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Classification of Covid-19 from Chest X-ray images using Deep Convolutional Neural Network

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Abstract:

Corona virus disease (COVID-19) is an infectious disease caused by the SARSCoV2 virus. It has devastating effects on the health and well-being of global population. People suspected of having COVID-19 to be known quickly if they are infected, so they can receive appropriate treatment. One of the important steps to stop the contamination of virus is by timely screening. This study aims in quick and precise detection of virus to maximize the accuracy in the detection of COVID-19 which can be done by digital chest X-ray images using the approach of Deep Convolutional Neural Networks (DCNN). In this project, DCNN based model Inception V3, Resnet along with Machine learning algorithms have been proposed for the detection of Corona virus pneumonia infected patients using chest X-ray radiography. Data augmentation is carried out as part of data pre-processing. It is far believed that this screening technique is going to help doctors in the field of medicine in making early & accurate decisions. The implementation will be in Python.

Keywords: covid-19, normal, pneumonia, detection

1. Introduction

1.1 About Project

At the end of 2019, humankind was faced with an epidemic—severe acute respiratory syndrome corona virus 2 (SARS CoV-2)–related pneumonia, referred to as corona virus disease 2019 (COVID-19)—that people did not expect to encounter in the current era of technology. While the COVID-19 outbreak started in Wuhan, China, the significant spread of the epidemic around the world has meant that the amount of equipment available to doctors fighting the disease is insufficient. At the time of writing (September 8, 2020), there have been more than 27,000,000 confirmed cases and more than 875,000 confirmed deaths worldwide.1Considering the time required for diagnosis and the financial costs of the laboratory kits used for diagnosis, artificial intelligence (AI) and deep learning research and applications have been initiated to support doctors who aim to treat patients and fight the illness. Although rapid point-of-care COVID-19 tests are

expected to be used in clinical settings at some point, for now, turnaround times for COVID-19 test results range from 3 to more than 48 hours, and probably not all countries will have access to those test kits that give results rapidly. Chest X-ray is the first imaging technique that plays an important role in the diagnosis of COVID-19 disease [1]. According to a recently published multinational consensus statement by the Fleischner Society, one of the main recommendations is to use chest radiography for patients with COVID-19 in a resource-constrained environment when access to computed tomography (CT) is limited. The financial costs of the laboratory kits used for diagnosis, especially for developing and underdeveloped countries, are a significant issue when fighting the illness. According to their previously mentioned statement, the Fleischner Society recommends that medical practitioners use chest X-ray and CT in the management of COVID-19. Chest X-ray (CXR) is one of the most common types of radiology examination for the diagnosis of thorax diseases[6] In the end, the choice of imaging modality is left to the judgment of clinical teams at the point of care, accounting for the differing attributes of chest radiography and CT, local resources, and expertise. In this study, we propose the use of chest X-ray images over CT of the thorax, considering the latter's required diagnostic time. A CT scan of the thorax takes significantly more time than a chest X-ray scan does, and this means more contact duration with suspected or confirmed COVID-19 patients.

1.2 Objectives of Project

People who are suspected of being infected with the COVID- 19 virus should find out if they are affected with covid as soon as possible so that they may get a proper treatment, isolate themselves, and warn their close connections. For a formal diagnosis of COVID-19, a laboratory test i.e., RT-PCR of nose and throat samples is necessary. This test needs to have specialized equipment and this test takes minimum of 24 hours to complete. It is not so accurate and requires a re-take another of RT-PCR test in order to confirm the diagnosis. Because covid-19 is a respiratory disease, we can diagnose or a give an overview to the persons regarding COVID-19 symptoms using chest imaging rather than waiting for RT-PTR results. To identify CT scan pictures based on their attributes, we created a CNN model. This will assist shorten the time it takes to diagnose COVID-19. With an accuracy of 90 percent, a chest X-ray may correctly identify patients. Not every country and every person will have access to fast-turnaround test Kits. Taking into consideration the time it takes to diagnose and the cost of the laboratory kits used in the diagnosis of covid-19, we have constructed a model that uses image processing and deep learning to assess whether patients are infected with corona or not. Our main objective is to create a model to detect covid-19.[8]

1.3 Scope of the Project

- DCNN typically perform better with a larger dataset than a smaller one[9]

- Machine learning algorithms can also be used to classify the images using ANN or CNN model will help in getting better accuracy

- We can evaluate performance of various algorithm using accuracy comparison graph

- This model also helps in comparing the performance of Machine learning and deep learning algorithms.

- The results would be accurate as we used more number of algorithms

2. Literature Survey

2.1 Existing System

- The highest quality level screening strategy utilized for testing the COVID-19 patients is the Reverse Transcription Polymerase Chain Response (RT-PCR) test on respiratory specimens.[9]
- In acute respiratory infection, RT-PCR is routinely used to detect causative viruses from respiratory secretions[10].This procedure is the most generally utilized strategy for testing for COVID-19 identification however is a manual, confused, relentless and time-consuming process.
- The test of COVID-19 is currently a difficult task because of inaccessibility of diagnosis system everywhere, which is causing panic. Because of the limited availability of COVID-19 testing kits, we have to depend on different determination measures.
- X-ray images to analyze pneumonia, lung inflammation, etc. And almost in all hospitals have X-ray imaging machines, it could be possible to use X-ray's to test for COVID-19 without the dedicated test kits. • Again, a drawback is that X-ray examination requires a radiologists and takes huge time, which is valuable when people are sick around the world. Therefore, developing an automated analysis system is essential to save medical professionals valuable time.

2.2 Proposed System

- Deep learning in smart health analytics is a prominent interdisciplinary field that merges computer science, biomedical engineering, health sciences, and bioinformatics.
- In order to control the spread of COVID-19, a large number of suspected cases need to be screened for proper isolation and treatment. Quick and precise strategies are desperately expected to battle the sickness.

- Various medical imaging devices have a dedicated image and signal analysis and processing module, on which deep learning based models can be implemented to provide accurate, real-time inferences.
- The proposed work is implemented with TensorFlow and Inception V3, res-net, pre-trained models along with SVM, logistic regression random forest, decision tree, KNN, Naïve Bayes, ANN that was trained to classify normal, viral and COVID-19 pneumonia images and tested on Chest X-ray images DCNN, a deep learning classification technique is used to classify the Chest X-ray images.

3. PROPOSED ARCHITECTURE

3.1 System Architecture

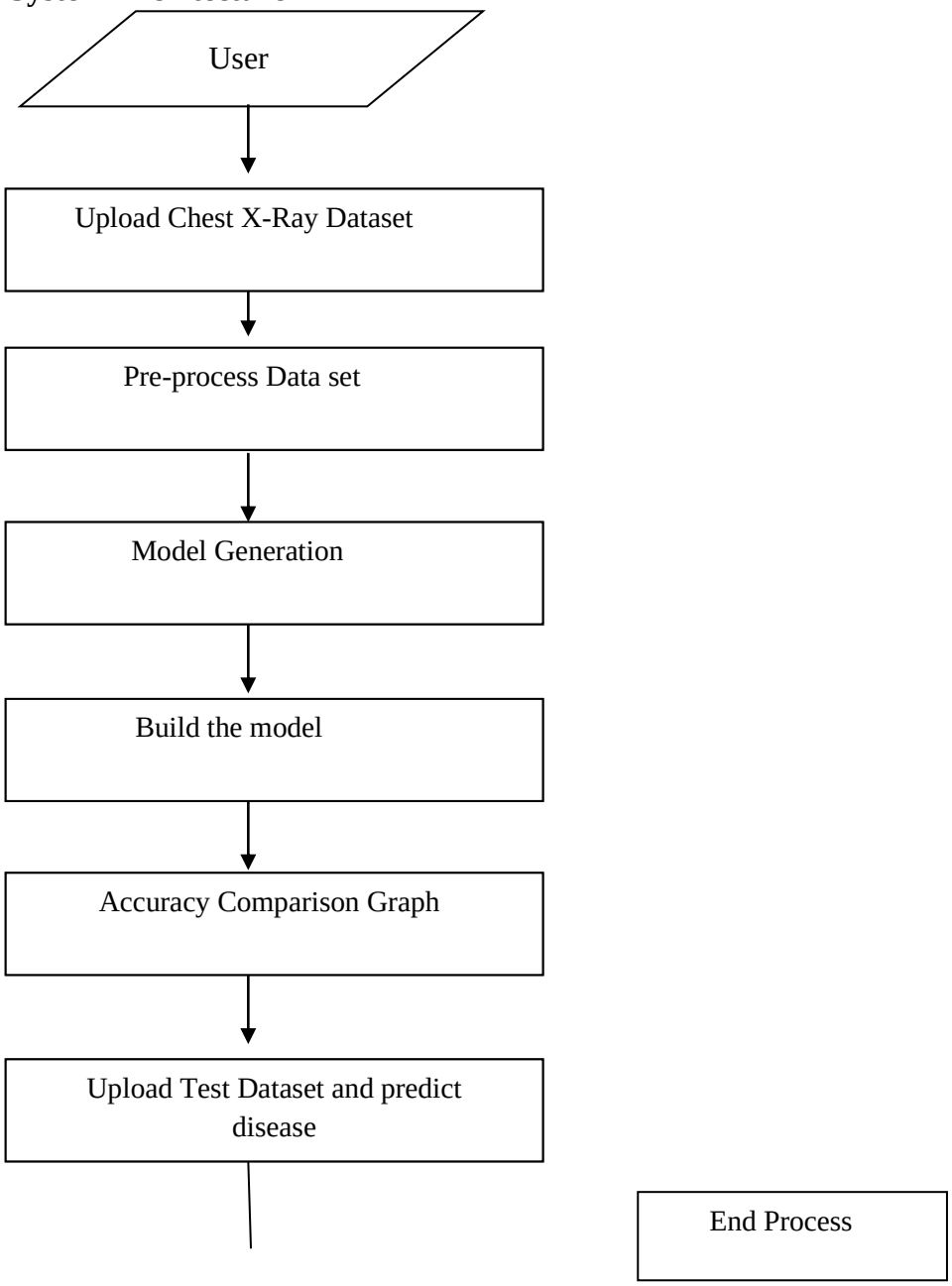

Fig 1 System Architecture

- The dataset used in building this model contains chest X-ray images of covid-19,pneumonia and normal and the dataset contain approximately 1000 images.
- Once the dataset is uploaded then the images get pre processed. Pre processing is done using resize and reshape functions and the images are resized to 400 X 400 and the image gets reshaped into a 3D array
- After pre processing we generate the model by splitting the data into training data and testing data in the ratio of 0.8:0.2 respectively this can be done using train_test_split function
- In this project we used hybrid architecture which consists of both machine learning algorithms as well as deep learning algorithms. There are 7 Machine learning algorithms and 2 deep learning algorithms which are used to train the model and accurately classify the disease. The Machine learning algorithms used in this project are SVM, logistic regression, Random Forests, Decision Tree, KNN, Naive Bayes, and ANN. The Deep learning algorithms which are used here are Inception v3 and Resnet 50.
- The data augmentation techniques used for deep learning algorithms are rescale, horizontal flip, rotation, shear
- The user interface is built using tkinter using which the the user can upload a test image and the image can be classified to 1 of the three categories the categories are Covid-19,Normal,pneumonia
- User can evaluate the performance using accuracy comparison graph the performance evaluation methods used for predicting the model are F1 score, Precision, Recall, Accuracy

4. Implementation

4.1 Algorithm

Input:

CXR image set divided into training and testing sets.

Ground-truth labels.

Predicted labels.

Output:

Step 1

- collect the chest x-ray images of pneumonia,covid-19,normal from kaggle

Step 2

- preprocess the data using rescale reshape techniques

Step 3

- Generate the model by splitting the data into training and testing in the ratio of 0.8:0.2

Step 4

- Train the model using machine learning algorithms(SVM, logistic regression, Random Forests, Decision Tree, KNN, Naive Bayes, ANN) and deep learning algorithms (Inception v3 and Resnet 50)

Step 5

- evaluate the performance using performance metrics such as Accuracy, Precision, F1 Score and Recall and generate the accuracy comparison graph

Step 6

- Upload a Chest X-ray image and the image gets classified into Covid-19,Pneumonia or Normal

4.2 Code Implementation

Python 3.7. Python is broadly utilized universally and is a high-level programming language. It was primarily introduced for prominence on code, and its language structure enables software engineers to express ideas in fewer lines of code. Python is a programming language that gives you a chance to work rapidly and coordinate frameworks more effectively.

PyCharm is a dedicated Python Integrated Development Environment (IDE) providing a wide range of essential tools for Python developers, tightly integrated to create a convenient environment for productive Python, web, and data science development.

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5. Result

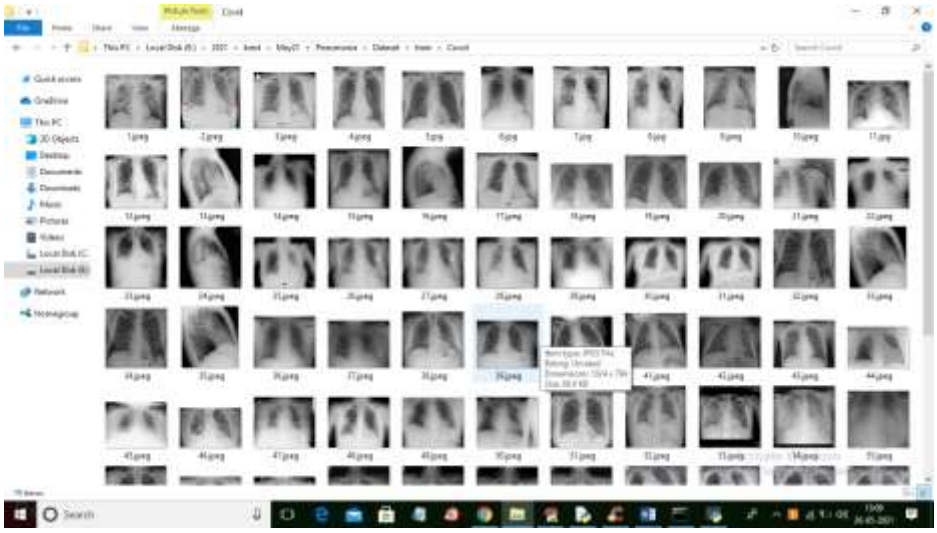

Fig :2 dataset

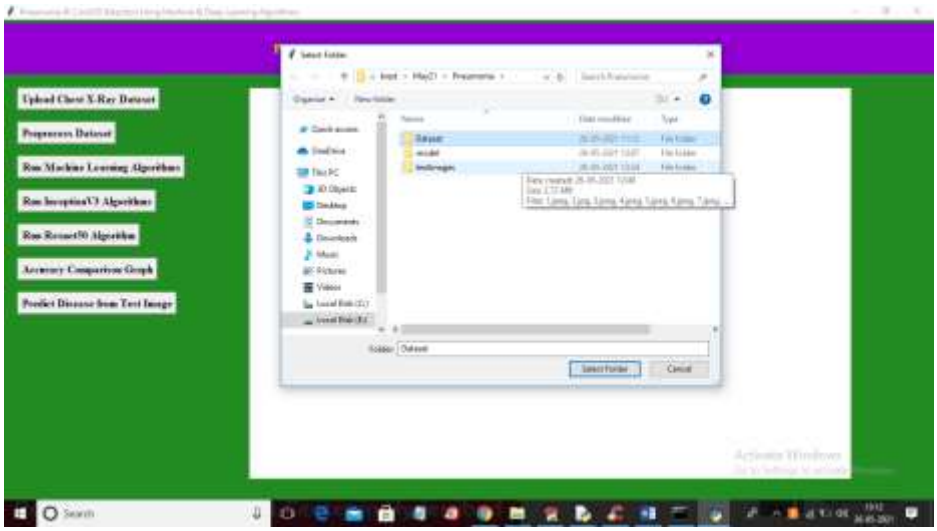

Fig:3 upload chest X-Ray image

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Fig:4 pre process dataset

Fig:5 Run Machine Learning algorithms

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Fig:6 Run Deep learning algorithms

Fig:7 Accuracy Comparison Graph

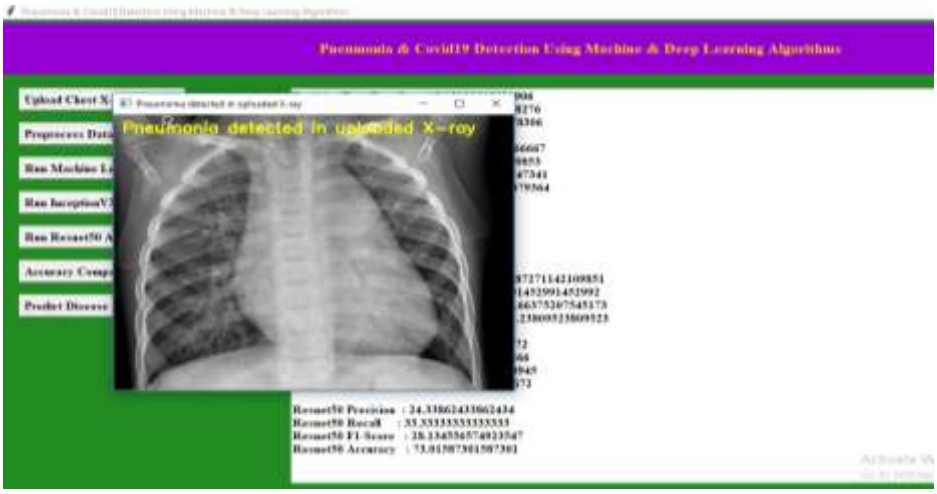

Fig :8 Pneumonia detected

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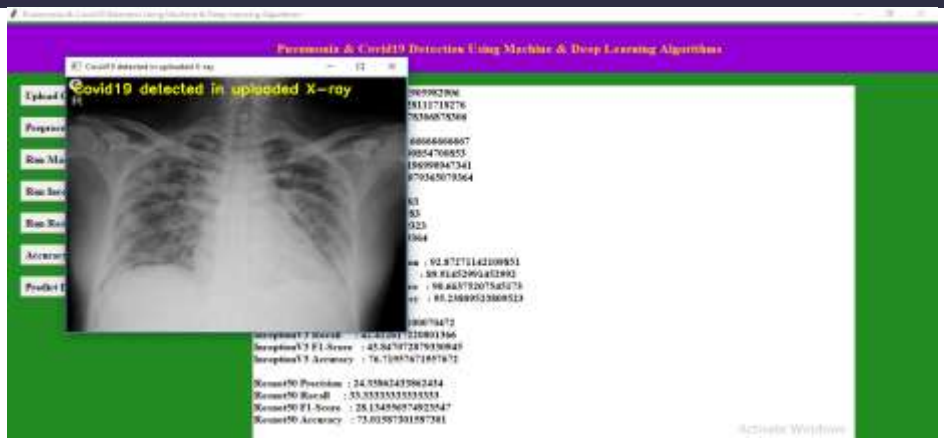

Fig :9 Covid-19 detected

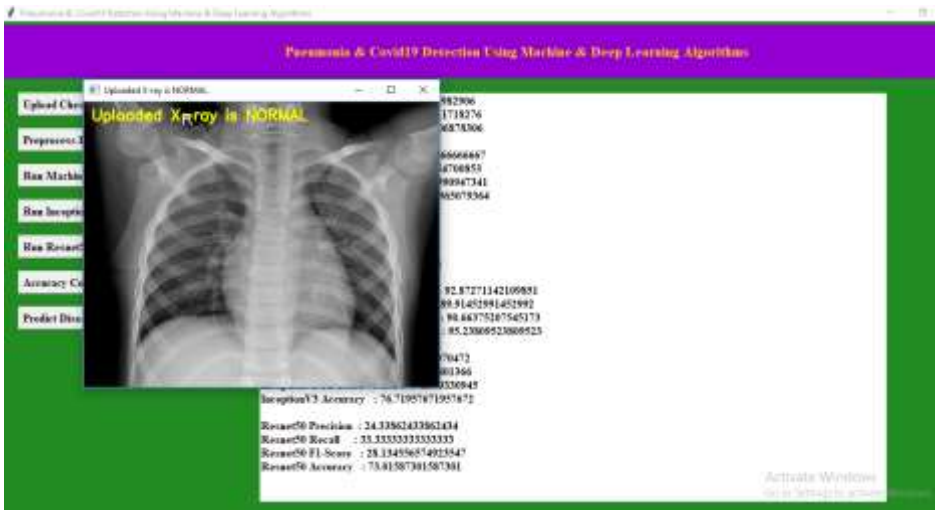

Fig:10 Normal detected

5. Conclusion

Early prediction of COVID-19 patients is important to avoid spreading the disease to different people. In this study, we developed a deep transfer learning-based approach the use of chest X-ray images obtained from COVID-19 patients, normal and viral pneumonia for automatic detection of COVID-19 pneumonia. In the light of our findings, it's far believed that it's going to help medical doctors to make decisions in scientific practice due to the high overall performance. In order to come across COVID-19 at an early stage, this study gives insight on how deep transfer learning methods can be used. COVID-19 has already become a danger to the world's healthcare system and thousands of people have already died. Deaths were initiated by way of respiration failure, which ends up in the failure of other organs. Since a big range of sufferers attending out-door or emergency, doctor's time is limited and computer-aided-analysis can save lives via early screening and proper-care. Transfer learning model exhibits an excellent performance in classifying COVID-19 pneumonia by effectively training itself from a comparatively lower collection of

images. We believe that this computer-aided diagnostic tool can significantly improve the speed and accuracy of diagnosing cases with COVID-19. This could be highly useful in a pandemic, where the burden of disease and the need for preventive measures do not match the availability of resources.

6.Future Scope

Although the proposed model classifies the COVID− 19 patients with more than 98% accuracy using chest X-ray images, we still face a serious need to find out the severity level of the infection too. In the future, we intend to perform experiments on chest CT scan image data for COVID-19 detection and combine both the models to identify the severity level. Voice recognition based early COVID-19 infection detection using intelligent methods is also part of our future plans.

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