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Predicting Covid-19 pneumonia Severity on Chest x-ray with deep learning

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Abstract - *Covid-19 is a viral disease that is quickly spreading and infects not only humans but animals as well. The economy of the country is affected by human beings' health because of this deadly disease. According to a clinical study the patients with this disease are frequently infected from lung infections coming in connection with the patients with this disease. The most efficient techniques to diagnose lung-related problems are Chest x-ray (i.e., radiography) and chest computed tomography. A huge amount of chest x-ray images provides a critical effect on the showing of Covid-19 using deep learning. In this study, Posterior – Anterior sight of chest x-ray examinations for both covid-19 affected patients as well as healthy patients. The examination of accuracy is compared with InceptionV3, Xception, and ResNet models. Out of 6432, 5467 training samples were used for training and 965 samples for validation to analyze the model performance collected from the Kaggle repository. The Xception model provides the maximum precision (i.e., 97.97%) for sensing chest X-ray images as compared to other models. This study only emphasizes on potential methods of categorizing covid-19 diseased patients and does not claim any medicinal accuracy.*

Keywords: Artificial Intelligence; Covid-19; Convolution Neural Network (CNN); Machine Learning; X-rays.

1. INTRODUCTION

Machine learning is a sub-branch of artificial intelligence (AI). The aim of machine learning in general is to know the structure of data and fit that data into models that can be understood and utilized by people. Machine learning is a turf in computer science and differs from traditional computing, computers are explicitly programmed to calculate or solve the problem. Data inputs are trained using the numerical study to check the output values fall inside an exact choice by using a machine learning algorithm. Computers use sample data to automate decision-making processes based on data inputs.

Users at present are benefitted from any technologies from machine learning. A social media platform helps users to tag and share photos using facial recognition technology. Image of text can be converted to movable type using optical character recognition (OCR) technology.

The world is now growling about the COVID-19 pandemic which is amusing life destruction and declared a global health crisis. Severe acute respiratory syndrome virus causes the COVID-19 pandemic and attacks human epithelial cells. Proper precautions are taken to stop this pandemic. Numerous scientists are making major hard work to save manhood from this disaster.

The human respiratory tract of epithelial cells is attacked by COVID-19, and X-Rays are used to detect the health of the patient's lungs. Deep CNN has achieved surprising growth in image recognition. Neural networks have been productively used in identifying pneumonia from X-Rays, and to achieve performances superior to those of radiologists.

1.1 Objective

- Image classifiers are built based on the X-ray images of patients who tested positive.
- Notice "normal" (i.e., uninfected) X-ray images from a healthy patient.
- CNN is trained automatically to notice COVID-19 in X-ray images through the dataset collected.
- The outcomes are evaluated from the trained model.

1.2 Problem Identification

The worldwide spreading of the COVID-19 deadly disease has resulted in a considerable loss in manhood. Medicinal and healthcare departments are in front of critical issues because it is discovered promptly. Therefore, diagnosis of suspected cases and facilitating to minimize the number of infected inhabitants is of great importance. Due to its low cost, extensive range of applications, and fast-speed X-Ray inspection is measured to be the most common method and plays a crucial role in the screening and detection of COVID-19 patients. X-rays are used in the detection of the patient's lungs health because it attacks a human respiratory cell.

1.3 Existing System

As COVID-19 examinations are hard to arise, they cannot be manufactured quickly, which is creating a fright. Because of this fright, there are the nefarious people who are selling the fake COVID-19 test kits. Provided limited COVID-19 test kits one must rely on other diagnosis measures.

Analysis of COVID-19 disease is taking more time as testing equipment is also expensive due to the speedy spreading of the Coronavirus across the globe. Appropriate measures are taken for automatic diagnosis of this pandemic, and proper medicinal consideration and action are taken for the patients as early as possible.

1.4 Proposed System

The complete system of COVID-19 for diagnosing can be separated into two parts:

- Image collection to create the dataset: The dataset here consists of patients' x-ray images meant for both training and testing purposes. In the training set, the images of those who have COVID-19 pneumonia and who do not suffer from COVID-19 pneumonia are collected.

- Training and testing of data to create the model: Convolutional neural network is used for training our model. It is most frequently applied to studying visual imagery in deep learning. Apiece x-ray image is passed via convolutional and max-pooling layers where the image data is compressed and passed throughout the layers of the fully-connected layers during training. The output class is predicted by the neural network and formerly equated with the real output is used to fine-tune the masses of the neural network.

2. LITERATURE SURVEY

Mustafa Ghaderzadeh, Mehrad Aria et. al., proposed artificial intelligence technique was used to decrease the mortality rate of COVID-19 infections because it attacks the epithelial cells of the respiratory region of a human being. X-rays were used to check the health of human lungs. [2]

Umashankar Subramaniam, M. Monica Subashini, et. al., suggested that the proposed work of the system promised good health, and preprocessing algorithms were introduced for preprocessing normal, COVID-19, and pneumonia. [1]

Ebrahim Mohammed Senan, Ali Alzahrani, Mohammed Y. Alzahrani, et. al., proposed that the symptoms were moderate fever and it was spread through the saliva droplets of infected patients. The Real-Time Reverse Transcription–Polymerase Chain Reaction was used to detect COVID-19 symptoms along with X-rays of chest imaging and chest computed tomography. [3]

Zeming Fan, Mudasir Jamil, Muhammad Tariq Sadiq, et. al, suggested that COVID-19 in patients can be identified through chest x-ray scans. The planned method contains three stages. In the first stage, works on preprocessing of data after obtaining from open-source. Later in the second stage, dissimilar training parameters were defined. [4]

Fareed Ahmad, Amjad Farooq, and Muhammad Usman Ghani suggested that the proposed model of a pathogen can transportable up to twenty-seven feet and uses the deep learning models, such as Alex Net, with five convolution layers such as three fully connected layers, and a SoftMax layer, comprised of approximately sixty million parameters. [5]

Sharmila V J and JemiFlorinabel D suggested the use of Long Short-Term Memory (LSTM) to forecast quickly COVID-19 cases and aid an exact COVID-19 classification. This study also proposed the use of the DCGAN-based CNN model. [6]

Surya Krishnamurthy, Kathiravan Srinivasan, Saeed Mian Qaisar, et. al., suggested that pneumonitis is an acute illness in the lungs categorized as a result of soreness in the alveoli, filled with pus, and unable to breathe. Pneumonitis contaminations can be instigated by viral, bacterial, and fungal agents where bacterial is the most common and viral infection the most dangerous. [7]

Dongsheng Ji, Zhujun Zhang, et. al., suggested that X-ray images of the chest were used to identify the infected patients with COVID-19 and to train the DenseNet121 and ResNet152 series models. The experiment also extracted output from convolutional layers of Xception, ResNet152, DenseNet201, etc. [8]

Yousef Alhwaiti, Muhammad Hameed Siddiqi, Madallah Alruwaili et. al., proposed that deep learning plays a key role in the detection of COVID-19 and it is accurate. With dissimilar radiology techniques COVID-19 showed its robustness on X-ray, CT, and MRI datasets. [9]

Rahib H. Abiyev and Abdullahi Ismail proposed that COVID-19 is a respiratory infection. According To WHO Non-COVID-19, viral pneumonia also causes the death of people, and chest X-rays are the best-obtained ways of diagnosing pneumonia. [10]

3. SYSTEM ARCHITECTURE

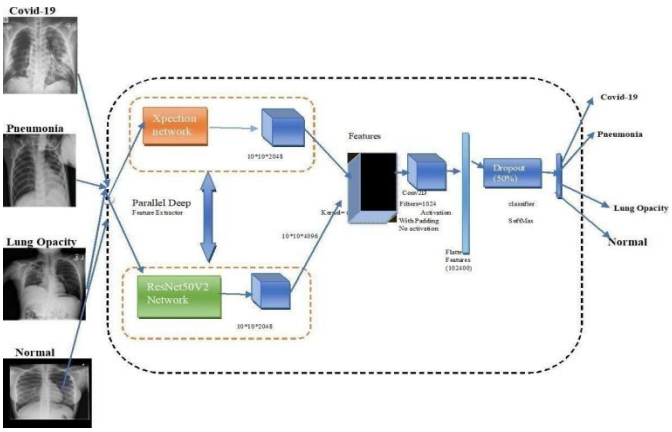
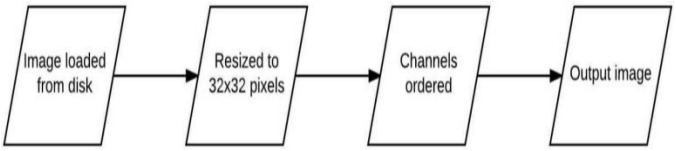


Fig-1: System Architecture of Proposed Model

Pixels are the building block of images. Normally it is considered as "color" or intensity of light. 0 to 255 is the value in a grayscale image where 0 corresponds to black and 255 is white respectively.

Open Computer vision stores the value of pixels in the order of blue, green, and red, and blue, green, and red order were popular among the camera manufacturers.

The process of maximizing or minimizing the size of image deals with scaling and aspect ratios.



The convolution neural network algorithm classifies the images collected into one of the following classes normal, covid-19, and pneumonia respectively. The system comprises an ensemble along with the preparation of images and the operations of the neural network combines with the convolution neural network features.

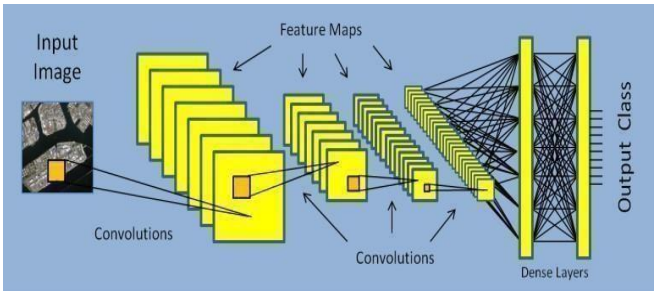


Fig-2: The structure of a convolutional network

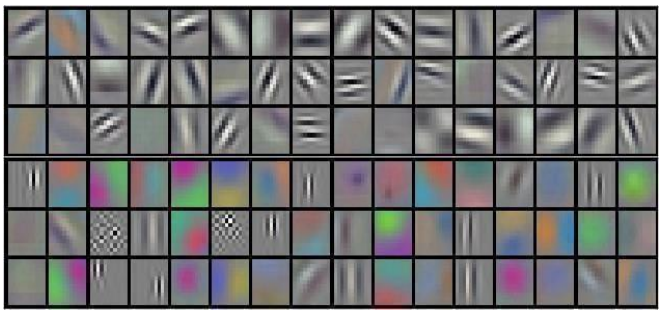


Fig-3: Examples of the image feature detectors that a CNN might "learn" during its training

A series of processing layers in CNN as shown in the Fig-2 and each layer is a family of layers of convolution filters each detector look like the Gabor-like and color blob filters as shown in Fig-3. Each layer consists of hundreds of thousands of filters, feeding the output result into the next layer in the network provided.

4. MODULES

1. Gather Your Dataset

Building a component for deep learning involves gathering the initial data set and labels are associated with each image, and these labels are a finite set of categories. Machine learning faces the common problem of class imbalance.

2. Pre-Processing RGB and BGR ordering

Open Computer vision stores the color channels in reverse order of blue, green, and red because the camera manufacturers follow the blue, green, and red color ordering.

3. Scaling and Aspect Ratio

The procedure of maximizing otherwise minimizing the extent of the image deals with scaling and aspect ratios. Maximizing and minimizing the size in the terms of width and height.

4. Split Your Dataset

The initial datasets are split into two types:

- A training set
- A testing set

The classifier usages a training set to learn and predict which group the image belongs to. If it is wrong then it will correct itself.

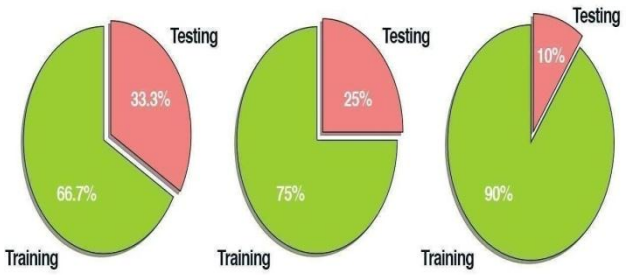


Fig-4: Examples of common training and testing data splits.

5. Train Your Network

Provided that a set of images for training, our network aims to identify which category the image belongs to. When it recognizes wrongly, it improves itself from wrong detection of category.

6. Evaluate

The network is provided with each image in the testing set and asked to predict correctly to which category the image belongs and these predictions are compared with ground truth labels and represent to which category the image belongs.

5. DATA FLOW

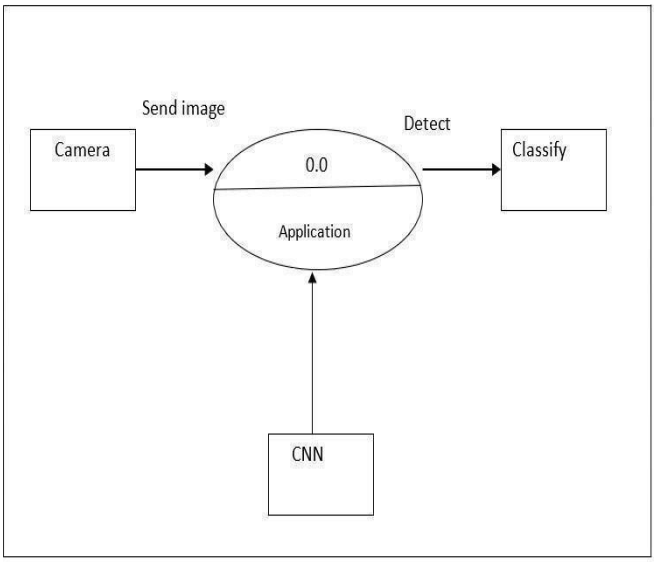


Fig-5.1: Data Flow Diagram Level 0

In the above Fig-5.1, the file image is to be loaded to the application where the loaded image is sent to the classification unit to predict the result with the assistance of a convolutional neural network model.

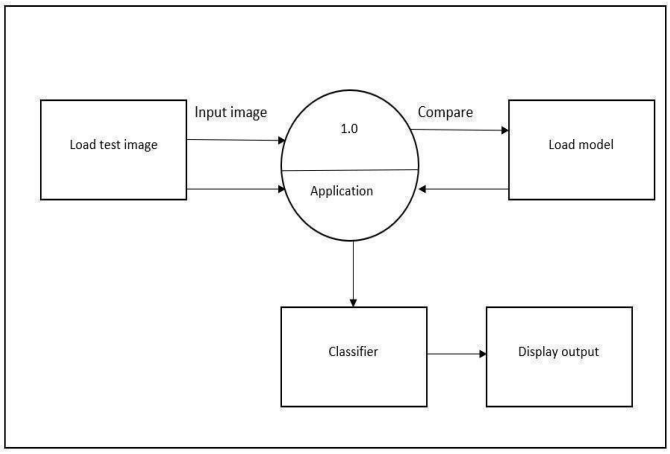


Fig-5.2: Data Flow Diagram Level 1

In the above Fig-5.2, the file image is to be loaded to the application where the loaded image is sent to the classification unit to predict the results to which class label the classified image belongs, for instance usual, COVID-19, viral pneumonia, and lung opaqueness.

6. USE CASE DIAGRAM

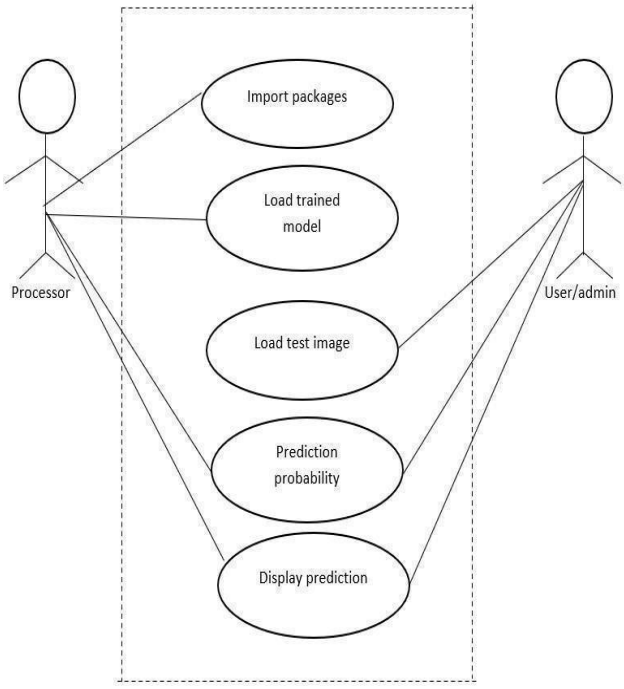


Fig- 6 Use Case Diagram

Fig-6 depicts the use case figure which represents the active performance of the system and the system functionality by using actors and use cases. In Unified modeling language, modeling with use cases is a core concept.

7. SEQUENCE DIAGRAM

The sequence diagram consists of 5 blocks namely user, processor, memory, model, and labels respectively as shown in the Figure. The user provides the input images via already saved information that has been captured, processing, and preprocessing of image data such as resizing, reshaping, and storing the reminiscence unit.

As preprocessing and loading the image in the memory unit has been done CNN model is trained, the feature of the image is extracted for output classification. Next, classification of the label is provided for instance usual, COVID-19, viral pneumonia, and lung opaqueness.

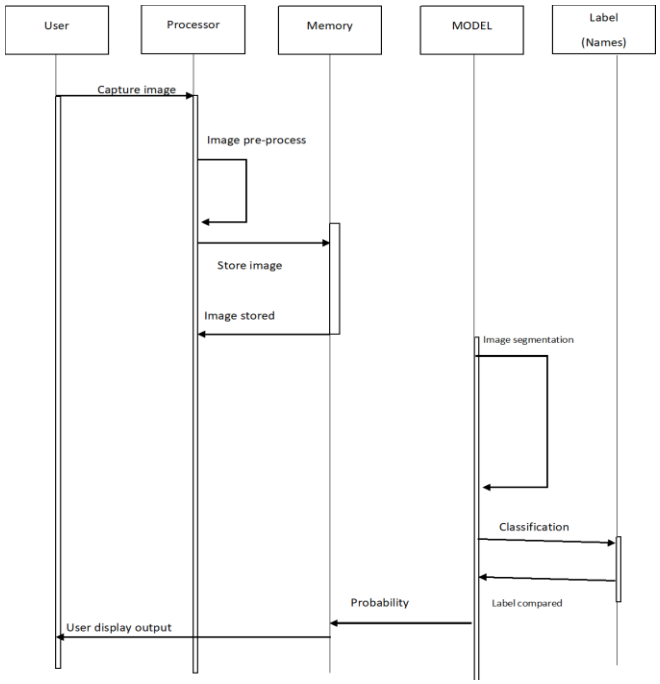


Fig-7: Sequence diagram for the proposed system

8. CONCLUSION

Deep learning stood as a serious in the response to the COVID-19 outburst. Analytic and diagnostic and classify chest X-ray imagery into four categories Normal, COVID-19, Viral Pneumonia, and opacity of lungs. Deep learning provides an orientation method for the COVID-19 epidemic situation to medicinal and health institutions, and supervision departments.

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