COVID AND PNEUMONIA ANALYSIS THROUGH CHEST X-RAY

EPICS report submitted in partial fulfillment of the Requirements for the Award of the Degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

Submitted by

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2022

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CERTIFICATE

This is to certify that the major project course report entitled " **COVID AND PNEUMONIA ANALYSIS THROUGH CHEST X-RAY** " being submitted by

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in partial fulfilment for the award of the Degree of Bachelor of Technology in Computer Science and Engineering to the Jawaharlal Nehru Technological University, Kakinada, is a record of bonafide work carried out during the period from 2021 - 2022.

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DECLARATION

We hereby declare that the Major Project project entitled **"COVID AND PNEUMONIA ANALYSIS THROUGH CHEST X-RAY"** submitted for the B.Tech Degree is our original work and the dissertation has not formed the basis for the award of any degree, associate ship, fellowship or any other similar titles.

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Abstract

As of April 2021, more than 170 million confirmed cases had been found across the globe, according to latest figures. The number of occurrences continues to rise. The proposed study seeks to diagnose Pneumonia and COVID patients using Chest X-Rays, Those are some of the medical imaging modalities often used for identifying lung inflammation in patients. For the specified dataset, the suitable CNN Model is determined. Using a database of chest X-Ray pictures from genuine patients, the model acknowledges Pneumonia and COVID patients. Images are pre-processed and properly trained for categories such as Normal, Pneumonia and COVID. Following pre-processing techniques, disease identification is performed by picking relevant features from each dataset's images. The graph depicts COVID detection accuracy to Pneumonia detection accuracy and vice versa. The COVID vs Normal test is more accurate than the COVID vs Pneumonia test. Not only does this approach detect Pneumonia or COVID, but it also recognises Pneumonia subtypes such as bacterial or virus infection, with accuracy rates of 81 percent and 91.46 percent respectively. The proposed approach for identifying COVID, Bacterial Pneumonia, and virus infection aids. COVID may be diagnosed and differentiated from various kinds of pneumonia quickly., allowing for the adoption of suitable and timely treatments.

Keywords: Covid-19, Pneumonia, Chest X-ray, Convolutional Neural Network, Deep Learning.

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Chapter 1

INTRODUCTION

The first case of COVID-19 was reported in Wuhan, China, in December 2019. By March 2020, the virus had spread widely, according to the UN Agency. By April 2021, there had been almost 4.5 million confirmed cases in the UK, with 129,080 deaths. Due to COVID-19, the global total number of confirmed cases has risen to almost 140 million, with a 3 million fatality rate. According to WHO estimates, the virus's incubation period ranges from 2 to 8 days, and During such periods, it is possible for sufferers to spread it. The patient's lung inflammation will be treated if this disease is detected early on.

The study's objective is to apply deep learning techniques to identify Pneumonia and COVID patients as Normal and Infected Pneumonia patients. For COVID-19 detection, transfer learning approaches can be applied. Image modes have a high resolution and are utilised for non-painful medical diagnosis. Convolutional neural networks are commonly employed in deep learning techniques and are useful for quickly identifying disorders. Deep learning approaches can forecast even in the presence of aberrant situations in the photos. Lung disease is a frequent ailment that affects people of all ages. Currently, this condition can manifest itself in a variety of ways, including COVID-19, Pneumonia, and so on. According to certain research, it can also provide false positive results. Tests performed too soon may result in erroneous negative results.

Chest X-ray images are frequently used to diagnose lung infections, COVID-19, and other diagnostics. The victim's chest X-ray images are often classified into three types: normal, Pneumonia and COVID Infected. Pneumonia, both viral and bacterial, can produce a variety of symptoms in humans, including erratic pulse, cardiovascular shock, muscular soreness and fatigue, as well as mortality in certain situations. As a result, recognising Pneumonia subtypes are an important requirement that can save time and minimize mistakes in outpatient health care. The prime motive is the challenge for an experienced professional in identifying a subtype of Pneumonia in patients. Subtype may exacerbate patients' health concerns.

1.1 Basic Concepts

Covid

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. Most people who fall sick with COVID-19 will experience mild to moderate symptoms and recover without special treatment. However, some will become seriously ill and require medical attention. Shortness of breath and chest pain are some of the symptoms of COVID-19.

Pneumonia

Infection that inflames air sacs in one or both lungs, which may fill with fluid. With pneumonia, the air sacs may fill with fluid or pus. The infection can be life-threatening to anyone, but particularly to infants, children and people over 65. Symptoms include a cough with phlegm or pus, fever, chills and difficulty breathing. Antibiotics can treat many forms of pneumonia. Some forms of pneumonia can be prevented by vaccines. Cough, Fatigue and chest pain while breathing are some of the symptoms of Pneumonia.

Chest X-ray

A chest radiograph, called a chest X-ray, or chest film, is a projection radiograph of the chest used to diagnose conditions affecting the chest, its contents, and nearby structures. Chest radiographs are the most common film taken in medicine. Chest X-rays produce images of your heart, lungs, blood vessels, airways, and the bones of your chest and spine. Chest X-rays can also reveal fluid in or around your lungs or air surrounding a lung.

Convolution Neural Network

A Convolutional Neural Network (Figure 1.1) is a model used in machine learning to extract features, like texture and edges, from spatial data. CNN's are powerful image processing, artificial intelligence (AI) that use deep learning to perform both generative and descriptive tasks, often using machine vision that includes image and video recognition, along with recommender systems and natural language processing (NLP). Just like the basic feedforward neural networks, CNNs learn from inputs, adjusting their parameters (weights and biases) to make an accurate prediction. The ability to extract features from images make CNN special from the basic feedforward networks. They are also known as "Shift Invariant (or) Space Invariant Artificial Neural Networks" (SIANN), based on the shared-weight architecture of the convolution kernels. [1] One of the most popular deep neural networks is the Convolutional Neural Network (CNN). It take this name from mathematical linear operation between matrixes called convolution. CNN have multiple layers; including convolutional layer, non-linearity layer, pooling layer and fully-connected layer. The convolutional and fully-connected layers have parameters but pooling and non-linearity layers don't have parameters. The CNN has an excellent performance in machine learning problems.

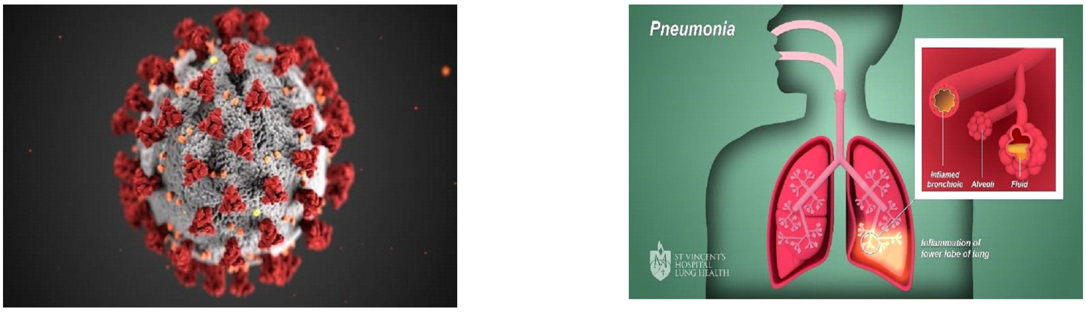

Figure 1.1: COVID-19 and Pneumonia

Deep Learning

Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans: learn by example. Deep learning is a key technology behind driverless cars, enabling them to recognize a stop sign, or to distinguish a pedestrian from a lamppost. Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to "learn" from large amounts of data.

Resnet50

The Residual neural networks [4] do this by utilizing skip connections, or shortcuts to jump over some layers. The principal on which ResNet50 work is to build a deeper network compared toother plain networks. Resnet-50 is a pre-trained Deep Learning model for image classification of the Convolutional Neural Network, Which is a class of deep neural networks, most commonly applied to analyzing visual imagery. Using a pretrained model is a highly effective approach, compared if you need it from scratch, where you need to collect great amounts of data and train it yourself. Networks with a large number of layers can be trained easily without increasing the training error percentage. Resnet helps in tackling the vanishing gradient problem using identity mapping. Same-stream and cross-stream activations are summed (along with the shortcut connection for the residual stream) before applying batch normalization and ReLU non-linearities to get the output states of the block. The function of the residual stream r resembles that of the original structure of the ResNet50 with shortcut connections between each unit of processing, while the transient stream t adds the ability to process information from either stream in a nonlinear manner without shortcut connections, allowing information from earlier states to be discarded. The form of the shortcut connection can be an identity function with the appropriate padding or a projection.

1.2 Motivation

For detection of COVID-19 and other pulmonary diseases the best method is CT-SCAN. One who undergoes CT-SCANNING, has reports regarding scanning and waits for the doctor to be examined. But this is vey time taking process, so we are developing a process so that it makes an individual with minimal knowledge regarding operating a computer able to detect the presence of COVID-19 and other pulmonary related diseases, which takes less time and less amount of money.

1.3 Photo with the client

We visited Pinnamaneni Siddhartha Medical College and explained our project to them. We had a discussion with the Professors in the Department of Radiology regarding the methodologies they have been following to analyze various diseases using Chest X-ray images.

Figure 1.2: Photo with the Client

1.4 Problem Statement

The pandemic of COVID-19 has caused 122.7 million infections worldwide to date. Considering the fact that this virus is extremely transmissible, a timely, fast, and sensitive prognosis technique is of crucial importance to help the radiologists to diagnose COVID-19 and Pneumonia within less span and by taking less effort. The idea is to identify COVID-19 and Pneumonia Infected patients using chest X-Ray images with the help of CNN.

1.5 Scope

The proposed model uses residual units instead of normal neural units for hidden layers. Kaggle Chest X-ray dataset is given as input to the model where data augmentation is performed to make the model capable of performing well on variations in Lung structures. Then the data is trained on the various models which are a part of Convolutional Neural Network (CNN) architecture. These models classify the lung pixels according to their intensity, various algorithms and strategies are used to refine those segments to produce a resized image suitable for analyzing the results. Finally, the model is evaluated for its precision and recall.

1.6 Objectives

Performing various Pre-processing techniques on the dataset to obtain the required specifications of the dataset. Testing various neural network models like VGG16, ResNet50, InceptionNet, AlexNet, DenseNet121 with the obtained dataset to select the models which give predictions with high accuracy. Developing a GUI to present the predicted results of selected models by uploading their Chest X-ray image.

1.7 Advantages

Contactless Healthcare for predicting Covid-19 and Pneumonia with simple UI. Reduces the effort and time of radiologists in analyzing the Chest X-ray images of patients to diagnose the diseases related to Lungs using Chest X-ray images.

1.8 Applications

This user interface is used by radiologists to analyze patient's chest radiographic reports and diagnose the condition in less time and effort.

Chapter 2

LITERATURE REVIEW

This chapter contains the list of research papers that we have studied under literature survey. We focused on the approaches for maintaining accuracy in these papers. Our study included the techniques used for developing and training the model.

2.1 Detecting Covid-19 And Community Acquired Pneumonia Using Chest Ct Scan Images with Deep Learning

Journal : 2021 Sixth International Conference on Advances in Biomedical Engineering (ICABME).

Methodology :
They analyzed the method of detecting illnesses and the current literature system, stating that the RT-PCR test is employed as a real-time standard diagnostic tool. Its primary purpose is to identify the COVID-19 virus, as well as other pathogens. The procedure begins with the collection of a nasopharyngeal swab from a patient's nose or throat. During the pandemic, it aids medical professionals with diagnosing COVID-19. The time it takes to receive findings, erroneous reports, and the difficulty of the test method for patients are some of the drawbacks of the test. The use of X-Ray images as an alternative screening method reduces the physician's diagnosis burden.

Advantages :
Individual slices of CT scans are labeled using fine-tuned DenseNet based deep-learning architecture. A fine-grained differential classification in three classes, i.e., COVID-19, CAP, and healthy individuals, by fine tuning the Efficient Net architecture.

Disadvantages :
Drawback of the best performing techniques is their immense number of parameters which directly influence their footprint and latency.

2.2 Covid-19 Diagnostic Using 3d Deep Transfer Learning for Classification of Volumetric Computerized Tomography Chest Scans

Journal : ICASSP 2021 - 2021 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).

Methodology :

In this project they exploited a 3D Network based transfer learning approach to classify volumetric CT scans with a novel pre-processing method to render the volume with salient features. This work uses the pre-trained 3D ResNet50 as the backbone network. The 3D network is trained on a dataset consisting of 3 classes: Community Acquired Pneumonia (CAP), COVID-19 and Normal patient. The final testing results have shown an overall accuracy of 85.56 percent with the COVID-19 sensitivity attaining 82.86 percent. They observed that radiological examination is much more sensitive than RT-PCR. Moreover, COVID detecting has a sensitivity accuracy around 80 percent. The dataset includes 182 photographs of the posteroanterior (PA) from an IEEE gateway, as well as additional images from the Kaggle pneumonia data set. Weight cross-entropy is the cause of the imbalance concerns in this scenario. The dataset is used to train the residual network model, in which the loss function is given a higher value, while the other classes are given a lower value. With the vanishing gradient strategy, the residual network solves the accuracy detection problem. Heat map uses image classification algorithms to clearly identify network regions of interest, extract proper features, and make classification decisions.

Advantages :

An overall classification accuracy of 85.56 percent was achieved. The sensitivity for COVID-19, CAP and NP was 82.86, 80.00 and 91.43 percents respectively. As there has not yet been many studies that investigate 3D networks for patient-wise COVID-19 prognosis, our solution has provided a promising approach.

Disadvantages :

Drawback of the best performing techniques is their immense number of parameters which directly influence their footprint and latency.

2.3 3-D Convolutional Neural Networks for Automatic Detection of Pulmonary Nodules in Chest CT

Journal : IEEE Journal of Biomedical and Health Informatics (Volume: 23, Issue: 5, Sept. 2019)

Methodology :
In this work, they addressed both of these issues for a 3D CNN implementation through the development of a two stage computer-aided detection system for automatic detection of pulmonary nodules. The first stage consists of a 3D fully convolutional network (FCN) for fast screening and generation of candidate suspicious regions. The second stage consists of an ensemble of 3D CNNs trained using extensive transformations applied to both the positive and negative patches to augment the training set and can achieve 91 percent sensitivity at 2 false positives per scan on cases from the LIDC dataset. They designed a two-stage computer-aided detection approach for automated identification of pulmonary nodules to address all of these challenges for a 3D CNN implementation. A 3D Fully Convolutional Network (FCN) is used in the first stage to quickly scan and produce candidate questionable locations. The second stage is to train an ensemble of 3D CNN's with considerable alterations to both the positive and negative patches in order to extend the training set, which, using samples from the LIDC dataset, may achieve 91 percent sensitivity with only two false positives per scan.

Advantages :
Medical datasets typically contain a small number of samples which makes training deep networks with high number of parameters. We have demonstrated that the combination of the network architectures and our training strategy can overcome all the limitations.

Disadvantages :
Increase the workload of radiologists and make the manual reading of screening exams very time consuming.

2.4 Prediction of COVID-19 Using Genetic Deep Learning Convolutional Neural Network (GD-CNN)

Journal : IEEE Access (Volume: 8)

Methodology :

This study aims to provide a solution for identifying pneumonia due to COVID19 and healthy lungs (normal person) using CXR images. In this research, the state-of-the-art technique used is Genetic Deep Learning Convolutional Neural Network (GDCNN). It is trained from the scratch for extracting features for classifying them between COVID-19 and normal images. Classification accuracy of 98.84 percent, the precision of 93 percent, the sensitivity of 100 percent, and specificity of 97.0 percent in COVID-19 prediction is achieved. They proposed concatenating two independent transfer learning models with approximately 2500 CT-Scan and ChestX-ray images to classify CT-Scan and X-ray images into distinct classes: normal Pneumonia and COVID. In their research, they employed the VGG16, MobileNet, DenseNet121, InceptionV3, Xception and ResNet50 image recognition models. As a result, the combination of VGG16 and ResNet50 networks obtained the highest classification accuracy of 99.87 percent. They also had the maximum classification accuracy of 98 percent when utilising a single modality of CT-Scan ResNet50 networks and 98.93 percent when using X-Ray VGG16 networks. They also had an absolute maximum categorization accuracy of 98 percent while integrating CT-Scan ResNet50 networks as a single modality and 98.93 percent is obtained while using Chest X-Ray VGG16 networks.

Advantages :

In this research, the GDCNN method is proposed for classifying COVID-19 and normal people, and it is done through CXR image samples. It is clear from the analysis table that the proposed method outperforms well compared to the existing model.

Disadvantages :

Increase the workload of radiologists and make the manual reading of screening exams very time consuming.

2.5 Classifying COVID 19 Pneumonia

Journal : IEEE Access (Volume: 8)

Methodology :
They highlighted the challenges (including dataset size and quality) in utilizing current publicly available COVID-19 datasets for developing useful deep learning models and how it adversely impacts the trainability of complex models. They identify a suitable Convolutional Neural Network (CNN) model through initial comparative study of several popular CNN models. Performs in considerable levels of COVID-19 detection against pneumonia or normal for all three lung image modes with the precision of up to 86 percent for X-Ray, 100 percent for Ultrasound and 84 percent for CT scans. While previous research has focused on CT scans, this study investigates the use of DL approaches to analyse lung ultrasonography (LUS) data. They provide a new fully-annotated dataset of LUS pictures gathered from multiple Italian hospitals, with labels reflecting the severity of disease on a frame-by-frame, video-by-video, and pixel-by-pixel basis (segmentation masks). They offer three deep models based on this data that solve key tasks for the automated processing of LUS pictures. They show a novel deep network built from Spatial Transformer Networks that predicts the sickness severity score associated with an input frame while simultaneously giving weakly-supervised pathological artifact placement. They also provide a new approach for effective frame score aggregation at the video level based on uninorms. Finally, they compare state-of-the-art deep models for calculating COVID-19 imaging biomarker pixel-level segmentations.

Advantages :
They isolate the lung field by segmentation for all image samples in order to remove noise and further reduce sampling bias. Transfer learning provides a fast and simple machine learning model for multiple imaging modes providing good results that may lead to clinically useful diagnostic tools.

Disadvantages :
One of their experiments 1A/2A yielded lower F1 scores and higher false negatives than experiments 1B/2B was unexpected since the manifestation of COVID-19.

2.6 Detecting Covid-19 And Community Acquired Pneumonia Using Chest Ct Scan Images with Deep Learning

Methodology :

They proposeded a multimodal deep learning method using concatenation of extracted features from two different transfer learning models for classifying COVID-19 Pneumonia with two biomarkers, CT-Scan and X-Rays. These biomarkers are frequently used to diagnose diseases that attack the human respiratory system and each of these biomarkers does not depend on human age. In this research, they have used two open-source datasets and balanced the allocated for each class. The input data for the feed of the network were normalized, resized to 150×150 pixels, and the number of channels was set to 3 (RGB images). The concatenation of DenseNet121-MobileNet gives an Accuracy 99.87 percent, Sensitivity 99.74 percent, and Specificity 100 percent. Then, the computational time for this network is quicker than the concatenation of ResNet50-VGG16 which had the same result. The classification using multimodal deep learning with the concatenation of DenseNet121-MobileNet can be implemented to classify COVID-19 Pneumonia. They discussed the difficulties (This includes the amount and quality of the dataset) in constructing viable deep learning models using COVID-19 datasets that are currently accessible for public use, as well as how this affects the trainability of complicated models. A preliminary comparison of numerous major Convolutional Neural Network (CNN) models was conducted. The identification of COVID versus pneumonia or normal is significant for all three lung imaging modalities,with Chest X-Ray precision of up to 86 percent, Ultrasound precision up to 87 percent and CT scan precision of nearly 84.7 percent.

Advantages :

They isolate the lung field by segmentation for all image samples in order to remove noise and further reduce sampling bias. Transfer learning provides a fast and simple machine learning model for multiple imaging modes providing good results that may lead to clinically useful diagnostic tools.

Disadvantages :

One of their experiments 1A/2A yielded lower F1 scores and higher false negatives than experiments 1B/2B was unexpected since the manifestation of COVID-19.

2.7 The Multimodal Deep Learning for Diagnosing COVID-19 Pneumonia from Chest CT-Scan and X-Ray Images

Methodology :

They proposeded a multimodal deep learning method using concatenation of extracted features from two different transfer learning models for classifying COVID-19 Pneumonia with two biomarkers, CT-Scan and X-Rays. These biomarkers are frequently used to diagnose diseases that attack the human respiratory system and each of these biomarkers does not depend on human age. In this research, they have used two open-source datasets and balanced the allocated for each class. The input data for the feed of the network were normalized, resized to 150×150 pixels, and the number of channels was set to 3 (RGB images). The concatenation of DenseNet121-MobileNet gives an Accuracy 99.87 percent, Sensitivity 99.74 percent, and Specificity 100 percent. Then, the computational time for this network is quicker than the concatenation of ResNet50-VGG16 which had the same result. The classification using multimodal deep learning with the concatenation of DenseNet121-MobileNet can be implemented to classify COVID-19 Pneumonia. They discussed the difficulties (This includes the amount and quality of the dataset) in constructing viable deep learning models using COVID-19 datasets that are currently accessible for public use, as well as how this affects the trainability of complicated models. A preliminary comparison of numerous major Convolutional Neural Network (CNN) models was conducted. The identification of COVID versus pneumonia or normal is significant for all three lung imaging modalities,with Chest X-Ray precision of up to 86 percent, Ultrasound precision up to 87 percent and CT scan precision of nearly 84.7 percent.

Advantages:

Easy to detect the disease. They identified other diseases and their stage of growth.

Disadvantages:

Drawback of the best performing techniques is their immense number of parameters which directly influence their footprint and latency.

2.8 Deep Learning for Classification and Localization of COVID-19 Markers in Point-of-Care Lung Ultrasound

Methodology :

While existing works focus on CT scans, this paper studies the application of DL techniques for the analysis of lung ultrasonography (LUS) images. Specifically, we present a novel fully-annotated dataset of LUS images collected from several Italian hospitals, with labels indicating the degree of disease severity at a frame-level, video-level, and pixel-level (segmentation masks). Leveraging these data, we introduce several deep models that address relevant tasks for the automatic analysis of LUS images. In particular, we present a novel deep network, derived from Spatial Transformer Networks, which simultaneously predicts the disease severity score associated with an input frame and provides localization of pathological artifacts in a weakly-supervised way. Furthermore, we introduce a new method based on uninorms for effective frame score aggregation at a video-level. Finally, we benchmark state of the art deep models for estimating pixel-level segmentations of COVID-19 imaging biomarkers. They designed a two-stage computer-aided detection approach for automated identification of pulmonary nodules to address all of these challenges for a 3D CNN implementation. A 3D Fully Convolutional Network (FCN) is used in the first stage to quickly scan and produce candidate questionable locations. The second stage is to train an ensemble of 3D CNNs with considerable alterations to both the positive and negative patches in order to extend the training set which, using samples from the LIDC dataset, may achieve 91 percent sensitivity with only two false positives per scan.

Advantages:

It is quicker, cheaper and superior to MRI scanning. The CT technique eliminates superimposition of images of undesired structures completely.

Disadvantages:

It is time consuming. The patient is exposed to higher radiation.

Chapter 3

ANALYSIS AND DESIGN

This chapter includes the analysis of requirements for the proposed project. This chapter contains

- Functional Requirements.
- Non-Functional Requirements.

3.1 Functional Requirements

Functional requirements that the end user specifically demands as basic facilities that the system should offer. All these functionalities need to be necessarily incorporated into the system as a part of the contract. These are represented or stated in the form of input to be given to the system, the operation performed and the output expected.

Non-Functional requirements are basically the quality constraints that the system must satisfy according to the project contract. The priority or extent to which these factors are implemented varies from one project to other. They are also called non-behavioral requirements.

Software Requirements

Pandas:
In computer programming, pandas is a data manipulation and analysis software package designed for the Python programming language. It includes data structures and methods for manipulating numerical tables and time series, in particular. It's open-source software with a three-clause BSD licence. The word panel data is an econometrics term for data sets that comprise observations for the same persons over multiple time periods. Its moniker is a pun on the term "Python data analysis".

Jupyter Notebook:
Language of choice Jupyter supports over 40 programming languages, including Python, R, Julia, and Scala. Share notebooks can be shared with others using

email, Dropbox, GitHub and the Jupyter Notebook Interactive Output Your code can produce rich, interactive output: HTML, images, videos, LaTeX, and custom MIME types. Big data integration Leverage big data tools, such as Apache Spark, from Python, R and Scala. Explore that same data with pandas, scikit-learn, ggplot2, TensorFlow.

Numpy:
NumPy (numerical Python) is a library that consists of multidimensional array objects and a collection of functions for manipulating them. NumPy allows you to conduct mathematical and logical operations on arrays. NumPy is a Python library that allows you to do things with numbers.

Keras:
Keras is a high-level, deep learning API developed by Google for implementing neural networks. It is written in Python and is used to make the implementation of neural networks easy. It also supports multiple backend neural network computation.

Matplotlib:
Matplotlib is a cross-platform, data visualization and graphical plotting library for Python and its numerical extension NumPy. As such, it offers a viable open-source alternative to MATLAB. Developers can also use matplotlib's APIs (Application Programming Interfaces) to embed plots in GUI applications.

Google Colab:
Colab is a cloud-based notebook environment that is free to use. It allows you and your team to collaborate on projects in the same way that you do with Google Docs. Many common machine learning libraries are supported by Colab and can be quickly loaded into your notebook. Colab notebooks let you blend executable code and rich text, as well as graphics, HTML, LaTeX, and more, in a single document. Your Colab notebooks are saved in your Google Drive account when you create them. Colab notebooks can easily be shared with coworkers or acquaintances, allowing them to make comments or even change them.

Operating System:
Windows 8 and later versions are recommended as some significant changes to the Windows operating system and its user interface (UI), targeting both desktop computers and tablets. It is a touch-optimized platform based on the modern Metro design architecture, which specifies how applications are delivered and ren-

dered in the UI.

Python3 and its packages:
Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is designed to be highly readable. It uses English words frequently whereas other languages use punctuation, and it has fewer syntactic constructions than other languages. Scikit-learn is arguably the most important library in Python for machine learning. After cleaning and manipulating your data with Pandas or NumPy, scikit-learn is used to build machine learning models as it has tons of tools used for predictive modeling and analysis.

Flask:
Flask is a small and lightweight Python web framework that provides useful tools and features that make creating web applications in Python easier. It gives developers flexibility and is a more accessible framework for new developers since you can build a web application quickly using only a single Python file.

Datasets of Chest X-ray:
The dataset is organized into 3 folders (train, test, val) and contains subfolders for each image category (Pneumonia/Normal). There are 5,863 X-Ray images (JPEG) and 2 categories (Pneumonia/Normal). Chest X-ray images (anterior-posterior) were selected from retrospective cohorts of pediatric patients of one to five years old from Guangzhou Women and Children's Medical Center, Guangzhou. All chest X-ray imaging was performed as part of the patient's routine clinical care. For the analysis of chest x-ray images, all chest radiographs were initially screened for quality control by removing all low quality or unreadable scans. The diagnoses for the images were then graded by two expert physicians before being cleared for training the AI system. In order to account for any grading errors, the evaluation set was also checked by a third expert.

Hardware Requirements

Processor:
Intel Core i5 and later versions are recommended for dedicated use on high-strain processes or for computers dedicated to resource-intensive tasks.

RAM:
Device with 8GB RAM is recommended to support the workspace with TensorFlow. TensorFlow aggressively occupies the full GPU memory even though it

actually doesn't need to do so. This is a greedy strategy adopted by TensorFlow to avoid memory fragmentation, but this causes a bottleneck of GPU memory. Only one process exclusively has all the memory.

3.2 Non-Functional Requirements

Non-functional requirements describe how a system must behave and establish constraints of its functionality. This type of requirements is also known as the system's quality attributes. The Non-functional requirements of this project are:

Usability:
Usability defines how difficult it will be for a user to learn and operate the system. It is assessed by using Efficiency of use, Intuitiveness, Low perceived workload.

Security:
Security requirements ensure that the software is protected from unauthorized access to the system and its stored data. It considers different levels of authorization and authentication across different user roles. For instance, data privacy is a security characteristic that describes who can create, see, copy, change, or delete information. Security also includes protection against viruses and malware attacks.

Reliability:
Reliability defines how likely it is for the software to work without failure for a given period of time. Reliability decreases because of bugs in the code, hardware failures, or problems with other system components. To measure software reliability, you can count the percentage of operations that are completed correctly or track the average period of time the system runs before failing.

Performance:
Performance is a quality attribute that describes the responsiveness of the system to various user interactions with it. Poor performance leads to negative user experience. It also jeopardizes system safety when it is overloaded.

Availability:
Availability is gauged by the period of time that the system's functionality and services are available for use with all operations. So, scheduled maintenance periods directly influence this parameter. And it's important to define how the impact

of maintenance can be minimized. When writing the availability requirements, the team has to define the most critical components of the system that must be available at all time. You should also prepare user notifications in case the system or one of its parts becomes unavailable.

Scalability:
Scalability requirements describe how the system must grow without negative influence on its performance. This means serving more users, processing more data, and doing more transactions. Scalability has both hardware and software implications. For instance, you can increase scalability by adding memory, servers, or disk space, can compress data, use optimizing algorithms, etc.

3.3 Design Diagrams

Design diagrams are based on the project's workflow with the purpose of visual representation of a system along with its main actors, roles, actions, artifacts or classes, in order to better understand, alter, maintain, or document information about the system.

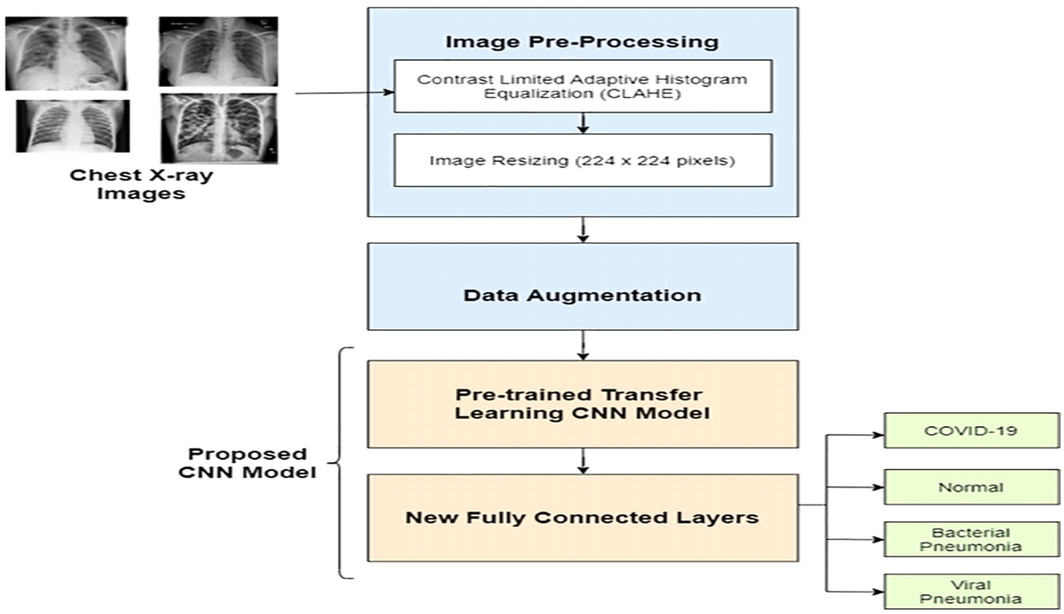

Figure 3.1: Block Diagram of Model

In this diagram the principal parts or functions are represented by blocks connected by lines that show the relationship between the blocks. The purpose of this block diagram is to provide a more visual representation of the information.

A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram depicts the system's numerous use cases and different sorts of users, and is frequently supplemented by other diagrams. Circles or ellipses are used to depict the use cases.

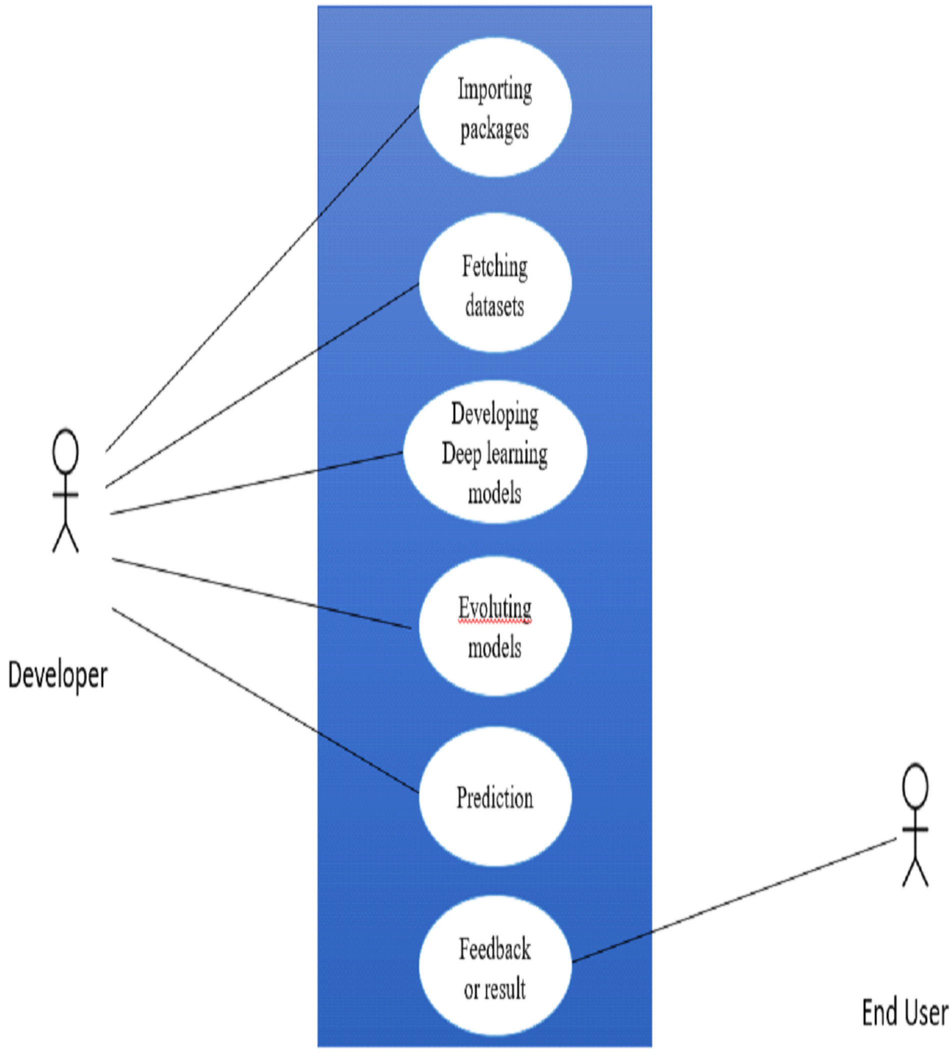

Figure 3.2: Block Diagram of Model

Chapter 4

PROPOSED SYSTEM

This chapter includes the proposed system architecture along with the modules of methodology and dataset collection

4.1 Process Flow Diagram

A Process Flow Diagram (PFD) is a flowchart that depicts the interactions between major components in a manufacturing facility. It can be used to document, improve, or model a new process. It's also known as a Process Flow Chart, Flow sheet, Block Flow Diagram, Schematic Flow Diagram, Macro Flowchart, Top-down Flowchart, Piping and Instrument Diagram, System Flow Diagram, or System Diagram, depending on its purpose and content. They illustrate a process with a set of symbols and notations.

The Figure 4.1 describes the process flow diagram of the Model.

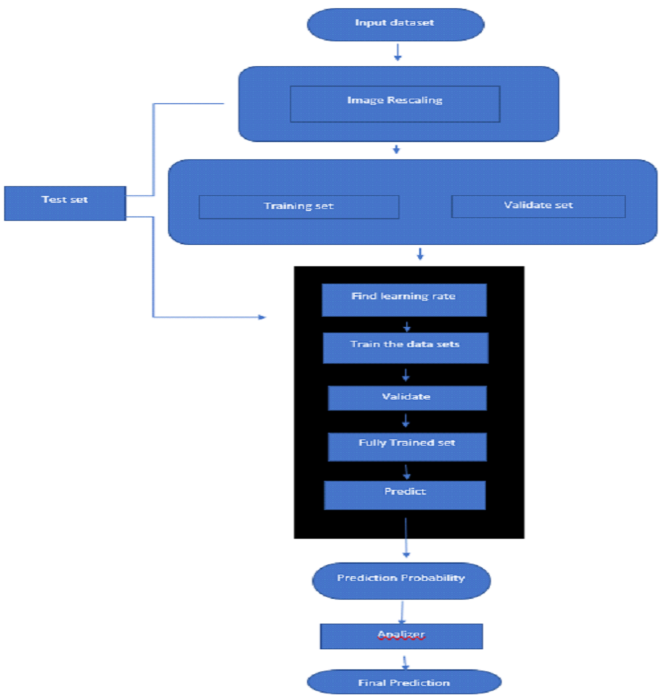

Figure 4.1: Scrum model

4.2 Methodology

CNN Architecture:
CNN focuses primarily on artificial intelligence and computer vision applications such as text classification, time series analysis, image classification and video identification for medical imaging. CNN can accommodate many picture pixel arrangements. Without any pre-processing stages, image processing algorithms may operate directly with images. Face recognition for real-time social media platforms, object recognition for self-driving vehicles, medical image analysis, and ailment diagnosis are all common applications that are using CNN networks.

Preparing training and test sets:

Data pre-processing
The process of changing raw data into a usable, intelligible format is known as data preparation. Real-world or raw data is prone to inconsistencies in formatting, human errors, and incompleteness. Data pre-processing tackles these problems by making datasets more full and efficient to analyse. It's an important step that can make or break data mining and machine learning projects. It speeds up the finding of knowledge from data sets and may have an impact on the performance of machine learning models. There is an 80/20 rule in machine learning. Every data scientist should devote 80 percent of their effort to data pre-processing and 20We conduct many operations in this assignment, such as rescaling data to our desired dimensions using various prepackaged packages. Rescaling data entails rotating the dataset, minimizing and maximizing it, and decreasing human mistakes while feeding it to the model. The image data generator is also used to convert provided photos into RGB matrix values.

Data Augmentation
We must now do data augmentation after completing the prerequisite stages for developing the model. Many AI systems require data augmentation since accuracy rises with the amount of training data. Basic data augmentation, according to studies, may considerably enhance accuracy on picture tasks such as classification and segmentation. Furthermore, because big neural networks and deep learning models require a great quantity of data, data augmentation techniques assist them even more.

Preparing Data Loader
After we've completed the data augmentation, we'll need to import the datasets

and assign them to three separate variables for validation, testing, and training. After that, we'll create a deep learning model for analysing the datasets. We use the VGG16 model for Pneumonia classification, and the Resnet model for classification. We use two Pneumonia classification classes (Pneumonia and normal) and three Covid-19 classification classes (Covid-19, normal, and severe). Pneumonia caused by a virus).

After we've prepared the model, we'll train it using the datasets we've collected and wait for the results. Now that we've finished training the data model, it's time to put it to the test. We have 89 percent accuracy in VGG16 classification and 75 percent accuracy in Covid-19 classification. We will now design a GUI to assist typical users, as we have done with the training and testing of datasets with great accuracy.

Model Building

A sequential model is created and trained for predicting crop yield. By building an object of the Sequential class and applying model layers to it, you may construct deep learning models with the Sequential model API. add() method is used to add layers to the neural network. To remove layers, use the pop() method. The Sequential function Object() is used to generate a Sequential model by supplying a list of levels to it. It is quite simple to determine the ideal number of layers. Continue to add layers until the test fault no longer improves.

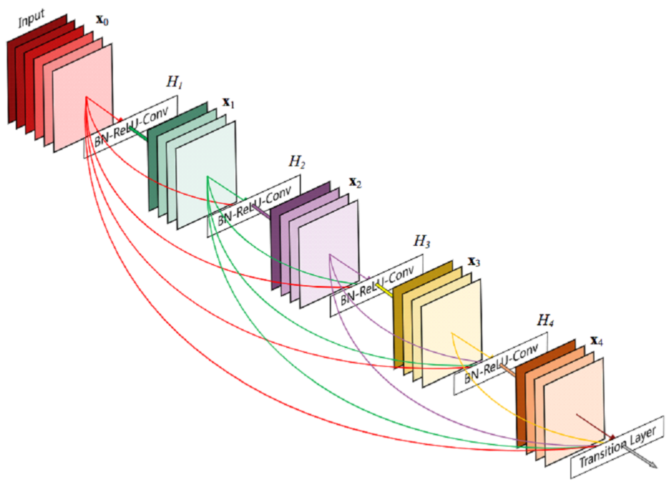

Figure 4.2: Different layers of the model

For the model, an effective activation function is chosen. A neural network's activation function is capable of translating the node's cumulative weighted input into network node activation. The activation function ReLU is utilized in this case.

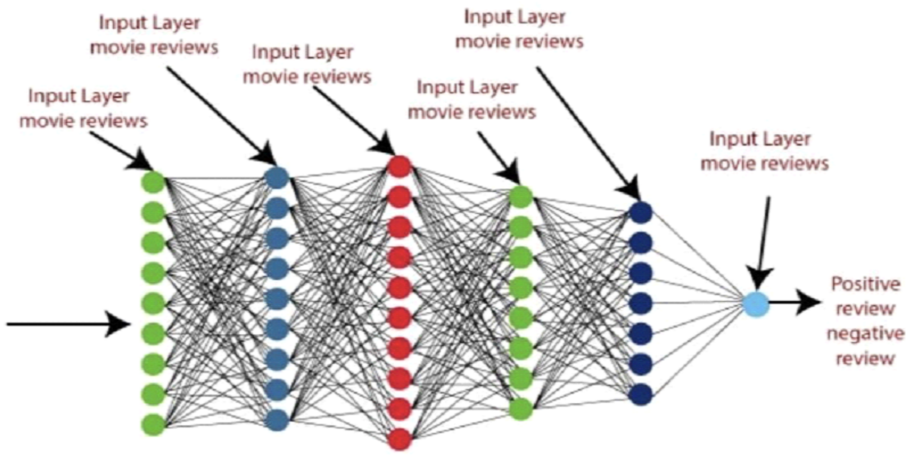

Figure 4.3: Various input layers used (Pre-processing)

The ReLU or rectified linear activation function is a linear function that provides the same kind of input as output if the input is indeed positive; else, it yields nothing. Since it is faster to train and produces exceptional results, it is commonly used in networks. It can be stated numerically as:

R (z) = max(0,z)

The ReLU function is defined as follows:

def ReLU(z):
if z¿0:
return z
else:
return 0

The learning rate is taken into consideration during the learning process. This is perhaps one of the most important factors that govern a neural network's learning process. Once a model has been built, call the summary() function to see its contents.

User Interface

We are presently expanding the basic programme to the next step so that it may be utilized by ordinary users for Pneumonia and Covid-19 analyses through our website. The site is built utilizing HTML, CSS, and FLASK languages for the development of our model. The website simply has a home page on which the visitor is asked to choose the image for which analysis should be performed.

Screenshots of the technology frameworks used are shown below:

```
@app.route('/predict', methods=['GET', 'POST'])
def upload():
    if request.method == 'POST':
        # Get the file from post request
        f = request.files['file']

        # Save the file to ./uploads
        basepath = os.path.dirname(__file__)
        file_path = os.path.join(
            basepath, 'uploads', secure_filename(f.filename))
        f.save(file_path)
        print(cache)
        # Make prediction
        preds = model_predict(file_path,cache['model'])

        os.remove(file_path)#removes file from the server after prediction has been returned

        cache['confidence_0'] = preds[0][0]
        cache['confidence_1'] = preds[0][1]
        # Process your result for human
        pred_class = preds.argmax(axis=-1)
           # Simple argmax
        # pred_class = decode_predictions(pred_class, top=1)   # ImageNet Decode
        # result = str(pred_class[0][0][1])               # Convert to string
        if pred_class == 1:
            result = 'Pneumonia'
        else:
            result = 'Normal'
        print(result)
        return result
    return None
```

Figure 4.4: Flask Framework

```
:\Users\chait\Desktop\Pneumonia-detection-web-app-main>Python app.py
022-04-08 11:36:40.996155: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'cudart64_110.dll'; dle
rror: cudart64_110.dll not found
022-04-08 11:36:40.996327: I tensorflow/stream_executor/cuda/cudart_stub.cc:29] Ignore above cudart dlerror if you do not have a GPU set up on yo
ur machine.
odel loaded. Check http://127.0.0.1:5000/
 * Serving Flask app 'app' (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: on
 * Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
```

Figure 4.5: Flask Execution

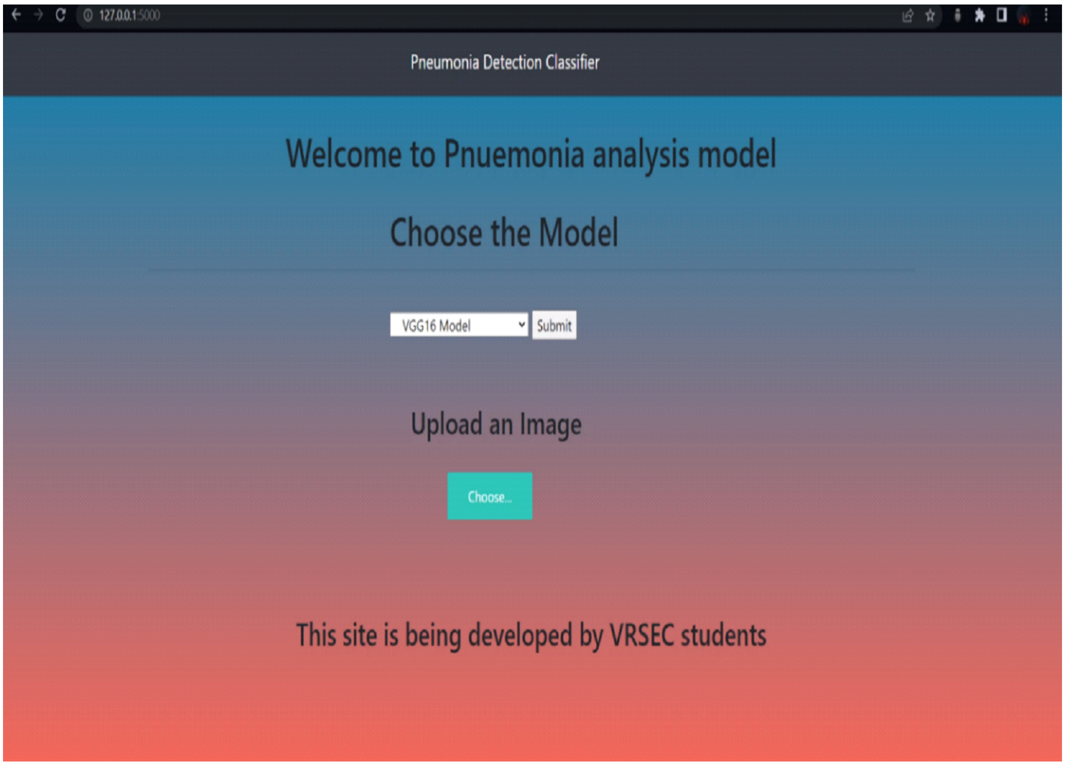

Figure 4.6: Website Interface

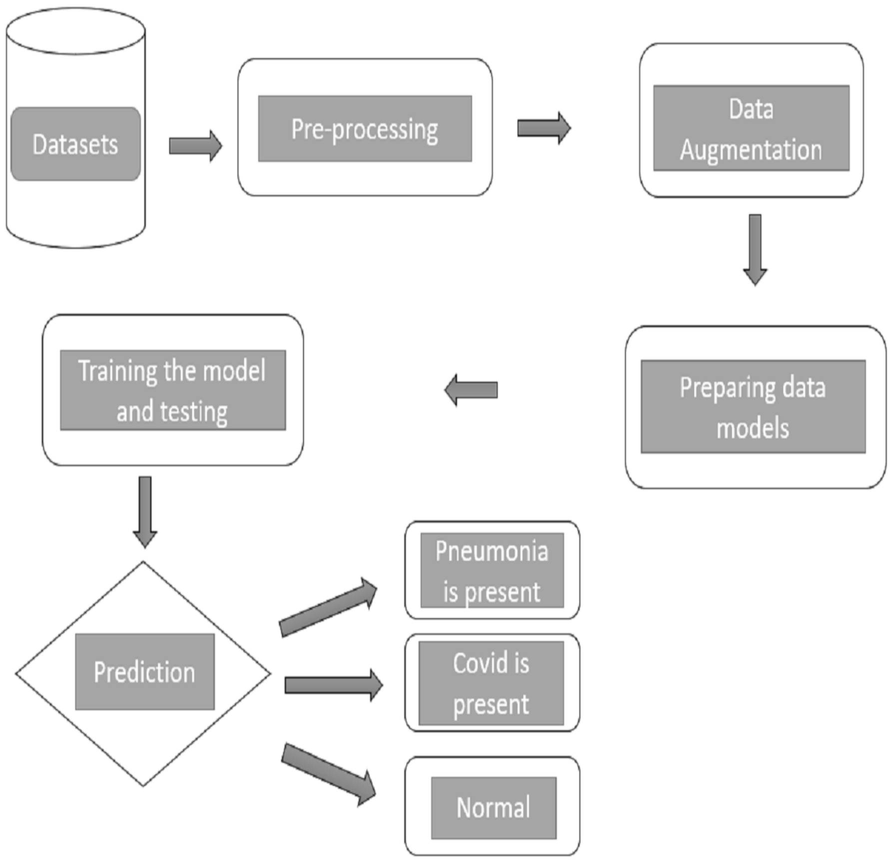

Figure 4.7: Architecture

4.3 Architecture

As shown in the above architecture, the model takes the input data set from various sources, performs preprocessing on the collected datasets, and then performs Data Augmentation, which helps the model learn new things so that we can validate the model against a new dataset, and then builds deep learning models to perform it against the GUI part and some other operations, and finally performs the newly built mod.

4.4 Algorithms

Training and Testing:
Step 1: Start
Step 2: Import the data
Step 3: Dataset classification.
Step 4: Filling in the missing values.
Step 5: Creating a training and testing dataset.
Step 6: Train and test the data using several models.
Step 7: Assessing the correctness of the results by comparing them.
Step 8: Getting the Results

4.5 Dataset collection

Description:
Kaggle was used to acquire a large number of datasets. The data is divided into three categories: Training Set, Testing Set, and Validation Set.
Link : https://www.kaggle.com/code/karan842/pneumonia-detection-transfer-learning-95-acc/data

Chapter 5

IMPLEMENTATION

This chapter presents the coding part for all the modules involved in our project.

5.1 Output and Results

We are predicting the type of sickness reflected in the supplied dataset in the given figure. We use a graph to do this by plotting the predicted outcome on the Y-axis.

On the X-Axis, the actual outcome is plotted

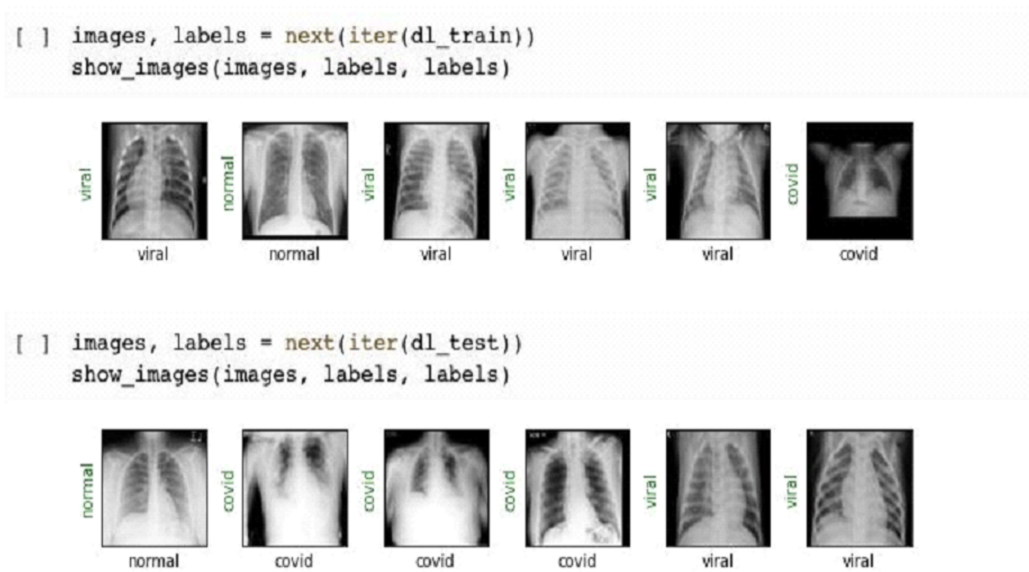

Figure 5.1: Output of Covid-19 Model

5.2 Test Cases

For covid validation, we used three distinct classes, and for Pneumonia validation, we used two different classes. We are uploading a picture of the Normal and Pneumonia datasets at each moment in the displayed figure and pressing the predict button to forecast the kind of website.

This figure represents the user interface of our website.

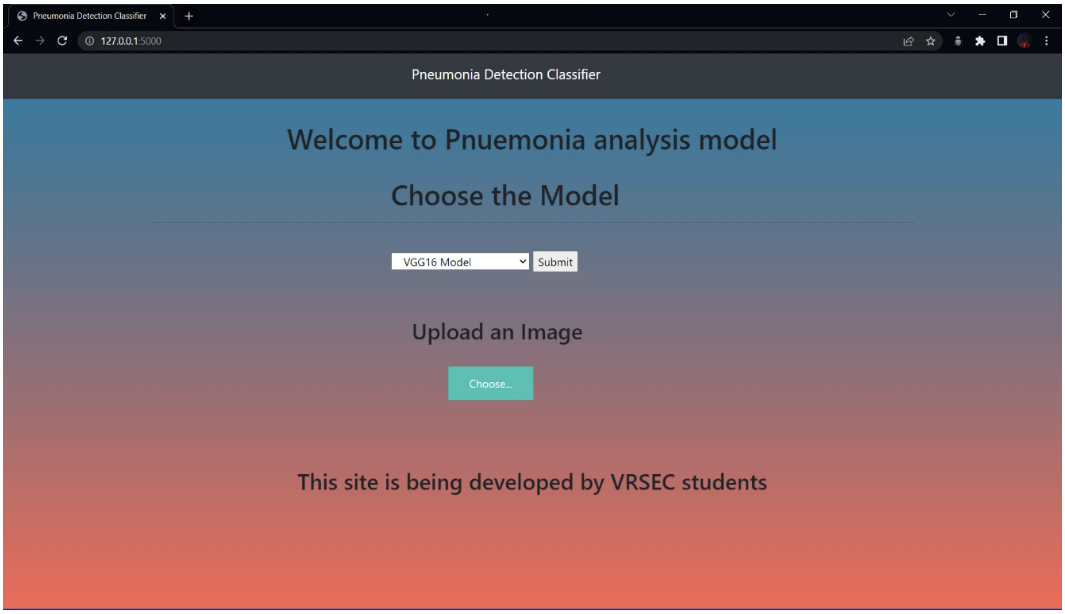

Figure 5.2: User Interface

The input image is selected from the validation dataset.

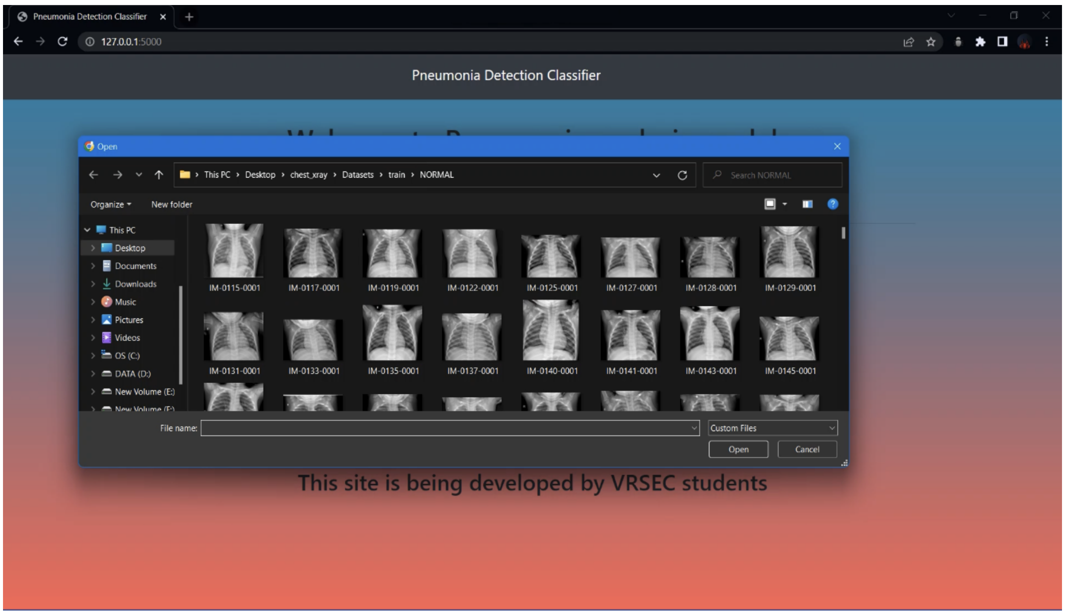

Figure 5.3: Input Selection

The selected image from the validation dataset is predicted here.

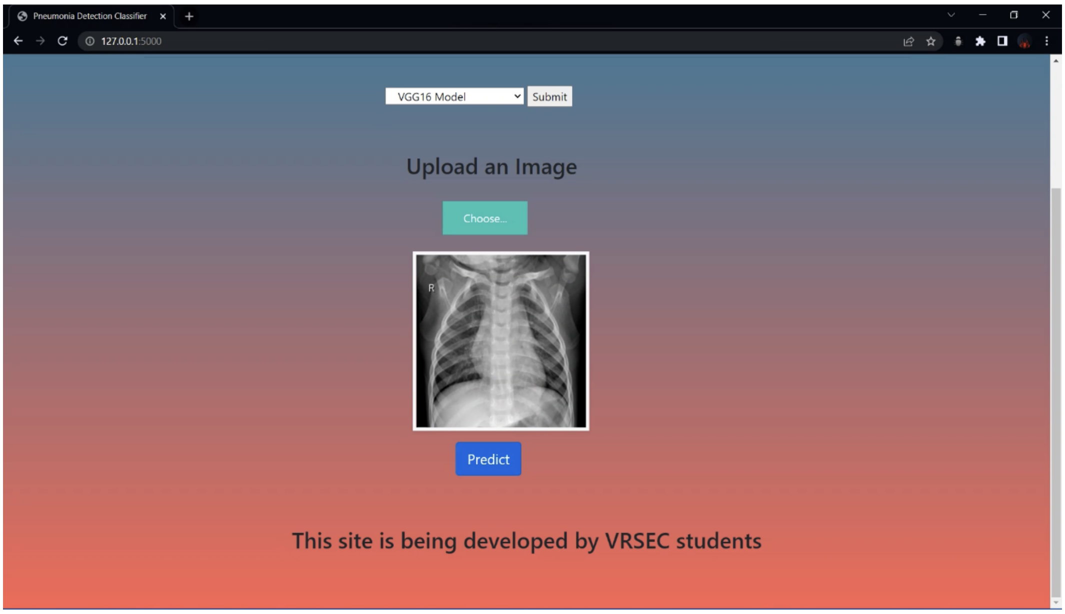

Figure 5.4: Validating the test case

The predicted analysis of the selected image is displayed here.

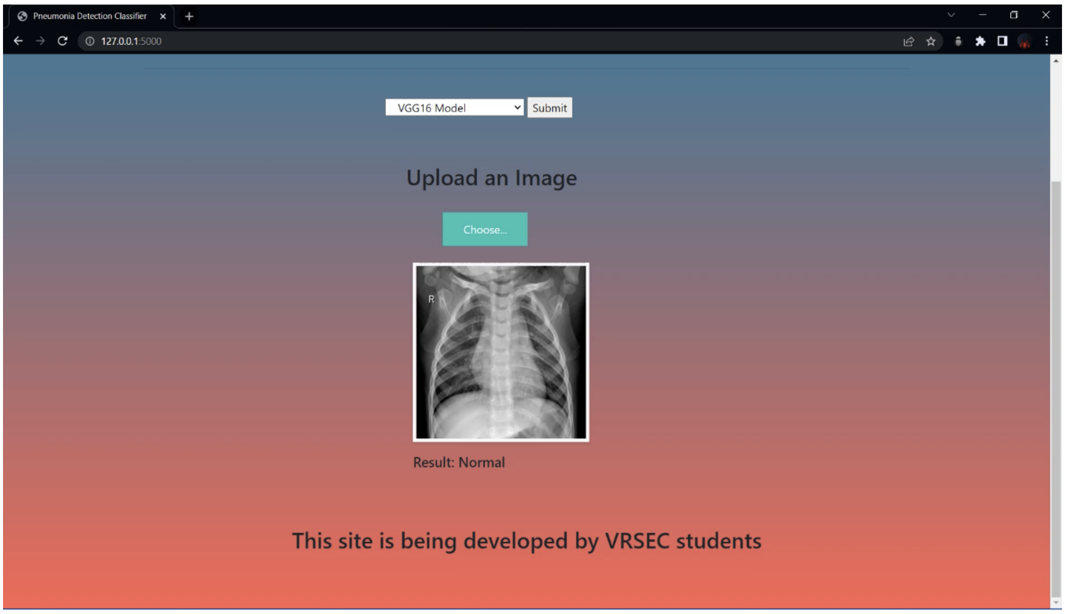

Figure 5.5: Predicted Output

5.3 Results and Analysis

With a small loss factor, the trained model is capable of reliably predicting the sickness. With the test dataset of local imaging centers, the model created has a 95.7 percent accuracy. The model can anticipate illness analysis with the assistance of excellent algorithms and other methodologies. Both the actual and anticipated values are exactly matched by the model. Our model uses the patient's chest x-ray scan as input and outputs the disease's anticipated analysis. The medical industry's throughput has grown thanks to Deep Learning models.

The results of the COVID-19 and Pneumonia analyses using various deep models are displayed in the table below. When compared to the other models in the table, VGG16 is the most accurate on the Chest X-Ray data dataset.

DL MODELS	X-Ray
RESNET-50	94 %
VGG-16	98 %
INCEPTIONV3	97 %
XCEPTION	97 %

Figure 5.6: Comparison accuracy of various DL Models

Chapter 6

CONCLUSION AND FUTURE WORK

This chapter includes the conclusion of the project and future work

From X-Ray pictures, the proposed study seeks to detect Normal lungs, COVID19 Infected lungs, and Pneumonia Infected lungs. It not only detects Pneumonia-infected lungs, but also differentiates between bacterial and viral Pneumonia with an accuracy of 80 percent and 91.46 percent, respectively. The CNN model is used to distinguish between normal and infected patients, such as COVID-19 infected lungs and Pneumonia infected lungs. COVID -19 detection accuracy is 95 percent, which is a bonus for this model and the present pandemic demand with limited expense and calculations. This approach is more suited for doctors, researchers, and other professionals. The approach may be expanded using an ensemble of several models to increase the accuracy of class recognition, but this comes at a cost. The work may be expanded using an aggregation of several models to increase the accuracy of class detection, but this comes at a cost in terms of time and computation. The proposed models of which we have developed in this project are feasible in analysis of Pneumonia and Covid-19 in the chest X-ray. After taking the input from the user we will provide a developed model and make it predict the type of disease present in the given patient. This model can be used by the common users by simply visiting the website we have been developed and able to predict the type of disease defined. Though we have developed the model for analysis, we are attempting to integrate the covid-19 and Pneumonia classification in order to operate in the same domain in the future. We intend to provide an easy-to-use GUI for analysing pneumonia and Covid-19, which will aid in resolving the problems that individuals encounter in diagnosing these diseases.

This model will be trained with a real-time dataset in the future to provide more accurate predictions in a short period of time.

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