Automatic Detection Of Covid'19 Infection

by

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Introduction

- COVID-19 is a deadly disease caused by the newly diagnosed coronavirus. In December 2019, coronavirus (SARS-COV-2) infected the human body for the first time, and can be transmitted mainly to humans by droplets produced by an infected person people when talking, coughing or sneezing
- Other symptoms may be body aches, sore throat, and headache all possible symptoms.
- A Deep learning study of CNN has also been used to diagnose diseases, such as cancer, by image classification.
  - Observations:
    - So, the CNN models can be used to detect Coronavirus also, because they have some catastrophic effect on the lungs of the patients.

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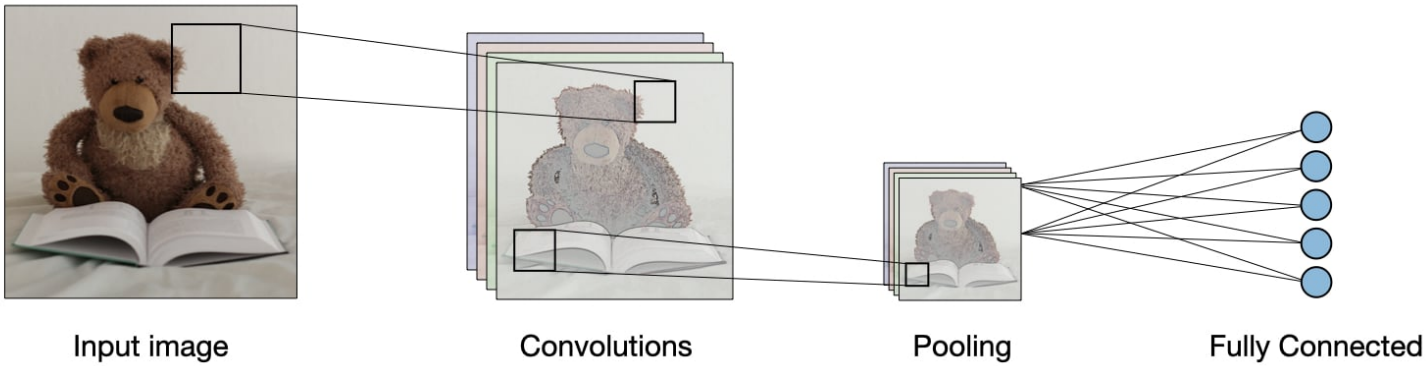
- According to WHO recommendations given in October 2020, chest examination is an effective way to detect clinical symptoms of affected people and recovered from the virus.
  - Currently, chest X-rays are widely used to diagnose of COVID-19 cases compared to CT image as it takes longer to think, and CT Scanners are not available in most developed countries.
  - A prediction framework has been used for the machine COVID-19 from Chest X-ray images. Unlike the classical approaches for the division of the following two medical image step process (manual feature release + recognition).
  - Models are based on deep learning (again especially convolutional neural networks (CNN)).

CNN Theory

- The formation of traditional Convolutional neural networks, also known as CNNs, is a type of neural network that usually consists of the following layers:



  - Types of layer:
  - Convolution Layer (CONV).
  - Pooling (POOL).
  - Fully Connected (FC).

Motivation

- Limited resources and accuracy constraints.
- Scalability and simplicity.
- Implementing the model for initial phase of detection.

Literature Survey

- Ohata et al.[1] they believe that the infection caused by the Coronavirus can turn into the Pneumonia, which can be detected by appropriate methods. They in turn proposed an automatic detection of Covid'19 infection using X-ray images. They applied the various CNN architecture on set of 194 Covid and 194 Healthy images along with consolidated machine learning methods, which in turn reached an accuracy of 96.5%.
- Ke et al.[2] apply the basic features of the image and analyze the functioning of the neural and heuristic network high efficiency, The overall accuracy was achieved to be: 79.6% in pretesting phase.
- Wang et al.[3] developed a model using ResNet-101 and ResNet-151 with fusion the effects of improving their weight ratio with strength, 96.31% accuracy was achieved during the testing phase.

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- Khan et al.[4] created a new structure for the discovery of X-ray images as COVID-19 or standard using in-depth study models such as ResNet50 The program the model in question has two phases such as advance preparation and data addition, and transfer read and finally showed 89.3% accuracy.
- Minnae et al.[5] reported a study-based framework for COVID-19 from chest X- ray images using three editing models such as ResNet18, ResNet50, SqueezeNet. This lead to an accuracy of 96%.
- Azemin et al.[6] used an in-depth learning approach based on the ResNet-101 CNN model. The accuracy of this method was only 71.9%.

Objectives

- Analysis of data set and data prepossessing to better visualize the data set, to perform feature extraction on the data set.
- To design a efficient Model Architecture that implement the detection by minimising the errors and maintain good accuracy.
- Selecting the algorithm for feature extraction that gives us accurate result.
- Selecting the top models that have a high accuracy and take all the top models to predict the final result.

Methodology

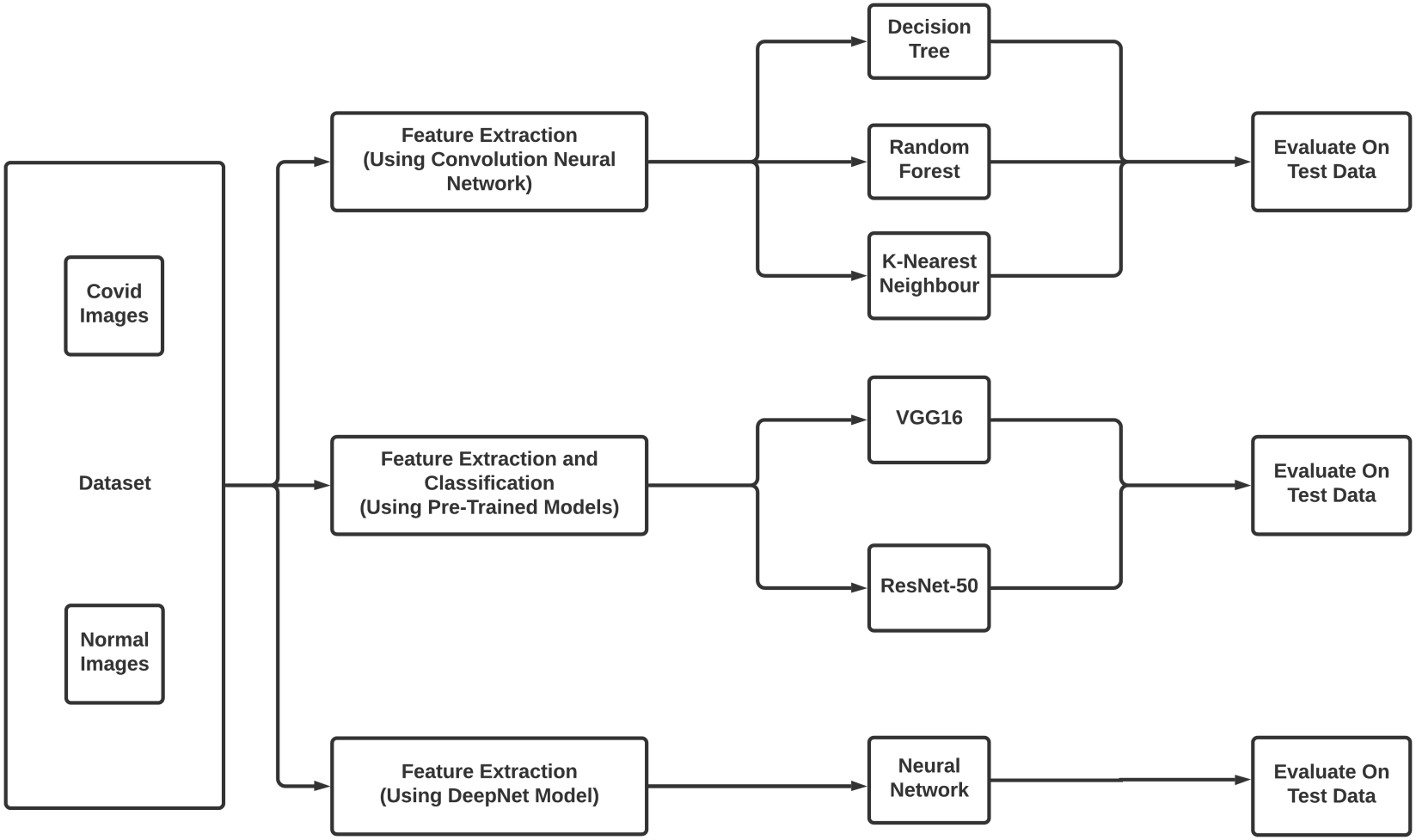

Figure: System block design diagram

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Data Preprocessing and Exploratory Analysis

- In our project, it contains frontal-view chest X-ray images. It is divided into two classes Covid and Normal: The X-ray images collected are of patients that diagnosed with Covid and X-rays images of healthy patients.
- The number of images were collected from open source dataset, and it contains 125 Covid images and 500 Normal images.
- These images were passed as input to feature extractor and it is also labelled as Covid and Normal represented as 0 and 1 respectively.

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Feature Extraction And Classification

- Different algorithm have its own criteria for finding the best feature. So, we had find the most common feature from all the feature extraction algorithm.
- In this project we will use three different feature extraction and classification algorithms one by one to obtain better results. These are **Convolutional Neural Networks**, **Pre trained models** and **DeepNet Model** are used as feature extraction and classification.

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Using CNN Architecture

- **Step 1:** Firstly, we select different CNN architectures that achieved excellent performance on the data set.
- **Step 2:** Secondly, we choose different configurations, previously trained on data set, from the selected CNN architectures.
- **Step 3:** Thirdly, we remove fully connected layers from these configurations, leaving only convolutional and pooling layers.

Figure: Proposed CNN Architecture

- Where C is Convolution layer, B is Batch Norm layer, and M is Max Pooling layer.

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Using Pre-trained CNN Models

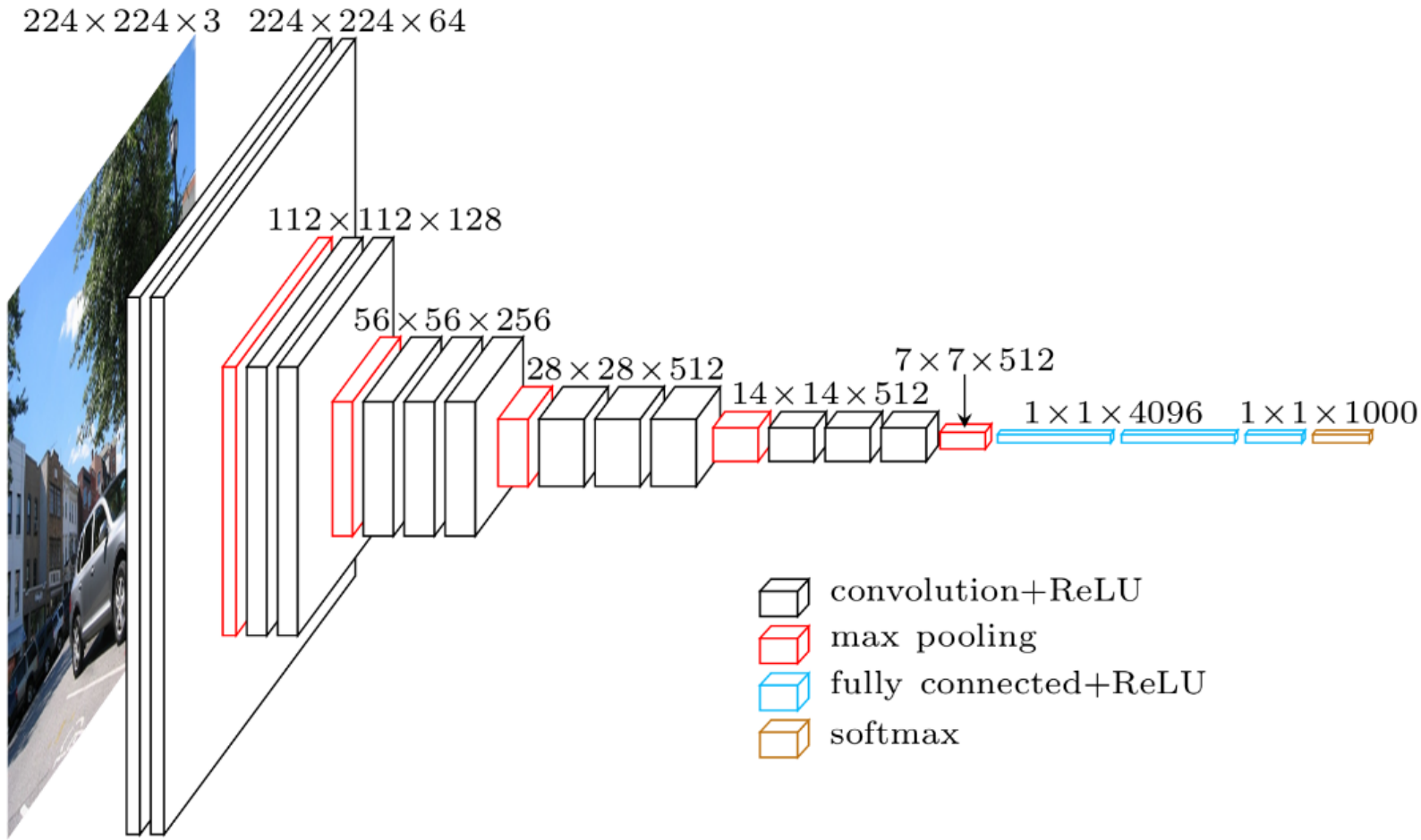

Figure: VGG16 Architecture

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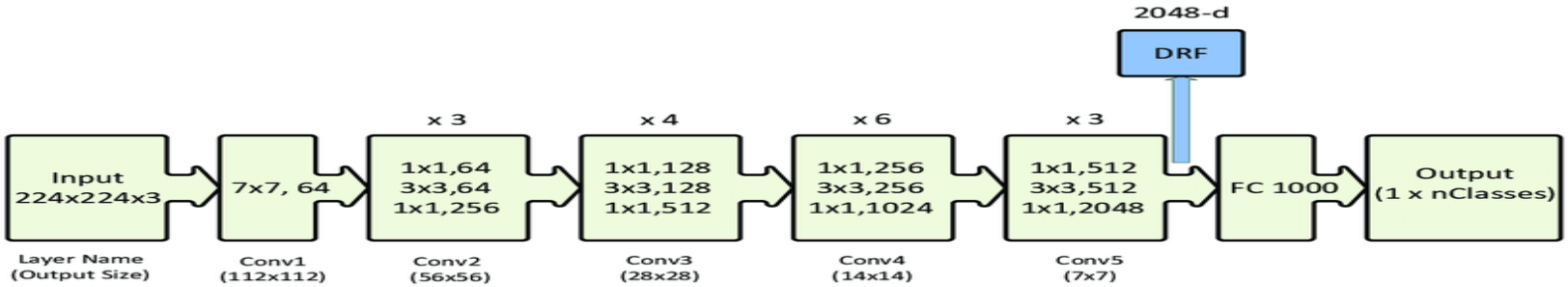

Figure: ResNet-50 Architecture

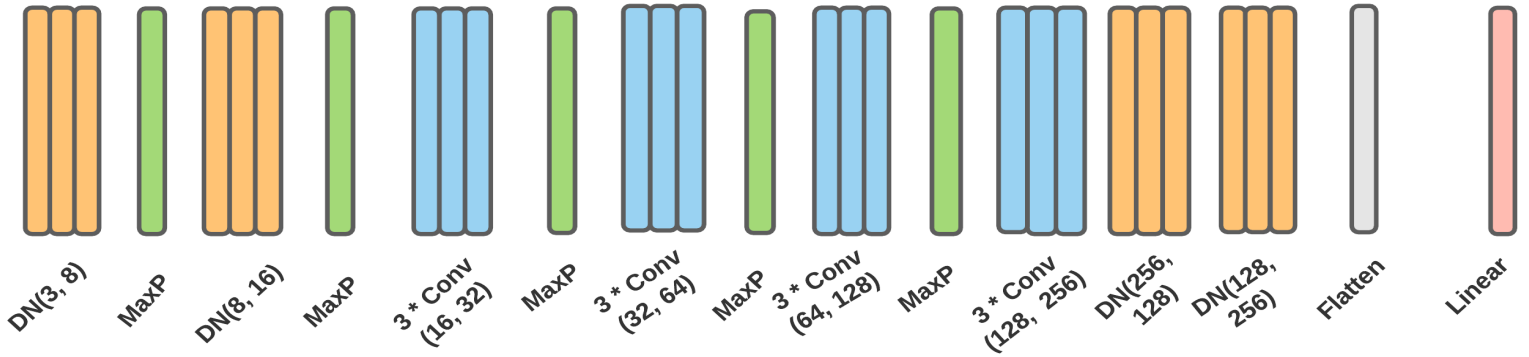

Figure: DeepNet Architecture

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- A typical CNN structure has a convolution layer that extracts features from the input with the kernal applies over it, a pooling layer to reduce the size for computational performance, and a fully connected layer, which is a neural network.
- The proposed model has 17 convolution layers. In each DN (DarkNet) layer has one convolutional layer followed by BatchNorm, and LeakyReLU operations, while each 3 Conv layer has the same setup three times in successive form.
- The leaky-ReLu function is used as an activation funtion in the DeepNet Architecture. The calculation is given below in the equation:

$$f(x) = \begin{matrix} 0.01x & \text{for } x \leqslant 0 \\ x & \text{for } x > 0 \end{matrix} \tag{1}$$

Where, x represents the outputs of last layer.

Training and Testing Of Model

For CNN Architecture

- **Decision Tree:** Decision Tree is a Supervised learning algorithm applied to Classification problems. A choice tree effectively asks a question and then divides the tree into sub-trees based on the answer (Yes/No).
  Accuracy: 92.06%

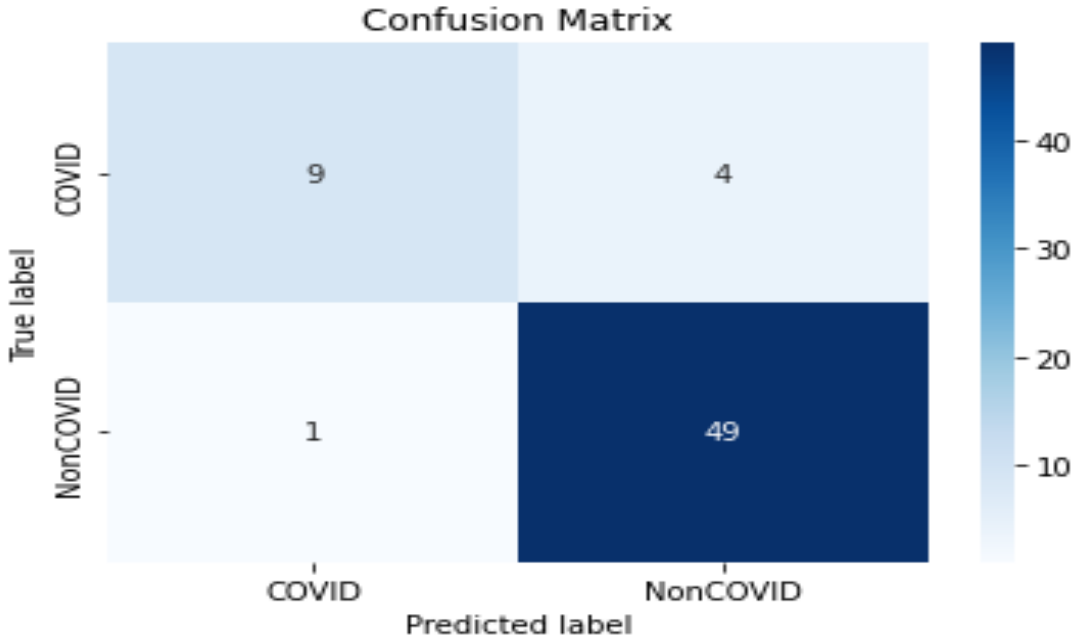

Figure: Confusion Matrix For Decision Tree

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- **Random Forest:** Random forest algorithm can be used for both regression and classification problems. It uses ensemble learning technique that combines various classifier to produce solutions. Each decision tree gives the output of the class and majority votes are taken as output.
  Accuracy: 95.23%

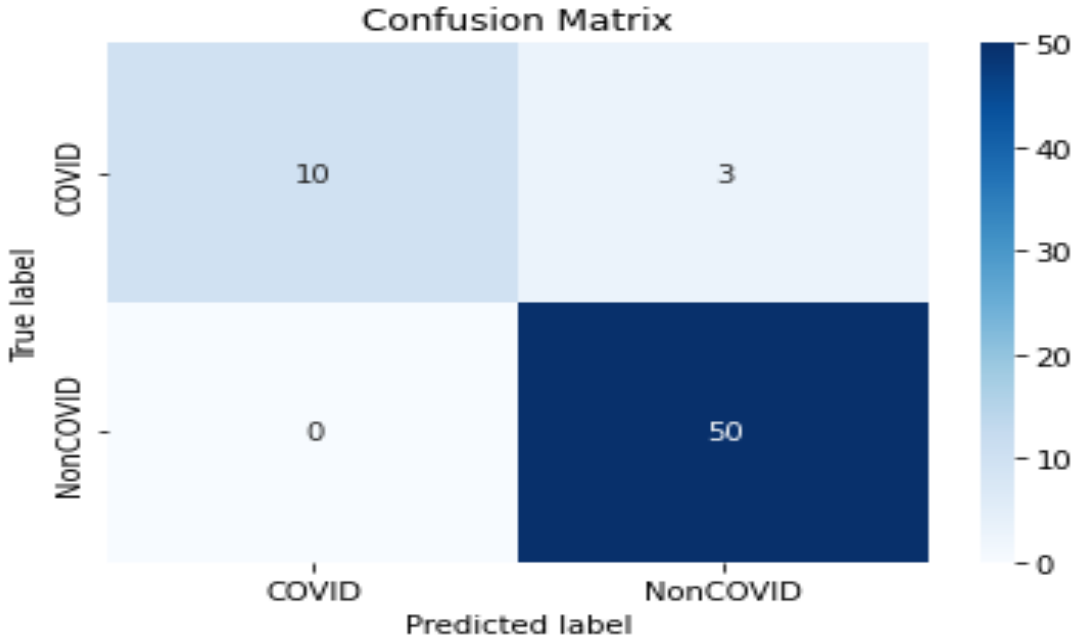

Figure: Confusion Matrix For Random Forest

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- **K-Nearest Neighbour:** K-Nearest Neighbors algorithm(K-NN) is a Supervised Learning algorithm.K-NN method considers the similarity between new and existing data and allocates this new example to a category that fits the existing categories.
  Accuracy: 95.19%

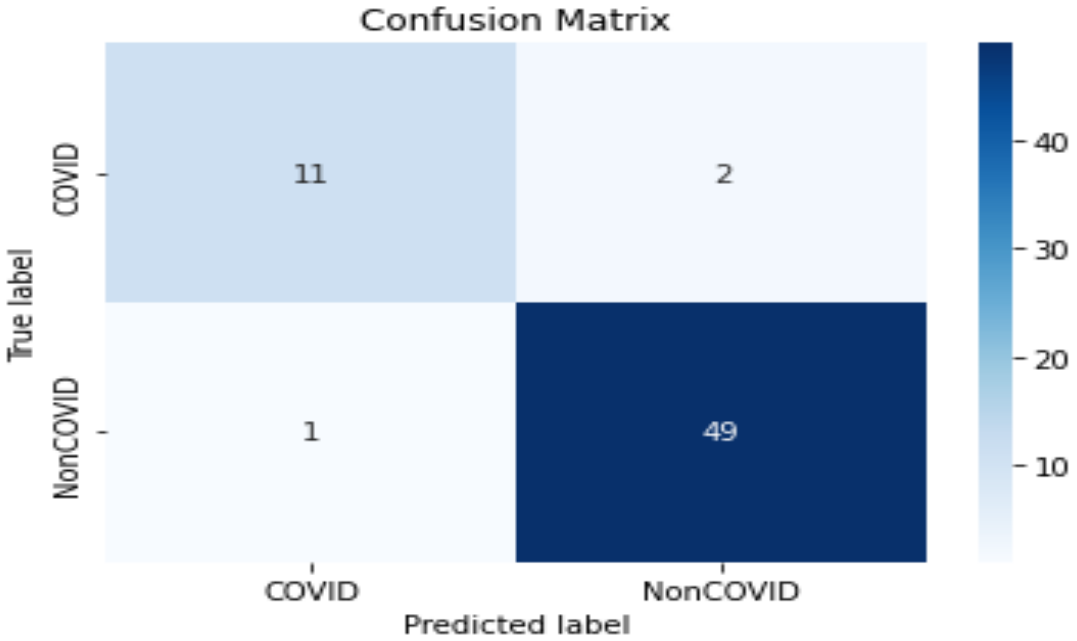

Figure: Confusion Matrix For K-Nearest Neighbour

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For Pre-trained CNN Models

- **VGG-16:** This model works in two ways: Firstly, it extracts feature from images and Secondly, it applies ANN for classification of various classes.
  Accuracy: 95.89%

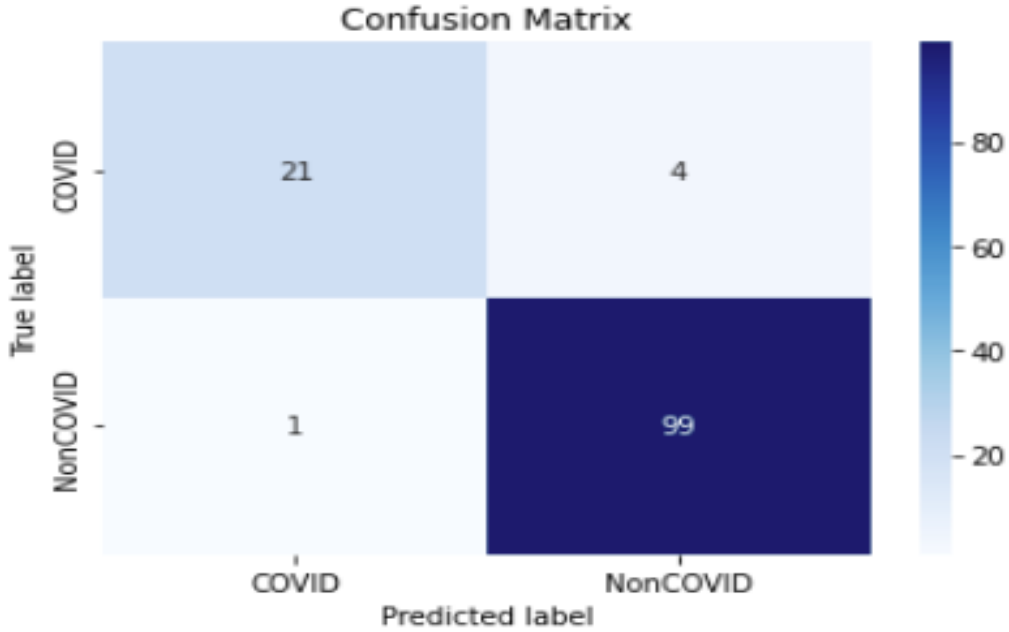

Figure: Confusion Matrix For VGG-16 Architecture

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- **ResNet-50:** It is a pre-trained model based on ImageNet database. It applies the concepts of residual blocks to increase the accuracy. In which previous input is added to the next layer to increase the accuracy.
  Accuracy: 76.25%

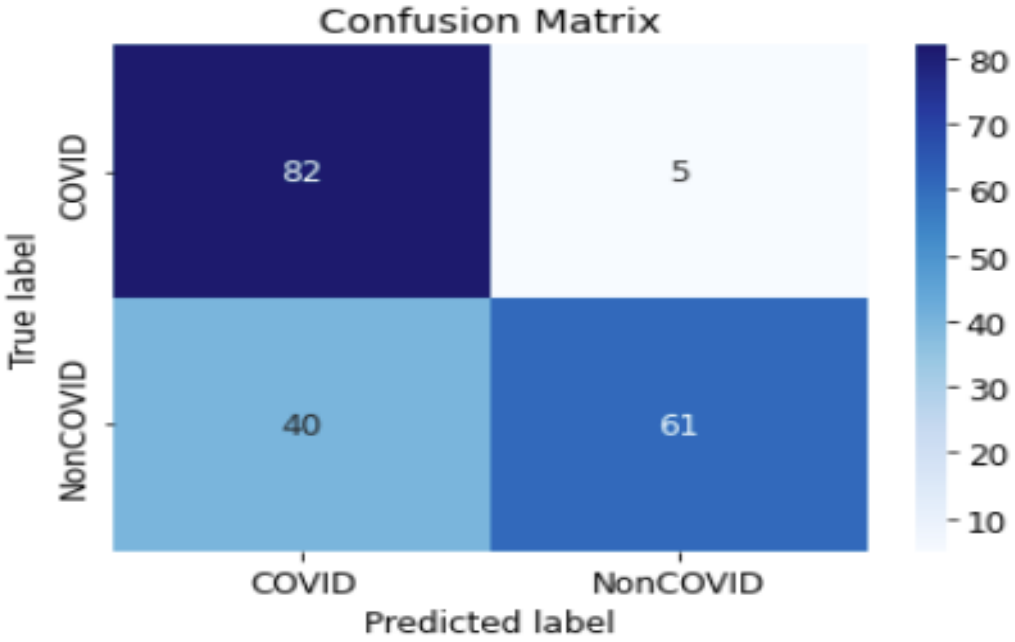

Figure: Confusion Matrix For ResNet-50 Architecture

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For DeepNet Architecture

- **DeepNet:** It uses ANN as a classifier after the feature extraction part is done. The major difference in this model is eliminating the Dead-Neuron Problem that was occurring in the Resnet and proposed CNN Architecture.
  Accuracy: 96.82%

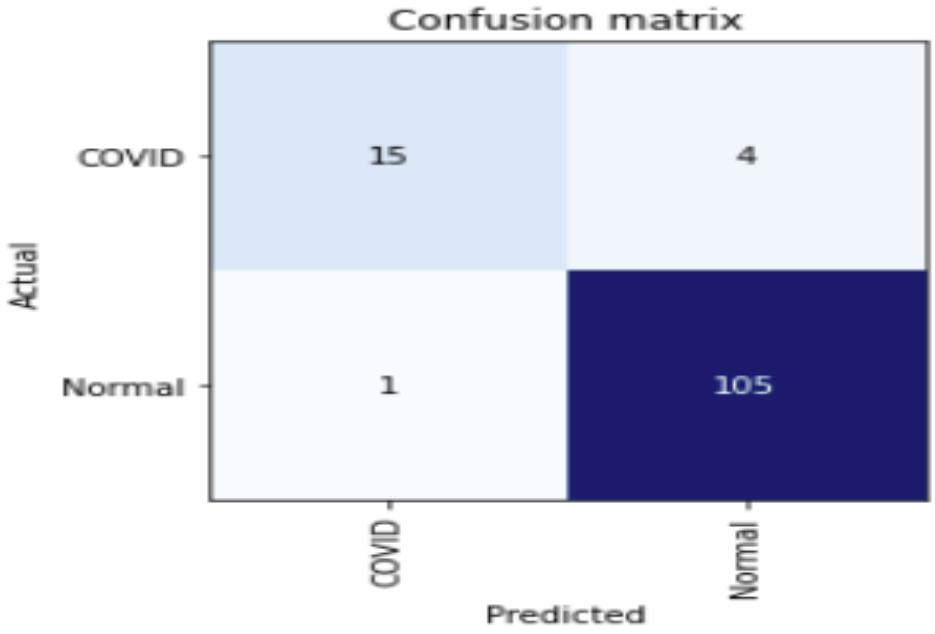

Figure: Confusion Matrix For DeepNet Architecture

Results and Discussion

- The main objective of our research project is to find the best combination of feature extraction and classifiers among all. To measure the performance of these techniques Confusion Matrix is drawn.

Table: Comparison table of Results

Feature Extraction	**Classifier**	**Accuracy**
CNN Architecture	Decision Tree	92.06
CNN Architecture	Random Forest	95.23
CNN Architecture	K-NN	95.19
VGG-16	NN	95.89
ResNet-50	NN	76.21
DeepNet	NN	96.82

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- On the Test Dataset, all model metrics are observed, as indicated in Table We can observe that the DeepNet Architecture with NN gives us the best Accuracy score of 96.82%, while the ResNet with NN gives us the least accuracy score
- After considering both Accuracy score the best possible combination of feature extraction and classifier is DeepNet Architecture with NN is best. So, it is selected as the preferred model for our project.
- Also, the total false positive rate of the proposed study is very low. So, this is the best among all available proposed methods.

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Table: Comparison of proposed COVID-19 diagnostic method with other deep learning methods developed using Radiology Images

Study	**Number of Cases**	**Method Used**	**Accuracy**
Ioannis et.al	224 Covid (+) 504 Healthy Images	VGG-19	93.48
Wang et.al	53 Covid (+) 8066 Healthy Images	COVID-Net	92.4
Sethy et.al	25 Covid (+) 25 Covid(-)	ResNet and SVM	95.38
Azemin et.al	344 Covid (+) 705 Healthy Images	ResNet-101	71.9

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Study	**Number of Cases**	**Method Used**	**Accuracy**
Narin et.al	50 Covid (+) 50 Healthy Images	DeepCNN and ResNet-50	98
Ke et.al	336 Covid (+) 336 Healthy Images	CNN	79.06
Khan et.al	20 Covid (+) 224 Healthy Images	VGG16, DenseNet121, AlexNet	88.3
Proposed Study	125 Covid (+) 505 Healthy Images	DeepNet and NN	96.89

Conclusion and Future Work

- In this project our main objective was to develop a platform for detecting of such viruses. These identification and detection methods early can protect patients and it can be life saving too.
- Our developed system is able to perform binary classification tasks with an accuracy of 96.82%.
- The system can be used in remote places in countries affected by COVID-19 to overcome a shortage of radiologists. Also, such models can be used to diagnose other chest-related diseases including tuberculosis and pneumonia.
- Although this project has broad scope, as with every research effort, there are other areas that can be further pursued.
- We can draw the HeatMap for such cases, so that it can be interpreted easily and the patients can be separated before spread of such viruses. So, this controls the amount of spread of such viruses.

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