Automatic Detection of Lungs Infection

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Abstract- LUNG'S INFECTION is considered to be the most dangerous and fatal disease in the human body caused by the novel coronavirus. In December 2019, the coronavirus spread rapidly worldwide, he is thought to have come from Wuhan in China and has a great responsibility death toll. In this project, I proposed an automatic detection method for coronavirus infection based on X-ray images. Since, there are many detection techniques already been proposed based on Convolutional Neural Networks (CNN). But these techniques and analysis many times failed to detect in an unknown image and accuracy is also a major issue. In this project, we will analyse the different detection methods such as Neural Networks (NN), K-Nearest Neighbour (KNN), Decision Trees, Random Forest for the detection of the virus and also implement detection making the use of Convolution Neural Networks and pre-trained models for feature extraction based on deep learning. We will be doing semantic analysis for such viruses. The results showed that the extractor-classifier pair with the best performance is DarkNet architecture with softmax as classifier, which achieves the accuracy of 96.82%. Thus, the results provides a chance of virus and a comparative analysis based on performance, accuracy.

Keywods: LUNG'S infection, X-Ray images, Machine Learning (ML), Deep Learning (DL), Convolution Neural Network (CNN), Decision Tree, K-Nearest Neighbour (KNN), Random Forest.

I.INTRODUCTION

1.1 Background

Lung infection is a deadly disease caused by the newly diagnosed coronavirus. In December 2019, coronavirus (SARS-COV-2) [1] infected the human body for the first time, and can be transmitted mainly to humans by droplets produced by infected person people when talking, coughing, or sneezing [2]. Although the exact timing is not yet known, a new study has estimated how, It can live on air up to 3 hours, copper for 4 hours, and up to 72 hours for plastic and non-corrosive iron. However, the exact answers to these questions are still not generally agreed upon the community is researching health and is currently under investigation. It attacks the lungs and damages the tissues of an infected person. In the first case, some people may not do it find any symptoms where most people had the flu and cough as the main symptoms. Other symptoms may be body aches, sore throat, and headache all possible. The proposed activity here provides a structured machine learning architecture systematically detecting such infection using chest X-ray images. This approach suggests a combination of features extracted by convolutional neural networks and passed to various machine learning algorithms for the classification. Currently, this infection is increasing daily due to undiagnosed detection methods. Globally, a large number of people died from the disease by 2020. Chest X-ray is promising in urgent cases and treatment due to the speed of operation, cost, and convenience of radiologists. Even World Health Organisation (WHO) also suggested to implement these methods. A prediction framework has been used for the machine to detect from Chest X-ray images. The rest of the project work is done as follows: A review study on the classification of chest X-ray images is given in section 2. Section 3 describes the system methodology used to identify lung infection from X-ray images. Section 4 represents the results and their analysis obtained from this work. After that, Section 5 discusses validation, comparison per performance, and limitations of the proposed system in obtaining lung infection. Finally, the conclusions extracted from this study will be represented in Section 6.

1.2 Motivation

My motivation for working on this project is to create a simple and effective virus detection system. Patients can be protected and millions of lives can be saved by early detection. As a result, developing a framework that can accurately detect infections like these is

crucial. As a result, safeguarding humans from such infections is critical in this sector. Existing physical detection technologies, such as RT-PCR and Antigen tests, are used to detect viruses, but they have low sensitivity and are time consuming, allowing emerging strains to go undetected. To address these challenges, I proposed using Machine Learning (ML) models to detect the virus using behavior-based, change based, and anomaly-based methods.

1.3 Abbreviation

The common abbreviation is: Machine Learning (ML), Deep Learning (DL), Convolution Neural Network (CNN), Decision Tree, K-Nearest Neighbour (KNN), Random Forest.

II.LITERATURE SURVEY

2.1 literature review

To move forward the most important step is the literature survey. The outcome of literature survey show that the author: Ohata etal.[3] they believe that the infection caused by the Coronavirus can turn into the Pneumonia, which can be detected by ap propriate 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 lung infection and 194 Healthy images along with consolidated machine learning methods, which in turn reached an accuracy of 96.5% Accuracy. Ke et al.[4] apply the basic features of the image and analyze the functioning of the neural and heuristic algorithms. This method is divided into the following steps: Firstly, image basic characteristics are used to analyze the Neural Network and along with heuristic algorithms. The overall ac curacy was achieved to be: 79.6 %. And classification errors were: 3.23 percent of False Positive and 3.76 percent of False Negatives. Ke and their team believed that image classification can reduce the error caused by medical examinations. Motivated by the shortcomings of the existing methods, they proposed a clinical decision support system on (Neural Networks and Heuristic Algorithms). Image data-sets consists 336 healthy images and 336 pneumonia images [2]. Wanget al.[5] developed a model using ResNet-101 and ResNet-151 with fusion the effects of improving their accuracy. Separation of chest X-ray image is made based on three classes, as usual, lung infection and viral pneumonia. 96.1 percent accuracy was achieved during the testing phase. They believed that RT-PCR Testing is a gold standard, as it is a highly specific, very time consuming and complicated process. The sensitivity of this testing is somewhat poor. An alternative to this testing is radiographic examinations, where chest radiographic imaging is used. They also said that radiographic examination can also be used as a primary tool for screening in epidemic areas. Motivated by the urgent needs to fight against the epidemic and open-source efforts and research community they developed CovidNET using CoviX datasets (it consists of 5 open-source datasets). The accuracy achieved was; 93.3 %. Khan etal.[6] created a new structure for the discovery of X-ray images as Covid using pre-trained study models such as ResNet50, VGG16, VGG19 and DensNet121, where VGG16 and VGG19 showed better results. Finally showed 88.3 percent accuracy. Basically, they used a pre-trained model on imageNET (a large image visualization library). The selection of a deep learning model depends upon the ability of the model to extract the features. Their model was close to AlexNET. Minnae et al.[7] reported a study-based framework for Covid from chest X- ray images using four pre-trained models such as ResNet18, ResNet50, SqueezeNet and DensNet-121. The proposed method took the opportunity to add data to create a file for a modified version of Covid images, which increased the number of samples The total positive rate for RT-PCR is 30-60 percent which can lead to undiagnosed patients and further can lead effects to huge populations. During, the early course of Covid cases, a green glass pattern is seen in areas that edge to pulmonary vessels. Such, patterns can be only be interpreted by experts radiologists. Automatic detection can subtly help in the increase the rate of detection. The datasets used were 19 X-ray images and Covid X-ray-5K which has 2000 training images and 3000 testing images, and instead of traditional deep learning methods they used a pre-trained library for feature extraction and classification. This lead to an accuracy of 96%. Azemin et al.[8] used an in-depth learning approach based on the ResNet-101 CNN model. In their proposed method, thousands of images were used in the pre-training phase to visualize patterns and re-training to find abnormalities in chest X-ray images.

The accuracy of this method was only 71.9%. From the literature survey the research gaps we found will define the objectives of our project

2.2 Objectives

The main objective is to Detect the possibility of any image is virus affected or not. Even, if it is newly developed using the information present in our data set with improved accuracy. It can be divided into different sub task.

• Analysis of data set and data prepossessing to better visualize the data set, per form feature extraction on the data set for different classifiers, prediction by using various machine learning models.
• 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.

III.METHODOLODY

3.1 SYSTEM Block Design Diagram

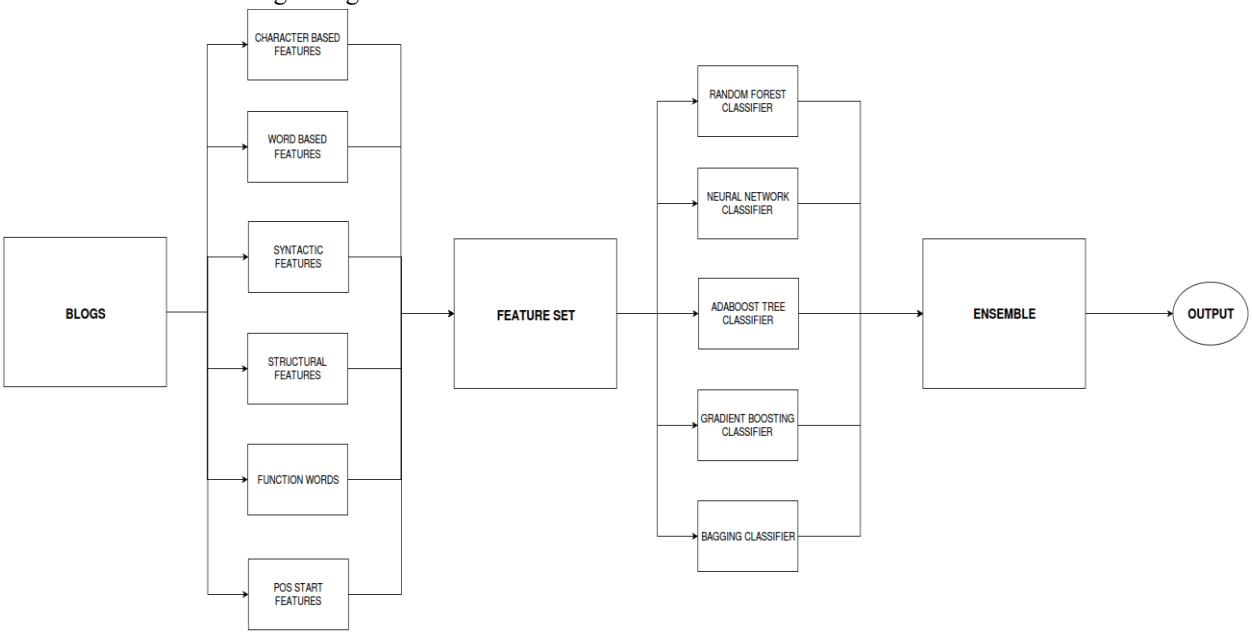


Figure 3.1: System Block Diagram

3.2 System Architecture

The Architecture of the Project is divided into Various Sub-tasks. The various subtasks performed in this Project are mention below-

3.2.1 Data pre-processing and Exploratory Data 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. All the images were in Portable Networks Graphic Format (PNG) of dimensions 224 * 224 pixels to 500 * 300 pixels. Meanwhile it is pre-processed to that size. These images were passed as input to feature extractor and it is also labelled as Covid and Normal represented as 0 and 1 respectively.

3.2.2 Feature and Feature Vector

The following is how features are obtained and mapped into classifier:

Feature: It is a single, independent value that is contained in a picture and serves as an input to the system. In this scenario, we have photos, thus the feature can be edges, shape, brightness, and so on, which serve as a numerical input to the system.

Feature Vector: In machine learning, a feature vector is an n-dimensional vector of numerical elements that characterise anything in a pattern recognition.

Essentially, it's a vector that represents a certain observation in a specific order.

3.2.3 Feature Extraction and Classification

There are a lot of features in this data set. Now, out of all the features, we must identify the most crucial and relevant one. To obtain the best characteristics, a variety of feature extraction algorithms can be applied. Each algorithm has its own set of criteria for determining the best feature. So, out of all the feature extraction algorithms, we had to discover the most common feature. The stage of selecting the most critical features in Covid detection is critical since it has a significant impact on the quality of the experimental outcomes. Working on a low-dimensional feature vector with solely discriminatory features will also help to lower the computing cost of the learning classifier. We will utilise three distinct types of models in this project, feature extraction and classification algorithms one by one to obtain better results. These are Convolutional Neural Networks, Pre- trained models and DeepNet Models are used as feature ex traction and classification.

3.2.3.1 Using CNN Architecture

The Images is fed through the CNN Architecture, which returns the optimal subset of features for the machine learning based classifier. Basically, a CNN architecture works on the two parts: Firstly, it does the Feature Ex traction and Secondly, it does the classification. The features are later used in a second network/classifier that will process its classification. In order to turn a CNN architecture to a feature extractor, below are the steps to perform. The following are steps involved in the feature extraction using Convolutional Neural Networks:

Step 1: Firstly, we select different CNN architectures that achieved excellent performance on the dataset.

Step 2: Secondly, we choose different configurations, previously trained on dataset, from the selected CNN architectures.

Step 3: Thirdly, we remove any fully connected layers from these configurations, leaving only convolutional and pooling layers. These two types of layers are responsible for extracting features from the image, while the fully connected ones are responsible for classifying the features and, consequently the image.

Step 4: Thus, removing these layers is necessary to turn a CNN into a feature extractor. After this step, the new output of the adapted CNN is a set of features extracted from an input image.

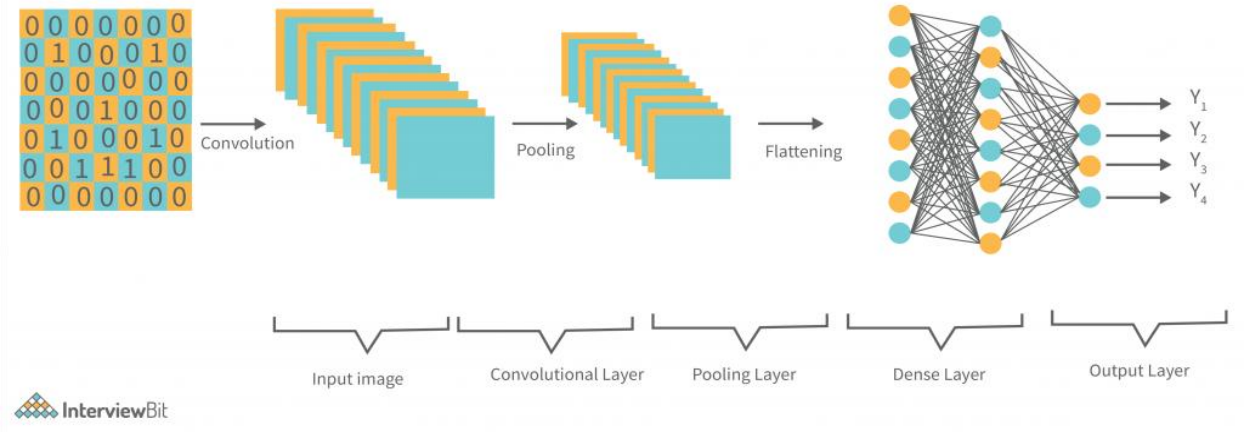


Figure 3.2: Proposed CNN Architecture.

3.2.3.2 Using Pre-Trained CNN Models

The ImageNet Large Scale Visual Recognition Challenge (ILSVRC) is a computer vision competition that takes place once a year. Teams compete on tasks every year. One of the primary challenges was classification, in which they used 1000 classes of such photos and produced the output vector of such classes.

3.2.3.3 VGG16

The VGG16 is an ImageNet-trained model (large image visualisation library). As a classifier, this model utilizes 13 convolution layers, 5 max pooling layers, and 3 fully connected layers with softmax activation. To produce the effect of the convolution layers, an offline ReLU activation function was applied. The

ReLU is used to pass the information as it travels through the network. Following that, pool layers were engaged to minimise the readable parameter. It has 1000 categories with relevant features. [9]

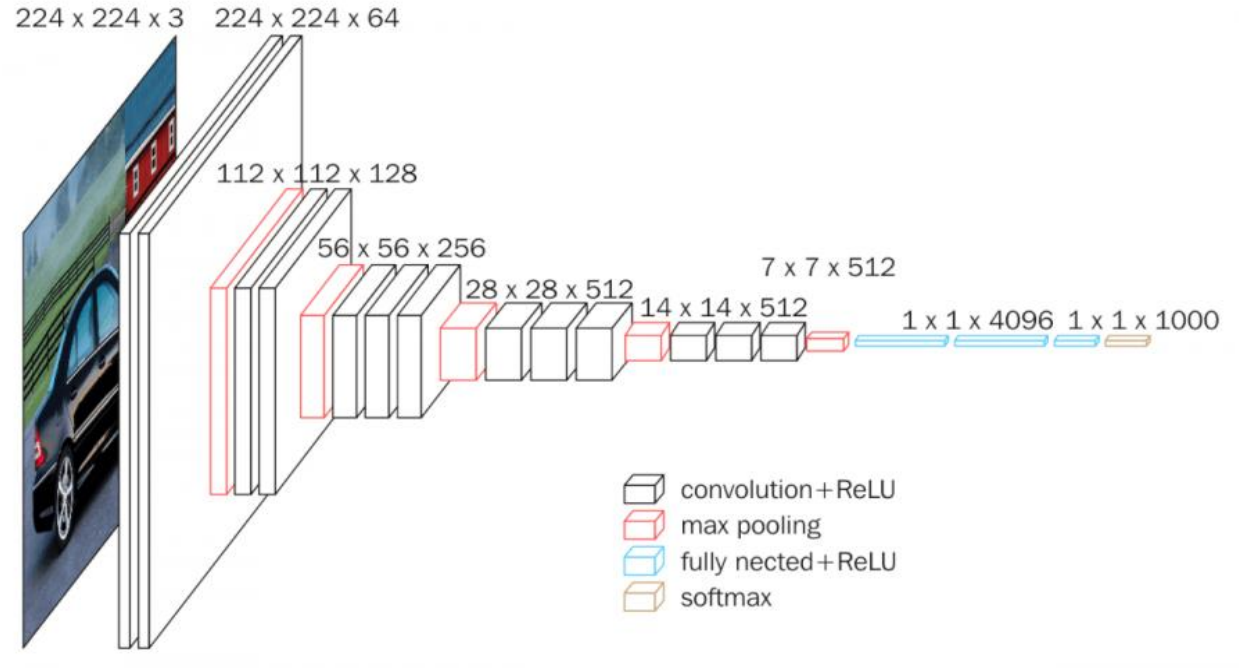


Figure 3.3: VGG16 Architecture.
[https://neurohive.io/en/popular-networks/vgg16/]

3.2.3.4 ResNet50

Pre-trained ResNet, one of the models utilized in this research, was trained in the ImageNet database. It's a network with a number of residual connections. *Database*, it was originally trained on 152 layers. It took first place in the ILSVRC's 15 competition. The Vanishing Gradient Problem was reduced using this model. The solution is to use the previous layer's input as the new layer's input. There are 48 convolution layers, one max pooling layer, and one average pool layer in this image.

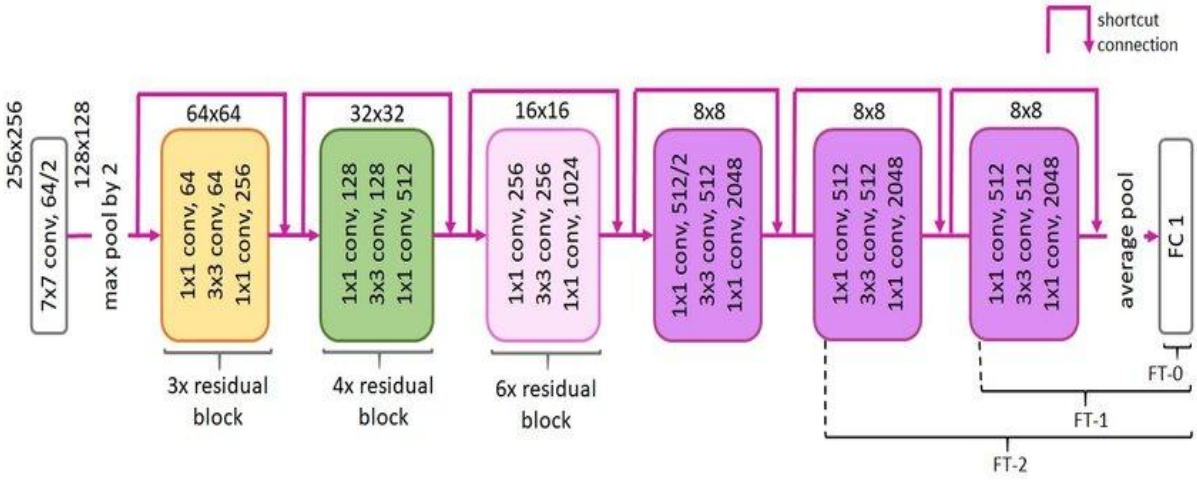


Figure 3.4: ResNet-50 Architecture.
[https://share.google/images/5LhVn2p94BP7Ihv24]

3.2.3.5 Using DeepNet Model

The term "deep" refers to the network's size increasing as the number of layers increases. The structure is named after the mathematical operator convolution. A typical CNN structure includes a convolution layer that collects features from the input while the kernel is applied, a pooling layer that reduces the size for better computational performance, and a fully connected layer that is a neural network. A CNN model is produced by integrating one or more of these layers. It solves the issue of the Dead Neuron. As a result, the model's accuracy is effectively increased. There are 17 convolution layers in the proposed model. Each DN (DarkNet) layer has one convolutional layer, BatchNorm, and LeakyReLU operations, and each 3 Conv layer has the same setup three times in succession.

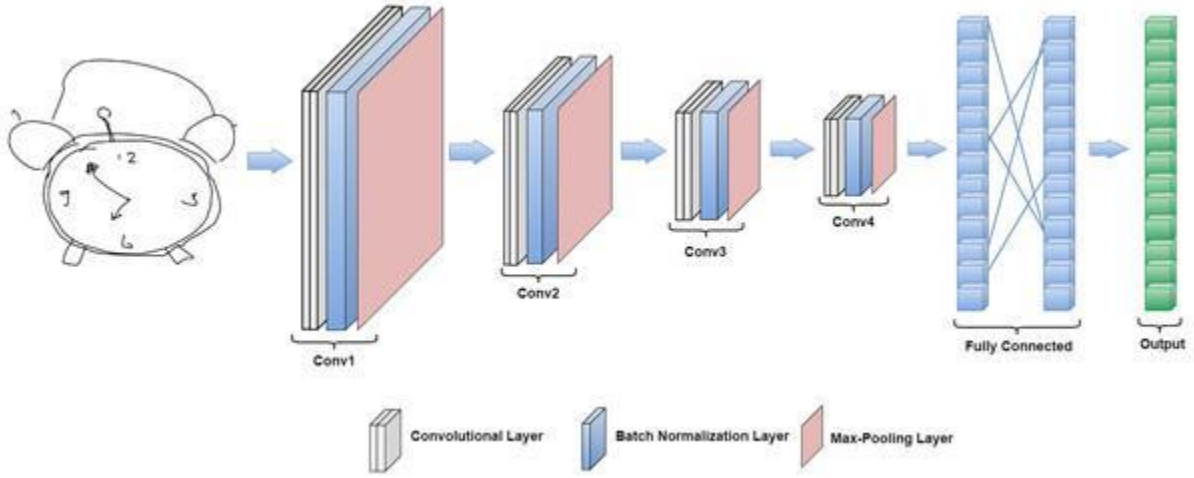


Figure 3.5: Proposed DeepNet Model.

The leaky-ReLu function is used as an activation function in the DeepNet Architecture. The calculation is given below in the equation.

f (x) = 0.01x for x ⩽ 0 x (3.1) for x > 0

Where, x represents the outputs of last layer.

3.2.4 Training and Testing Our Model

For Training the Model we have implemented different Models and compare their ac curacy score to get the best combination of feature extraction method and model out of it.

3.2.4.1 For CNN Architecture

a. Decision Tree:

A decision tree is a supervised learning method that is used to classify problems. It's a tree-organized classifier with an internal core that highlights the data set. The test or the selections are made based on the dataset's highlights. It's called a choice tree because it's shaped like a tree: it starts with a root hub, expands into branches, and eventually becomes a tree. A choice tree asks a question and then divides the tree into sub-trees based on the response (Yes/No).

Accuracy: 92.06%

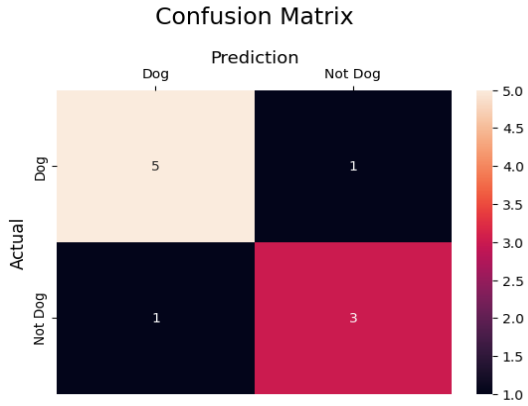


Figure 3.6: Confusion Matrix For Decision Tree

b. Random Forest: Both regression and classification problems can derive from the Random Forest algorithm. It employs an ensemble learning technique that combines multiple classifiers to get results. Many decision trees make up a random forest. It arrived at a conclusion based on decision tree predictions. The result of each decision tree is the class's output, which is determined by the majority vote. It comprises the

use of bagging processes to produce the desired output.

Accuracy: 95.23%

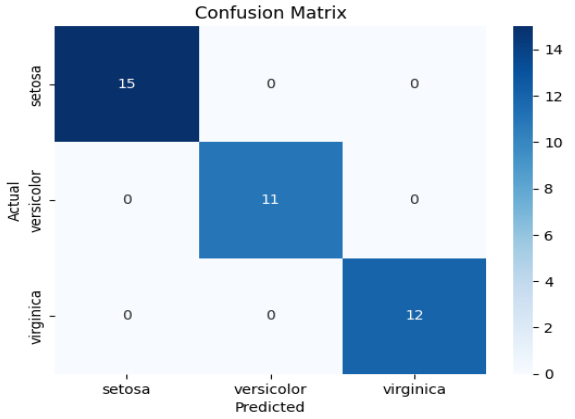


Figure 3.7: Confusion Matrix For Random Forest

c. K-Nearest Neighbour: K-Nearest Neighbours algorithm (K-NN) is a Supervised Learning algorithm. The K-NN approach takes into account the similarity between new and old data and assigns this new sample to one of the existing categories. This algorithm collects all existing data and uses similarity to try to find new data points. As a result, the K-NN method can classify any new data into a suitable category or class in a fraction of a second. It can be used to address classification and regression problems.

Accuracy: 95.19%

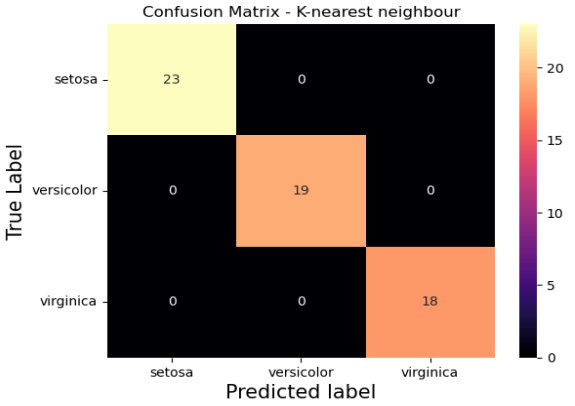


Figure 3.8: Confusion Matrix For K-Nearest Neighbour

3.2.4.2 For Pre-Trained Models

a. VGG16: It is a pre-trained model based on ImageNet database. 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%

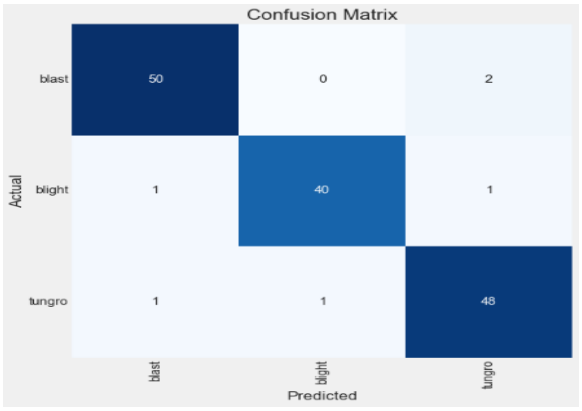


Figure 3.9: Confusion Matrix For VGG16 Architecture

b. ResNet50: It is a pre-trained model based on ImageNet database. This model works in two ways: Firstly, it extracts feature from images and Secondly, it applies ANN for classification into various classes with the help of Flatten Layer and outputs classes accordingly. It applies the concepts of residual blocks to increase the accuracy.

Accuracy: 76.25%

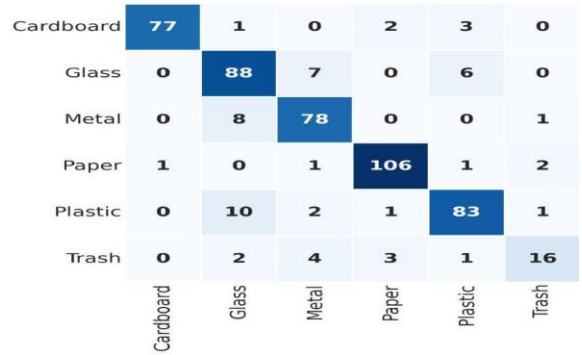


Figure 3.10: Confusion Matrix For ResNet-50 Architecture

It uses ANN as a classifier after the feature extraction part is done.

Accuracy: 96.82%

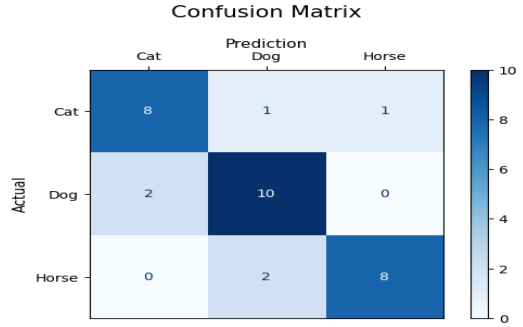


Figure 3.11: Confusion Matrix for DeepNet Architecture

3.3 Implementation

Implementation of Various Machine Learning Models and Feature Extraction is done using various ML Libraries.

3.3.1 Tools and Library Used

1. Numpy- In the project, the NumPy library is utilised to deal with a wide collection of high-level mathematical functions that operate on arrays.
2. Matplotlib- The photos and graphs are plotted using the Matplotlib library.
3. SkLearn- Sklearn is a library that contains numerous machine learning algorithms that are used in the project, such as Decision Tree.
4. Pandas- Pandas is a data manipulation and analysis software library for the Python programming language. It includes data structures and methods for manipulating nu merical tables and time series, in particular.

IV.RESULTS AND DISCUSSION

This section describes the results of our experiment, which involves three different fea ture extraction techniques and 4 different classifiers: Decision Tree, Neural Networks, K-Nearest Neighbour's, Random Forest. The main objective of our research is to find the best combination of feature extraction and classifiers among all. To measure the performance of these techniques Confusion Matrix is drawn.

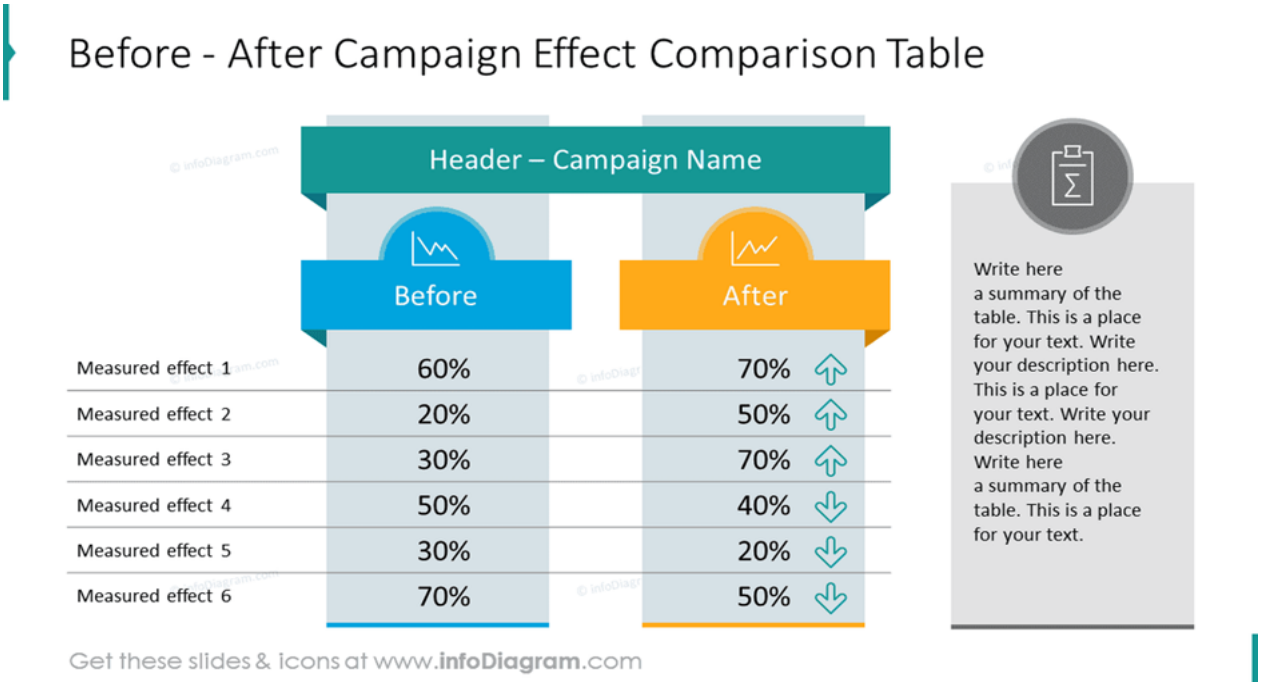
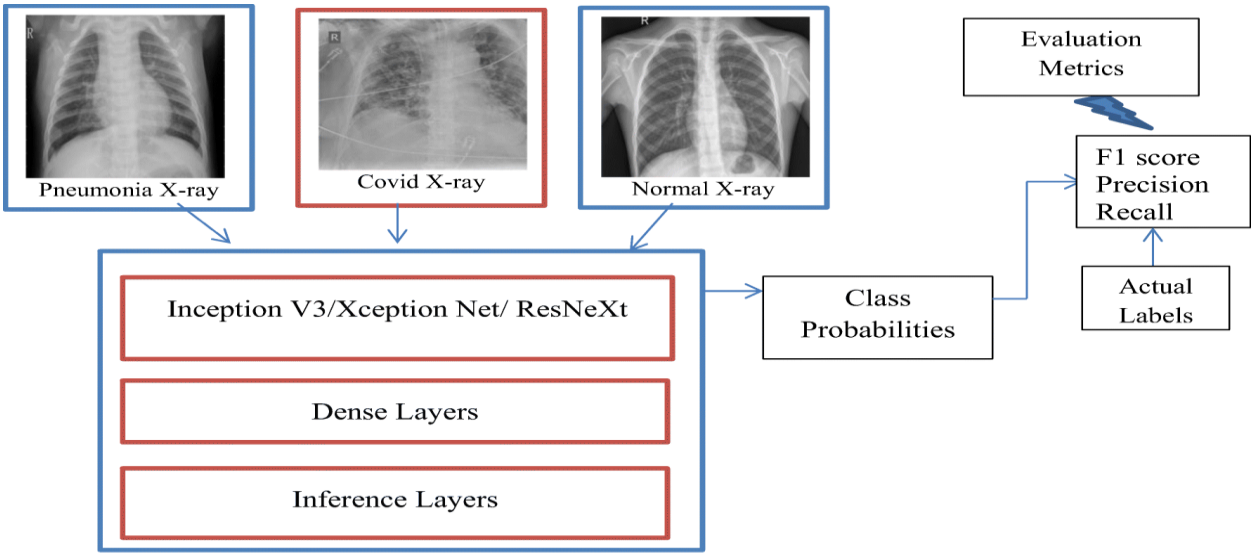


Table 4.1: Comparison table of Results

On the Test Dataset, all model metrics are observed, as indicated in Table 4.1. 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. The accuracy of a model is determined by how well it recognises correlations and patterns between variables in a dataset using the input, or training, data. The greater the value of accuracy, the more accurate model it is. After considering both Accuracy score the best possible combination of feature extraction and classifier is DeepNet Architecture with NN with Accuracy score. So, it is selected as the preferred model for our project. However, Random Forest, K-Nearest Neighbour also give us appreciable amount of accuracy with 92% and 95%, but the DeepNet architecture perform better. So, it is selected. Also, the total false positive rate of the proposed study is very low. So, this is the best among all available proposed methods.

Table 4.2: Comparison of proposed COVID-19 diagonostic method with other deep learning methods developed using Radiology Images



4.1 Conclusion

Our main goal in this project was to create a framework for detecting infections like these. These early detection and identification approaches can both safeguard and save patients' lives. As a result, developing a framework that can reliably detect viruses is crucial. With a 96.89% accuracy rate, our developed system can perform binary classi f ication tasks. Since they are easily available for medical diagnosis, X-ray radiographs are favoured. Without the need for manual feature extraction, our model is totally auto mated and has an end-to-end structure. The technique can be employed in remote areas of COVID-19-affected countries to alleviate a population scarcity. Our model has an end-to-end structure that eliminates the need for manual feature extraction. To over come ashortage of radiologists in COVID-19-affected countries, the technology can be employed in remote locations. Other chest-related disorders, such as tuberculosis and pneumonia, can also be diagnosed using such models. The study's usage of a restricted number of COVID-19 X-ray pictures is a restriction. We plan to use additional such photos from our local hospitals to make our model more robust and accurate.

V.FUTURE WORK

Although the scope of this project is extensive, like with every research project, there are additional areas that might be investigated further. Extending this research by in cluding other feature extraction approaches could be a viable option for this project. Feature validation with a different set of classifiers would also be interesting. Another possibility is to widen the study by changing the ensemble voting method to include other similarity algorithms in addition to Euclidian distance. These would not change the experimental outcomes, but they might provide novel insights and interpretations. For such circumstances, we may create a HeatMap that can be simply compre hended and the patients can be isolated before the infection spreads. As a result, the propagation of such viruses is confined. Finally, if such problems arise in the future, this project can be improved to address them.

VI.ACKNOWLEDGEMENTS

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mentors always answered myriad of our doubts with smiling graciousness and prodigious patience, never letting us feel that we are novices by always lending an ear to our views, appreciating and improving them and by giving us a free hand in our project. It's only because of their overwhelming interest and helpful attitude, the present work has attained the stage it has. Finally, we are grateful to our Institution whose constant encouragement served to re new our spirit, refocus our attention and energy and helped us in carrying out this work.

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