layer, which determines whether it is Covid-positive or Covid-negative.

- Once the model has been trained it is possible to carry out model testing. During this phase a test set of data is loaded. This data set has never been seen by the model and therefore its true accuracy will be verified. Finally, the saved model can be used for detecting the presence of Covid-19 in the chest CT Scan images.
- An image is provided to the proposed model to detect the presence or absence of Corona virus. The model employs the above mentioned layers and classifies the image as either Covid-19 positive or normal.

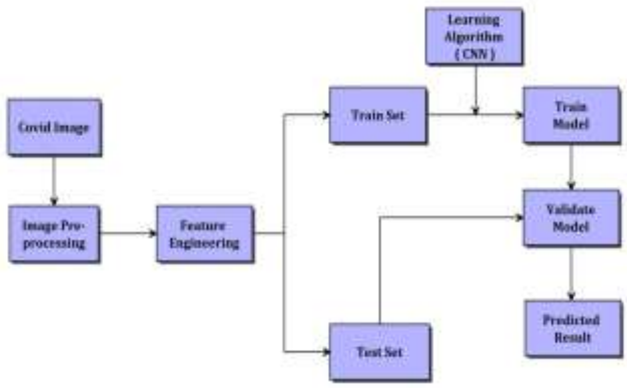

Fig.4:-*System Architecture*

RESULTS AND DISCUSSIONS

We adopted a methodical technique to identify the appropriate model for the classification problem by combining multiple strategies.

This paper introduces a deep learning-based end-to-end framework that can detect the presence COVID-19 infection in lung CT Scan images. Keras and TensorFlow libraries in Python were used to create the simulations. Using Python's Matplotlib module, we were able to comprehend the experimental data.

Confusion Matrix

The performance of a classification model on a set of test data for which the true values are known is examined using a confusion matrix. The confusion matrix is used to compute most performance measurements, such as precision and recall.

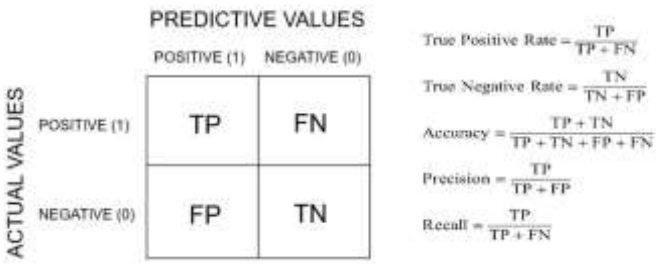

Fig.5:-*Confusion matrix and formulae*

The numbers along the diagonal from upper-left to lower-right reflect accurate decisions, whereas the numbers outside this diagonal represent errors, as depicted in the above image. A classifier's true positive rate is obtained by dividing the frequency of correctly classified positives by the total positive count. The classifier's false positive rate is determined by dividing the number of inaccurately labeled negatives by the total number of negatives. The total successfully identified positives and negatives divided by the total number of samples yields the overall accuracy of a classifier.

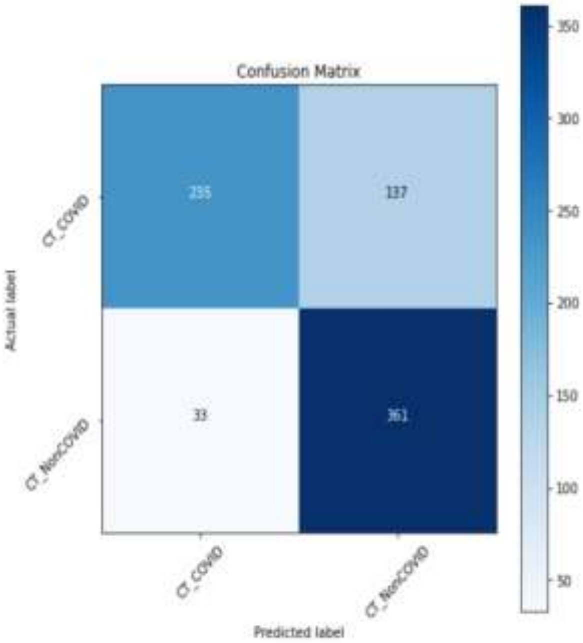

Fig.6:-*Confusion Matrix of Proposed CNN Model*

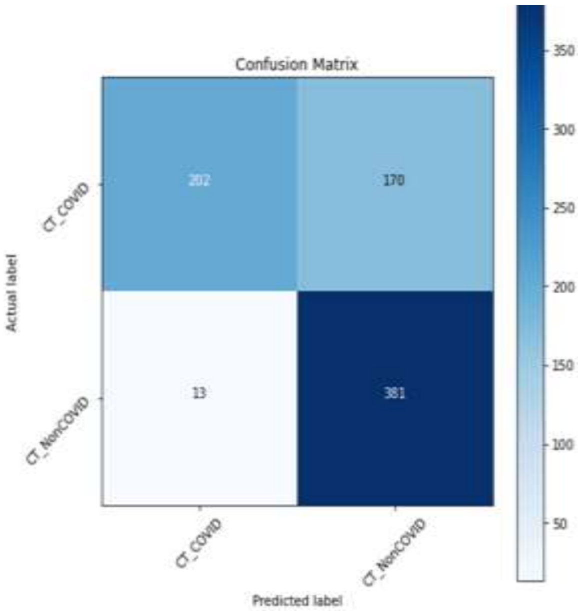

Fig.7:-*Confusion Matrix of Pre-Trained VGG-16 Model*

From the above results that were produced after training the models, it is clear that the proposed CNN model outperformed VGG-16 for detection accuracies of COVID-19 cases. In addition to the classification efficiency, the proposed model is more lightweight than that of used in VGG-16. The customized CNN model consists of 6 convolutional layers while the VGG-16 model comprises 16 convolutional layers, making our model's training phase more lightweight and computationally less expensive than the VGG-16 model.

The below graph shows the comparison between the Proposed CNN Model and Pre-Trained VGG-16 Model in terms of detecting the presence of Covid-19 infection in lung CT Scan Images.

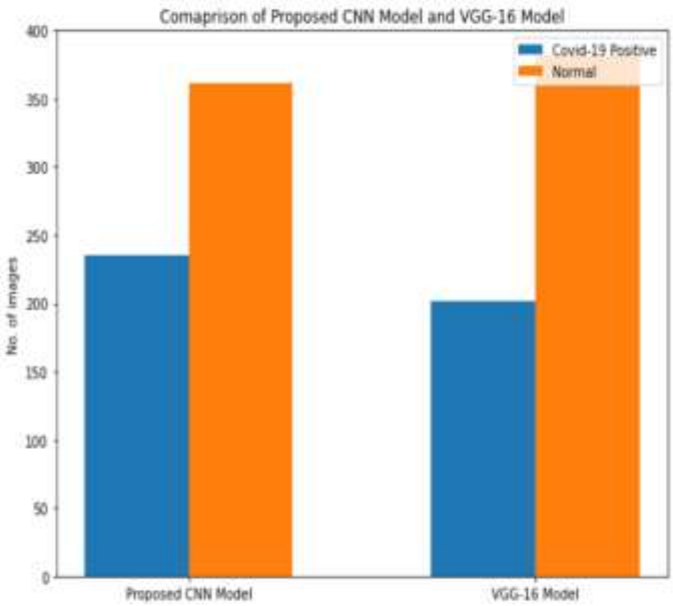

Fig.8:*-Comparison between Proposed CNN Model and the VGG16 Model*

CONCLUSION

In this project, the emerging challenges of detecting COVID-19 are addressed. Due to the shortage of efficient diagnosis equipment and personnel in many areas, particularly in developing and/or rural zones, numerous people remain non-diagnosed. This results in a substantial gap between the number of confirmed and actual cases.

Radiographs such as chest X-ray images and CT scans have been demonstrated to have the potential for detecting COVID-19 infection in the lungs that can complement the time-consuming viral and antibody testing. Therefore, to leverage the availability of chest CT Scan imaging, in this project, aCNN model is proposed to automate COVID-19 detection that can complement existing viral and antibody testing methods.

A unique dataset was employed from multiple publicly available sources, containing radiograph images of COVID-19 infected lungs, along with normal lung imaging. The main objective of this project is to develop a deep learning model using convolutional neural network (CNN) to detect the presence of corona virus in the lungs of an individual through CT scan images.

In other words, this project focuses on presenting a CNN model for identifying the corona virus using CT scan images. The primary benefit of this Deep

Learning-based stage is to speed up the strategy of analysis and treatment of the COVID-19 sickness.

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