Project Stage-II Report on

COVID-19 detection using chest x-ray

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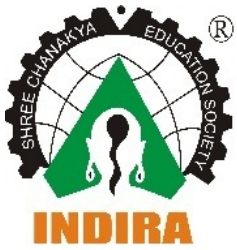

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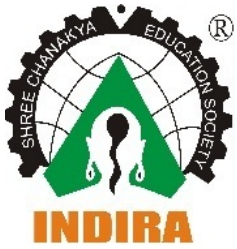

C E R T I F I C A T E

This is to certify that -

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have successfully completed the project Stage-2 entitled "COVID-19 detection using chest x-ray." under my supervision in the partial fulfilment of Bachelor of Computer Engineering of Savitribai Phule Pune University.

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Abstract

Covid-19 is discovered in 2019. No one knows the origin of this virus. When the virus came it spread throughout the globe. The whole world suffers from it. In the beginning, cases were low, but they increased, and WHO had to declare the pandemic. Covid-19 spread all over the world and millions of cases started to show. The pandemic was horrible. Lots of people are affected due to this. At the begging of the pandemic, there wasn't a proper testing procedure to detect the infection of the patient. It caused lots of confusion among the people. To prevent the infection people had to take preventive measures and had to get quarantined even though you are not infected, which caused lots of problems. Then the RT-PCR test is used for checking the infection. But this test 2-3 days for detection. And there were millions of testing cases, so it took a lot more time to give results to the patients. There was another problem that is false positive or false negative reports. People got this kind of report and got the wrong medication. To confirm the report doctor recommended a CT scan of the chest to detect the infection. But CT scan is high in cost. Not every person has that kind of money. Also, not every hospital has a CT scan device. But there is another way to detect the infection and that is through x-ray. X-ray in cheap and every hospital has an x-ray machine. In this system, we are proposing a deep learning method. In this system, we are going to use chest x-ray images to predict the infection. Deep learning is the future of the medical industry. In this system, the user will get the result in a few seconds.

Keywords: *CNN, ResNet, COVID-19, Infection, Detection.*

Contents

1 Introduction **1**

1.1 **Overview** . . . 2

1.2 **Motivation** . . . 3

1.3 **Problem Definition and Objectives** . . . 3

1.4 **Project Scope & Limitations** . . . 4

1.5 **Methodologies of Problem Solving** . . . 4

2 Literature Review **6**

3 Software Requirement Specifications **9**

3.1 Purpose . . . 9

3.2 Design and Implementation Details . . . 9

3.3 Assumption . . . 10

3.4 Constraints . . . 10

3.5 Usability . . . 10

3.6 Functional Requirements . . . 11

3.6.1 The User Should Be Able to Upload the Image . . . 11

3.6.2 The User Should Get the Result Within A Few Seconds . . . 11

3.7 Nonfunctional Requirements . . . 11

3.7.1 Performance Requirements . . . 11

3.7.2 Software Quality Attributes . . . 11

3.8 System Requirements . . . 12

3.8.1 Database Requirements . . . 12

3.8.2 Software Requirements . . . 12

3.8.3 Hardware Requirements . . . 12

4 System Design **13**

4.1 System Architecture . . . 13

4.2 Data Flow Diagram . . . 15

4.3 UML Diagrams . . . 16

4.3.1 Use Case Diagram 16
4.3.2 Class Diagram 16
4.3.3 Activity Diagram 17
4.3.4 Sequence Diagram 18
4.4 Algorithmic Strategy 20

5 Project Plan **21**
5.1 Project Estimate 21
5.1.1 Reconciled Estimates 21
5.1.2 Project Resources 21
5.2 Risk Management 22
5.2.1 Risk Identification 22
5.2.2 Risk Analysis 22
5.3 Overview of Risk Mitigation ,Monitoring,Management 23
5.4 Project Schedule 23
5.4.1 Project Task Set 23
5.4.2 Time line Chart 24
5.5 Team Organization 24
5.5.1 Team Structure 25
5.5.2 Management reporting and communication 25

6 Project Implementation **27**
6.1 Overview of Project Modules 27
6.2 Tools and Technologies Used 28
6.3 Algorithmic Details 28
6.3.1 Algorithm 1: CNN 29
6.3.2 Algorithm 2: ResNet 30
6.3.3 Algorithm 3: VGG-16 30

7 Software Testing **32**
7.1 Types of Tasting 32
7.2 Test cases and Test Results 32

8 Results **34**

8.1 Outcomes 34

8.2 Screen Shots 34

9 Conclusions **39**

9.1 Conclusions 39

9.2 Future Work 39

9.3 Applications 39

References **40**

Appendices **42**

A Appendix **42**

A.1 Appendix A 42

A.2 Copyright 42

B Appendix B **50**

B.1 IRJMETS Paper 50

B.2 IRJMETS Certificates 56

C Appendix C **62**

C.1 Plagiarism Report 62

Abbreviations

CNN	:	Convolutional Neural Network
DFD	:	Data Flow Diagram
ResNet	:	Resedual Neural Network
VGG	:	VVisual Geometry Group
URL	:	Unified resource locator
SRS	:	Software requirement specification
GUI	:	Graphical user interface
STP	:	Software test plan

1 Introduction

Covid-19 is discovered in 2019. No one knows the origin of this virus. When the virus came it spread throughout the globe [1]. The whole world suffers from it. In the beginning, cases were low, but they increased, and WHO had to declare the pandemic[2]. Covid-19 spread all over the world and millions of cases started to show. The pandemic was horrible. Lots of people are affected due to this. The mortality rate of the covid-19 is very low. A lot of people suffer from lung failure[3].

At the begging of the pandemic, there wasn't a proper testing procedure to detect the infection of the patient. It caused lots of confusion among the people. To prevent the infection people had to take preventive measures and had to get quarantined even though you are not infected, which caused lots of problems.[4] Then the RT-PCR test is used for checking the infection. But this test 2-3 days for detection. And there were millions of testing cases, so it took a lot more time to give results to the patients[4][5].

There was another problem that is false positive or false negative reports. People got this kind of report and got the wrong medication. To confirm the report doctor recommended a CT scan of the chest to detect the infection. But CT scan is high in cost. Not every person has that kind of money. Also, not every hospital has a CT scan device. But there is another way to detect the infection and that is through x-ray. X-ray in cheap and every hospital has an x-ray machine[6],[7],[8],[9].

In this system, we are proposing a deep learning method. We are going to use chest x-ray images to predict the infection. Deep learning is the future of the medical industry. In this system, the user will get the result in a few seconds. To predict the infection, we are going to use CNN (Convolutional neural network), ResNet (residual neural network), and VGG-16 and transfer learning. Our project will detect the infection spread in the lungs through a chest x-ray which the user will provide. Then the given image will process through the model and give the result. There will be three types of results positive, negative, and viral[10].

There will be a window in which one box will tell you to upload the image in that box user have to click and upload the image and, in a few seconds, the user will get the result. The system will be easy to use and user-friendly. Every hospital and patient also can use it. result. There will be three types of results positive, negative, and viral.

In the proposed system we used CNN, RES-net, VGG-16, and transfer learning. With help of these models, we will be predicting user has a covid infection or not. the covid dataset will be divided into two different datasets training dataset and testing dataset. Meanwhile, the dataset will be cleansed. In which image will get cleared and sharp for training. In the next phase, data will be preprocessed after the preprocessing of the data-specific features of the covid infections will be extracted. This process is done on the training and testing of both datasets. After that machine learning classification or models will be run. The models we are using are CNN. After the classification result will be predicted3. The system will be user-friendly, easy to use.

The proposed system is only predicting the infection is present or not. It will not give any kind of diagnosis for the infection. If the user has covid then he/she must visit the doctor as early as possible. And he/ she needs to take medication which the doctor will provide.

1.1 Overview

There will be a window in which one box will tell you to upload the image in that box user have to click and upload the image and, in a few seconds, the user will get the result. The system will be easy to use and user-friendly. Every hospital and patient also can use it.

In the proposed system we used CNN, RES-net, VGG-16, and transfer learning. With help of these models, we will be predicting user has a covid infection or not.

1.2 Motivation

The COVID-19 was first detected in 2019. It has rapidly spread around the world. The detection of COVID-19 cases is one of the important factors to stop the spread because the infected individuals must be quarantined. In the pandemic year, 2020 COVID-19 was not able to detect through RT-PCR test, there was some false negative and false positive reports, so doctors had to check CT scan report to detect the infection.

CT scan reports are too expensive. Not every person affords to do a CT scan. Also, CT Scan machine is very expensive and big and available only in big hospitals and private hospitals. Hospitals are present in the village where no electricity is available and low staff members are present, they don't have CT scan machine.

One way to detect COVID-19 cases is using chest x-ray images, where signals of the infection are in lung areas. X-rays are cheap and available in a small village as well. And every person can afford a single x-ray. This is the reason we propose a solution to automatically classify COVID-19 cases in chest x-ray images.

1.3 Problem Definition and Objectives

The spread of COVID-19 or coronavirus was first detected in 2019. It has rapidly spread around the world. The detection of COVID-19 cases is one of the important factors to stop the spread because the infected individuals must be quarantined. In the pandemic year, 2020 COVID-19 was not able to detect through RT-PCR test, there was some false negative and false positive reports, so doctors had to check CT scan report to detect the infection.

CT scan reports are too expensive. Not every person affords to do a CT scan. Also, CT Scan machine is very expensive and big and available only in big hospitals and private hospitals. Hospitals are present in the village where no electricity is available and low staff members are present, they don't have CT scan machine.

There is one way to detect COVID-19 cases is using chest x-ray images, where signals of the infection are in lung areas. X-rays are cheap and available in a small village as well. And every person can afford a single x-ray. We are proposing a system that will detect the infection from an x-ray image of the patient.

1.4 Project Scope & Limitations

Project Scope:

Determine the infection using a non-human contact method using chest radiographs. To be used in clinical diagnostics for imaging and low cost. The non-contact method with acceptable accuracy is a potential alternative for rapid COVID-19 testing that can be adapted by the medical fraternity considering the criticality of the time along with the magnitudes of the outbreak. To be used as a second opinion for doctors. To help doctors to detect patterns in medical images. Computer-aided diagnosis (CAD) systems employed with deep learning techniques help professionals to make clinical decisions.

Limitations:

1. It can give false results.
2. It can take extra time for some images
3. Can not use for diagnosis purpose.
4. Only x-ray image can be uploaded.
5. Second opinion needed from doctors.

1.5 Methodologies of Problem Solving

We used CNN, RES-net, VGG-16, and transfer learning. With help of these models, we will be predicting user has a covid infection or not. The covid dataset will be divided into two different datasets training dataset and testing dataset. Meanwhile, the dataset will be cleansed. In which image will get cleared and sharp for training. In

the next phase, data will be preprocessed after the preprocessing of the data-specific features of the covid infections will be extracted. This process is done on the training and testing of both datasets. After that machine learning classification or models will be run. The models we are using are CNN, ResNet, VGG-16. After the classification result will be predicted.

2 Literature Review

Recommendation on the web is nothing but the information filtering technique that presents informational items needed by the user.

The paper Automatic detection of COVID-19 from chest radiographs using deep learning written by M.K. Pandit, S.A. Banday, R. Naaz, M.A. Chishti showed that we can use chest radiograph for the covid detection [10]. They made an automated system to process the data and infection detection. They used deep learning convolution neural networks and transfer learning. They used a VGC-16 network for covid detection. VGC-16 is a 16-layer convolutional neural network. which consists of 13 convolutional layers and 3 fully connected layers. It also contains 5 max-pooling layers. It is very slow to train (the original VGG model was trained on Nvidia Titan GPU for 2-3 weeks). The size of VGG-16 trained imageNet weights is 528 MB. So, it takes quite a lot of disk space and bandwidth that makes it inefficient. The total number of parameters used is 134,268,738. Accuracy claimed by the author for 2- class is 96% and for 3-class is 92%

The paper COVID-19 detection and heatmap generation in chest x-ray images written by Worapan Kusakunniran showed that we can use chest X-ray and generate heat map or covid detection. They used Res-Net-101 architecture. The whole net is trained using the large size of 1500 $\times$ 1500 x-ray images [11].

The heatmap under the region of interest of the segmented lung is constructed to visualize and emphasize signals of COVID-19 in each input x-ray image. Lungs are segmented using the pretrained U-Net. The confidence score of being COVID-19 is also calculated for each classification result. In this paper, the authors have used the RESNET-101 network. Very deep neural network (101 layers) and the number of parameters is around 44 million. Better accuracy (for 3 classes) but very heavy network.

In the paper SOM-LWL method for identification of COVID-19 on chest X-rays written by Ahmed Hamza Osman, Hani Moetque Aljahdali, Sultan Menwer Altarrazi, Ali Ahmed [12]. They used the SOM-LWL algorithm to detect covid infection. They detected covid-19 pneumonia infection in the lungs using a chest X-Ray.

In this paper, the authors have used the SOM-LWL algorithm (instance-based algorithm). Classification costs are high, a large amount of memory is required to store the data, and eachquery

involves starting the identification of a local model from scratch. Better accuracy is achieved for 3 class classification (97%).

Table 1: Related Work

ID	Title	Authors	Description
1	Automatic detection of COVID-19 from chest radiographs using deep learning [10].	M.K. Pandit, S.A. Banday , R. Naaz, M.A. Chishti	The proposed model is a noncontact process of determining whether a subject is infected or not and is achieved by using chest radiographs. They used CNN, VGG-16, and transfer learning.
2	COVID-19 detection and heatmap generation in chest x-ray images[11].	Worapan Kusakunniran, Sarattha Karn janapreechakorn, Thanongchai Siriapisith, Punyanuch Borwarnginn, Krittanat Sutassananon, Trongtum Tongdee, Pairash Saiviroonporn	The proposed solution is evaluated based on COVID-19 and normal cases. It is also tested on unseen classes to validate a regularization of the constructed model. They used RESNET for training.

3	SOM-LWL method for identification of COVID-19 on chest X-rays[12].	Ahmed Hamza Osman , Hani Moetque Aljahdali, Sultan Menwer Altarrazi, Ali Ahmed	new COVID-19 identification technique based on the localityweighted learning and selforganization map (LWL-SOM) strategy for detecting and capturing COVID-19 cases.

Above approaches are solutions for the covid-19 detection in less time. All approachesare focused on the giving best solution to the comunity so that they can detect the infection in early stages.

3 Software Requirement Specifications

3.1 Purpose

The purpose of Software Requirement Specifications (SRS) is to provide a detailed overview of the system "COVID-19 detection using chest x-ray", its parameters and goals and to outline functional requirements of the system. SRS provides a detailed description of behaviour of the system as well as lists any assumptions made while developing the system and all the constraints faced by the system. It also specifies the hardware and software requirements of the system.

3.2 Design and Implementation Details

The objective of the project is to detect covid-19 infection with the help of deep learning methods. We developed this project to help people and doctors to detect the infection faster than the traditional method.

To achieve the goal of the project, our project contains the following modules:

1. Home

   The home module contains a button called Detect Covid. When the user clicks on that button user will navigate to the next page.

2. Detect covid

   In this module, the user has to upload an x-ray image. After uploading the image user will navigate to the next page.

3. Result

   In this module, the user will get the result based on the x-ray image he/she uploaded. The result will be displayed either covid, normal, or viral.

3.3 Assumption

There is the possibility that the system will give a false result. But there is a way to solve this problem. People with a high risk must seek medical attention immediately. If a person doubts the result can get a second opinion from the doctor. The proposed system will not give you any diagnosis. For the diagnosis purpose person must visit the doctor.

The proposed system is dependent upon the image data user will provide. Also, it is dependent upon doctors and their opinion. And it depends upon the opinion of the patient. If he doesn't want to use the system, no one can force him to use it.

3.4 Constraints

The dataset used is from Kaggle
`https://www.kaggle.com/tawsifurrahman/covid19-radiography-databas`,
we only compare our approach with exsisting approach with some improvements.

3.5 Usability

Usability is a non-functional requirement of the system that specifies how easy the system is to use or how user-friendly the system is. It specifies how the system functionality is to be perceived by the user and how efficient it is in carrying out user's tasks. There are several factors that decide usability of the system such as ease of learning, task efficiency, understandability, subjective satisfaction, etc. This system is only design to predict the infection based on x-ray image. User will get direct output in 2-3 second. When user insert the image into the system, our models performs their assigned tasks and give output to the user. The assigned tasks are, preprocessing, image resizing, etc.

3.6 Functional Requirements

3.6.1 The User Should Be Able to Upload the Image

When the proposed system will run on the device of the user, the user should be able to upload the image into the system. The image will be the black and white and x-ray image.

3.6.2 The User Should Get the Result Within A Few Seconds

After uploading the image into the system user should get the result within a few seconds. And the result should be accurate.

3.7 Nonfunctional Requirements

3.7.1 Performance Requirements

The proposed system should upload multiple images at a time. The system should be able to process multiple images in a minimum time duration. The system should give accurate results to the user

3.7.2 Software Quality Attributes

- Availability

  The system will be working all the time. There is only a 10-15At this time system maintenance will be performed.

- Integrity

  We could integrate the system with the hospital management system to reach as many people as we want.

- Performance

  The proposed system should upload multiple images at a time. The system should be able to process multiple images in a minimum time duration. The system should give accurate results to the user

- Reliability

  Our system will give about 90-95 the user can rely on our system for the detection of the infection.

3.8 System Requirements

3.8.1 Database Requirements

To implement this project, we required a database. Covid-19 database is available on different platforms. We used the database from Kaggle. The name of the database is Hide tree COVID-19_Radiography_Dataset. The link for the dataset is `https://www.kaggle.com/tawsifurrahman/covid19-radiography-database` [13]

The database contains 4 directories covid-19, normal, lung opacity, viral pneumonia. In the database 3616 COVID-19 positive cases along with 10,192 Normal, 6012 Lung Opacity (Non-COVID lung infection), and 1345 Viral Pneumonia images are present. Database images are of chest x-rays of the patients.

3.8.2 Software Requirements

Operating System (OS): Windows 7

Programming Language: Python 3.7

Cloud-based Jupyter Notebook environment to run code: Google colab

3.8.3 Hardware Requirements

Processor (CPU): Intel i3 generation

RAM: 512 MB

Hard Drive: 250 GB or more

4 System Design

In the system, the covid dataset will be divided into two different datasets training dataset and testing dataset. Meanwhile, the dataset will be cleansed. In which image will get cleared and sharp for training. In the next phase, data will be preprocessed after the preprocessing of the data-specific features of the covid infections will be extracted. This process is done on the training and testing of both datasets. After that machine learning classification or models will be run. The models we are using are CNN, ResNet,VGG-16. After the classification result will be predicted.

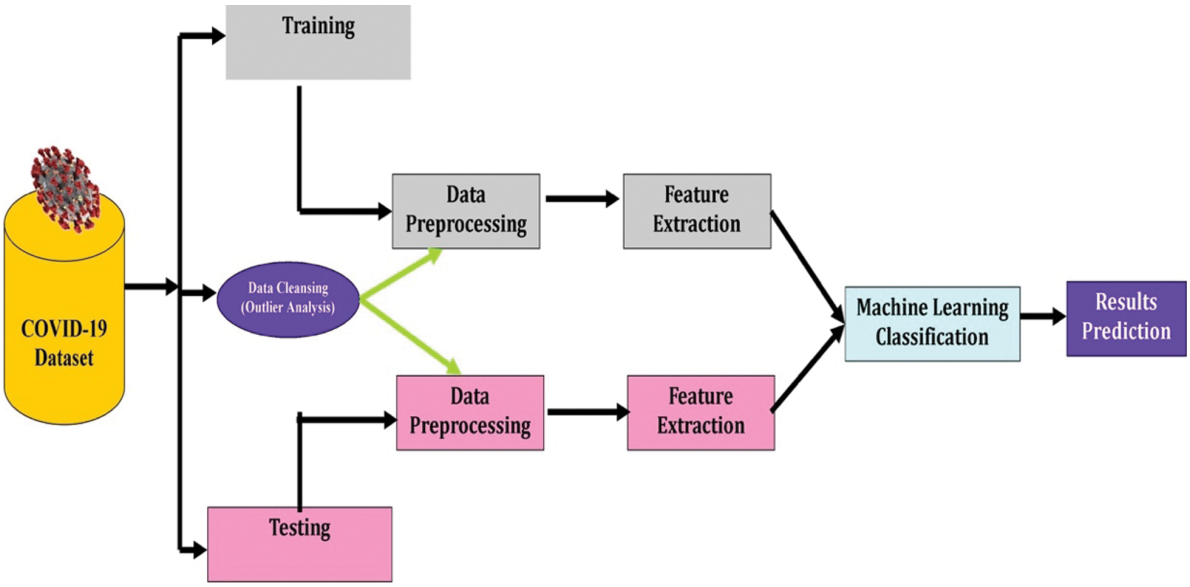

Figure 1: System Design

4.1 System Architecture

The architecture of the proposed system is shown in figure 2. It has 3 modules explained as follows:

1. Database and GUI: We downloaded the database from kaggle. Then we uploaded that database to our system for traing and testing purpose. Our system contains 3 webpages. First is home, in home page there is a button named detect covid user have to click that button to upload the image. Second is upload image, in this page

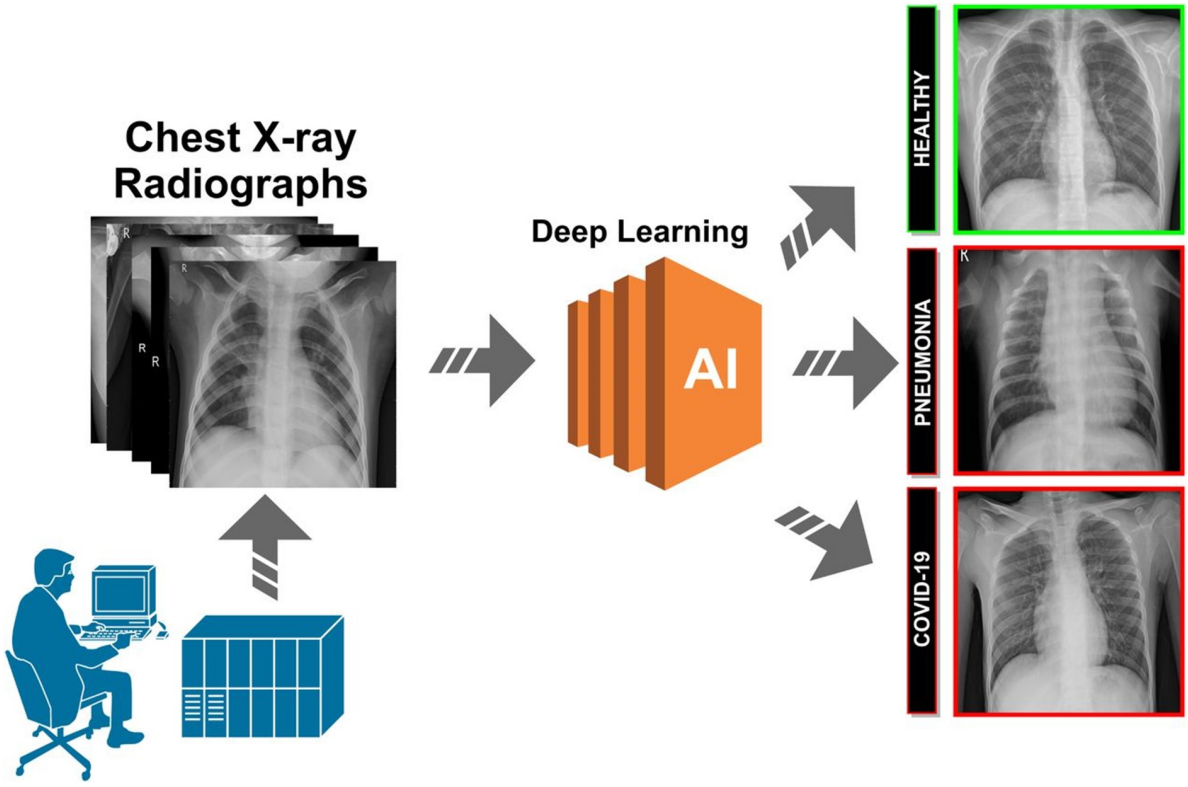

Figure 2: System Architecure

user have to upload x-ray image from their system and have to click on submit to get result. And third is result page, on this page user will get the result of their x-ray iamge.

2. Preprocessing and model traing: Before accepting the image from user we trained our models and downloaded them to use as the backend to predict the user images. After accepting the image from user preprocessing is done in the backend. In this process image augmentation, resizing, image clensing, etc., are implemented.

3. Output: After accepting image from user and preprocessing, image goes through trained models and gives user the output.

Working step by step:

1. Insert database
2. preprocessing

3. Model training
4. Insert iamge
5. testing image in trained model
6. Output

4.2 Data Flow Diagram

A data flow architecture represents graphical view of flow of data through an information system and modelling its process aspects. This are a preliminary step used to create an overview of the proposed system which can be elaborated later. Data flow architecture (Data Flow Diagram) can also be used for the visualization of data processing of system.

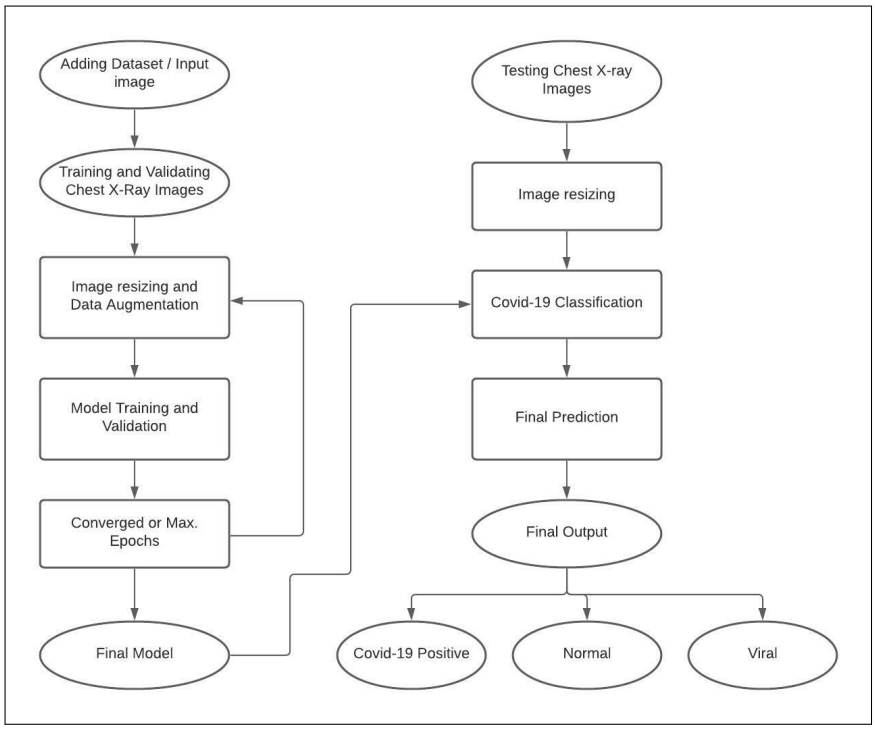

Figure 3: Data Flow Diagram

Data will be added to the system as an input or a single image will be added as an input. Then the validation of the image and resizing and augmentation of the image

will be performed. Then implemented model will be trained and validation will be performed. Then converged or max. epochs will be added, and a final model will be generated. Input image will be passed through the trained model and classification will be performed. We will get the final prediction after the classification. After the final prediction, the final output will be generated. The output will be either covid-19 positive or normal or viral.

4.3 UML Diagrams

4.3.1 Use Case Diagram

Use case diagram is a list of steps, typically defining interactions between a role (known in UML as an actor) and a system, to achieve a goal. In systems engineering, use cases are used at a higher level than within software engineering, often representing missions or stakeholder goals. The detailed requirements may then be captured in SysML or as contractual statements. A use case diagram represents all different types of users and all the various ways in which they can interact with the system. Thus, it helps providing a high level view of the system. It is a graphical representation of what the system must accomplish. Use case diagrams help in capturing user requirements, validating design, and generating test cases. Use case diagram for current system is shown in figure 4.

With the help of these diagrams, we can see the design and implementation of the system. The user will give an image as input. Pre-processing will be performed on the input image. The image will be passed through the trained model. After the processing image through trained model output will be generated. The output will be in three-class covid positive, normal, viral.

4.3.2 Class Diagram

Class diagram describes the structure of a system by showing the system's classes, their attributes, and the relationships among the classes. Proposed system contains

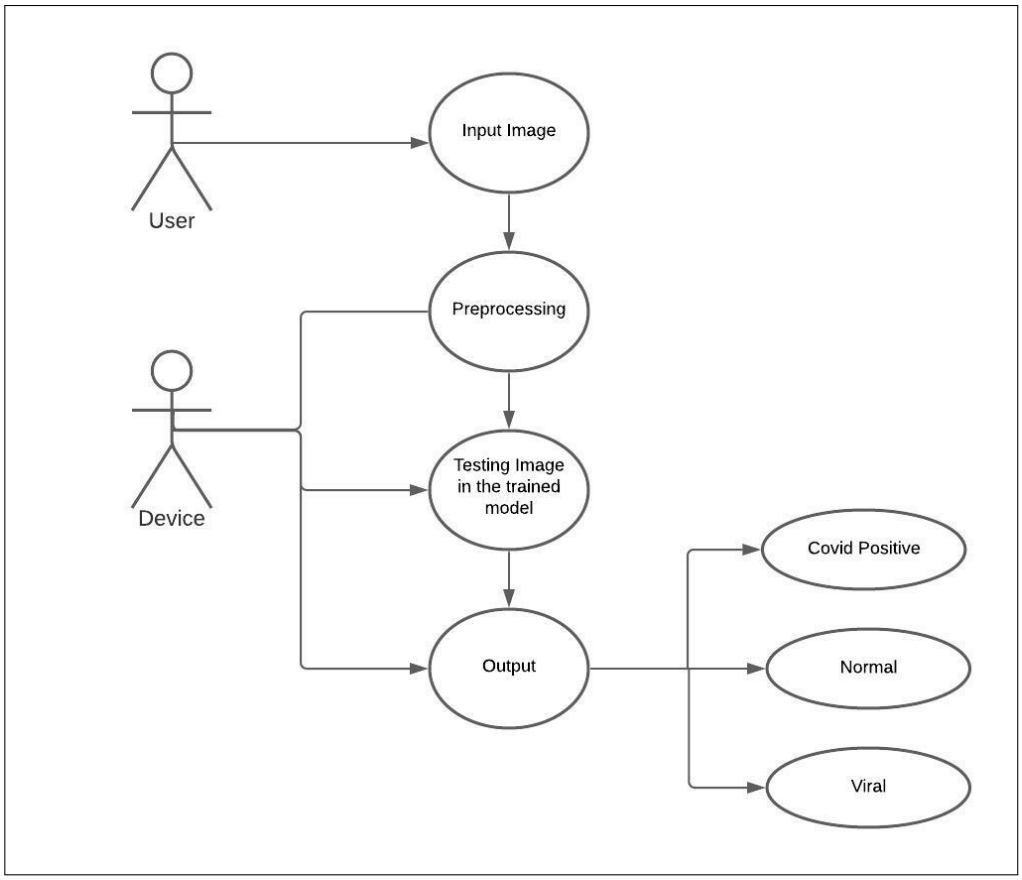

Figure 4: Use case Diagram

seven different types of classes and each posses their own attributes and methods. Main Classes of the proposed system are RandomJump, DBconnection, DFS, Bipartitegraph and HDModel each have different functionalities. Class diagram for proposed system is in figure 5.

4.3.3 Activity Diagram

An activity is particular operation of the system. An activity diagram is intended to represent stepwise work-flow of activities or actions that can take place in the system. It shows overall flow of control and models computational and organizational processes. Activity diagrams are used to model dynamic aspects of the system. Activity diagram for the system is shown in figure 6.

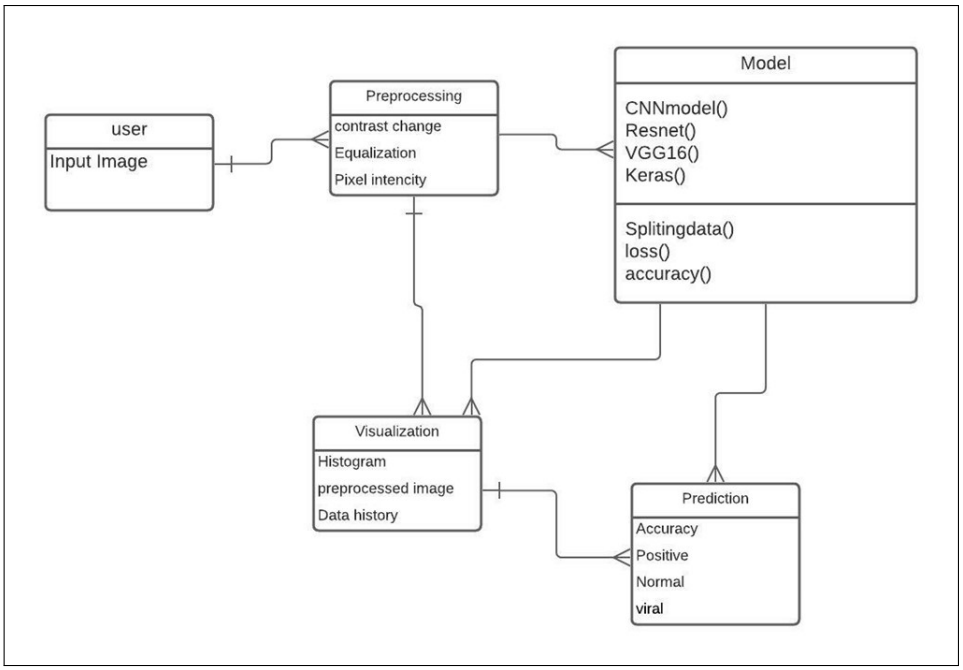

Figure 5: Class Diagram

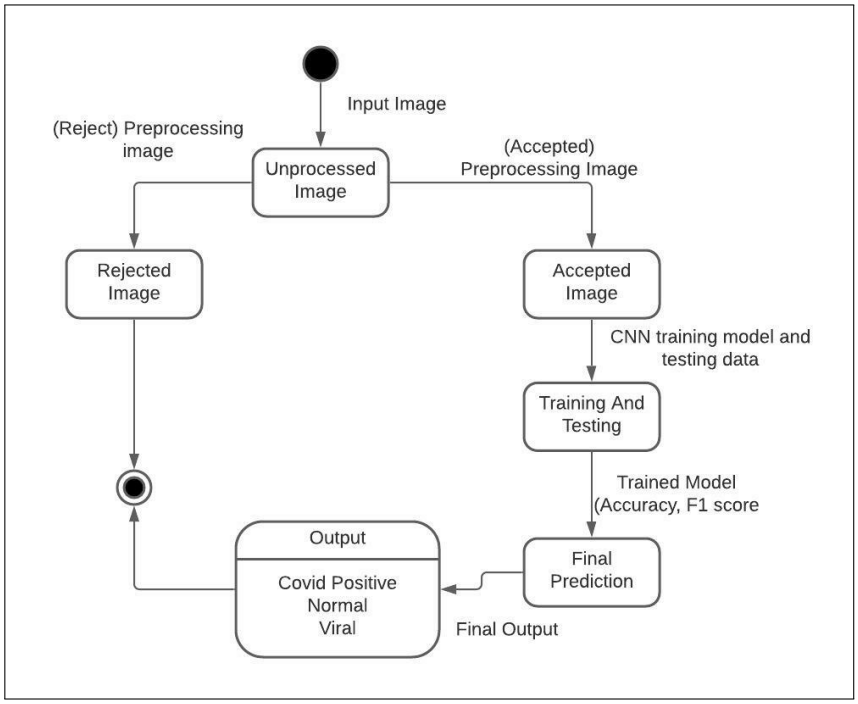

Figure 6: Activity Diagram

4.3.4 Sequence Diagram

Sequence diagram shows how objects communicate with each other in terms of a sequence of messages. It also indicates the lifespans of objects relative to those messages.

There are mainly three different objects User, Recommender system and Database. User enters query, recommender system extracts suggestions from the database using diffusion model and provide results to the user. Figure 7 is sequence diagram for the proposed system.

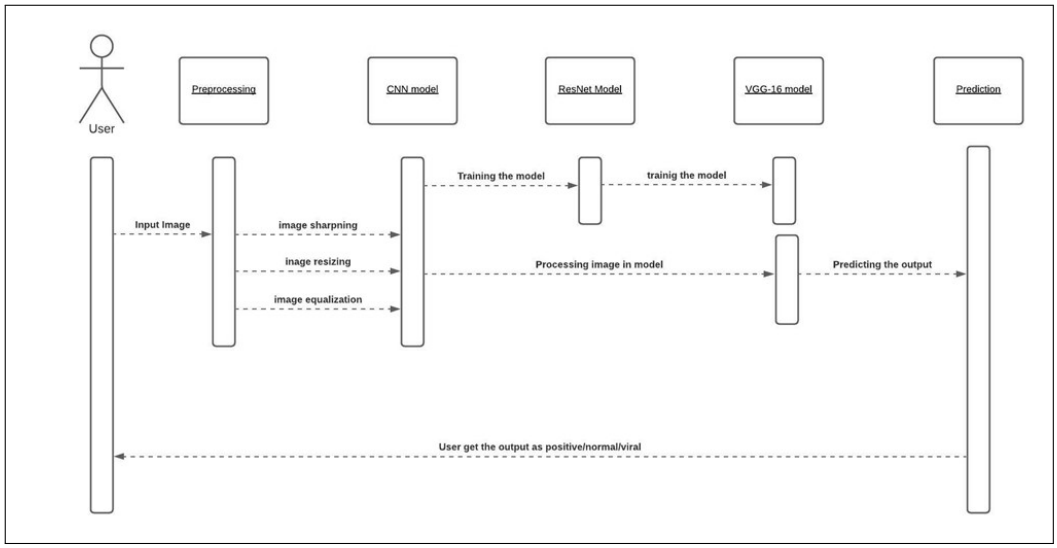

Figure 7: Sequence Diagram

4.4 Algorithmic Strategy

The covid-19 detection system is based in deep learning algorithms. We are using CNN, ResNet and VGG-16 algorithms to build our projects. We used these algorithms because they used for feature extraction. In our project we are extracting feature of infection in x-ray images to detect covid. These three algorithms are placed in order, CNN, ResNet, VGG-16 respectively.

Algorithm:

1. Insert required packeges and libreries.
2. Insert dataset
3. Make directory for test and train data
4. Preprocessing steps
5. CNN, Resnet,VGG-16 model implementation and training
6. Take input image
7. Test image through trained model
8. Output of all three models

This algorithm can be used in may types of infection detection or any types of detection we just have to make changes in dataset, and some commands. Then we have to implement our algoroithm with that dataset and we can detect any kind of infection

5 Project Plan

5.1 Project Estimate

Project Estimation means analysing project from start to end. Project estimation consists scope, estimarte time, estimate cost and risk. This project took around one year to complete. To do this project we had to search for topic. After looking hundreds of websites and reading many research paper we decided to take this topic. After selection of topic we had to present our synopsis to guide and panel so that they can approve our project. After their approval we started working on our project. The concepts of the projects were new to us so our start was bit slow but we caught up in no timewith the team work. After the approval we started doing research related to our topic. We read different papers, check different websites, and read news articals. According to these research we chose algorithms for our project. and started implementation along with documentation as well. All resources were available on the internet we didn't had to pay for anything so the cost of the project was free. Risk of this project is system failure, wrong output etc., We tried to overcome some of the risks.

5.1.1 Reconciled Estimates

Inbetween above process we had to give reviews to our guide and panel members. They gave us some suggestion regarding our project. We implemented that suggestions in our projects time to time. Some Suggestions were very important and lead to better research and study path. Because of that we made some changes in the previous estimation and implement improved system for our project.

5.1.2 Project Resources

Project resources are nothing but materials we used in the project implementation. We studied 4-5 research paper based on our topic. We also studied research paper for algorithms we used. Then we read all news articals related to project and also search for best dataset for our project.

5.2 Risk Management

Risk management is identifying risks involved in the project, analysing the risk and providing solutions for that risks.

5.2.1 Risk Identification

In risk identification process we find out what risks are involed in the project. following are the risks involed in our project:

1. It can give false results.
2. It can take extra time for some images
3. System failure

5.2.2 Risk Analysis

In risk analysis phase we study about the risks and try to provide best solution for that risk.

Following risks are involved in building proposed solution and mitigation plan for each of them. 2

Table 2: Risk Analysis

Risk	Probability	Mitigation
It can give false results.	Low	1. We tried to improve our system to avoid this problem by adding some accuracy features. 2. If still we get wrong output we can also reach to doctors for second opinion.
It can take extra time for some images	Low	Help from developer community from various blogs and forums can be taken
System failure	Low	Help from developer community from various blogs and forums can be taken

5.3 Overview of Risk Mitigation ,Monitoring,Management

In the above table we listed some risks involved in our project. With that we also provided the mitigation for same. Whenever these risks occurs we can use mentioned mitigation to solve it. The probability of these risks are low. These risks may not occur in future.

5.4 Project Schedule

We started our project early in academic year 2021-22. First two week were spent on research and requrement analysis. Every month we had a review meeting with our guide and panel members. In these reviews we got some suggestions from guide and panel members. We divided our project some some sections called task. Each member of the team were assign to some task with dead line. Every team had to complete their task in given time.

5.4.1 Project Task Set

Project task were divided into following section:

1. Project Research
2. Finalization of projects & allotment of guide
3. Detail Reaserch about project
4. Problem Statement, Motivation, Objective Study
5. Literature Survay
6. Feasibility and Scope Study
7. Requirement analysis study
8. Design study
9. Submission of partial project report

10. Modeling (Model Refinement and Algorithm development)
11. Coding / Implementation
12. Validation and Testing
13. Report Writing

5.4.2 Time line Chart

In the figure green bar and red bar shows the progress of the tasks. The green color indicates the completed tasks, and the red color indicates the incomplete tasks.

Folowing figure shows the time line chart of the project for Sem 1 and sem 2:

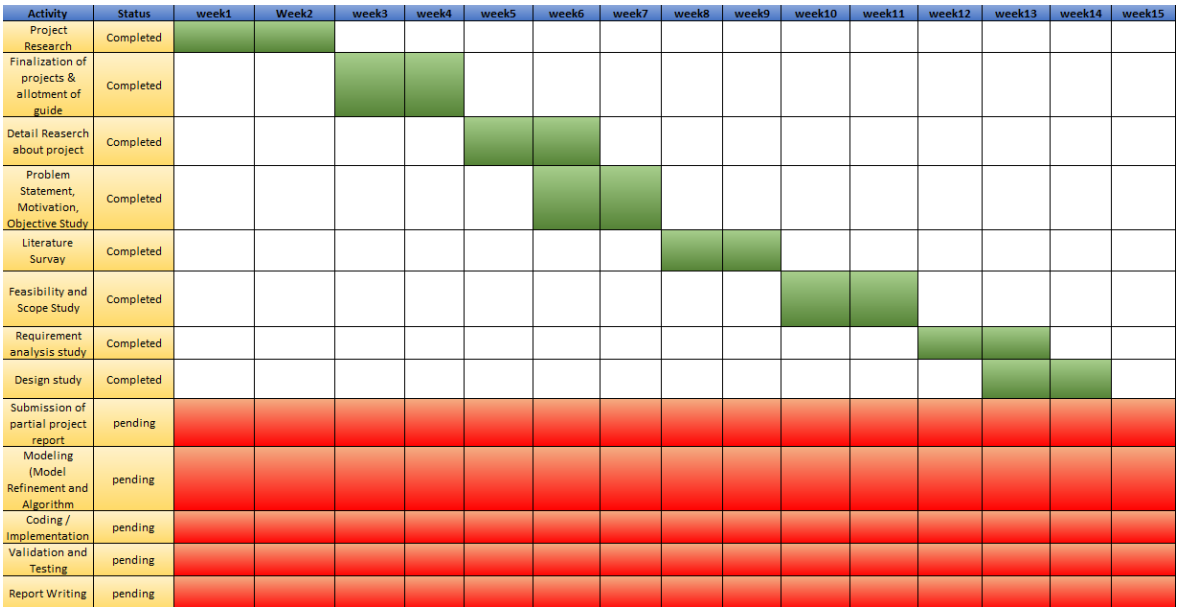

Figure 8: Timeline of Project Sem 1

5.5 Team Organization

There are 4 members in our team and 1 guide.

1. Shweta Gaikwad
2. Pallavi Karde
3. Vaibhav Maindad

Activity	Status	week1	Week2	week3	week4	week5	week6	week7	week8	week9	week10	week11	week12	week13	week14	week15
Project Research	Completed															
Finalization of projects & allotment of guide	Completed															
Detail Reaserch about project	Completed															
Problem Statement, Motivation, Objective Study	Completed															
Literature Survay	Completed															
Feasibility and Scope Study	Completed															
Requirement analysis study	Completed															
Design study	Completed															
Submission of partial project report	Completed															
Modeling (Model Refinement and Algorithm	Completed															
Coding / Implementation	Completed															
Validation and Testing	Completed															
Report Writing	Completed															

Figure 9: Timeline of Project Sem 2

4. Kaustubh Pawar

5. Prof. Sumit Harale (Guide)

Each member of the team assigned to some tasks of the project. Every member had to complete their task in specific time according to timeline chart of project.

5.5.1 Team Structure

Our team has 4 members in which 2 are girls and 2 are boys. All members belong to Final year computer engineering department.

Team members and their assined tasks are as follows:3

5.5.2 Management reporting and communication

We had team meeting before every review. I that meeting all team members and guide were present. Due to lockdown initial meetings were happn on microsoft team and some happen offline in college.4

Table 3: Team Structure

Team member	Task	Completion Time
Shweta Gaikwad.	Literature Survey, Project implementation, Report Writting,	2-3 week each
Pallavi Karde	Literature Survey, Problem stement, Motivation, Objective study,	2-3 week each
Vaibhav Maindad	Literature Survey, Feasibility & Scope study, Requirement analysis, Design study	2-3 week each
Kaustubh Pawar	Literature Survey, Feasibility & Scope study, Report Writting, Validation and testing	2-3 week each

Table 4: Management Reporting and communication

Date	Team Member Present	Suggestion given
14/7/2021	All present	Project topic selection
28/8/2021	All present	Change the name of the project. Keep either x-ray or radiography in the title of the project. Change the requirements slide make it as minimum requirements.
18/9/2021	All present	Add cost estimation using templates. Templates will be available online. Make changes in the timeline chart. Make timeline chart week wise.
28/11/2021	All present	Change class diagram
12/3/2022	All present	Change in proposed system

6 Project Implementation

6.1 Overview of Project Modules

The purpose of Software Requirement Specifications (SRS) is to provide a detailed overview of the system "COVID-19 detection using chest x-ray", its parameters and goals and to outline functional requirements of the system. SRS provides a detailed description of behaviour of the system as well as lists any assumptions made while developing the system and all the constraints faced by the system. It also specifies the hardware and software requirements of the system.

The objective of the project is to detect covid-19 infection with the help of deep learning methods. We developed this project to help people and doctors to detect the infection faster than the traditional method. To achieve the goal of the project, our project contains the following modules:

1. Home

   The home module contains a button called Detect Covid. When the user clicks on that button user will navigate to the next page.

2. Detect covid

   In this module, the user has to upload an x-ray image. After uploading the image user will navigate to the next page.

3. Result

   In this module, the user will get the result based on the x-ray image he/she uploaded. The result will be displayed either covid, normal, or viral.

USER CLASSES

According to Investopedia, an end-user is a person or other entity that consumes or makes use of the goods or services produced by businesses. In this way, an end-user may differ from a customer since the entity or person that buys a product or service

may not be the one who uses it. In this project, we created a platform that will help the medical sector and people to detect the infection in less time and less money.

CHARACTERISTICS

The end-user of the applications are the patients who are suffering from the symptoms like cough, fever, body pain, loss of test, trouble breathing, etc. After inserting their x-ray into the application, it will give results either covid positive or viral. If the person does not have any kinds of symptoms and he is healthy and that person uploaded his x-ray into the application it will give the result as normal.

6.2 Tools and Technologies Used

The proposed system focusses on developing a Recommendation system to detect the covid infection from chest x-ray. This system is designed by applying CNN, ResNet, VGG-16 algorithm from available dataset.

Tools and Technologies are as follows:

Sr. No.	Tools and Technologies	Version
1	Flask	2.0.2
2	HTML	HTML5
3	TensorFlow	2.6.0
4	Keras	2.6.0
5	NumPy	1.21.5
6	Pandas	1.4.1
7	Python	3.9.7

Table 5: Tools and Techonologies used

6.3 Algorithmic Details

We used three algorithms CNN,ResNet, Vgg-16. Convolutional Neural Network is deep learning neural network that is generally used for analyzing images by processing data with grid topology. CNN is used to detect and classify objects in an image. In CNN image is represented in the form of an array of pixels.

A Residual Neural Network is an artificial neural network. Residual neural networks utilize skip connections, or shortcuts to jump over some layers. It is introduced by Shaoqing Ren, Kaiming He, Jian Sun, and Xiangyu Zhang in their paper. The paper was named "Deep Residual Learning for Image Recognition" in 2015. The ResNet model is one of the popular and most successful deep learning models so far.

VGG-16 is Convolutional Neural Network that contains 16 layers. We can load the pre-trained model from the ImageNet database. The pre-trained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. We can also free some of the layers from the model and add our trained layers into the model. It is called transfer learning.

6.3.1 Algorithm 1: CNN

1. Choose Dataset
2. Prepare Dataset for Training
3. Create Training Data
4. Shuffle the Dataset
5. Assigning Labels and Features
6. Normalising X and converting labels to categorical data
7. Normalising X and converting labels to categorical data
8. Define, compile and train the CNN Model
9. Accuracy and Score of model

This algorithm can be used in many types of image classification. To classify image this algorithm uses feature extraction. We used three algorithms CNN,ResNet, Vgg-16. Convolutional Neural Network is deep learning neural network that is generally used for analyzing images by processing data with grid topology. CNN is used to detect and

classify objects in an image. In CNN image is represented in the form of an array of pixels.

6.3.2 Algorithm 2: ResNet

1. Define the identity block
2. Convolution block
3. Build the model
4. Training
5. Print the model summary
6. Accuracy and Score of model

A Residual Neural Network is an artificial neural network. Residual neural networks utilize skip connections, or shortcuts to jump over some layers. It is introduced by Shaoqing Ren, Kaiming He, Jian Sun, and Xiangyu Zhang in their paper. The paper was named "Deep Residual Learning for Image Recognition" in 2015. The ResNet model is one of the popular and most successful deep learning models so far.

6.3.3 Algorithm 3: VGG-16

1. import necessary libraries for Keras to implement a vgg 16 model.
2. Now we need to define a model Keras
3. The first part has two conv64 with a pooling layer
4. The second part has two conv128 with a pooling layer
5. The Third part has three conv256 with a pooling layer
6. The fourth part has four conv512 with a pooling layer
7. The fifth part has four conv512 with a pooling layer

8. At last, We have Two Dense layers with 4096 nodes and an output layer

9. Summary of model

VGG-16 is Convolutional Neural Network that contains 16 layers. We can load the pre-trained model from the ImageNet database. The pre-trained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. We can also free some of the layers from the model and add our trained layers into the model. It is called transfer learning.

7 Software Testing

7.1 Types of Tasting

Testing is an important part of software development life cycle. It is performed to ensure quality of the developed system. Testing includes a set of investigative activities that can be planned in advance and conducted systematically, to assure the stakeholder that system fulfils all the requirements gathered during requirement gathering phase. Software testing is one of the key elements in software projects that is often referred to as verification and validation. Verification refers to the set of activities that ensure that software correctly implements specified functionality. Validation refers to a set of activities built around traceability matrix which ensure that the functionality implemented by the system is traceable to customer requirements.

The software test plan (STP) is designed to test each module to measure its performance, to uncover bugs in the system, to set aright any flaws in logic that may be present, and to check logical flow from one module to another within system.

7.2 Test cases and Test Results

A strategy outlines what to plan, and how to plan it. A successful strategy is your guide through change, and provides a firm foundation for ongoing improvement. Unlike a plan, which is obsolete from the point of creation, a strategy reflects the values of an organization - and remains current and useful. When an organization tests its products or its tools, it tries to compare them against its expectations and values. By its nature, testing introduces change as problems are identified and resolved. A test strategy is necessary to allow these two impulses to work together. Furthermore, testing can never be said to be 'complete', and a core skill in testing is the justified management of conflicting demands; without a strategy, these judgements will be inconsistent to the point of failure.

Software development is a creative process. A test strategy is a vital enabler to this process keeping focus on core values and consistent decision-making to help achieve

desired goals with best use of resource. A good strategy stands as a clear counter to reactive, counter-productive test approaches.

Table 6: Test cases for covid detection

TC ID	Description	Expected Output	Actual O/P
1.1	Insert Invalid Image .	Error page occured	Error generated
1.2	Insert Valid Image	Result page occured	Result Generated
2.1	No image selected	Error page occured	Error Generated.
2.1	Image selected.	Result page occured	Result Generated
3.1	Click on select image	Select image page occurs	image is selected
3.2	Click on submit	Result page is occured	Result generated.
3.3	Click on Detect covid	Upload page occured	Upload image page occurd

8 Results

8.1 Outcomes

The covid-19 detection using chest x-ray is created to help people with their infection detection. We build Web application using Flask and HTML. Flask is used as backend and Html is used as frontend. We also use bootstrap and CSS to style the webpage So that webpage look attractive to people.

8.2 Screen Shots

We implemented all the algorithms in python and compiled using google colab. All the experiments were run on windows 7 machine with an intel core i3 processor and 4Gb memory. Dataset we used was in zip format. We implemented frontend and backend using HTML and Flask. Both were complied in anaconda IDE.

Prerequisite: Python 3.7 or later should be installed on the system, a webcam and a microphone should be there on the system.

Step 1: Open the "Covid-19 detection using chest x-ray" folder.

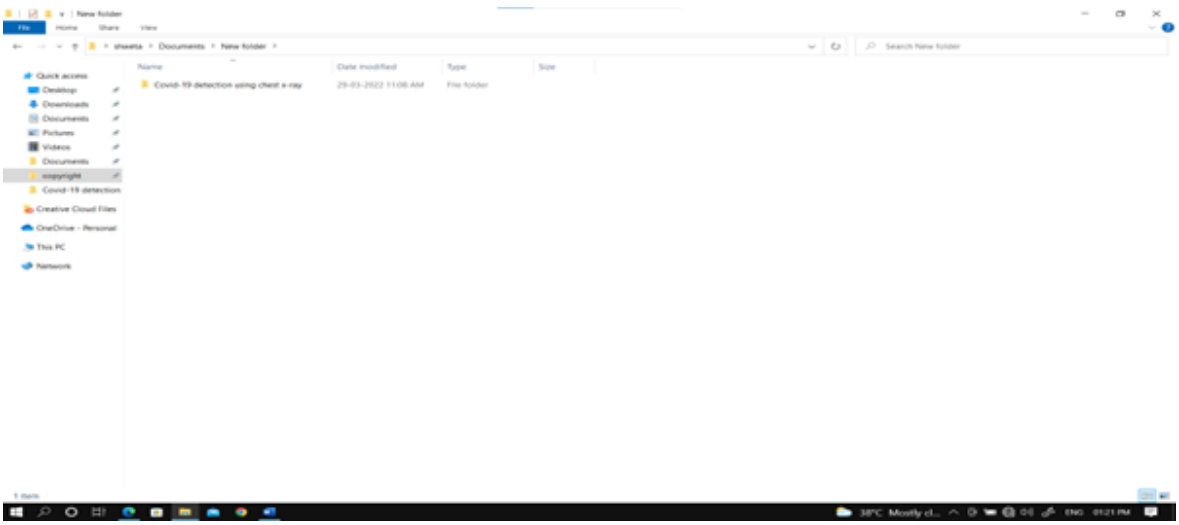

Figure 10: Step1

Step 2: Step 2: Locate the "App1.py" file. Open "Command prompt" in this folder. Keep the Command Prompt opened throughout all the steps mentioned below

Step 3: Run "App1.py" file by using command "Python app1.py".

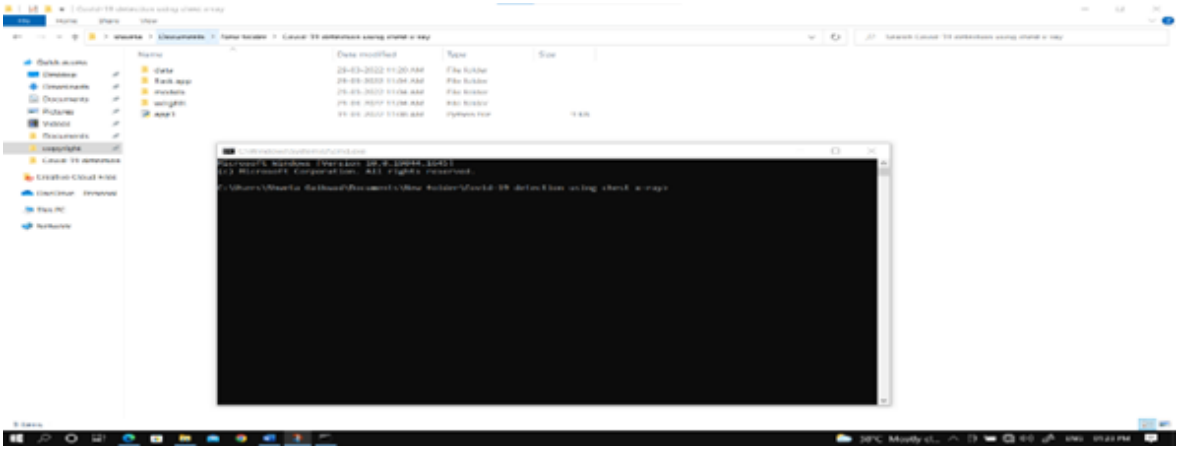

Figure 11: Step2

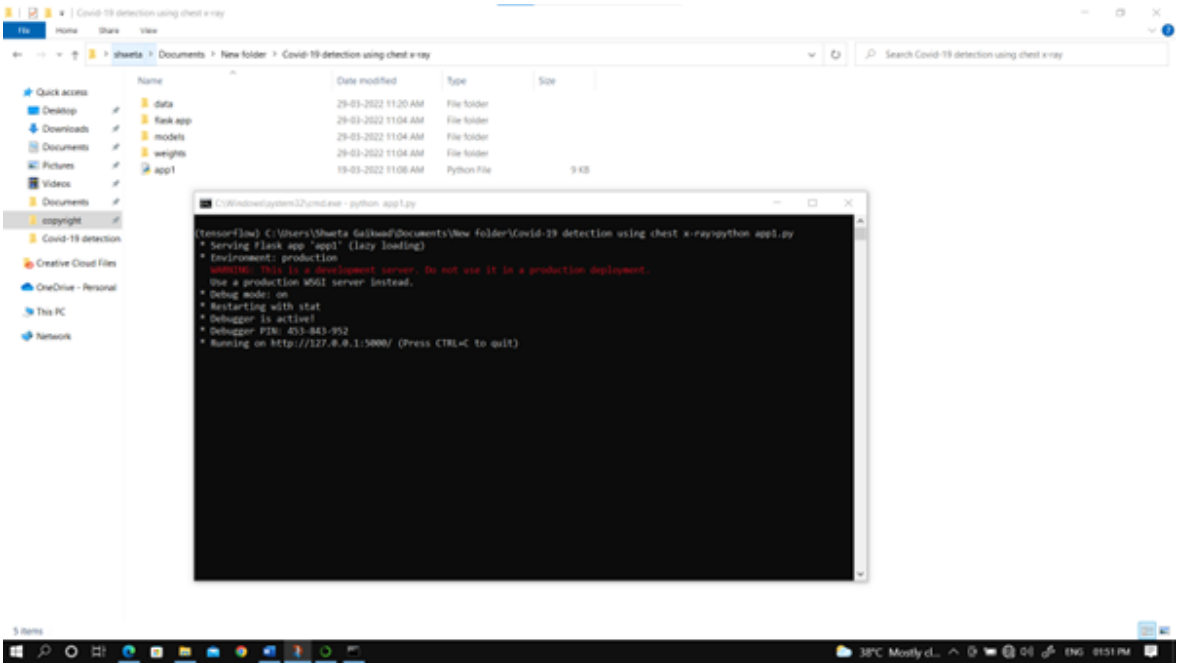

Figure 12: Step3

It will execute App1.py file. Now application is running on server. After running above command it will give us one address.

Step 4: Copy the address and paste it in browser.

It will take us to our home page.

Step 5: Click on "Detect Covid?". It will take us to next page where user have to upload the x-ray image.

Step 6: Click on select image to upload the image.

Step 7: After selecting image click on upload. It will give us the result according

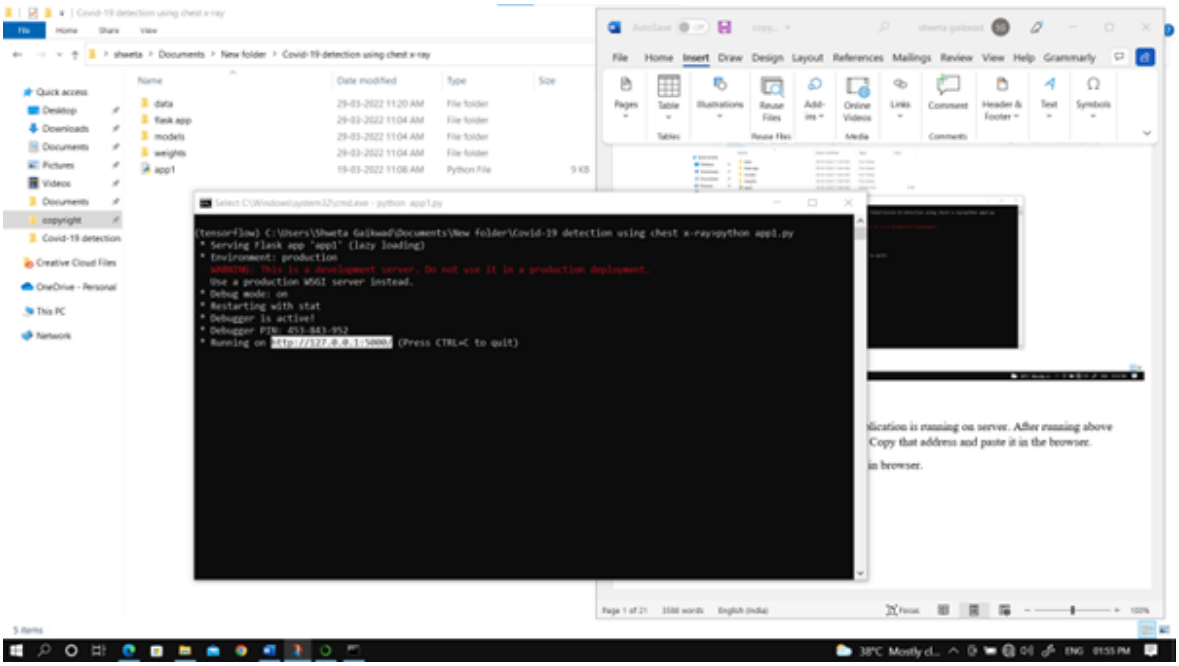

Figure 13: Step3

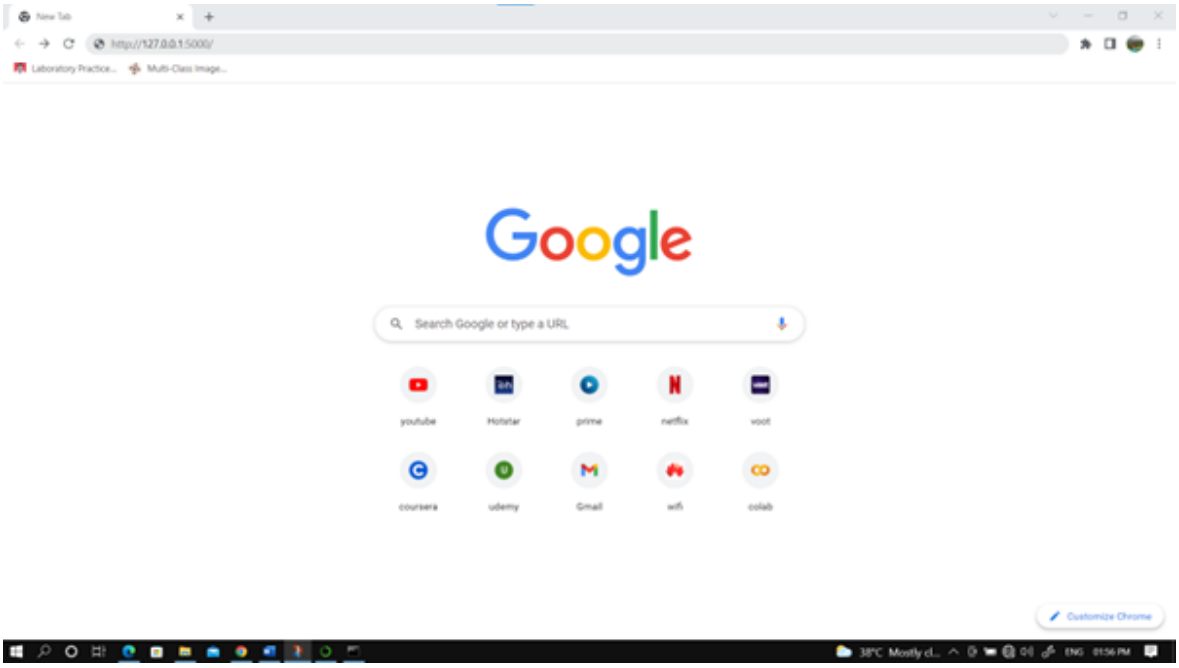

Figure 14: Step4

to our model prediction.

Step 8: Close the application by closing browser and command prompt.

Figure 15: Step4

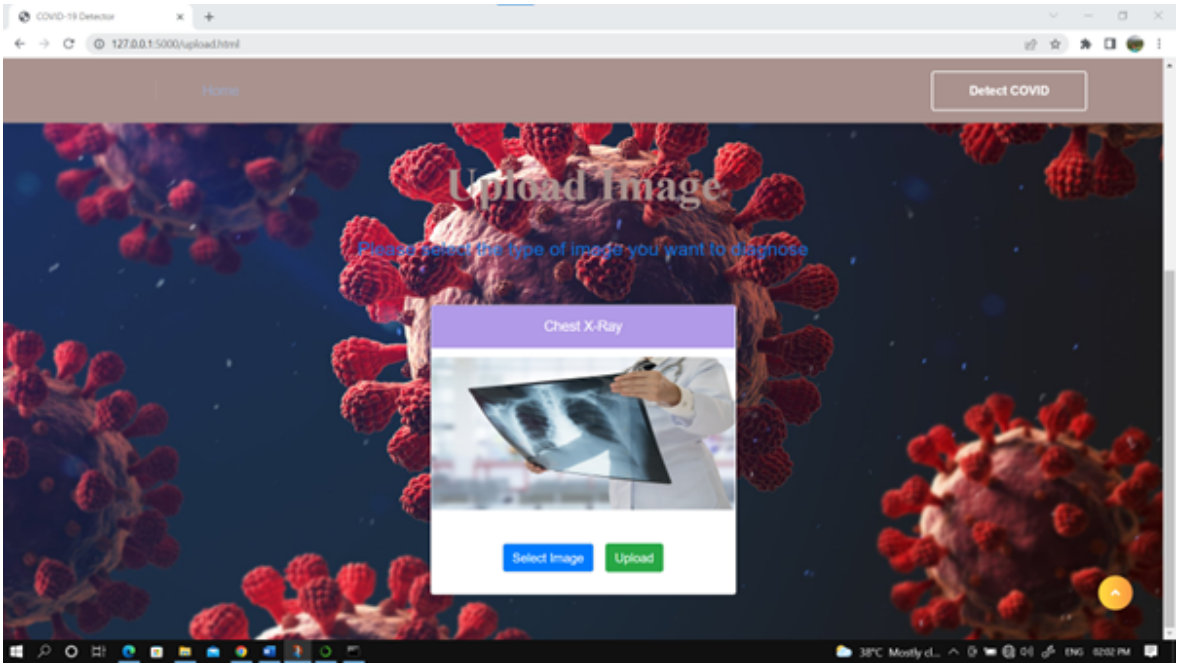

Figure 16: Step5

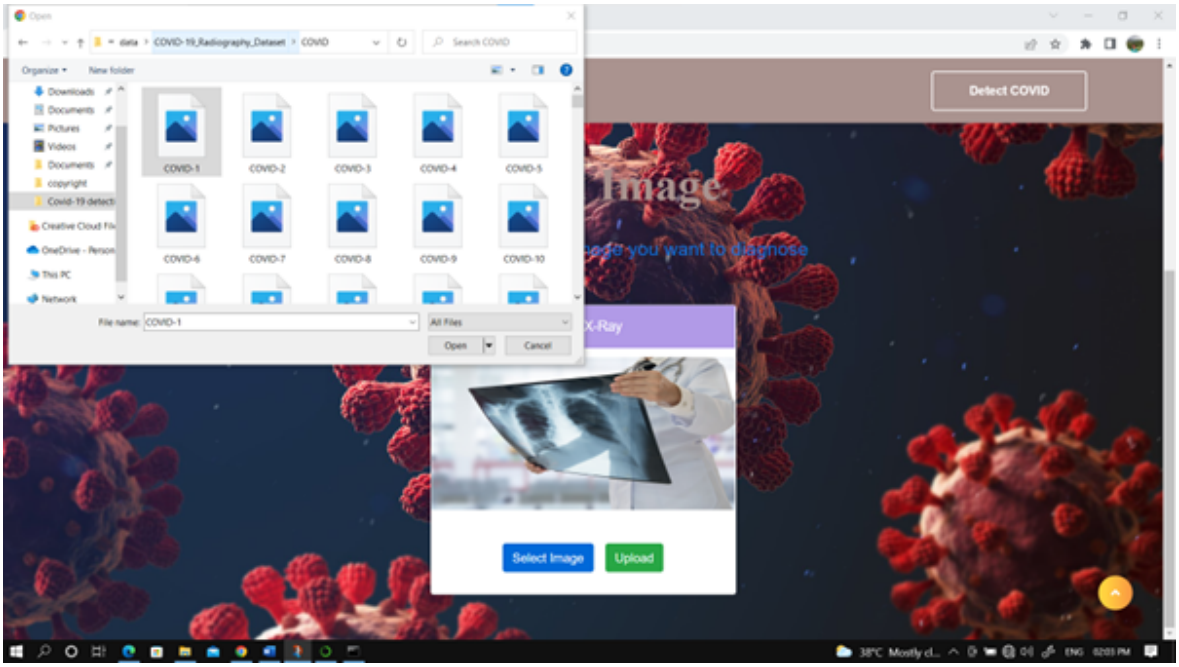

Figure 17: Step6

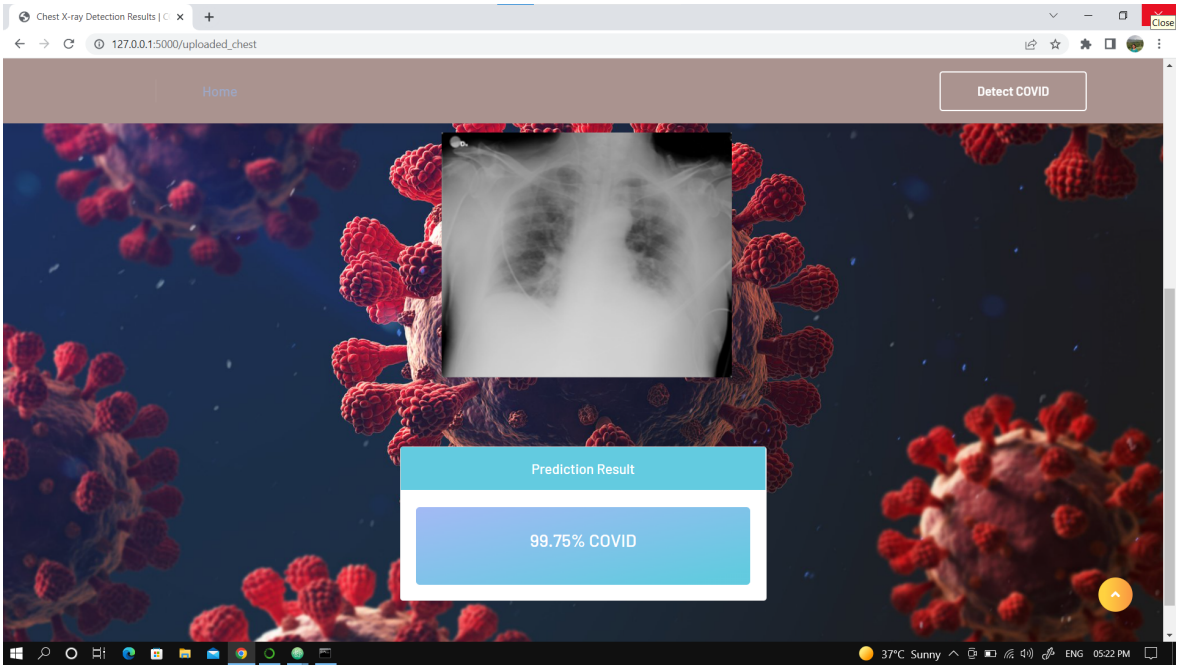

Figure 18: Step7

9 Conclusions

9.1 Conclusions

We used the deep learning model to detect COVID19 using chest x-rays automatically. The study shows the effective method of non-human-contact testing on COVID-19 patients, which can help in early and low-cost detection of COVID cases. X-ray images of the chest are presented, which shows the regions for confirmed COVID-19 positive cases, bacterial pneumonia, and healthy cases.

9.2 Future Work

We believe that this project could be used as initial testing, which can help doctors to detect the COVID infection by better screening the presence of the disease. It is not only low-cost but also an automatic non-human-contact testing method. It will help to reduce the risk of COVID-19 infection by doctors.

We are going to build the network of CNN, VGG-16, Res-Net, and transfer learning algorithms. In the system, we will be using the F1 score for accurate prediction. We can do cascading for combining these three models for better results.

9.3 Applications

We can use this system in our day-to-day life, but the main application of this project is in the medical industry. The medical industry will make better use of this system. The hospital will use this system to check mass images to reduce their workload. Ana many people will get their results on time and doctors can save many lives. We can use this product for business purposes. But in this people have to pay for the use of the system. This system will be made public for some amount and then they can check their x-rays at home

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Appendices

A Appendix

A.1 Appendix A

A.2 Copyright

FORM XIV
APPLICATION FOR REGISTERATION OF COPYRIGHT
[SEE RULE 70]

Diary Number: 8209/2022-CO/SW

To

The Registrar of Copyrights,
Copyright Office,
Department of Industrial Policy & Promotion,
Ministry of Commerce and Industry,
Boudhik Sampada Bhawan,
Plot No. 32, Sector 14, Dwarka,
New Delhi-110075
Email Address: copyright@nic.in
Telephone No.: (Office) 011-28032496, 08929474194

Sir,

In Accordance with Section 45 of the Copright Act, 1957 (14 of 1957), I hereby apply for registration of Copyright and request that enteries may be made in the Register of Copyrights as in the enclosed Statement of Particulars.

1. I also send herewith duly completed the Statement of further Particulars relating to the work. (for Literary/Dramatic, Musical, Atristic works only) **Computer Software works**

2. In accordance with rule 16 of the Copyright Rules, 1958, I have sent by prepaid registered post copies of this letter and of the Statement of Particulars and Statement of Further Particulars to other parties concerned as shown below:

Name of Party	Address of Party	Date of Dispatch
SHWETA GAIKWAD	11, SAINATH COLONY, NEAR VINAYK NAGAR, KRISHNA CHOWK, NEW SANGVI-411061	09/04/2022
PALLAVI KARDE	CHIKHALI PRADHIKARAN GHARKUL SPINE ROAD SECTOR NO 17/19 NAVJEEVAN HSG SOC BUILDING NO A15	09/04/2022
VAIBHAV MAINDAD	SAPTSHRUNGI HOUSING SOCIETY RUPEENAGAR, TALWADE 411062-411062	09/04/2022
KAUSTUBH PAWAR	RICHMOND PARK, G-701, RAMBAGH COLONY, RAHATANI - 411017-411017	09/04/2022
SUMIT HARALE	M 102, ABHIMAN HOMES, SHIRGAON TAL MAVAL PUNE 410506-410506	09/04/2022
INDIRA COLLEGE OF ENGINEERING AND MANAGEMENT PUNE	S.NO. 64,65, GAT NO. 276 AT POST : PARANDWADI, NEAR SOMATNE PHATA, TAL. : MAVAL, DIST. PUNE – 410 506-410506	09/04/2022

[See columns 7,11,12, and 13 of the Statement of Particulars and party referred in col.2 (e) of the Statement of Further Particulars.]

3. The prescribed fee has been paid, as per details below: **500/-**

Payment ID	Payment Date	Amount	Bank Name	Payment Mode
278011	19/04/2022	500		

4. Communications on this subject may be addressed to:

SHWETA GAIKWAD
11, SAINATH COLONY, NEAR VINAYK
NAGAR, KRISHNA CHOWK, NEW SANGVI-
411061
7262019858

5. I hereby declare that to the best of my knowledge and belief, no person, other than to whom a notice has been sent as per paragraph 2 above any claim or interest or dispute to my copyright of this work or its use by me.

6. I hereby verify that the particulars given in this Form and the Statement of Particulars and Statment of Further Particulars are true to the best of my knowledge, belief and information and nothing has been concealed there from.

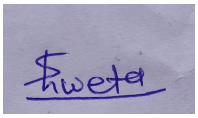
List of Enclosures:

1. 2 Copies of Work
2. DD/IPO of Rs.500 Per Work
3. Authorization from author/publisher
4. If the application is being filed through attorney , a specific Power of Attorney in original duly signed by the applicant and accepted by the attorney

Place:

Date: **19/04/2022**

For : SHWETA GAIKWAD



Proprietor

STATEMENT OF PARTICULARS

Diary Number: 8209/2022-CO/SW

1.	Registration Number	
2.	Name, Address and Nationality of the Applicant	NAME: SHWETA GAIKWAD, ADDRESS: 11,SAINATH COLONY, VINAYAK NAGAR, KRISHNA CHOWK, NEW SANGVI-411061, Indian
3.	Nature of the Applicant's interest in the Copyright of the work	Author
4.	Class and description of the work	Computer Software Work
5.	Title of the work	COVID-19 detection using chest X-Ray
6.	Language of the work	Python, Deep learning, Flask, HTML
7.	Name, Address and Nationality of the Author and if the Author is deceased, the date of decease.	NAME: SHWETA GAIKWAD, ADDRESS: 11,SAINATH COLONY, VINAYAK NAGAR, KRISHNA CHOWK, NEW SANGVI-411061, Indian,

8.	Whether the work is Published or Unpublished	Unpublished
9.	Year and Country of first publication, and Name, Address and Nationality of the publisher	N/A
10.	Year and Countries of subsequent publications, if any, and Name, Address and Nationality of the publisher	N/A
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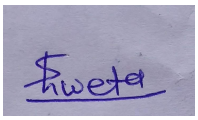

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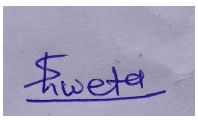

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B Appendix B

B.1 IRJMETS Paper

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COVID-19 DETECTION USING CHEST X-RAY

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ABSTRACT

Covid-19 is discovered in 2019. No one knows the origin of this virus. Infection rate of the virus is very high. The whole world suffers from it. In the beginning, cases were low, but they increased, and WHO had to declare the pandemic. The virus spread all over the world and very high number of cases started to show. The pandemic was horrible. Lots of people are affected due to this. At the begging of the pandemic, there wasn't a proper testing procedure to detect the infection of the patient. It caused lots of confusion among the people. To prevent the infection people had to take preventive measures and had to get quarantined even though you are not infected, which caused lots of problems. The RT-PCR test is used for checking the infection. But this test 2-3 days for detection. And there were millions of testing cases, so it took a lot more time to give results to the patients. There was another problem that is false positive or false negative reports. People got this kind of report and got the wrong medication. To confirm the report doctor recommended a CT scan of the chest to detect the infection. But CT scan is high in cost. Not every person has that kind of money. Also, not every hospital has a CT scan device. But there is another way to detect the infection and that is through x-ray. X-ray is cheap and almost every hospital has an x-ray machine. In this paper we have proposed the system, which uses deep learning method. In this system, we are going to use chest x-ray images to predict the infection. In this system, the user will get the result in a few seconds.

Keywords: Covid-19, X-Ray, AI, Deep Neural Network, Resnet, VGG16, CNN.

I. INTRODUCTION

Covid-19 is discovered in 2019. No one knows the origin of this virus. The virus was spread throughout the world. The whole world suffers from it. In the beginning, cases were low, but they increased, and WHO had to declare the pandemic. The pandemic was horrible. Lots of people are affected due to this. A lot of people suffer from lung failure. At the begging of the pandemic, there wasn't a proper testing procedure to detect the infection of the patient. It caused lots of confusion among the people. To prevent the infection people had to take preventive measures and had to get quarantined even though you are not infected, which caused lots of problems. But this test takes 2-3 days for detection. And there were millions of testing cases, so it took a lot more time to give results to the patients. There was another problem that is false positive or false negative reports. People got this kind of report and got the wrong medication. To confirm the report doctor recommended a CT scan which is high in cost. Alternate way to detect the infection is through x-ray. In this paper we are proposing a system which will use X-ray to predict COVID_19 infection. We are going to use CNN (Convolutional neural network), ResNet (residual neural network), and VGG-16 and transfer learning. Our system will detect the infection spread in the lungs through a chest x-ray which the user will provide. Then the given image will process through the model and give the result. There will be three types of results COVID19-positive, COVID19-negative, and viral pneumonia.

The covid dataset will be divided into two different parts. The training dataset and testing dataset. Meanwhile, the dataset will be cleansed. In which image will get sharpen for training. In the next phase, data will be preprocessed after the preprocessing of the data-specific features of the covid infections will be extracted. This process is done on the training and testing of both datasets. These pre-trained models will be used for COVID-19 prediction. The proposed system will predict the infection is present or not.

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II. LITERATURE SURVEY

The paper Automatic detection of COVID-19 from chest radiographs using deep learning written by M.K. Pandit, S.A. Banday, R. Naaz, M.A. Chishti showed that we can use chest radiograph for the covid detection [10]. They made an automated system to process the data and infection detection. Deep learning convolution neural networks and transfer learning is used in it. They used a VGC-16 network for covid detection. VGC-16 is a 16-layer convolutional neural network. It has 13 convolutional layers along with 3 fully connected layers. It also contains 5 max-pooling layers. VGG-16 is quite slow to train and acquire a lot of disk space, which makes it very inefficient. The total number of parameters used is 134,268,738. Accuracy claimed by the author for 2-class is 96% and for 3-class is 92%.

Worapan Kusakunniran proposed that we can use chest X-ray and generate heat map for covid detection. They used Res-Net-101 architecture. The entire network is trained using 1500 × 1500 x-ray images [11]. The heatmap of the segmented lung is constructed to visualize signals of COVID-19 in each input x-ray image. Lungs are segmented using the pretrained U-Net. The confidence score of COVID-19 is also calculated for each classification result. In this paper, the authors have used the RESNET-101 network. Very deep neural network (101 layers) and the number of parameters is around 44 million. Better accuracy (for 3 classes) but very heavy network.

In the paper SOM-LWL method for identification of COVID-19 on chest X-rays written by Ahmed Hamza Osman, Hani Moetque Aljahdali, Sultan Menwer Altarrazi, Ali Ahmed [12]. They used the SOM-LWL algorithm to detect covid infection. They detected covid-19 pneumonia infection in the lungs using a chest X-Ray. In this paper, the authors have used the SOM-LWL algorithm (instance-based algorithm). In this case also classification costs is high, and a large amount of memory is used to store the data. Better accuracy is achieved for 3 class classification (97%).

III. METHODOLOGY

We used CNN, RES-net, VGG-16, and transfer learning. With the help of these models, we will be predicting user has a covid infection or not. The covid dataset will be divided into two different datasets training dataset and testing dataset. Aim of the project is to classify the images in to three types ie. COVID-19, Normal and Viral infection. The dataset will be cleansed. In which image will get cleared and sharp for training. In the next phase, data will be preprocessed after the preprocessing of the data-specific features of the covid infections will be extracted. This process is done on the training and testing of both datasets. After that machine learning classification or models will be run. The models we are using are CNN, ResNet, VGG-16. After the classification result will be predicted.

IV. MODELING AND ANALYSIS

System Architecture

The proposed system is shown in Fig. 1. It has 3 modules explained as follows:

1. Database and GUI: We downloaded the database from kaggle. Then we uploaded that database to our system for training and testing purpose. Our system contains 3 webpages. First is home, in home page there is a button named detect covid user have to click that button to upload the image. Second is upload image, in this page user have to upload x-ray image from their system and have to click on submit to get result. And third is result page, on this page user will get the result of their x-ray image.

2. Preprocessing and model training: Before accepting the image from user we trained our models and downloaded them to use as the backend to predict the user images. After accepting the image from user preprocessing is done in the backend. In this process image augmentation, resizing, image cleansing, etc., are implemented.

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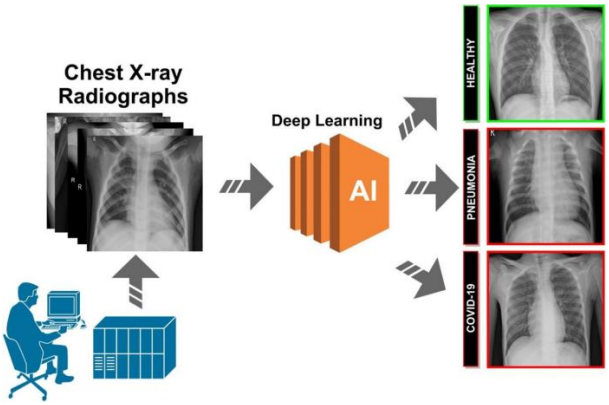

Figure 1: System Architecture.

3. Output: After accepting image from user and preprocessing, image goes through pre trained models. The predictions of all three models will be further processed by average polling method to give final output.

V. RESULTS AND DISCUSSION

We have taken up three different model for study in this paper. These models are CNN, Resnet and VGG-16. We have trained these models on the images in our datasets. The training and validation results indicating accuracy, F1-score are given Fig. 2,3 and 4.

	precision	recall	f1-score	support
0	0.81	0.95	0.88	616
1	0.99	0.93	0.96	2170
2	0.87	0.95	0.91	244
accuracy			0.93	3030
macro avg	0.89	0.95	0.91	3030
weighted avg	0.94	0.93	0.94	3030

Figure 2: Classification table for CNN.

	precision	recall	f1-score	support
0	0.90	0.95	0.92	723
1	0.97	0.98	0.97	2038
2	0.98	0.70	0.82	269
accuracy			0.95	3030
macro avg	0.95	0.88	0.90	3030
weighted avg	0.95	0.95	0.95	3030

Figure 3: Classification table for Resnet.

	precision	recall	f1-score	support
0	0.63	1.00	0.78	723
1	0.99	0.80	0.88	2038
2	0.96	0.90	0.93	269
accuracy			0.85	3030
macro avg	0.86	0.90	0.86	3030
weighted avg	0.90	0.85	0.86	3030

Figure 4: Classification table for VGG-16.

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These pretrained models are individually used to do the prediction of the image. The predictions of these models will be averge polled to give final output. With average polling variance in the results will be reduced.

FINAL OUTPUT

The final output of the system is given in Fig.5. It shows the uploaded image and the percentage chances of the persen infected with COVID-19, Viral pneumonia or the person is Normal.

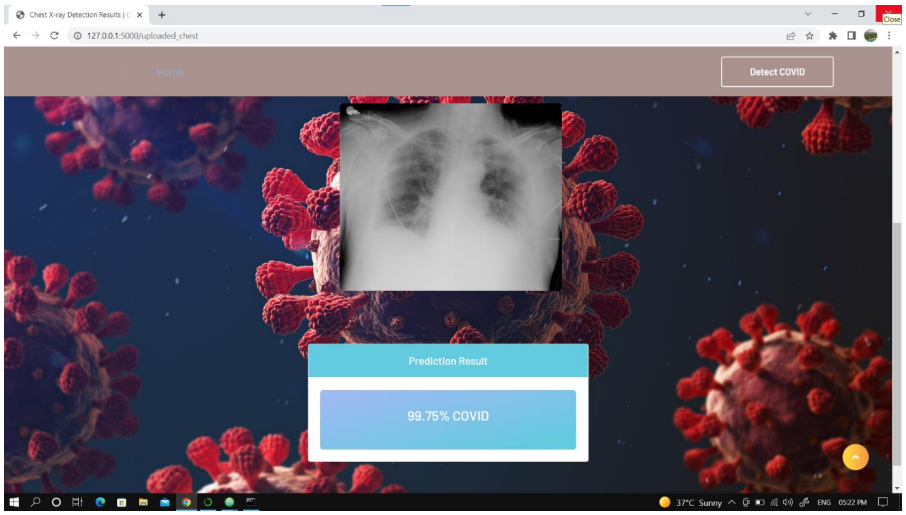

Figure 5: Final output of the system.

VI. CONCLUSION

We used the deep learning model to detect COVID19 using chest x-rays. Three different models are trained independently on our dataset. These pre-trained models are independently used to predict uploaded image on our system. Predictions obtained by all three models are averaged to give final prediction output. The study shows the effective method of non-human-contact testing on COVID-19 patients, which can help in early and low-cost detection of COVID cases.

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[11] Journal Article Kusakunniran, Worapan Karnjanapreechakorn, Sarattha Siriapisith, Thanongchai Borwarnginn, Punyanuch Sutassananon, Krittanat Tongdee, Trongtum Saiviroonporn, Pairash COVID-19 detection and heatmap generation in chest x-ray images 8 Journal of Medical Imaging S1 014001 2021 https://doi.org/10.1117/1.JMI.8.S1.014001 DOI 10.1117/1.JMI.8.S1.014001 SPIE

[12] SOM-LWL method for identification of COVID-19 on chest X-rays Osman AH, Aljahdali HM, Altarrazi SM, Ahmed A (2021) SOM-LWL method for identification of COVID-19 on chest X-rays. PLOS ONE 16(2): e0247176. https://doi.org/10.1371/journal.pone.0247176

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B.2 IRJMETS Certificates

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Character count	45973

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Sentences similarity distribution

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