Automated Deep Learning for Covid Prediction Using Computerized Tomography Scans

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Abstract – In order to prevent losses from COVID-19, which is a serious global issue, AI can monitor and identify infected individuals at an early stage. The goal of our study is to suggest a quick, precise, totally automated approach for identifying COVID-19 from a patient's CT scan data. We introduce a new dataset that includes 1000 images from COVID-19 patients and 1000 images from people with normal CT scans. Our system executes our suggested image processing technique in the initial stage to eliminate any CT images that do not accurately show the inside of the lung. By taking this action, processing time and false detections are reduced. In the following stage, we present a cutting-edge technique for improving convolutional networks' classification accuracy. In order to predict COVID-19, we used Vgg-16, and in order to segment data, we used U-Net architecture. The system uses a chosen threshold to assess the patient's state after executing these two steps. The first to assess our system in two separate ways is us. Our model achieved 97% accuracy for the segmentation stage and 87% accuracy for the single picture classification stage for COVID.

Keywords – Deep learning, Convolutional Neural network, COVID-19, CT-Scan, Medical image analysis, lung CT scan dataset, Automatic medical diagnosis.

I.INTRODUCTION

A new viral disease outbreak was reported by the World Health Organization (WHO) as a global public health risk. The new coronavirus-related illness was given the name COVID-19 by the WHO. In Wuhan, China, the first COVID-19 cases were noted. The fact that these folks worked at the neighborhood wild animal market suggests that the virus may be passed from animals to people. The new coronavirus's catastrophic outbreak quickly swept throughout China before reaching other nations. The virus disrupted numerous political, economic, and sporting events and had an impact on many people's lives around the world. The new coronavirus's ability to spread quickly and widely is its most crucial quality. The majority of the time, the virus spreads from an infected person to an uninfected person directly; however, the virus can also spread inadvertently through surfaces and air in the environment that the infected person comes into contact with. Hence, recognizing the disease's symptoms and isolating those who exhibit them is crucial to avoid the spread of the illness. Viral pneumonia in the lungs brought on by the new coronavirus produces severe acute respiratory syndrome. Each person has a unique set of symptoms related to this illness. Some people may also experience other symptoms like headaches, sore throats, and loss of taste and smell, but severe symptoms like shortness of breath, chest pain, and the inability to move or speak suggest that COVID-19 is progressing.

The majority of patients with COVID-19 symptoms at least four days later have lung X-rays and CT scans, which reveal infections and establish the existence of a novel coronavirus in their bodies. Medical imaging can be utilized for an early diagnosis of COVID-19 due to the shortcomings of other techniques, even though it is not advised for a final diagnosis. On CT scans of some patients with early-onset COVID-19 symptoms, additional coronavirus infections were discovered. One of the finest methods for identifying tumors and infections brought on by different diseases is through the use of machine vision and deep learning. This technique has been applied to a variety of medical imaging, including segmenting skin and brain lesions. The majority of patients with COVID-19 symptoms at least four days later have lung X-rays and CT scans, which reveal infections and establish the existence of a novel coronavirus in their bodies. Medical imaging can be utilized for an early diagnosis of COVID-19 due to the shortcomings of other techniques, even though it is not advised for a final diagnosis. On CT scans of some patients with earlyonset COVID-19 symptoms, additional coronavirus infections were discovered. One of the finest methods for identifying tumors and infections brought on by different diseases is through the use of machine vision and deep learning. This technique has been applied to a variety of medical imaging, including segmenting skin and brain lesions.

II. MOTIVATION

The immediate need for an accurate and effective Covid-19 diagnosis is often what motivates the use of automated deep learning for Covid prediction using computerized tomography (CT) scans. In circumstances where conventional diagnostic techniques like RT-PCR testing may not be accessible or may yield inconclusive findings, CT scans have been found to be an effective tool for identifying Covid-19 infections. Nevertheless, manual CT scan interpretation takes a lot of time and demands a high level of competence. Automatic Deep Learning systems can speed up diagnosis, increase accuracy, and lighten the load on the medical staff. In order to forecast the presence of the disease in new patients, these algorithms can be trained to recognize certain patterns in CT scans that are suggestive of Covid-19 infection. The Covid-19 pandemic has also brought attention to the need for quick, scalable diagnostic methods that can be used all over the world. Automatic Deep Learning algorithms are a viable option since they are simple to install on cloud-based platforms and have the capacity to process massive amounts of data rapidly and reliably. This method may have implications in various sectors of healthcare where the quick and precise diagnosis is essential. It has the potential to greatly enhance Covid-19 diagnosis and treatment outcomes.

III. PRIOR WORK

Mohammad Rahimzadeh (2020) et.al. A fully automated method for detecting COVID-19 cases. The images used here are from the lung HRCT scan device. The dataset used here is COVID-CT. Three different neural networks were trained, tested, and compared – Xception, ResNet50V2, and the proposed model. FPN (Feature Pyramid Network) is used to help the network learn better and detect objects at different scales that exist in an image. It also helps to extract various semantic features of the input image. The images were converted to 32-bit float type in the TIFF format for visualization. Data was divided into 5 folds, and training followed by testing was done. All three models were trained until 50 epochs. The proposed model achieved 98.49% accuracy and 94.96% sensitivity, better than the Xception model. Grad-CAM algorithm was used to highlight the CT scan images' infection areas and the validation of classification.

Tahereh Javaheri (2021) et.al. This model helps accurately differentiate Covid-19 from other lung diseases. It is composed of a pipeline of deep learning algorithms trained on identifying Covid-19 lesions in lung CT images to improve the detection of the disease. BCDU-Net is a CNN used for image analysis. This model implemented BCDU-Net to clean images and to train a noise cancellation model, used to extract infection. After infection extraction, output images were fed into CNN to classify them as control, CAP, or Covid-19. The algorithm used here is BCDU-Net and Perlin noise exposure. The AUC of the model is 90%, sensitivity is 93% and specificity is 100%. A total of 16,750 images were analyzed.

Zeguo Xu (2020) et.al. COVNet (Covid-19 detection neural network) is the deep learning model developed here to extract visual features from volumetric chest CT scans. For testing the robustness of the model, CAP and other non-pneumonia CT scans were included. Data were collected from 6 hospitals and thus used real time data. The model consists of RestNet50 as the backbone, which takes a series of CT Slices as inputs and generates features for the corresponding slices. U-Net based image segmentation method is used to pre-process the image and extract the lung region as the region of interest. This model had 90% sensitivity, 96% specificity, 0.96 AUC for the detection of covid-19.

Zhong Qui Lin (2020) et.al. COVID-Net is the deep convolutional neural network trained to detect Covid-19 from chest X-Ray images. COVIDx is the dataset used here, comprises of 13,975 CXR images. The dataset was formed from 5 different publicly available data repositories. The three types of identification here are no infection, non-COVID infection, and COVID infection. The model was designed on 2 primary conditions: COVID-19 sensitivity >= 80% and COVID-19 positive predictive value >= 80%. This model was pre-trained on the ImageNet dataset and then trained on COVIDx using the Adam optimizer. The number of epochs was 22 and the batch size was 64. The accuracy of the model is 93.3% and the sensitivity is 91% and the positive predictive value is 98.9%.

Xueyan Mei (2020) et.al. A deep convolutional neural network (CNN) to learn the imaging characteristics of patients with COVID-19 on the initial CT scan was developed. Support Vector Machine (SVM), random forest, and multilayer perceptron (MLP) to classify patients as normal or COVID-19 infected. MLP showed the best performance on the training set. The algorithm consisted of two CNN subsystems to first identify the abnormal CT slices and then to perform regionspecific disease diagnosis. More specifically, the slice selection CNN was trained to evaluate a chest CT slice and assign a probability that it was normal.

IV. PROPOSED APPROACH

We can separate the dataset into 2 classes: Normal and covid. We train our DL model based on this dataset and we try to get better training and testing accuracy.

COVID-CTset: Covid-CTset is the dataset that we use. It contains CT scans of multiple patients from Negin Radiology located at Sari in Iran. CT scan selection algorithm selects the right CT scan for the purpose of learning. Many previous methods selected an image of each patient's lung HRCT images and then used them for training and validation. Here we decided to make the patient lung analysis fully automated. Consider we have a convolutional neural network that is trained for classifying COVID-19 cases based on selected data that inside the lung was obviously visible in them.

Vgg-16 for COVID prediction: An image classification taskspecific convolutional neural network architecture is called VGG-16. While COVID-19 detection is not a straightforward picture classification task, it is possible to employ VGG-16 for COVID-19 prediction. In order to diagnose COVID-19, doctors often analyze medical imaging such as chest X-rays and CT scans. They also examine clinical symptoms and the results of laboratory tests. The use of deep learning models, such as VGG-16, for COVID-19 identification based on medical pictures has been investigated by researchers, though. It's vital to remember that the effectiveness of these models depends on a number of variables, including the dataset's size and quality, the characteristics that can be retrieved from the photos, and the training process. In order to guarantee the model's generalizability and clinical utility, it is also critical to validate it on a broad and independent dataset. In order to use deep learning models for COVID-19 diagnosis in clinical practice, more study and validation are required.

U-Net architecture for segmentation: For the purpose of biomedical picture segmentation, U-Net is a convolutional neural network architecture developed in 2015 by University of Freiburg computer science faculty members. Since then, it has been frequently utilized in computer vision for a variety of segmentation problems. The contracting path and the expansive path make up the U-Net architecture. The contracting path uses a standard convolutional network plus a sequence of convolutional and max-pooling layers to increase the number of feature mappings while decreasing the input's spatial resolution. On the other hand, the expansive path employs a number of convolutional and up-sampling layers to lessen the number of feature maps while improving the spatial resolution of the feature maps. The insertion of skip connections between equivalent levels in the contracting and expansive paths is what makes UNet special. The network is able to keep high resolution information from the contracting path and use them to enhance the segmentation outcomes in the expanded path thanks to these skip connections. U-Net has gained popularity for biomedical image segmentation because it consistently performs at the cutting edge on a variety of datasets. It has also been applied to applications requiring segmentation in several fields, including cell segmentation, road segmentation, and satellite picture segmentation.

We use Covid-CTset as the dataset that we use. It contains CT scans of multiple patients from Negin Radiology located at Sari in Iran. We use the CT scan selection algorithm to select the right CT scan. Many previous methods selected an image of each patient's lung HRCT images and then used them for training and validation. Here we decided to make the patient lung analysis fully automated. Consider we have a neural network that is trained for classifying COVID-19 cases based on selected data that inside the lung was obviously visible in them. If we test that network on each image of an image sequence that belongs to a patient, the network may fail. Because at the beginning and the end of each CT scan image sequence, the lung is closed as it is depicted in the figure. Hence, the network has not seen these cases while training; it may result in wrong detections, and so does not work well.

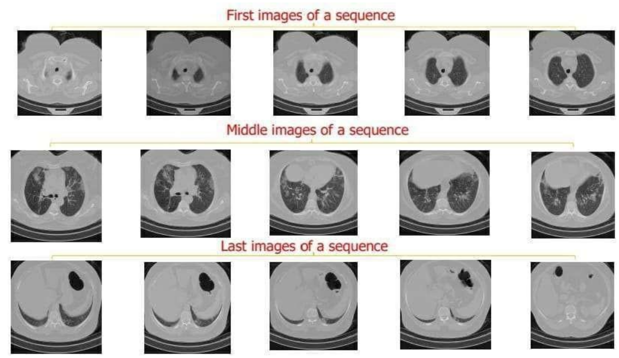

Figure 1: This figure presents some of the first, middle, and final images of a patient's CT scan sequence. It is obvious from the images in the first and the last images, inside the lung is not observable.

To solve this, we can separate the dataset into three classes: infection-visible, no-infection, and lung-closed. Although this removes the problem dividing the dataset into three classes has other costs like spending some time for making new labels, and changing the network evaluating way. Also, it increases the processing time because the network shall see all the images of patient CT scans. But we propose some other techniques to discard the images that inside the lungs are not visible in them. Doing this also reduces performing time for good because, in the last method, the networks should have seen all the images, and now it only sees some selected images. We finally use an advanced deep convolutional neural network for classification

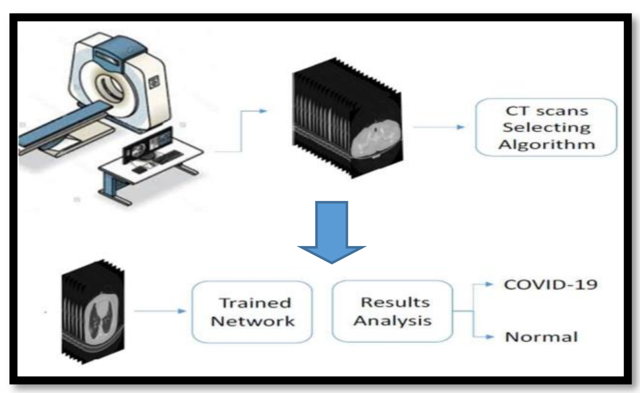

Figure 2: General view of our proposed method for automated patient classification.

V. Experimental Results

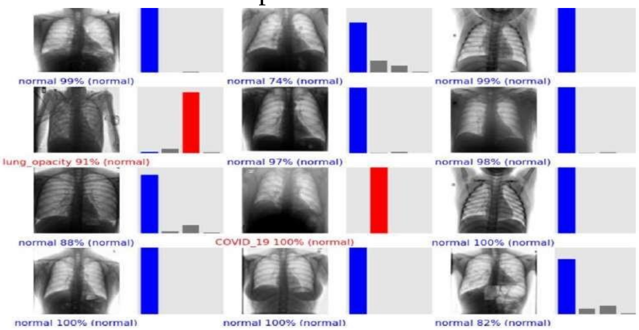

Figure 3: Output for covid prediction using Vgg-16

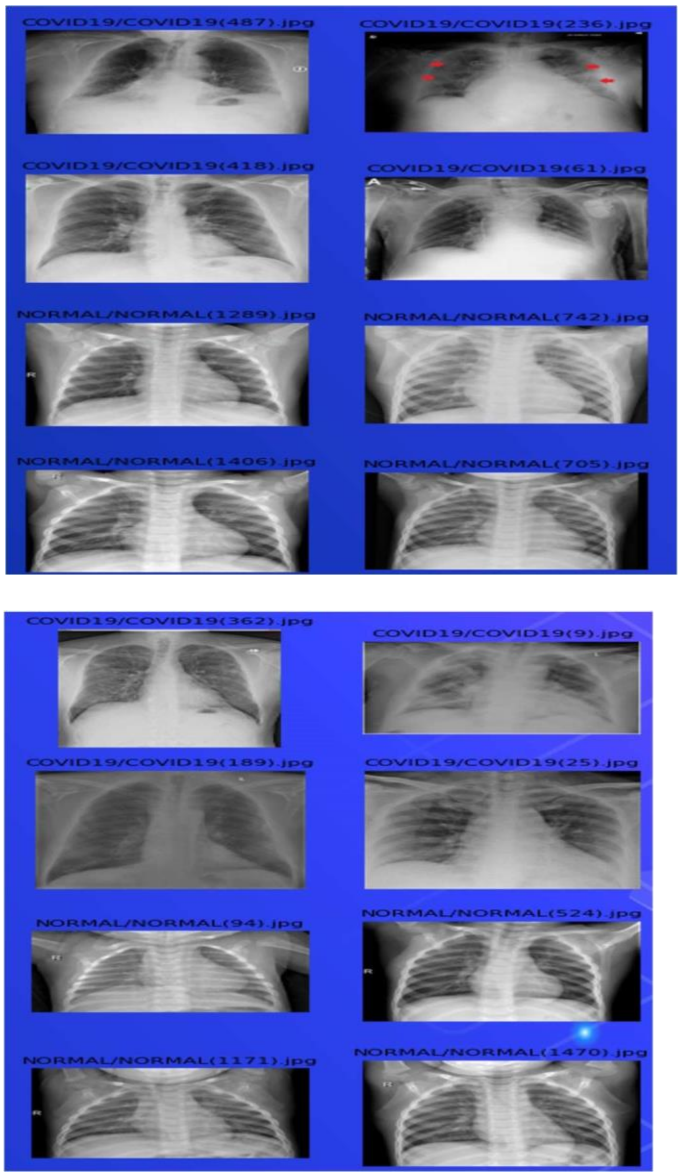

Figure 4: Normal lungs with covid infected lung

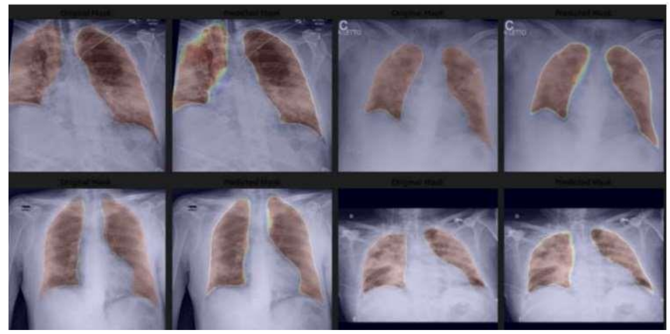

Figure 5: Output for which part of the lung got affected using U-NET architecture

VI.CONCLUSION

We have proposed a fully automated system for COVID-19 detection from lung HRCT scans. We also introduced a dataset containing 1000 images of normal persons and 1000 images belonging to patients with COVID-19. First, we proposed an approach for filtering the correct images from the patient's CT scans, which accurately depict the inside of the lung. The accuracy and speed of the network are improved by this technique. After that, we developed a deep convolutional neural network to enhance classification. To increase accuracy, this network can be applied to a variety of classification difficulties. We trained a deep convolution network for classifying the CT scan images into COVID-19 or normal using VGG-16. We used U-Net architecture for the segmentation of the images. We have obtained an accuracy of around 87% for covid prediction using VGG-16 and an accuracy of around 97% for segmentation using U-NET architecture.

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