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Covid-19 Detection using Chest X-Ray Images

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Abstract - *Covid-19, an infectious illness that first emerged in Wuhan, China, in December 2019, has claimed the lives of a large number of individuals throughout the world by hurting their mental and physical health. It has shaken the global economy adding to being harmful to public health. Given the virus's fast transmission, an effective and timely way of detecting and diagnosing the illness is required. Radiology is another discipline of medicine that aids in the diagnosis of individuals with coronavirus symptoms. Our work intends to carry out the task of diagnosing the disease using radiography pictures of the human chest, with inspiration and understanding from numerous studies. The purpose of this work was to show how deep learning can be used to achieve great accuracy. COVID-19 detection utilising X-ray images of the chest. The research comprised the training of deep learning and machine learning classifiers using publicly accessible X-ray pictures (1583 healthy, 4292 pneumonia, and 225 verified COVID-19).*

Key Words: **Covid-19, Chest X-Ray, Artificial Intelligence, Deep Neural Network, CNN.**

I. INTRODUCTION

Coronavirus disease (COVID-19) is a newly found viral infectious disease. Many people all across the world have been affected by it. It is basically divided into 3 phases. In very first phase people have symptoms of fever accompanied with the body pain, fatigue and a dry cough. In second phase they might have loss of taste or smell, a sore throat, diarrhea, types of skin rashes. In third phase they will have breath shortness, a loss of appetite, a chest pain besides high fever too. The majority of those infected with the COVID-19 virus will develop mild to severe respiratory illness and recover without any additional treatment. Diseases that might cause a severe illness in the elderly and individuals with underlying health problems such as chronic respiratory disease, diabetes, and heart disease. It affects in different ways to different people. Many people can recover from mild to moderate sickness without any treatment. There have been many companies who tried to takeout many possible solutions to test corona virus affected persons but as the most of the solutions were manual it took 2-3 days time to take out the results. Then companies tried to use digital methods to detect the corona virus. As the number of corona virus patients had been increasing day by day, we needed a fast and an efficient method to diagnose a patient and where Artificial Intelligence is the best solution for diagnosis. ML is useful it can give a set of images together and the more accurate results too. Only once we need to train our model on a dataset and we can then use it for corona virus classification. Many people across the globe have developed many models for corona virus detection using machine learning and deep learning algorithms. They have achieved a good accuracy too. But the main focus of our model is to develop a CNN model which is computationally efficient and gives a good accuracy on smaller dataset too. It was difficult earlier to find a dataset of Chest X-Ray images of COVID-19 patients. With the help of this model, we would be able to detect the corona virus even if we have a smaller number of datasets. CNN is complicated, and its only flaw is that it requires a large number of datasets for training, yet it is excellent at classification. CNN is complicated, and its only flaw is that it requires a large number of datasets for training, yet it is excellent at classification. Each trained neural network learns about the task under consideration. While the basic goal of artificial neural networks is to mimic human behaviour and intellect, transfer learning allows them to apply the accumulated knowledge of one task to another. Deep learning for image recognition applications can learn millions of photos, and various large models with diverse architectures have been trained.

II. RELATED WORK

Tulin et al. [1] developed an automatic model for COVID-19 detection by using Chest X-ay images. Under this model they did two types of classification i.e., Binary classification (contained images of COVID and No-Findings) and Multi-class classification (contained images of COVID, Pneumonia and No-Findings).They employed a DarkNet model as a classifier for "You Only Look Once" (YOLO), a real-time object identification system, in their research. They used 17 layers of convolutional. They achieved accuracy about 98.08% for binary classification and 87.02% for multi-class classification.

Khan et al. [2] in his paper proposed a model named "CoroNet," which is a CNN model for COVID-19 diagnosis using radiography images of chest. The solution proposed is based on the "Xception Architecture," which is a pre-trained model using the ImageNet dataset. It is trained on a dataset that has been gathered from the various publicly accessible databases for the research purpose. The average model result rate has been 89.6 %. The recall and precision rate of COVID-19 cases is as follows: 93% and 98.2% for 4-classes (normal vs COVID vs. pneumonia bacterial vs. pneumonia viral). For the 3-class classification (COVID vs. Pneumonia vs. normal), classification performance achieved is 95%.

Alazab et al. [3] in his paper tried to find COVID19 with the help of COVID19 X-Ray images. They used Chest X-Ray images because they are easily available at a low price. Short-term Memory Neural Network (LSTM), Autoregressive Integrated Moving Average (ARIMA) model, and The Prophet Algorithm were employed for detection (PA). They were successfully able to achieve 95-99% F-Score. The PA gave the overall best performance. For COVID19 confirmation and recoveries they achieved 99.94% and 90.29% respectively. Shelke et al. [4] in her paper did the classification on chest X-ray's images and designed a classification model which focused on accurate diagnosis of COVID-19. Their dataset contained the chest X-ray's images that were divided into 4 classes, are as follows: Tuberculosis (TB), Pneumonia, COVID-19 and the Normal. They used VGG16 model which achieved the precision of 95.9%.

Asif et al [5] in her paper tried the detection of COVID19 pneumonia automatically in the patients using chest x-ray imaging while improving the accuracy in detection using deep convolutional neural networks (DCNN). The dataset contained images Normal Chest X-ray, Viral Pneumonia and COVID-19 pictures as follows: 864 of the COVID19, 1345 of the Viral Pneumonia and 1341 of Normal chest x-ray images. In this they have used deep convolutional neural networks-based model that is, Inception V3 with the transfer learning for the detection. And they achieved a classification accuracy of more than 98% (where the training accuracy was 97% and validation accuracy was 93%).

Artificial Intelligence:

Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that require the human intelligence. AI is an interdisciplinary science with the multiple approaches. The advancements in machine learning and the deep learning are creating a paradigm shift, virtually in every sector of the tech industry.

Four different approaches that have historically defined the field of AI are:

- Thinking humanly
- Thinking rationally
- Acting humanly
- Acting rationally

Convolutional Neural Network:

Recently, CNNs are the most studied machine learning (ML) algorithms for the medical lesions diagnosis using images. The justification behind this is that CNNs retain complex features while scanning input images. As stated above, spatial relationships are of primary importance in radiology, such as how the bone joins the muscle, or where the standard lung tissue interfaces with infected cells.

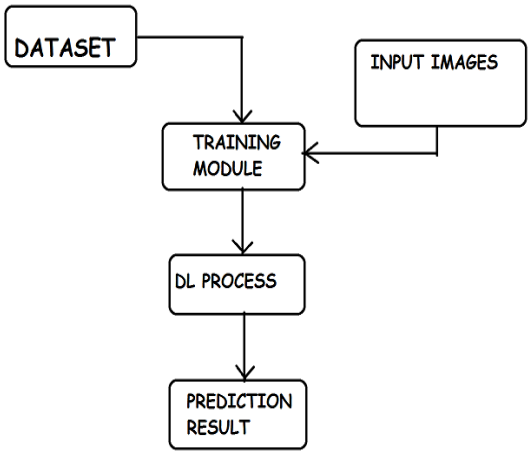
III. LITERATURE SURVEY

Sr. No.	Title	Methodology	Pros & Cons
1.	Automated Detection of Covid 19 Cases using Deep Neural Networks with X-Rays Images.	This paper aims to apply deep learning algorithms technique on dataset developed by cohen JP. CNN algorithms with Naïve Bayes classifier for the performance improvement is used in presence of YOLO technique	**Pros: -** 1) Easy to use. 2)Easy to implement **Cons:-** Large Non-public dataset required.
2.	Covid-19 Detection and Diagnosis Using a Deep Neural Network from Chest X-Ray and Diagnosis of Covid-19	In this paper they propose CoroNet, a deep convolution neural network model to automatically detect COVID 19 infection from chest X-	**Pros:-** Pre-trained network. **Cons: -** Take time to train.

	from Chest X-Ray.	Rays images.	
3.	COVID-19 Prediction and Detection using Deep Learning.	An artificial intelligence technique based on a deep convolutional neural network to detect COVID-19 patients using real world datasets.	**Pros:** Pre-trained network. **Cons:** Large memory is required.

IV. METHODOLOGY

1. Working Model:



2. Project Planning

Step I: Image Dataset Exploration.

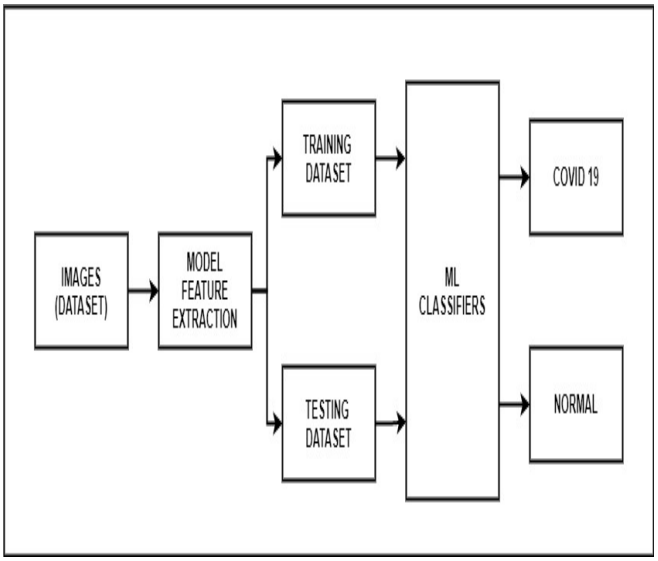
Step II: Importing Pretrained Model.

Step III: Splitting dataset into testing& training dataset to find accuracy of the model.

Step IV: Actual image input for analysis.

Step V: Testing & debugging.

3. System Architecture:



4. Algorithm:

Step 1: A publicly available chest x-ray images dataset is taken for the development of the system.

Step 2: Steps like exploration and feature extraction are performed to make the dataset suitable for the use.

Step 3: Once the dataset is ready, we will split it into train and test dataset.

Step 4: Pretrained ML model will be used for training and testing and accuracy will be determined.

Step 5: Once everything is done then the user can provide actual test data for COVID19 Prediction.

Step 6: User Interface is provided using Streamlit Python Module.

5. Proposed Methodology:

1) In proposed system we are using dataset of chest x-rays with covid positive and non positive labelled.
2) Proposed system is able to take input from user.
3) Proposed system is able to do Deep learning operation by splitting it into training and testing data.
4) Proposed system is able to compare the extracted feature from users input x-ray image with previously trained dataset having bunch of features.
5) Finally proposed system returns the compared result with 94% accuracy of deep learning model.

5.1 Deep Learning Model (HDF5)

Deep learning is the current trend and most prolific AI technique used for classification problems. It has been successfully used in a variety of applications, particularly in the medical industry.

Here we consider two deep learning model for our system HDF5, 2D sequential CNN model and Resnet-50.

1. **2D sequential CNN model**

This model is a type of feed forward neural network that's been discovered to be particularly effective at interpreting multidimensional data (e.g., images). In comparison to multilayer perceptrons, CNNs save memory by sharing parameters and using sparse connections. The input images are turned into a matrix before being processed by the various CNN parts. The model is made up of numerous alternating layers of convolution and pooling.

Convolutional Layer

The features of the various patterns in the input are determined by the convolutional layer. It is made up of a series of dot products (convolutions) that are applied to the input matrix. This stage produces a feature map by creating an image processing kernel with a number of filters (i.e., motifs). The input is separated into receptive fields, which are convolved with the kernel using a set of weights. In this paper 2D convolution layer was used.

Pooling Layer

This down-sampling layer minimises the spatial dimensions of the output volume by lowering the amount of feature mappings and network parameters. Furthermore, pooling improves the model's generalisation by lowering overfitting. This step produces a set of features invariant to translational shifts and distortions.

Dropout

Overfitting is a common problem in neural networks. As a result, dropout is used to introduce regularisation inside the network, which increases generalisation. It works by ignoring some visible and hidden units at random. Due to this, the network is trained to handle numerous independent internal representations.

Fully Connected Layer

This layer takes the feature map as input and uses an activation function to provide nonlinear altered output. This is a global operation that uses features from all phases to generate a set of nonlinear classification features. In this stage, the rectified linear unit (ReLU) was used to help overcome the vanishing gradient problem.

2. **Pre-trained Model**

ResNet-50

ResNet-50 is a 50-layer deep convolutional neural network. We can use the ImageNet database to load a pretrained version of the network that has been trained on over a million photos. The network has been trained to categorise photos into 1000 different object categories. As a result, the network is able to learn rich feature representations for a variety of images. The network has an image input size of 225-by-225.

Model Implementation

These models were implemented and evaluated using the Keras high-level application program interface (API) of TensorFlow 2.

V. IMPLEMENTATION

BASIC DETAILS OF IMPLEMENTATION:

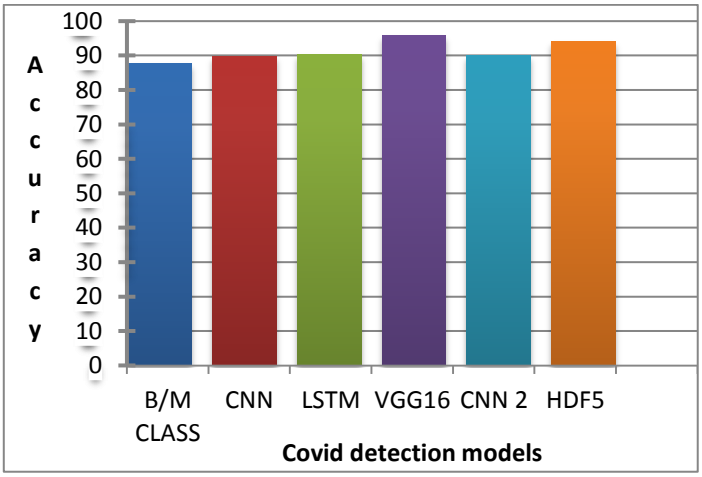
1. Hardware Interface

- System: Pentium IV 2.4 GHz and above recommended
- Hard Disk Space: Approx. 4 GB

2. Software Interface:

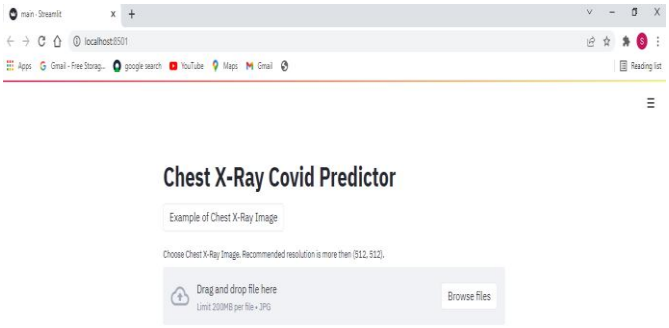
- Operating System: Windows 7/8/8.1/10/11 or Linux or MacOS
- Coding Language: Python
- Dataset: Image Dataset of Covid & Normal Patients
- IDE: Python IDLE/Spyder

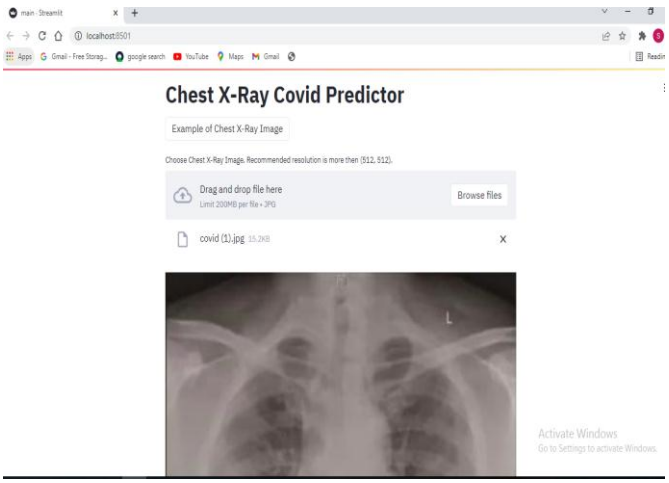
VI. PERFORMANCE EVALUATION

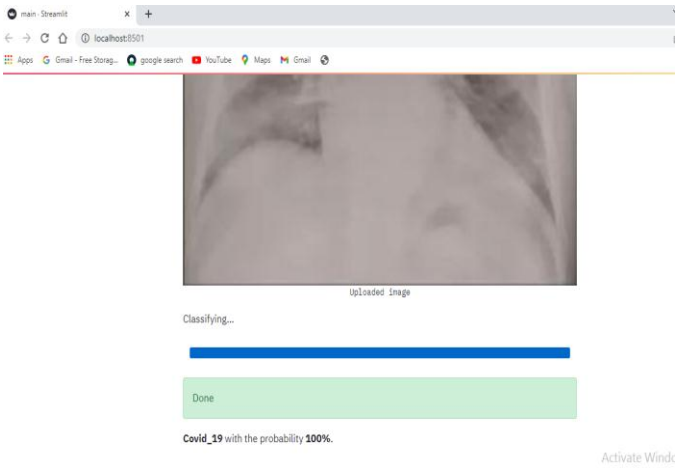


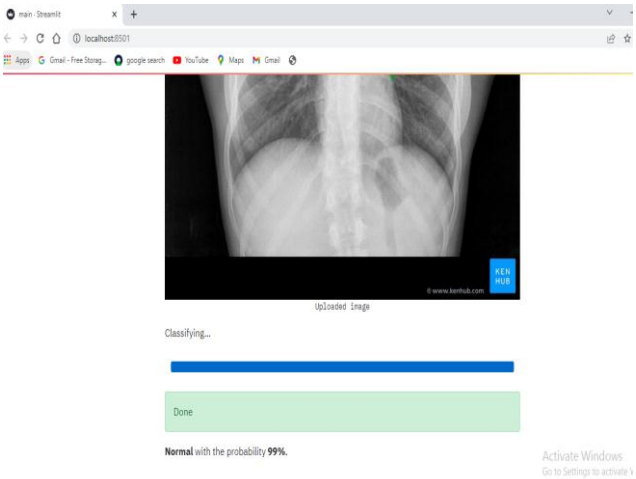
VII. RESULTS

This section describes the implementation and scan results of X-ray images predicting covid-19.In this section a user has to input the chest X-ray image, the predicator then predicts whether the patients is covid19 positive or covid19 negative. This predictor is also capable of classifying the chest x-ray images along with the percentage.









VIII. FEATURES

- It consumes less time compared to the current testing method.
- Since it's a software implementation hence no cost is involved.
- It gives 94% of accuracy.

IX. CONCLUSIONS

This paper has preferred a model to detect COVID-19 cases from the chest X-Ray images. COVID-19 detection plays an important role to halting the spread of this global pandemic. Given the scale of the publicly available dataset, the results appear promising. Through the dataset, we get the F1-Score. We can acquire the best outcome if we improve further with a multi-class classification and the availability of a large dataset. Finally, the system has excellent success in detecting COVID-19 with minimal time, resource and cost. Such a high accuracy will play an essential role in detecting COVID-19 patients, very fast. This will thus reduce the testing time and the cost for the general public.

X. FUTURE SCOPE

- Future work can include assessment of additional models probably with an exhaustive search of optimum classification parameters, increasing dataset size, number of epochs for training etc.
- It enhances the efficiency of Covid test procedures on routine basis.
- Can be useful in predicting any other diseases by training the machine accordingly.

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