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Automated Detection of COVID-19 Cases using Chest X-Ray Images

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Abstract: Corona Virus continues to possess its effects on the people lives across the world. The screening of infected persons is vital step because it is a fast and low-cost way. Chest X- ray images plays a major crucial role and it is used for examination in detection of CORONA VIRUS(COVID-19). Here radiological chest X-rays are easily available with low cost only. In this survey paper, we are using a Convolutional Neural Network(CNN) based solution that will benefit in detection of the Covid-19 Positive patients using radiography chest X-Ray images. To test the efficiency of the solution, we are using public available X- Ray images of Corona Virus Positive cases and negative cases. Images of Positive Corona Virus patients and pictures of healthy person images are divided into testing images and trainable images. The solution which we are providing will give good results in classification accuracy within the test set-up. Here we are going to develop a GUI application for medical Examination areas. This GUI application can be used on any computer and performed by any medical examiner or technician to determine Corona Virus positive patients using radiography X-ray images. The result will be shown or provided by this application is really fast and done within a few seconds.

***Index Terms*: Corona Virus, Deep Learning, CNN, Convolutional neural networks, Deep CNN, Detection.**

INTRODUCTION

In this paper, machine learning method have been used to determine COVID-19 cases using individual's chest X-ray images. Machine learning is a sub-branch of "Artificial Intelligence" (AI). It is fast growing technology in various field which enables computers to learn automatically from the previous data. Machine learning uses several algorithm for building prediction model.

The novel Corona virus is an infectious and fast spreading virus which easily spreads with even the least physical contact, hence being socially distant is one among approach proposed by the World Health Organization to control the fast spreading of COVID-19. The pandemic proceeds to have a severe and catastrophic effect on health and well-being

of human kind. The virus causes an acute respiratory infection where people lives are at risk due to the high death rate as there is no proper or effective vaccine as a precaution against Covid-19. Headache, dry cough, difficulty in breathing and lack of taste and smell are general symptoms, whereas on the other hand, in some extreme cases dyspnea or hypoxemia can occur a week after the infected by the virus alongside Acute Respiratory Distress Syndrome (ARDS) and dysfunction of coagulation. Although presently RT-PCR test is one of the most accurate testing methods for the current pandemic. The RT-PCR tests the swabs, nasopharyngeal, sputum of the patients affected with Covid-19. The RT-PCR test extracts the RNA, a genetic material of Covid-19 virus, this test analyses the genetic sequence like SARS-COV-2 virus, which results positive. The results are negative where sample does not contain virus. Although the test results of RT-PCR test are not completely accurate or perfect because of laboratory error insufficient sample size, which results in false negative. Since the tests could take a few hours or few days to get the results. Radiological imaging is used that emphasizes the performance that produces a 2-D image. The radiological X-ray images of Covid-19 affected patient have identical spots on the image. Those identical spots can be identified by comparing it with other patients X-ray images. In order to classify the images deep learning techniques are needed and the images are enhanced to higher quality. For learning and extraction purpose convolution Neural networks are approved by many of the image quality in dim light images that helps in differentiating the final images of Pneumonia through chest X-ray images. Here deep learning is used for the detection of pathology by utilizing trained imgae Net. Since there is a less hearness diagnosis procedures like diagnosis procedures like diagnosing by using X-ray images. These are epthelial cells present on the lungs, X-ray images are used to find the presence of the cells on the infected lungs. This procedure are used to differentiate Covid, pnemonis cases. The only drawback is that a proper radiography examiner is required for diagnose purpose. hence developing an automate analysis application will save time.

II. LITERATURE SURVEY

Majeed, T., Rashid, R., et al., [1] did a quantitative analysis that evaluates 12 off-the shelf convolutional neural networks to analyze the COVID-19 X-Ray images. Then the author proposed architectures such as Xception and DenseNet using CNN transfer learning procedure using few parameters that distinguish the normal X-Ray images from COVID-19 images. A qualitative investigation was performed to inspect the decisions made by CNNs using a technique called as Class Activation Mappings (CAM). The final prediction score is differentiated as Positive or Negative.

Sarkar A., et al., [2] has designed a deep learning model called as COVID-Net using the dataset COVIDx. Deep Learning software from COGNEX called VisionPro Deep Learning is used in various domains ranging from factory automation to life sciences is used to classify chest X-Rays from COVIDx dataset. A confusion matrix is obtained as an output along with recall, precision and F-score. A report is generated that is helpful for Radiologists, researchers, hospitals that identify misclassified images.

Chowdhury N.K., et al., [3] proposed deep convolutional neural networks which are based on EfficientNet called ECOVNet that detects COVID-19 using chest X-ray images. Firstly, X-Ray is augmented later fine tuning of top layers are done. The ensemble of model snapshots classifies chest X-Rays corresponding to COVID-19, normal and pneumonia. A visualization study is made to locate areas in X-Ray images through CAM that classifies X-Ray into its particular category.

Qjidaa. M., et al., [4] developed an Intelligent Clinical Decision Support System known as SADC for early diagnosis of COVID-19 using chest X-rays which are classified into COVID-19, Pneumonia and Normal. Transfer Learning concept and pre-trained architecture such as DenseNet121, VGG16, InceptionResNetV2, Xception, MobileNet, InceptionV3 were used to determine features from X-ray images.

Ahmed. S., et al., [5] proposed a CNN architecture called Residual Image-Based Covid-19 Detection Network (ReCoNet). This model has a multi-level preprocessing filter block in cascade with a multi-layer CNN based feature extractor and classification block. The complete network is pre-trained end-to-end on the CheXpert open source dataset. The proposed system has high sensitivity and specificity of the proposed CXR-based detection scheme plays a key role in mass detection and triage amid the COVID-19 pandemic.

Asif. S., et al., [6] proposed a study that aimed to automatically detect COVID-19 pneumonia patients using digital chest X-ray images using deep Convolutional Neural Networks. In this study InceptionV3 model exhibits an excellent performance in differentiating COVID-19 pneumonia by training itself from lower collection of images.

Islam. M. M., et al., [7] has presented combination architecture of Convolutional Neural Network and Recurrent Neural Network (RNN) to diagnose COVID-19 from Chest X-ray images. The deep transfer techniques that are used are VGG19, DenseNet121, InceptionV3 and InceotionResNetV2. A Grad-CAM was used to visualize class-specific regions of images responsible to make decision. The VGG19-RNN is considered as the best of all the networks.

Shorfuzzaman. M., et al., [8] uses Convolutional Neural Networks in order to detect COVID-19 cases using chest X-ray images by pre-training the CNN-based models as feature extractors to substantiate transfer learning and added classifier in detecting COVID-19cases. A 5-fold cross validation is used to evaluate the model by using two publicly available data repositories that has infected and healthy X-ray images.

Zulkifley. M.A., et al., [9] proposed a deep learning approach to automate the screening by using LightCovidNet model. This model consists of three components called entry, middle and exit flows. The mid flow has five units of feed forward convolutional neural network. The exit flow is built to improve capability of network through a spatial pyramid pooling module. The synthetic data generated from conditional DC-GAN its classification accuracy. The proposed model LightCovidNet is more faster and accurate mobile-based model for COVID-19 screening.

Alghamdi. H. S., et al., [10] used Artificial Intelligent methods such as deep learning for automatic diagnosis in the analysis of visual information and wide range of medical images. The results achieved by Generative Adversarial Networks (GAN) are promising. A deep CNN architecture tailored for COVID-19 classification task using GenSynth is utilized to make layer and comprehensive COVID-19 CXR dataset.

Alhudhaif A., et al., [11] proposed a Transfer Learning based CNN model using chest X-ray images by pre-trained architecture such as DenseNet-201, ResNet-18 and SqueezeNet and the images are acquired from available databases. The activation mapping helps in improving the causality and visuality of radiography. The proposed DenseNet-201 can be used for detection of COVID-19 cases from CXIs in an automated way.

Rehman. A., et al., [12] proposed a Machine Learning and Deep Learning techniques to predict diagnose, classify and detect the Corona Virus. The analysis was performed to select appropriate Machine Learning/Deep Learning techniques using radiological and clinical datasets. The data was obtained from Science Direct, Web of Science, PubMed by using search code strategy. The ML/DL technique plays a significant in prediction, classification, screening and minimizing the spread of the COVID-19 pandemic.

III. METHODOLOGY

3.1 Model diagram:

A selection algorithm can be seen for presenting new characteristics subsets, along with an approximation measure which tells the different detail subsets. Feature selection is used to simplify the models to make them users to be interpreted, and used to enhanced generalization by decreasing over fitting, avoid the curse of dimensionality.

Feature extraction is also involved in minimizing the amount of available sources needed to describe a huge set of information. One of the major problems, while performing or analyzing the complex data is the problem arise from the amount of variables involved in it. By examine of huge amount of the variables we required a huge amount of memory study power, and it also cause a sorting algorithm of over fitting samples and observe poorly to latest samples. X- ray machines use light or radio waves as radiation to look at the affected parts of the body due to cancers, lung diseases, bone dislocations, and injuries. Meanwhile, CT scans are used as sophisticated X-ray machines to look at the soft structures of active body parts for better views of the particular soft tissues and organs. The advantages of using X-rays over CT scans are that X-rays are quicker, safer, simpler, and less harmful than CT scans. Narin et al proposed a Convolutional Neural Network-based model to identify Covid patients using 450 X-ray images, in which 250 images belong to Covid patients and the 200 images belong to healthy people. He applied this concept in 3 Convolutional Neural Network models: - Residual Network-50, Residual inception v-3, and inception Convolutional Neural Network using five-fold cross-validation and submitted the report that Residual Network-50 had the only detection accuracy (98%).

Another similar study which is conducted by Sethy and Behera, the authors extracted the attributes by using Deep Convolutional Neural Network algorithm from chest X-ray images and classified images as either infected or healthy using a SVM. They collected two datasets the first dataset contains the collection of 25 infected patient's images and 25 non- infected patient's images while the other dataset contains X-ray images of 133 infected patients and 133 non-infected patients. They applied separate feature extractions on each dataset using various models and achieved a 94.38% accuracy with ResNet- 50 and SVM. Furthermore, Hemdan et al put forward a framework, called Covidx-net, which will assist radiologists in diagnosing Covid patients using X-ray. They evaluated their framework employing a collection of data of fifty X-ray images divided into two classes: 25 Covid- positive person images and 25 Covid-negative person images. The images used were resized to 224×224 pixels. The COVIDX-Net framework employs 7 deep learning models such as : MobileNet. ResNet-v2. The authors trained model outcome indicate that the VGG19 and DenseNet models delivered comparable execution with an F-score of 91% for COVID-19 cases. In addition, Hassanien et al proposed an arrangement that uses multi- level thresholding and an SVM to identify covid persons by the help of using X-ray images. Their model was implemented by using 50images (20 healthy and 30 covid infected) with a resolution of 512×512 pixels. This arrangement achieved a performance of 94.32%, accuracy of 99.64% and specificity of 96.13.7%.

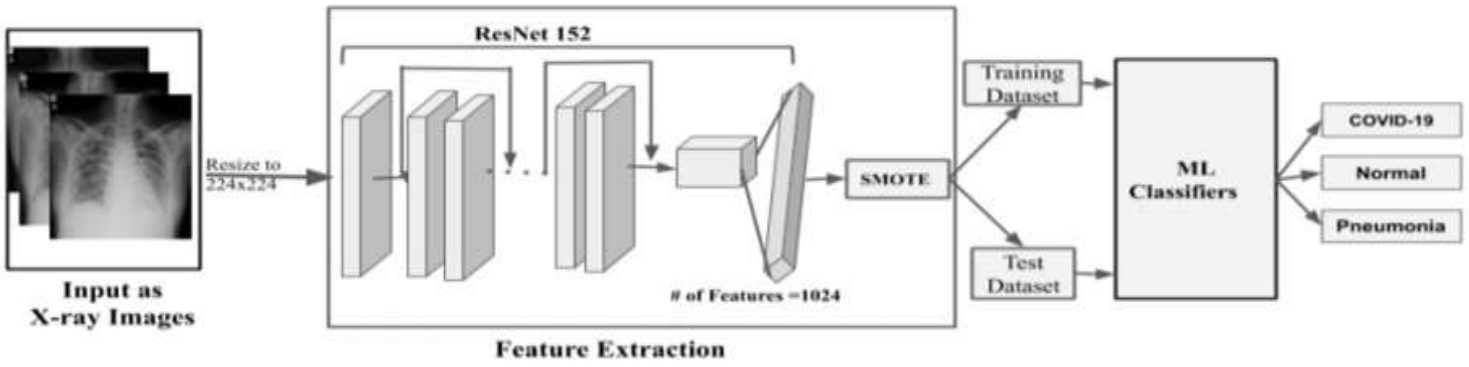


Fig.1: Block diagram of proposed model

3.2 Dataset description: To validate the proposed method, we require two types of chest related x-ray images they are common x-ray image and the other one is covid affected patient x-ray image. While chest X-ray images of common category had been collected from a GitHub or from Kaggle dataset which contains some images selected from Chest X- ray dataset. Granting them in a notable number of infected COVID-19 patients universally, but chest x-ray images that are accessible online are not mostly significant and dispersed. Kaggle chest X-ray data is a far-fetched popular database containing chest X-ray images of normal or healthy, viral, and bacterial- pneumonia. Positive and mistrust CORONA VIRUS images were acquired in open available resources. Lungs X-ray images for regular and effected with pneumonia were used from this gathering to generate the up to date database collection. the first dataset contains the collection of 25 infected patient's images and 25 non- infected patient's images while the other dataset contains X-ray images of 133 infected patients and 133 non-infected patients.

3.3 Brief description of Algorithm: In CNN algorithm, we first collect the image, process the collected image and classify it under certain category. Here we are labelling the images into three categories like C for COVID, N for Normal and P for Pneumonia. In CNN there are different layers such as Convolutional Layer, Pooling Layer, ReLu Layer and Fully Connected Layer. The input image is passed to the Covolutional Layer as a 2D array format. The pixels of the input image is classified as small where 32 pixels are applied, for medium 64 pixels are applied and for large 128 pixels are applied. We are taking input in the matrix format and the unwanted images are removed in the pre-processing step. ReLu layer is used to remove the negative values and those negative values are converted into zeros. The next layer is the Max-Pooling layer, where the complete image is reduced and all the unwanted images are removed. In this layer the actual output is obtained and it is passed to fully connected layer. In the Fully Connected layer we are using 3 classes called COVID, Normal and Pneumonia. Since we are using multiple types of images, a method called categorical_cross entropy is used. Once the model is loaded, we use slicing concept where images are trained by converting images into array format by resizing and reshaping them. After the model is loaded, we are defining 0 for COVID, 1 for Pneumonia and 2 for Normal as their status. In the front end, when an input image is selected and the selected image is a COVID image, the status is displayed as COVID, same applies for Normal and Pneumonia images when selected.

V. PERFORMANCE ANALYSIS:

The CNN model is trained with from dataset Lung X-Ray images from JSRT dataset.The CNN model is trained with 300 X-Ray images in 80:20 ratio.

Basic measures derived from the confusion matrix:

Error rate (ERR) is calculated as the number of all incorrect predictions divided by the total number of the dataset. The best error rate is 0.0, whereas the worst is 1.0.

Error Rate=(FP+FN)/(P+N).

Accuracy (ACC) is calculated as the number of all correct predictions divided by thetotal number of the dataset. The best accuracy is 1.0, whereas the worst is 0.0. It can also be calculated by 1– ERR.

Accuracy = (TP+TN)/(P+N).

Precision (PREC) is calculated as the number of correct positive predictions dividedby the total number of positive predictions. It is also called positive predictive value (PPV). The best precision is 1.0, whereas the worst is 0.0.

Precision = TP/TP+FP.

Specificity (SP) is calculated as the number of correct negative predictions dividedby the total number of negatives. It is also called true negative rate (TNR). The best specificity is 1.0, whereas the worst is 0.0.

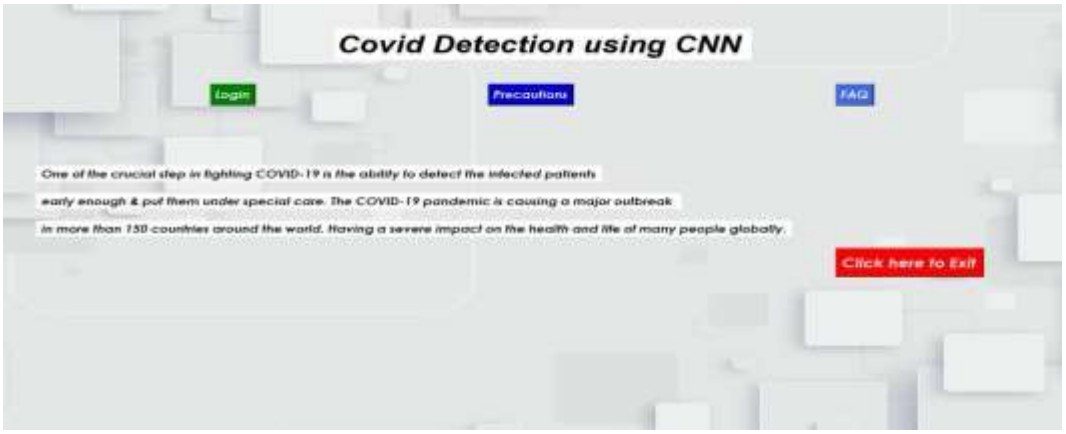
SP=TN/TN+FP.

False positive rate (FPR) is calculated as the number of incorrect positivepredictions divided by the total number of negatives. The best false positive rate is
whereas the worst is 1.0. It can also be calculated as 1 – specificity.FP= FP/TN+FP.

VI. RESULT

A convolution layer extracts the features of the input images by convolution and outputs the feature maps. It is composed of a series of fixed size filters, known as convolution kernels, which are used to perform convolution operations on image data to produce the feature maps.

Figure 8.1: HomePage



This is the front end of our project where the homepage with buttons are developed using Tkinter programming.

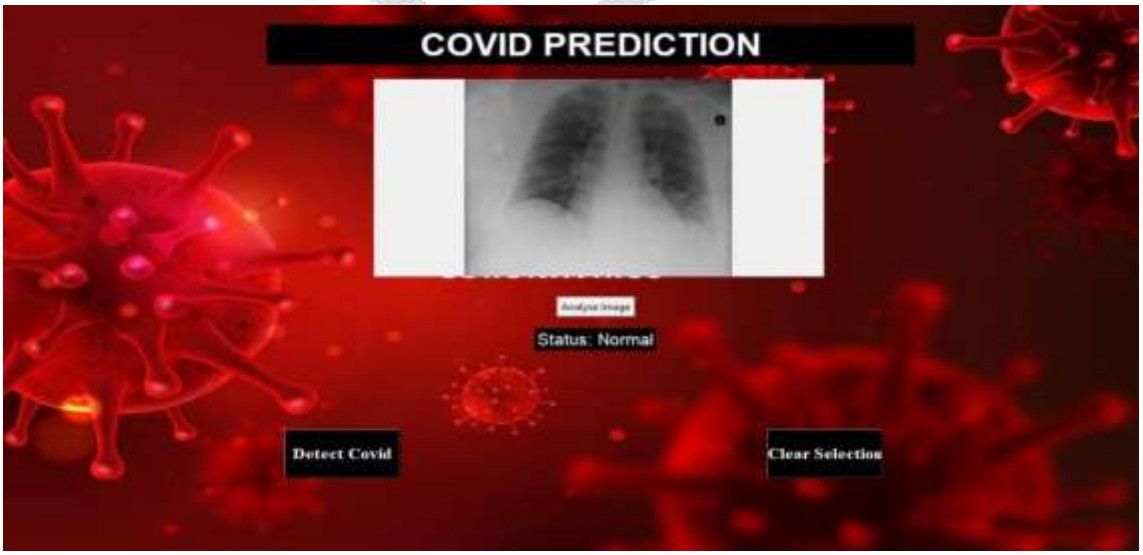
Figure 8.2: Login Page

Once the login button is clicked on the home page, the login page with input fields like Username, Password and Login button appears.

Figure 8.3: After successful login to page

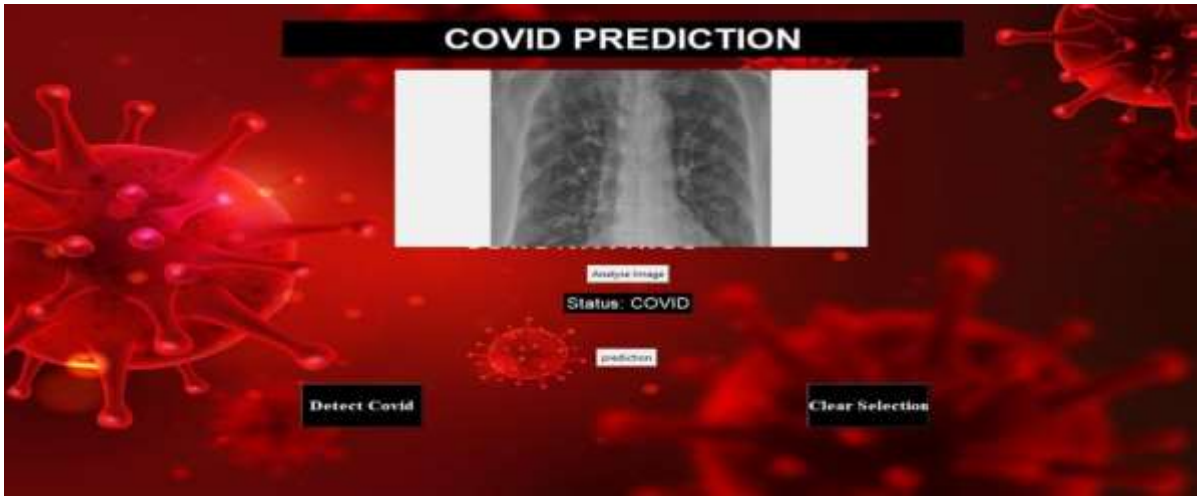
Once the Login is done using the Login credentials given to the User, Prediction page appears where User is able to select the image by clicking on Detection button, once the image is loaded the User has to selct Prediction button.

Figure 8.4: Prediction of normal X-Ray Image



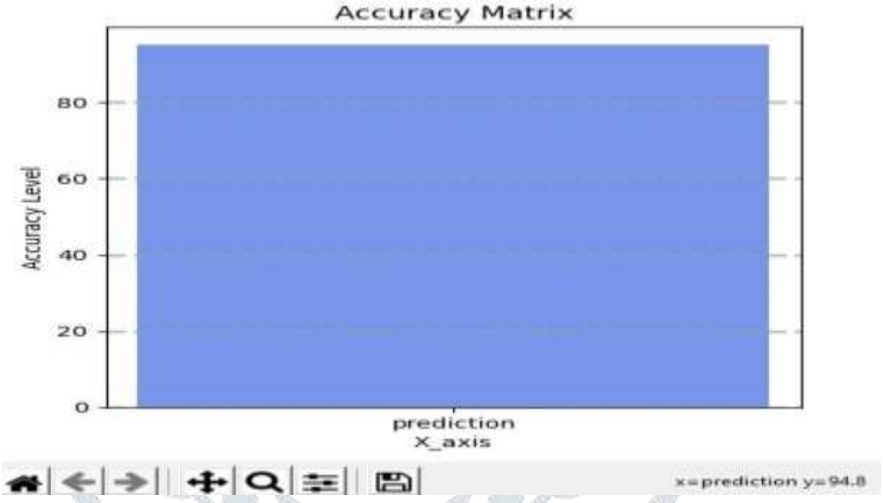
After selecing the image, the User has to click on the Prediction button. This Prediction button helps to analyse the image. In the above output, the selected image is Normal.

Figure 8.5: Prediction of Covid X-Ray Image



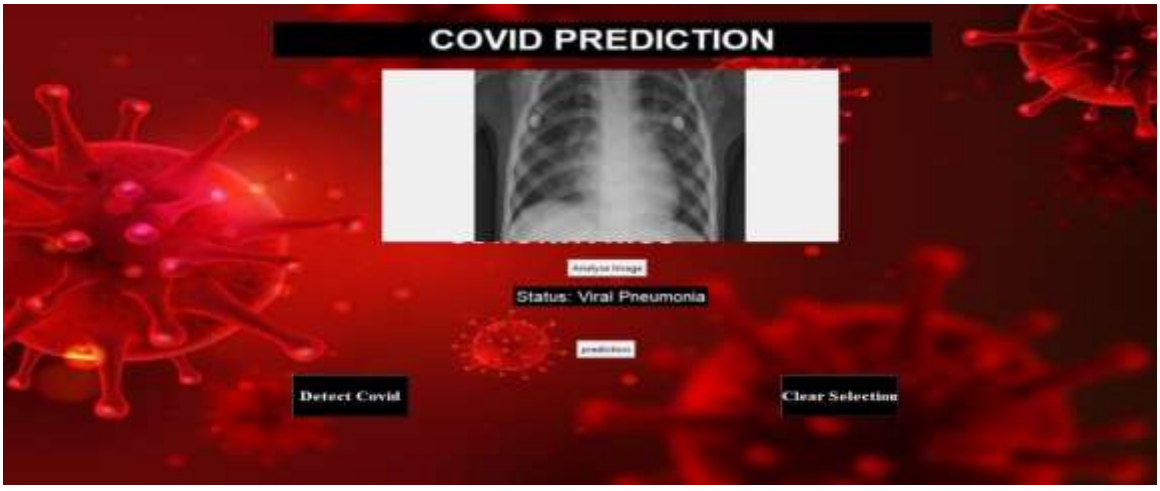
After selecing the image, the User has to click on the Prediction button. This Prediction button helps to analyse the image. In the above output, the selected image is COVID.

Figure 8.8: Covid detection accuracy level prediction graph



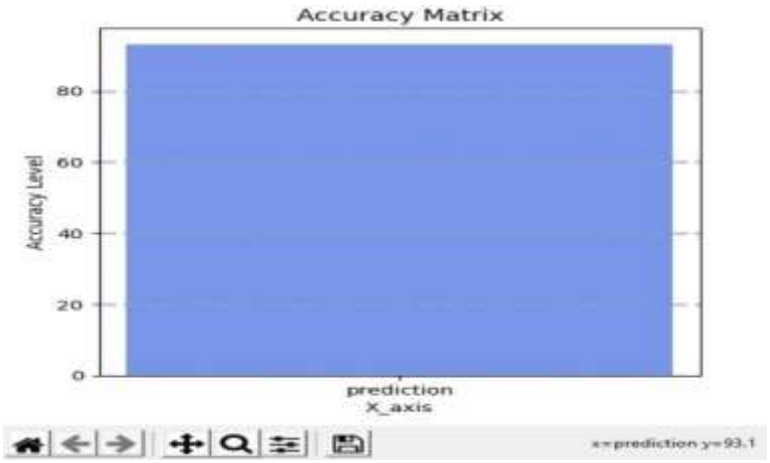
The above accuracy matrix is obtained for the corresponding input which is COVID prediction and the accuracy found was 94.8.

Figure 8.6: Prediction of Pneumonia X-Ray Image



After selecing the image, the User has to click on the Prediction button. This Prediction button helps to analyse the image. In the above output, the selected image is Viral Pneumonia.

Figure 8.9: Pneumonia detection accuracy level prediction graph



The above accuracy matrix is obtained for the corresponding input which is Pneumonia prediction and the accuracy found was 93.1.

V. CONCLUSION

The model results, an evaluation of the proof of concept, future work to improve the application and a personal statement.The model resulted in a 65.7% accuracy using the dice coefficient on the training set.

The dice coefficient is much lower on the training set however the confusion matrix outputs a high true and false positive rate on a set that contains positive and negative samples. This indicates that the model is great at distinguishing between X - Ray slices with no COVID nodules compared to the ones with COVID. I believe with more hyper parameter tuning and model training the accuracy could be increased. When doctors find small nodules (less than 3mm) the current practice suggests that they should wait and rescan in 6-12 weeks to see signs of growth. Depending on the tumor, a tumor can grow up to double its size and evolve to a more advanced form of COVID.

It is also important to note that the second most frequent diagnosis is small tumors. The project demonstrates that it would be possible for Doctor's to use CNN applications to aid their decision making process regarding whether a patient with a small tumour should perform a biopsy or rescan in a few weeks which to a patient could mean early treatment and a better prognosis.

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