KLE Society's
KLE Technological University, Hubballi.

A Minor Project Report

On

Covid-19 Detection using Chest X-Ray Images

submitted in partial fulfillment of the requirement for the degree of

Bachelor of Engineering

In

School of Computer Science and Engineering

Submitted By

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SCHOOL OF COMPUTER SCIENCE & ENGINEERING

CERTIFICATE

This is to certify that Minor Project titled "Covid-19 Detection using Chest X-Ray Images" is a bonafied work carried out by the student team comprising of Mr. Mohammed Tousif Adhoni (01FE19BCS401), Mr. Suraj Meharwade (01FE19BCS420), Mr. Manjunath Mankani (01FE19BCS421), Mr. Gagandeep Ramgiri (01FE19BCS423), Mr. Shahid Afrid Hasnabadi (01FE19BCS431), for partial fulfillment of completion of sixth semester B.E. in Computer Science and Engineering during the academic year 2020-21.

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ABSTRACT

COVID-19 early diagnosis has a substantial impact on reducing COVID-19 transmission at a faster rate, and it is the need of the hour. The automatic diagnostic using Deep Learning models trained with Chest X-Ray images is a new promising method that helps in early prediction and identification of COVID infected persons.This project, titled "COVID-19 Detection Using Chest X-ray Images," introduces a technique for recognising coronavirus from chest X-rays. We took chest x-ray scans of covid-19-affected patients, pneumonia-affected patients, and healthy patients for this study. We compared the performance of CNN models based on deep learning. We compared the accuracy of Inception V3, VGG-16, and ResNet models to a customized CNN model. The model's performance was evaluated using 15,153 chest x-ray scan samples from the Kaggle repository, of which 80% were used for training and 20% for Testing. In comparison to other models, the VGG-16 model has the highest accuracy (i.e., 98.67%) for detecting Chest X-ray images.

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Chapter 1

INTRODUCTION

COVID-19 is an infectious disease caused by the most recently discovered coronavirus, pos- ing serious health and economic dangers to countries. This affects respiratory infections ranging from the common cold to serious sicknesses such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome. Its case began in December 2019 in Wuhan, China. The disease is carried mostly from person to person, and the only method to prevent it is by social separation and self-isolation. Early detection is critical for controlling its spread. Fever, sore throat, headache, cough, and moderate respiratory symptoms are all indications of the condition, which can escalate to pneumonia. It's currently a global pandemic that's affecting several countries. One of the existing method of detecting this coronavirus is PCR testing (Polymerase Chain Reaction). It detecs a certain covid-19 gene pattern and replicates it it, allowing it to be easily seen. We can utilize the reverse transcription PCR test(RT-PCR) in addition to this PCR test. Nasal secretion samples are used to do this. These test kits are only available in extremely small quantities, making them unsuitable for the current situation. Alternative techniques for detection of coronavirus infections are expected due to the shortage of RT-PCR test kits.

1.1 Motivation

The most significant respiratory organ is harmed and could be diagnosed ten to twelve days after being infected with the virus. Doctors say that because RT-PCR testing takes longer to predict, fast and early detection from clinical X-rays can help evaluate whether a patient should be kept in isolation until laboratory test results arrive. Because of the early detection provided by X-rays, the disease does not spread as quickly to others at that time. Many computer scientists are involved in using medical image processing to locate infected individuals, such as X-rays. In corona testing, X-ray identification of covid can be extremely helpful. As a result, we can utilize an X-ray test as a preliminary test to boost the rate of covid testing.

1.2 Literature Review / Survey

Sl.no	Authors	Paper's Title	Algorithms	Classes	Dataset	Result (Accuracy)
1	D.haritha, Ch.Praneeth, M Krishna	COVID prediction from X-ray images (2021)	Transfer learning using VGG 16 model	5	1824 X-ray images	99%
2	Dr D.haritha, N Swaroop, M Mounika	Prediction of COVID-19 cases using CNN with X-rays (2021)	Transfer learning using GoogleNet model	2	1824 X-ray images	98%
3	Wahab Ahmed Musleh, Ashraf Yunis Maghari	COVID-19 detection in X-ray images using CNN Algorithm (2020)	CNN model	2	550 X-ray images	95.7%
4	Amit Kumar Das, Sayantani Ghosh, Samiruddin Thunder , Rohit Dutta, Sachin Agarwal ,Amlan Chakrabarti	Automatic COVID-19 Detection from X-Ray images using Ensemble Learning with Convolutional Neural Network (2020)	DenseNet, ResNet, Inception .Among these ResNet gave an accuracy of 95.7%	2	1006 X-ray images	95.7%
5	Rachna Jain, Meenu Gupta, Soham Taneja1, D. Jude Hemanth	Deep learning based detection and analysis of COVID-19 on chest X-ray images (2020)	Inception V3, Xception, and ResNeXt. Among these models Xeption gave an accuracy of 97.97%	3	6432 X-ray images	97.97%

Table 1.1: Literature survey

- Research Paper 1: "COVID prediction from X-ray images". Author: D.haritha, Ch. Praneeth, M Krishna, 2020. In this paper,Deep Learning models were trained with X-ray radiographs of COVID-19 infected and non-infected individuals to create an Artificial Intelligence diagnostic. They have introduced a system that can be used to automatically identify coronavirus from chest X-ray images by machines in less than 5 minutes. To meet this challenge, they used a dataset of chest X-ray images of healthy people, pneumonia patients, and COVID19 disease patients. They have taken advantage of the notion of transfer learning, which reduces the training time for neural networks. The VGG model of transfer learning achieved a 99.49% accuracy in predicting virus from suspected paternity photos.

- Research Paper 2: "Prediction of COVID-19 cases using CNN with X-rays". Author: Dr. D.haritha, N Swaroop, M Mounika, 2020. This research offers a GoogleNet-based transfer learning model for COVID-19 prediction from X-ray pictures. Image categorization is performed in this paper adopting one of the CNN architectures, GoogleNet, commonly known as InceptionV1. This model yielded 99% for training and 98.5% for testing. for testing.

- Research Paper 3: "COVID-19 detection in X-ray images using CNN Algorithm". Author: Areej A.wahab Ahmed Musleh, Ashraf Yunis Maghari,2020. In this paper, the CheXNet algorithm was developed to diagnose and detect pneumonia and these small changes were made to the algorithm to diagnose 14 pathological conditions in the chest x-ray pictures. they experimented by applying a Convolutional neural network (CNN) the algorithm in a similar way to the mechanism of work in the CheXNet algorithm using a dataset of 550 X-rays pictures which were collected from Kaggle. The dataset con- trained two different classes of images. One coronavirus infected X-rays, other normal. The model given an acceptable accuracy of 89.7% which was close enough to the CheXNet algorithm.

- Research Paper 4: "Automatic COVID-19 Detection from X-Ray images using Ensemble Learning with Convolutional Neural Network". Author: Amit Kumar Das, Sayantani Ghosh, Samiruddin Thunder, Rohit Dutta, Sachinagarwal, Amlan Chakrabarti, 2020. In this paper, the researchers have proposed a Deep Convolutional Neural Network-based the solution that can detect the COVID-19 positive patients using chest X-ray images. To achieve this challenge, they have used a CNN model and trained it with a dataset of different classes which were, Covid-19 positive 538 x-ray images, Covid-19 negative 468 x-ray images, these were divided into 771 training images and 235 testing images, which in turn, gave up the accuracy of 95%.

- Research Paper 5: "Covid-19 Detection using Chest X-Ray Images X-ray images". Author: Rachna Jain, Meenu Gupta, Soham Taneja, D. Jude Hemanth,2020. In this paper, they have chosen an acceptable solution to overcome this problem which was to use deep learning. They have used images of covid affected patients as well as healthy patients. Then they used a deep learning-based CNN model and compared the results with different other algorithms, which were Inception-v3 model, Xception model, and ResNeXt algorithms, and compared accuracy. 6432 x-ray images were acquired from Kaggle to examine the model's performance, with 965 serving as testing images and 5467 serving as training images. The Xception model has the best accuracy of all the algorithms, at 97.97 percent.

1.3 Problem Statement

Detecting covid-19 disease using the Chest X-ray images of the patients. Classifying the images into normal, covid -19, and bacterial pneumonia using convolutional neural networks.

1.4 Applications

- It is used for covid prediction where the user can check his results through the website.
- It helps the user so that he can isolate himself within the next minute of his/her result.
- It helps Medical experts to know the result early than traditional process results which would take quite a time by RT-PCR test.

1.5 Objectives and Scope of the project

1.5.1 Objectives

- To perform classification on Chest X-ray images.
- To Evaluate the model and compare the obtained results of different Pre-trained models with the Custom CNN model.
- To use Django framework and create a user-friendly GUI for the user to upload and fetch the result.

1.5.2 Scope of the project

The project results can be used for better understanding of models, which performs well for chest disease, and further those algorithms can help in developing a Convolutional Neural network, and betterment can be done in terms of User interface, which would help medical experts to detect the covid before incubation period, helping in finding covid symptom where it would rather take 6 or more days with the traditional approach with RT- PCR test.

Chapter 2

REQUIREMENT ANALYSIS

Requirements Analysis describes the software operational characteristics, it indicates software's interface with other elements of the system, it specifies the constraints that a software must meet.

2.1 Functional Requirements

Funtional requirement specifies the list of services or functions that a system is intented to perform.

- The user shall be able to browse the input image and upload it.
- The system should be able to take the input image in any format (jpg, jpeg, and png).
- The system shall be able to process the input data given by the user.
- The system should be able to recognize the class of the input image.
- The system shall be able to display the processed result onto the GUI.

2.2 Non Functional Requirements

Non Funtional Requirements defines the performace based attribute , such as speed, security and reliability of a system.

- Efficiency: The system should provide better results with accuracy greater than 95%
- The system shall be reliable and able to run for 98% percent of the time without failure.
- Response Time: After the user providing the input, the system shall respond within one minute.
- Portability: The system should be able to perform with the same accuracy across all platforms.

2.3 Hardware Requirements

- RAM (minimum 4GB)
- GPU

2.4 Software Requirements

- Operating System (Windows/Linux)
- Python 3.0 or Higher Vesion

Chapter 3

SYSTEM DESIGN

System design is the where we define the architecture, modules and components of a system. It is a conceptual model which describes the structure and behaviour of the system.

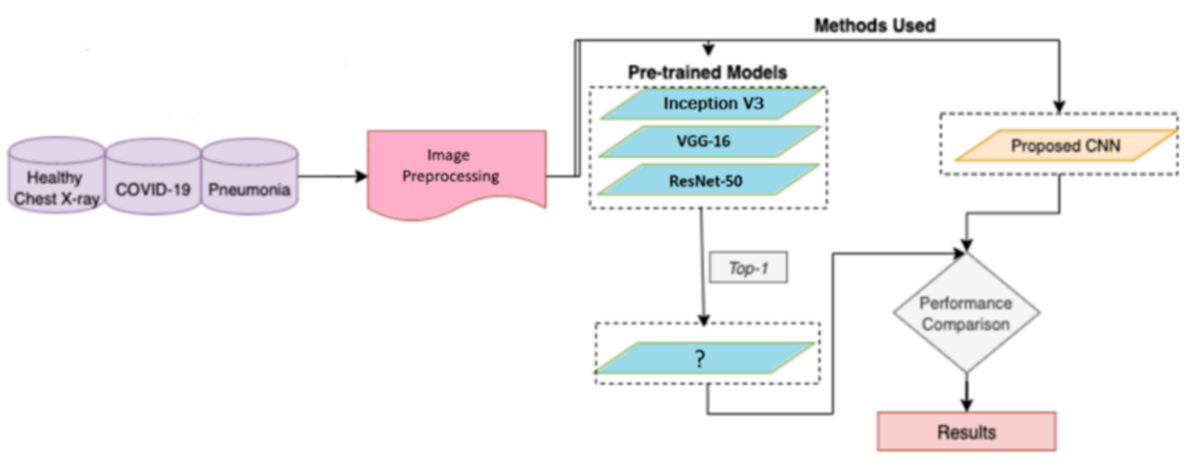

Figure 3.1: Pipe Line Process

3.1 Architecture Design

To detect the covid-19 cases, we use the concept of convolutional neural networks. A Convolutional Neural Network is perhaps a Deep Learning-based function that uses an image as input and assign appropriate learnable weights and biases to distinguish images categories among one another.

The layers of CNN:

Convolutional Layer: This is the fundamental building component of CNN, and it is in charge of executing convolution operations. The element in this layer that performs the convolution process is known as the Kernel/Filter (matrix). The kernel shifts horizontally and vertically based on the stride rate until the entire image has been scanned.

Pooling Layer:This layer is in charge of reducing dimensionality. It saves a great deal of computing power needed to process the data. Maximum pooling and average pooling are the

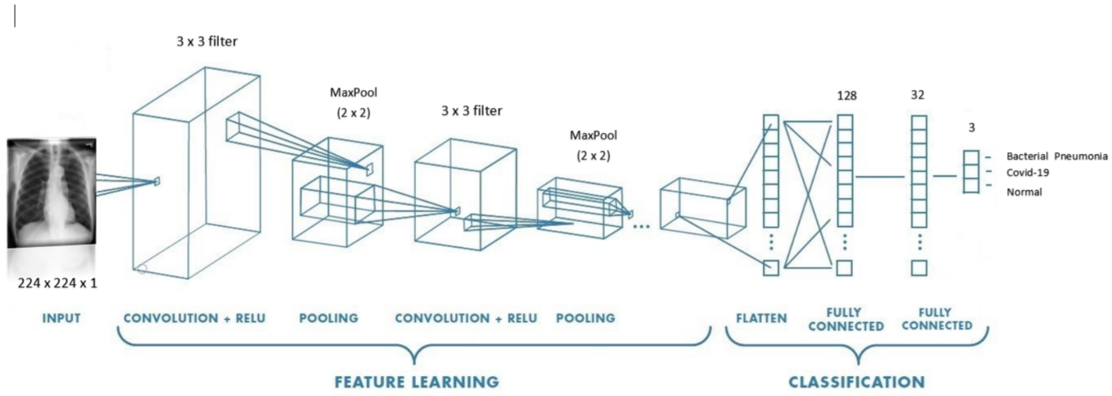

Figure 3.2: Architecture of a Convolutional Neural Network

kinds of pooling. The maximum value from the portion of the picture covered by the kernel is returned by max pooling.The average from the portion of the picture covered by the kernel is returned by the average pooling.

Fully Connected Layer:The completely connected layer operates on a flattened input where each input is connected to all neurons. FC layers, if present, are commonly found near the conclusion of CNN architectures.

Softmax: This is a generalisation of the logistic function to many dimensions that is attached at the end of the layer. It is commonly employed as the last activation function of a neural network to normalise the output of a network to a probability distribution over expected output classes in multinomial logistic regression.

Dropout: This layer has been added where. The Dropout layer randomly sets input units to 0 with a frequency of rate at each step during training time, which helps minimise overfitting. Inputs that are not set to 0 are scaled up by one so that the sum of all inputs remains constant.

3.2 Data Design

The dataset was fetched from the Kaggle repository. The dataset has 3 classes, Covid-19 positive having 3,616 samples in it, Healthy category has 10,192 samples and Bacterial Pneumonia has 1345 images. In total it consists of 15,153 images, of size 1GB. The dimension of the images in the dataset is 299X299 (Height X Width).

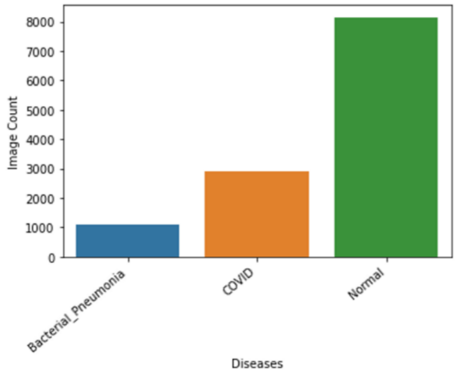

Figure 3.3: Number of images in each class

3.3 User Interface Design

Django web framework has been used to develop website with good interactive User Interface (UI), and with the help of Bootstrap, then integrating machine learning module into website and fetching results.Django is a web development framework that makes it easier to create and manage high-quality websites. Django makes the development process simple and time-saving by eliminating repeated operations.

Chapter 4

IMPLEMENTATION

This chapter provides a quick overview of the system's implementation details by discussing each component.

4.1 Data Collection

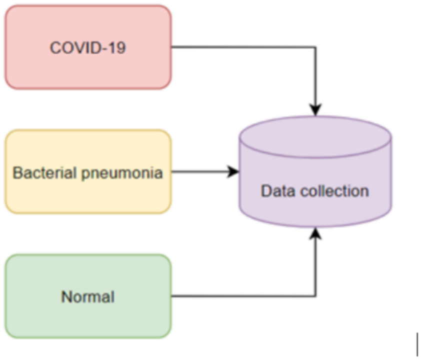

Figure 4.1: Data Collection

The procedure of collecting, measuring, and evaluating correct insights for study using established approved techniques is defined as data collection. In most cases, regardless of the subject of study, data gathering is the first and most significant stage. Depending on the information requested, the approach to data gathering differs for different topics of study. Data for this project was gathered via one of Google LLC's well-known websites, kaggle. They have included 3616 COVID-19 positive patients to the database, along with 10,192 Normal and 1345 Bacterial Pneumonia pictures. These photos were taken from 43 different publications and made available on Kaggle. The photos are all in PNG format and it has a resolution of 299x299 pixels.

4.2 Data Preprocessing

Data preprocessing is an important process because data-gathering methods are frequently poorly managed, resulting in out-of-range values and impossible data combinations. Analyzing

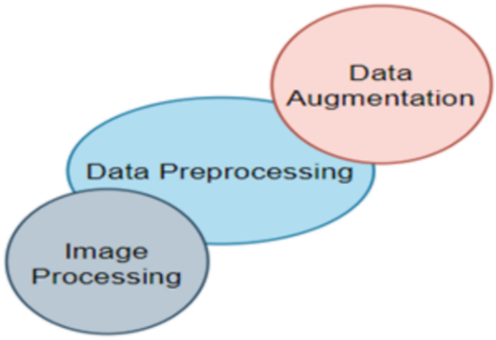

Figure 4.2: Data Preprocessing

data that has not been thoroughly vetted for such issues might generate misleading findings. As a result, before doing any analysis, the representation and quality of data must come first. Data preprocessing is frequently the most crucial part of a project. As a result, in this project, the dataset is imbalanced, the class bacterial pneumonia have less number of photographs; to address this, we use one of the data preprocessing techniques, data augmentation, and then balanced the dataset with an approximately equal amount of X-Ray images. Laplacian filter is used as a part of image enhancemet to sharpen the images which improves the detection by highlighting the edges present in X-Ray images.

Data Augmentation: to get the most out of it we need a large dataset but at the time of training we faced a problem of data imbalance and we overcome it with the technique called data augmentation where we generate more data from available data, to achieve this, we need to make minor alterations to our existing dataset. The alteration we have performed are zoom operation and rotate operation. We generated extra 1800 images with augmentation technique.

Figure 4.3 is the image of an Chest X-Ray before applying the laplacian filter, and Figure 4.4 is the image after applying laplacian filter, in order to detect the edges in the image. The number of images in "Normal" class are more (10,192), so in order to under-sample the class, we excluded 6,500 images from this class.

At the end of data pre-processing, the dataset is balanced. The number of images in covid-19 remain same(3616), "normal" has 3692 images, bacterial pneumonia has 3145 images.

Figure 4.3: Original Image

Figure 4.4: Sharpened Image

4.3 Model Training

After the pre-processing part, the convolutional neural network has to be designed and trained. We have built a convolutional neural network consisting of 3 convolution layers, and 3 max-pooling layers. The first convolution layer has 16 filter, the second convolution layer has 32 filter and the last layer has 64 filter. All the convolution layer has fixed kernel size i.e., 3X3. A dropout of 0.2 is added in order to restrict the overfitting. A flatten layer is added after the convolution layer, where we convert the array to 1 dimensional. Further it is connected to fully connected layer having 256 neurons. Finally the output layer consisting of 3 neurons which determine our output classes.

This model has been trained for 10 number of epochs, a validation split of 0.2, with adam as the optimizer, which has learning rate equal to 0.0001

4.4 Pre-trained Models

For better performance of model we tried with different transfer learning models, and those are :

- ResNet-50
- Inception-v3
- VGG16

Deep Convolutional Neural Networks are excellent at identifying low, mid, and high level features in images, and stacking more layers generally improves accuracy. In this project, we used the algorithm ResNet50, which is a ResNet model variant with 48 Convolution layers, 1 MaxPool layer, and 1 Average Pool layer. It has a total of 3.8 x 109 floating point operations. ResNet-50 is a 50-layer deep convolutional neural network. ResNet is an abbreviation for residual Network. In this experiment, the same preprocessed data was fed into ResNet-50 and trained the model with 10 epochs, yielding an accuracy of up to 84.54 percent for training and 84.39 percent for testing.The second model utilised was Inception-v3, which is a 48-layer deep convolutional neural network. Inception-v3 is an architecture from the Inception family that makes several improvements such as using Label Smoothing, Factorized convolutions, and the use of an auxiliary classifer to propagate label information lower down the network. The accuracy we obtained from this model is 90.80 percent for training and 88.34 percent for testing data. The third model utilised was VGG16, which is a convolutional neural network model with very deep convolutional networks for large-scale image recognition and they concentrated on having convolution layers of 3x3 filter with a stride of 1 and always used the same padding and maxpool layer of stride 2's 2x2 filter. Finally, it has a fully connected layers with softmax as the activation function for output. After testing the model, the accuracy was 98.67 percent for training data and 97.54 percent for testing data.

Chapter 5

RESULTS AND DISCUSSIONS

All the models have been trained for 10 epochs and then the models are saved as .h5 files. The model was trained with a set of X-Ray images with classes Covid +ve, Normal, Bacterial Pneumonia, but the dataset was imbalance, so we used a data preprocessing technique which was data augmentation, so that the dataset is balanced and models can achieve a more accurate identification from images. Image preprocessing where we applied laplacian filter for sharpening, so that model extracts more important features, then divided into testing and training dataset, and after training the models, the best result was achieved by the model VGG-16 with 98.67% training and 97.54% for testing. The model's training-validation accuracy as well as loss has been shown with the help of graphs (fig 5.1 onwards).

Table 5.1 gives the summary of all the models trained during the project. In summary, our proposed customized CNN outperforms ResNet-50 and Inception-V3, but VGG-16 outperforms the proposed CNN, obtaining an accuracy of 98.67 percent.

A simple desktop interface has been created (see Figure 5.9) to detect Covid-19 positive and negative cases. This enables any medical personnels to browse and provide a chest X-ray image to the programme. In turn, the programme will run the model provided in this by him/her, and as an output, it will display either Covid +ve or Bacterial Pneumonia or Normal.

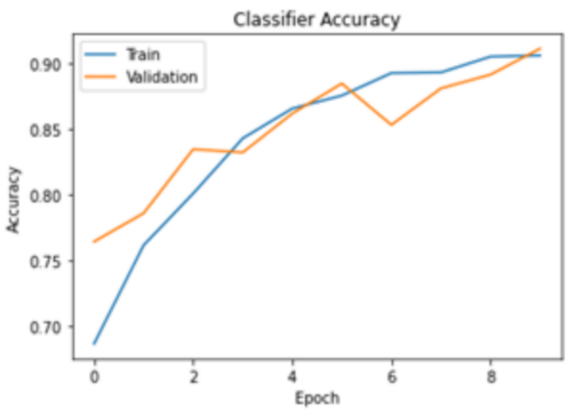

Figure 5.1: Training and validation accuracy of custom CNN

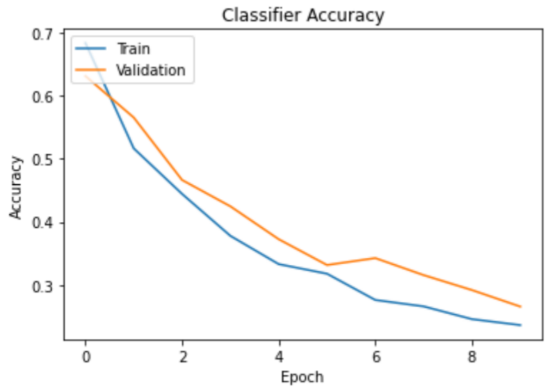

Figure 5.2: Training and validation loss of custom CNN

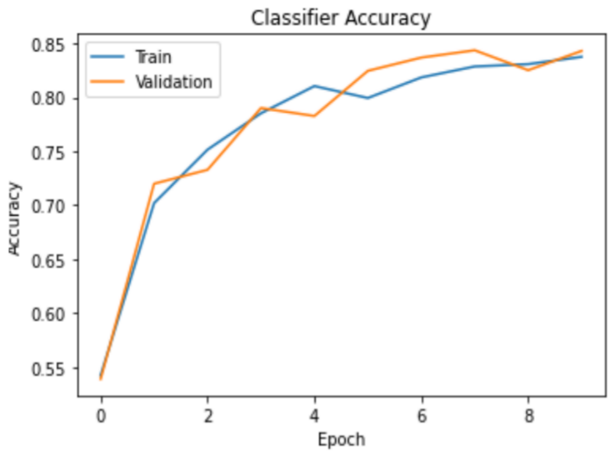

Figure 5.3: Training and validation accuracy of ResNet-50

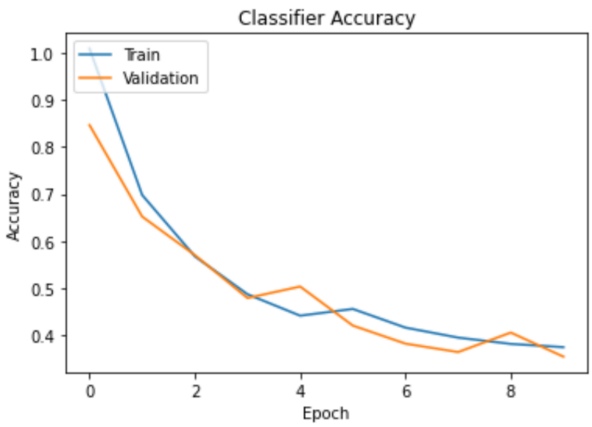

Figure 5.4: Training and validation loss of ResNet-50

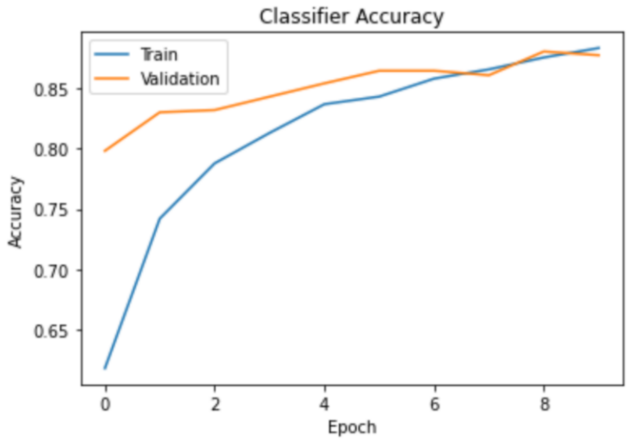

Figure 5.5: Training and validation accuracy of Inception-v3

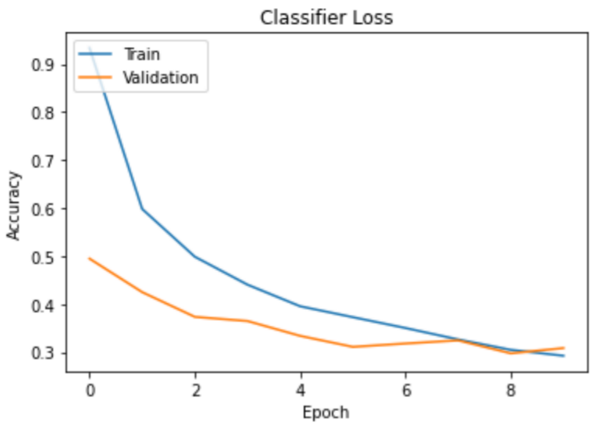

Figure 5.6: Training and validation loss of Inception-v3

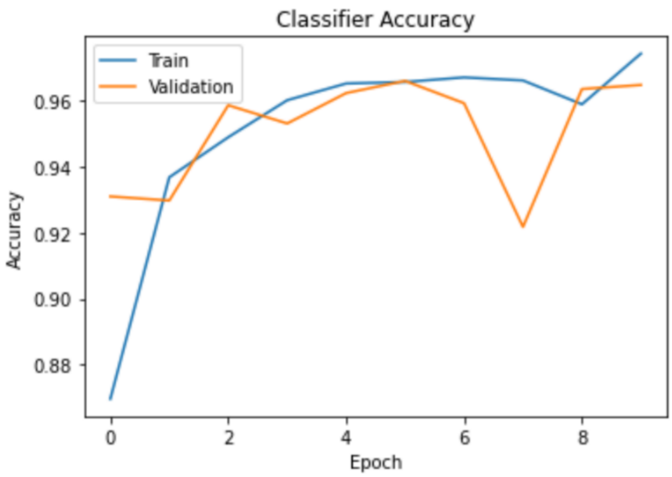

Figure 5.7: Training and validation accuracy of VGG-16

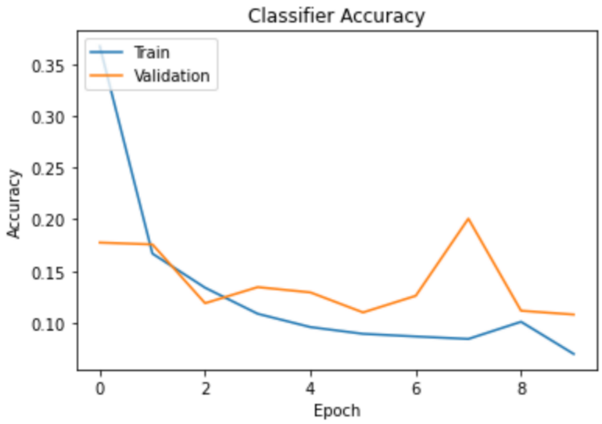

Figure 5.8: Training and validation loss of VGG-16

Sl No	Name	No of epochs	Training accuracy	Testing accuracy
1	Custom CNN	10	91.65%	91.49%
2	ResNet-50	10	84.54%	84.34%
3	Inception-v3	10	90.80%	88.34%
4	VGG-16	10	98.67%	97.54%

Table 5.1: Summary of the trained models

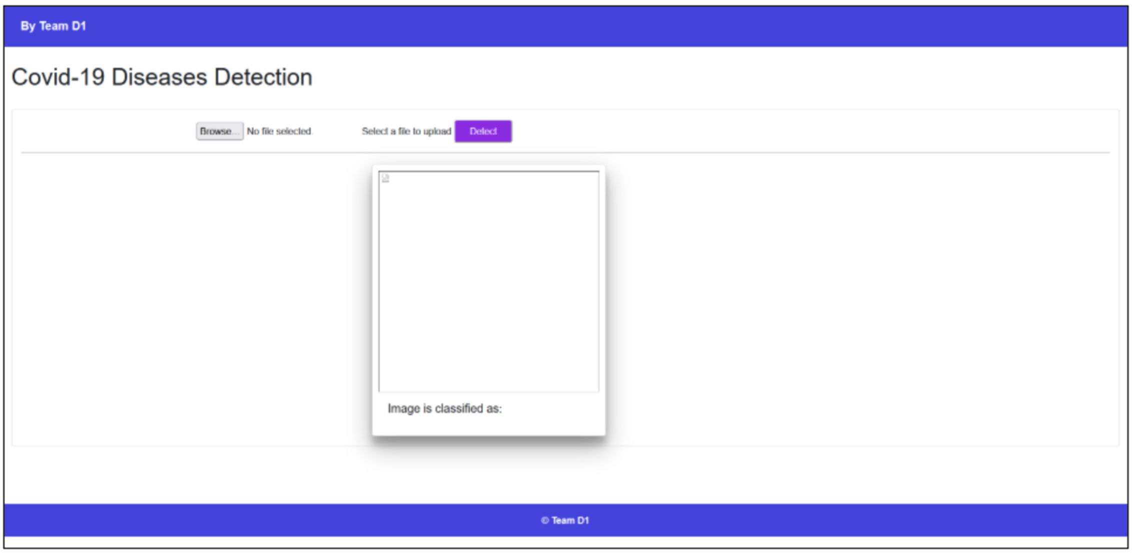

Figure 5.9: User interface

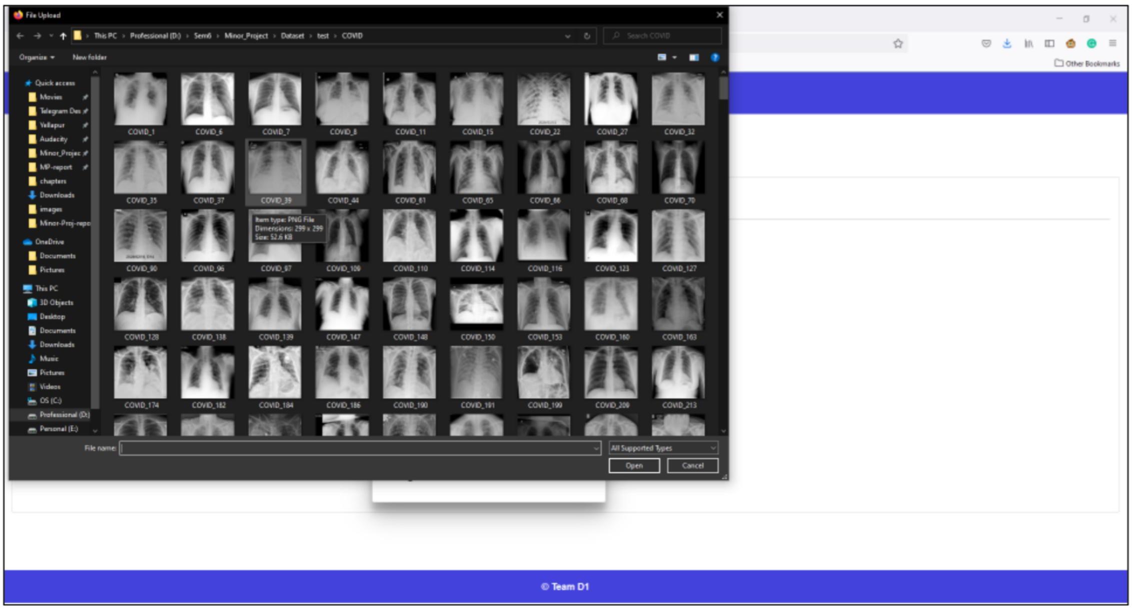

Figure 5.10: User browsing an image

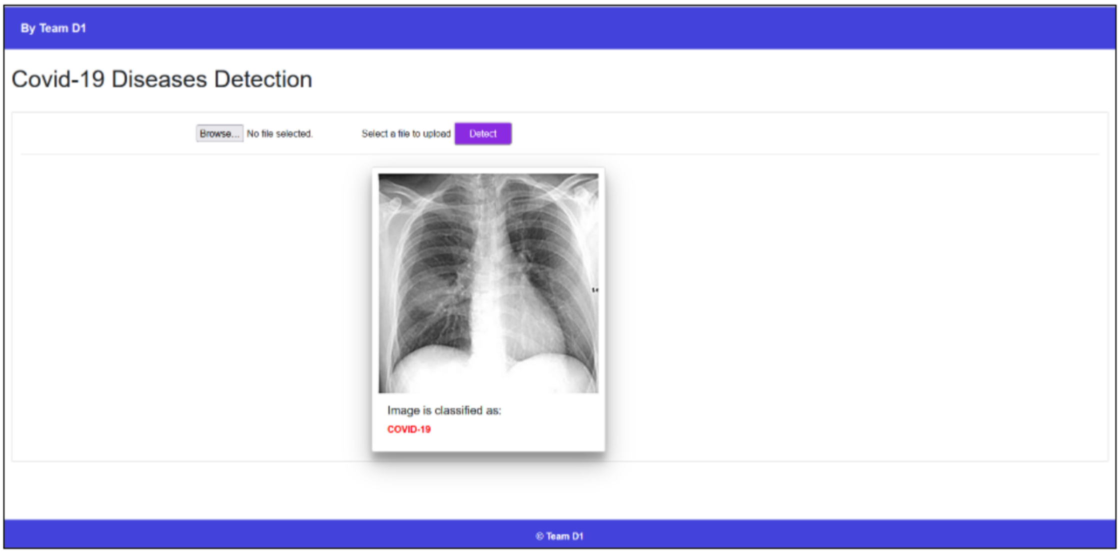

Figure 5.11: User achieving the result

Chapter 6

CONCLUSION AND FUTURE SCOPE OF THE WORK

On a daily basis, the covid-19 epidemic spreads exponentially. With the growing number of cases, rapid bulk testing of patients may be necessary. We used different CNN models to classify Covid-19 afflicted individuals based on their chest X-ray scans in this study. We also came to the conclusion that, of the four models, the VGG-16 has the best performance and is the most appropriate for use. In the future, a larger dataset of chest X-rays can be considered to validate our proposed model on it. A more improved user interface can be provided in the future to accommodate more and more functionality. In the future, a larger dataset of chest X-rays can be considered to validate our proposed model on it. A more improved user interface can be provided in the future to accommodate more and more functionality.

Plagiarism Report

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Project Domain: Machine Learning and Image Processing

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