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Comparative Analysis of Covid-19 Classification and Detection Methodology

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Abstract: Covid-19 is an infectious disease, and can also cause damage to the lungs. COVID 19 spread very quickly, which is a leading cause of death and is responsible for approximately 7% of all deaths worldwide. Coronavirus can spread by direct close contact or by coughing and sneezing of COVID-19 patients. The incidence of COVID 19 is increasing at a dangerous rate in the world, Therefore it is very important to detect, isolate, diagnosis, and treatment in the incubation **period. This paper is based on the different method and literature based on the number of the article in the same field.**
Keywords: COVID-19, SARS-COV2, computed tomography, deep learning, image acquisition, segmentation, diagnosis.

I. INTRODUCTION

The virus is named SARS COV-2. It belongs to the family of Coronavirus, which has a name similar to the crown on their surfaces. SARS COV-2 can cause COVID-19, an infectious viral infection that primarily attacks your throat and lungs. Inside the virus, genetic material contains information on making more copies of itself. A protein shell provides a tough protective attachment to genetic material as the virus travels between those who infect it. An outer envelope permits the virus to infect cells by merging with the cell's outer membrane. There are spikes of protein molecules projecting from the envelope. Both a specific influenza virus and the new coronavirus use their spikes to move inside a cell in their body, where it handles its internal system, remodelling it to form components of the new virus. When an infected person talks, coughs or sneezes, the virus-carrying droplets can land in your mouth or nose, and then in their lungs. Once inside the body, the virus comes into contact with cells in the throat, nose, or lungs. A spike on the virus inserts into a receptor molecule on the healthy cell membrane like a key during a lock. This action allows the virus to enter the cell. A specific flu virus will travel from the cell membrane to the nucleus of the cell inside a sack, where the cell carries all its genetic material. On the other hand, coronaviruses are not required to enter the host cell nucleus. It can directly reach parts of the host cell, called Ribosomes. Ribosomes use genetic information from viruses to make viral proteins, such as spikes on the surface of the virus. A packaging structure in the cell then moves the spikes into the vesicles, which merge with the cell membrane, the outer layer of the cell. All the parts needed to make a new virus gather under the membrane of the cell. Then a new virus starts from the cell membrane. Each lung has separate sections, called lobes. Normally, as breath, air moves freely through trachea or windpipe, Then, through large tubes, called bronchi, through small tubes, called bronchioles, and finally into tiny sacs, it is called alveoli. Its airways and alveoli are flexible and polymorphic. When breath, each air sac inflates like a small balloon. And when exhaling, the sacs shrink. The alveoli are surrounded by small blood vessels on all four sides, the small blood vessels are called capillaries.

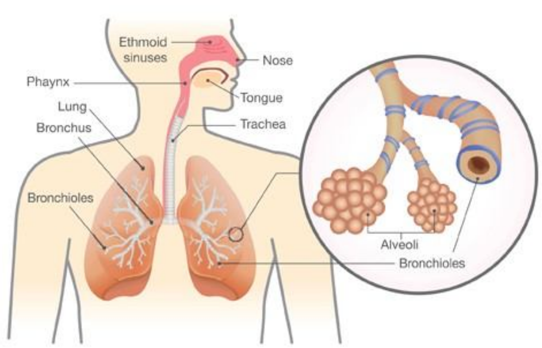

Fig. 1 Structure of Lungs

The oxygen from the air breathe goes to capillaries, then the carbon dioxide from the body comes out of capillaries to alveolar part, so that lungs get rid of it when exhaling. The airways hold the most germs in the mucus that pull trachea, bronchi and bronchioles. In a healthy body, the hair-like cilia tubes continuously emit mucus and germs from the airways, where they provoke a cough. Normally, the cells of immune system attack viruses and germs that make it past mucus and cilia and enter alveoli. However, if the immune system is weak such as in the case of coronavirus infection, the virus can affect immune cells and bronchiole and alveoli form, which causes your immune system to attack multiplying viruses. Inflammation can fill alveoli with fluids, making it difficult for the body to get the oxygen it needs. It may develop lobar pneumonia, where one lobe of the lung is affected, or may have bronchophenia that affects multiple areas of both lungs. Pneumonia may cause Chest pain, difficulty breathing, cough fever and chills, headache, pain and fatigue. It may cause a lot of serious complications. Respiratory failure occurs when breathing becomes so difficult that a machine called ventilator is needed to help breathe. These are machines that save lives and medical device companies currently build ramps for production. Whether or not these symptoms will develop depends on many factors, such as age and whether there is a pre-existing condition. While it all sounds scary, the push to develop a coronavirus vaccine is at a rapid pace. Studies from other coronaviruses have led most researchers to assume that people who have recovered from SARS-CoV-2 infection can be protected from relapse for some time. But that assumption must be supported by empirical evidence and some studies suggest otherwise. There are several different approaches to a potential vaccine against coronavirus.

II. PROBLEM FORMULATION

Coronaviruses are a group of RNA viruses that cause disease in mammals and birds. Its quick spread globally. Now it is affecting every continent. The COVID-19 symptoms usually take 3-7 days after exposure sometimes it takes up to 14 days to appear. Manually classifying the COVID-19 from CT is very tedious and extremely hard. So a mechanized over strategy is worn to decrease the load on the operator and produces satisfactory outcomes for classified the COVID-19.

III. OBJECTIVE

The purpose of this effort is to provide an automatic technique which locates the infection on CT image. Manual detection includes many deep learning algorithms. In the process, the human invention is regularly expected to initialize the technique to check the Precision of outcome while in fully automatic decision method.

IV. LITERATURE SURVEY

In recent years, predictive classification is one of the most essential and important tasks in deep learning. Its application to the medical diagnosis has received a strong boost due to earnest research activities in the medical big data. Many researchers have highlighted the potential of predictive classification to provide decision support for doctors and medical professionals. Over the last few months, a great deal of research has been conducted on different data set to predictive COVID-19. Following is some of the research which has been reviewed for the proposed system:-

A. Linda Wang et al. introduced COVID-Net, a deep convolutional neural network design for the detection of COVID-19 cases from a total of 13,800 chest X-ray (CXR) images across 13,725 patients. A human-machine collaborative design strategy is leveraged to create COVID-Net, where human-driven principled network design prototyping is combined with machine-driven design exploration to produce a network architecture tailored for the detection of COVID-19 cases from CXR images. [2]

B. In this paper, screening the COVID-19 is done in three stages. In the first stage AI model is trained to predict from a given CXR image the regions of interest, i.e., the mask of lung regions. In the second stage, features from the predicted regions are extracted to decide whether the image is a positive case of pneumonia. In the final and the third stage, the platform would further decide on whether the underlying cause is COVID-19 or another type of pneumonia. [3]

C. Initial Results for Automated Detection of COVID-19 & Patient Monitoring Ophir Gozes [5] have discussed a system which is comprised of several components and analyzes the CT case at two distinct levels: first is a 3D analysis of the case volume for nodules and focal opacities using existing, previously developed algorithms and second is newly developed 2D analysis of each slice of the case to detect and localize larger-sized diffuse opacities including ground glass infiltrates which have been clinically described as representative of the coronavirus.

D. For Detection of coronavirus Disease (COVID-19), Prabira Kumar Sethy et al have used Deep feature extraction which is based on pre-trained CNN and each CNN networks are used by SVM classifier. The classification is performed, and the performance of all classification models are measured high accuracy. [7]

E. Shuai Wang et al. have used M-inception architecture. The architecture consists of three main processes: Pre-processing of input images; Feature extraction of ROI images and training and Classification with fully connected network and prediction of multiple classifiers. They built a transfer learning neural network based on the Inception network. The entire neural network can be roughly divided into two parts: the first part used a pre-trained inception network to convert image data into one-dimensional feature vectors, and the second part used a fully connected network and the main role is for classification prediction. These predictions give high accuracy. [8]

F. Fei Shan et al. detected Lung Infection Quantification of COVID-19 in CT Images with Deep Learning. Segmentation is done by DL-based “VB-Net” neural network to segment COVID-19 infection regions in CT scans. The system is trained using 249 COVID-19 patients and validated using 300 new COVID-19 patients. To accelerate the manual delineation of CT images for training, a human-in-the-loop strategy is adopted. [9]

G. In this research paper, COVID-19, the infected area is segmented. Two CNN three-dimensional classification models were evaluated in this study. One was the relative traditional ResNet based network and another model was built based on the first network structure changing the location-focus mechanism in the full-connection layer to improve the overall accuracy rate. [10]

TABLE I
Comparison Various Deep Learning Algorithm

Authors	Methodology	Dataset	Sensitivity	Accuracy	AUC
Linda Wang *et al*. [2]	COVID-Net	COVID-19 image data collection [1]	COVID - 87.1% Normal – 97.0%	92.6%	-
Chun-Fu Yeh *et al*. [3]	U-Net, DenseNet-121	RSNA [4], COVID-19 image data collection [1]	COVID – 96.8% Normal - 98.0%	89.36%	0.973
Ophir Gozes *et al*. [5]	Resnet-50	Coronavirus COVID-19 Global Cases by Johns Hopkins CSSE [6]	94.0%	-	0.994
Prabira Kumar Sethy *et al.* [7]	ResNet50	GitHub (Dr Joseph Cohen), Kaggle (X-ray images of Pneumonia)	97.4%	95.3%	-
Shuai Wang *et al*. [8]	M-Inception	Xi'an Jiaotong University First Affiliated Hospital	87.0%	89.5%	0.93
Fei Shan *et al*. [9]	VB-Net with Human-In-The-Loop Strategy	Shanghai Public Health Clinical Center	-	91.6%	-
Xiaowei Xu *et al*. [10]	V-NET	Hospital of Zhejiang University, Hospital of Wenzhou	-	86.7 %	-

V. AVAILABLE DATASETS

The commonly used data set in COVID-19 detection research are as follow-

1) *Github:* The dataset of chest X-ray and CT images of patients which are positive or suspected of COVID-19 or other viral and bacterial pneumonia. Data will be collected from public sources as well as through indirect collection from hospitals and physicians. All images and data will be released publicly in this Github repository.
2) *RSNA:* RSNA Pneumonia Detection Challenge dataset, which used publicly available CXR data from. In a series of RSNA dataset, no of total images are 18,406 patients with CXR assay performed, the sensitivity of CT for COVID-19 infection was 98%. The choice of these three datasets from which to create COVIDx is guided by the fact that both are open source and fully accessible to the research community and the general public, and as datasets grow we will continue to grow COVIDx accordingly.
3) *Kaggle:* The dataset is separated into 3 folders (train, test, val) and contains subfolders for the category of each image named "Pneumonia" and "Normal". There is a total of 5,863 X-Ray images and 2 categories. All chest X-ray imaging was performed as part of routine clinical care of patients. The diagnosis of images was classified by two specialist physicians before being cleared for AI system training. To account for any grading errors, the evaluation set was also examined by a third expert[11].

TABLE III. Commonly Used Dataset

S. No	Dataset	Number of Images
1	COVID-19 image data collection [1]	167
2	RSNA [4]	18,406
3	Kaggle (X-ray images of Pneumonia) [11]	5,863

VI. DEEP LEARNING IMAGE CLASSIFIERS

This paper presents a brief review of methods discussed in earlier researches for image segmentation along with the latest approaches [12].

1) *VGG-16*: Visual Geometry Group Network (VGG) is a convolutional neural network architecture, it's named VGG-16 comes from the fact that it has 16 layers. Its layers consist of Convolutional layers, Max Pooling layers, Activation layers, Fully connected layers. It has 13 narrow layers, 5 maximum pooling layers and 3 dense layers, up to 21 layers, but only 16 weight layers. Conversion 1 has 64 filters while Conversion 2 has 128 filters, Conversion 3 has 256 filters while Conversion 4 and Conversion 5 have 512 filters, which gives higher accuracy.
2) *DenseNet121:* The Dense Convolutional Network (DenseNet) have several compelling benefits: they lighten the vanishing-gradient problem, reinforce feature propagation, encourage feature reuse, and the number of parameters reduced substantially. DenseNet121 is a model generated with 121 layers, the model was loaded from the ImageNet database with pre-trained loads.
3) *ResNet-50:* It is a fifty layers deep convolutional neural network, which might be trained on over 1,000,000 pictures from the ImageNet database. One it is trained then this network can classify images into one thousand objects and easily distinguish objects.
4) *Inception Network:* It is the 22-layered network and it has 93.3% accuracy. Next versions are referred to as inception VN where N is the version number. The inception V3 network has several symmetrical and asymmetrical building blocks, where each block has several branches of convolutions and has average pooling, max pooling, concatenated, dropouts, and fully-connected layers.

VII. FUTURE SCOPE

The proposed system can be developed in many different directions which have vast scope for improvement in the system. This includes:

A. Increase the accuracy of the algorithm.
B. Improvising the algorithm to add more efficiency of the system to enhance its working.
C. Some more attributes so to tackle COVID-19 even more.
D. To make it as a complete Health Care diagnosis system to be used in research.

VIII. CONCLUSIONS

By our in-depth analysis of a literature survey, we acknowledge that the action done earlier did not use a large data set. A large data set ensures better prediction. The prediction will be done with the help of that deep learning algorithm which gives better accuracy based on their performance factor.

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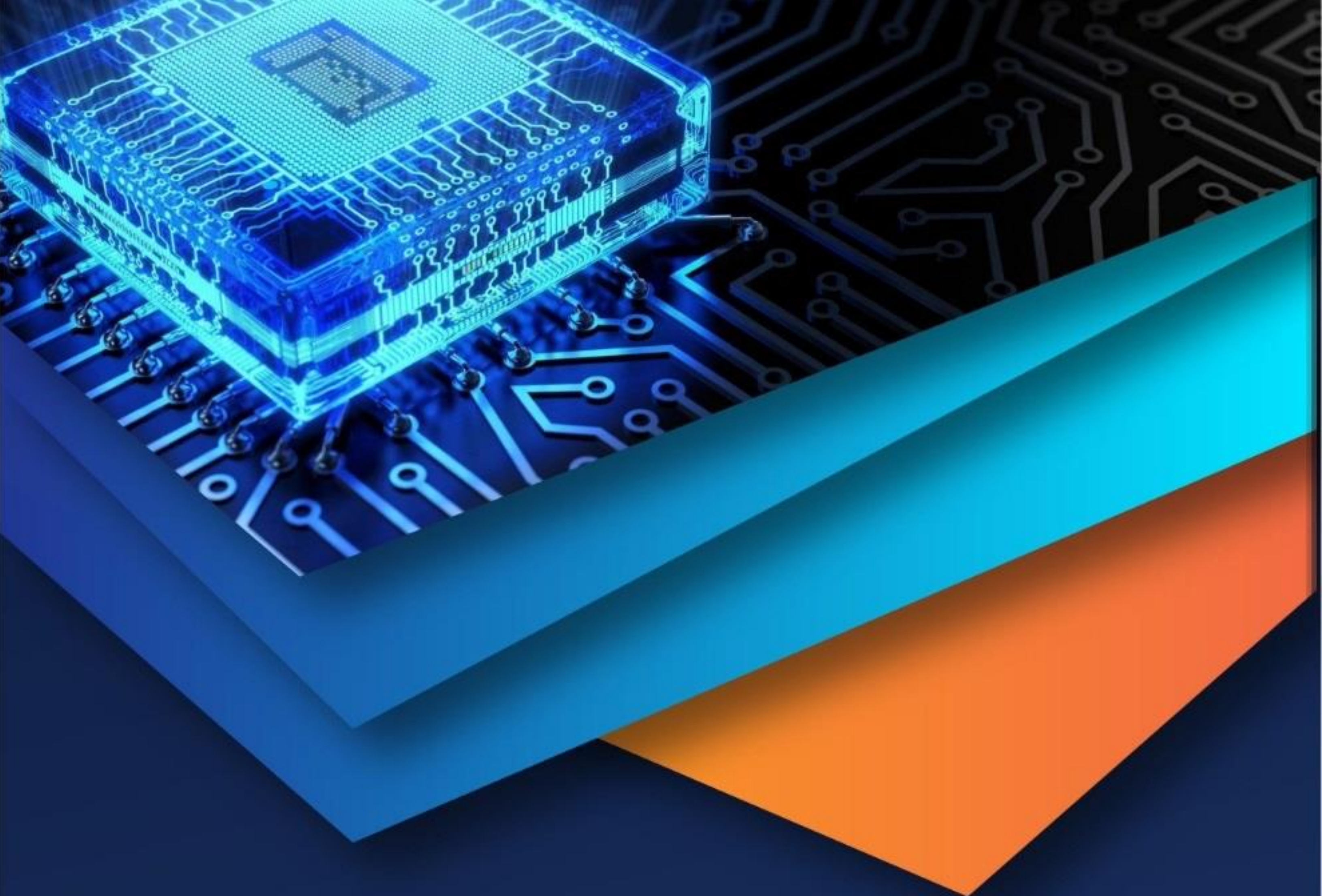

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