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Patch Based Convolutional NeuralNetwork Approach for Covid-19

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ABSTRACT: In the rapidly evolving global pandemic of COVID-19, the use of CXR for COVID-19 diagnosis or triage for patient management has become an important issue to preserve limited medical resources and prevent further spreading of the virus. However,the current diagnostic performance with CXR is not sufficient for routine clinical use, so the need of artificial intelligence to improve diagnostic performance of CXR is increasing. Our analysis found that there are statistically significant differences in the patch-wise intensity distribution, which is well-correlated with the radiological findings of the localized intensity variations in COVID-19 CXR. This findings lead us to propose a novel patch-based neural network architecture with random patch cropping, from which the final classification result are obtained by majority voting from inference results at multiple patch locations. .The main objective is to detect whether the given Patient X-Ray image is Covid-19 or non covid-19.

KEYWORDS: COVID-19, chest X-ray, Deep learning, Segmentation, Convolutional Neural network.

I. INTRODUCTION

Deep learning is an artificial intelligence (AI) function that imitates the workings of the human brain in processing data and creating patterns for use in decision making. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as deep neural learning or deep neural network.

Lung cancer is the deadliest of all cancers in the United States and the world. It kills more Americans than the next four most common cancers combined. Lung cancer is largely preventable; inroads in reducing cigarette smoking are having a positive influence, though otherenvironmental exposures also put people at risk. Advances in understanding this disease are leading to new means of diagnosis and treatment. Lung cancer symptoms typically include persistent cough, difficulty breathing, coughing up blood, and chest discomfort, though many patients are asymptomatic. Patients with advanced disease often have weight loss, fatigue, or pain outside the chest. This patient's evaluation included diagnostic studies generally performed in a lung cancer evaluation, the purpose of which is to determine the cancer stage. Staging predicts prognosis and influences treatment.

II. LITERATURE SURVEY

For instance in the year 2020, Sohaib Asif1, Yi Wenhui proposed to automatically detect COVID-19 pneumonia patients using digital chest x-ray images while maximizing the accuracy in detection using deep convolutional neural networks (DCNN). The dataset consists of 864 COVID-19, 1345 viral pneumonia and 1341 normal chest x-ray images. In this study, DCNN based model Inception V3 with transfer learning have been proposed for the detection of coronavirus pneumonia infected patients using chest X-ray radiographs and achieved more than 96% accuracy. The results demonstrate that transfer learning proved to be effective, showed robust performance and easily deployable approach for COVID-19 detection.

In another study in the year 2020, Daisy Young, Liana Tatarian Ghulam Mujtaba proposed to perform a meta-analysis using retrospective studies comparing Chest CT and RT-PCR in COVID-19 detection among hospitalized patients. We performed a comprehensive literature search using Pubmed and Google Scholar for studies comparing Chest CT and RT-PCR between January 1 and April 3, 2020. Outcomes included COVID-19 detection using RT-PCR alone, Chest

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CT alone, true positives when combining the two, and true negatives when combining the two. Results were reported as an odds ratio (OR) with 95% CI. A total of 6 retrospective studies were included comparing RT-PCR with Chest CT. A total of 1,400 patients were enrolled (average age 46.28 ± 2.7 years, 41.6% were males). Chest CT was superior to RT-PCR for COVID-19 detection [OR 3.86, 95% CI (1.79- 8.31, p=0.0006)]. Heterogeneity (I2) was high (75%), but sensitivity analysis failed to reveal any single contributor to observed heterogeneity. Chest CT appears to be a more sensitive and quicker alternative to RT- PCR in the detection of COVID-19 in hospitalized patients, and may serve as a superior screening tool.

In year 2020, Sana Salehi and Aidin Abedi proposed a systematic literature search of PubMed, Embase (Elsevier), Google Scholar, and the World Health Organization database. Known features of COVID-19 on initial CT include bilateral multilobar ground-glas opacification (GGO) with a peripheral or posterior distribution, mainly in the lower lobes and less frequently within the right middle lobe. A typical initial imaging presentation of consolidative opacities superimposed on GGO may be found in a smaller number of cases, mainly in the elderly population. Septal thickening, bronchiectasis, pleural thickening, and subpleural involvement are some of the less common findings, mainly in the later stages of the disease. Pleural effusion, pericardial effusion, lymphadenopathy, cavitation, CT halo sign, and pneumothorax are uncommon but may be seen with disease progression. Follow-up CT in the intermediate stage of disease shows an increase in the number and size of GGOs and progressive transformation of GGO into multifocal consolidative opacities, septal thickening,and development of a crazy paving pattern, with the greatest severity of CT findings visible around day 10 after the symptom onset. Acute respiratory distress syndrome is the most common indication for transferring patients with COVID-19 to the ICU and the major cause of death in this patient population. Imaging patterns corresponding to clinical improvement usually occur after week 2 of the disease and include gradual resolution of consolidative opacities and decrease in the number of lesions and involved lobes.

Parnian Afshara, Shahin Heidarianb and Farnoosh Naderkhania in the year 2020 proposed an alternative modeling framework based on Capsule Networks, referred to as the COVID-CAPS, being capable of handling small datasets, which is of significant importance due to sudden and rapid emergence of COVID-19. Our results based on a dataset of X-ray images show that COVID-CAPS has advantage over previous CNN-based models. COVID-CAPS achieved an Accuracy of 95:7%, Sensitivity of 90%, Specificity of 95:8%, and Area Under the Curve (AUC) of 0:97, while having far less number of trainable parameters in comparison to its counterparts. To potentially and further improve diagnosis capabilities of the COVID-CAPS, pre-training and transfer learning are utilized based on a new dataset constructed from an external dataset of X-ray images. This is in contrary to existing works where pre-training is performed based on natural images. Pre– training with a dataset of similar nature further improved accuracy to 98:3% and specificity to 98:6%.

III. PROPOSED METHODOLOGY AND DISCUSSION

Several imaging biomarkers that are often used in CXR analysis, such as lung area intensity distribution, the cardio-thoracic ratio, etc. Our analysis found that there are statistically significant differences in the patch-wise intensity distribution, which is well-correlated with the radiological findings of the localized intensity variations in COVID-19 CXR. This findings lead us to propose a novel patch-based neural network architecture with random patch cropping, from which the final classification result are obtained by majority voting from inference results at multiple patch locations.

The Proposed system focus on tumor segmentation of medical image sequences using back propagation neural network. The proposed work utilizes pattern based classification using neural network function. Active Contour segmentation is designed in the proposed area. Here the threshold required for segmenting adjusts itself according to the segmented area and position.

The overall algorithmic framework is the CXR images are first pre-processed for data normalization, after which the pre-processed data are fed into a segmentation network, from which lung areas can be extracted

From the segmented lung area, classification network is used to classify the corresponding diseases using a patch-by-patch training and inference, after which the final decision is made based on the majority voting. Additionally, a probabilistic Grad-CAM saliency map is calculated to provide an interpretable result. In the following, each network is described in detail.

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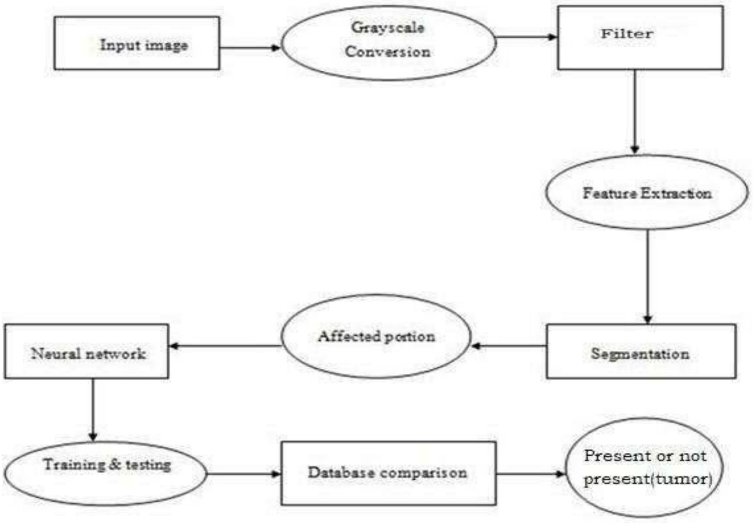

Figure 1: Architecture Diagram

MODULES

1) Preprocessing:

If the input images are color images means we are convert to gray scale from that color images. In the complement of a binary image, zeros become ones and ones become zeros; black and white are reversed. In the output image, dark areas become lighter and light areas become darker. Images may have different types of noise. In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display. Examples include contrast and edge enhancement, pseudo-coloring, noise filtering, sharpening,and magnifying. Image enhancement is useful in feature extraction, image analysis and an image display. The median filter is used in order to remove the noise from the image. Median filtering is a nonlinear operation often used in image processing to reduce salt and pepper noise. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges

2) Segmentation:

The image features like color, weight, and depth and pixel information to apply before the classifier. Here we used the active contour segmentation algorithm is used in order to segment the portion of defected areas. Image segmentation is typically used to locate objects and boundaries in images. More precisely image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.

3) Classification:

This module is used to establish the neural network concept for training the image and testing the image with the help of weight estimating classifier. The most common type of neural network consists of three groups, or layers, of units: a layer of "**input**" units is connected to a layer of "**hidden**" units, which is connected to a layer of "**output**" units. The activity of the input units represents the raw information that is fed into the network. The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units. The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units. This simple type of network is interesting because the hidden units are free to construct theirown representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents. The result image will compared with the dataset images and it will display whether it is normal or abnormal

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ALGORITHMS

Active Contour Segmentation:
The Active Contour Segmentation methodology is based upon the use of deformable contours which match to various object shapes and motions. This section provides a theoretical setting of active contours and an indication of existing active contour methods. There are two main approaches in active contours based on the mathematic implementation: snakes and level sets. Snakes explicitly shift predefined snake points based on an energy minimization method, while level set approaches move contours completely as a particular level of a function.

Neural Network:
A Neural Network (NN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. NNs, like people, learn by example. An NN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons.

IV. EXPERIMENTAL RESULTS

The Fig. 2 shows the image being preprocessed to covert to grayscale and filter any noise in the image to give the filtered image and in Fig. 3, the portion of image to be compared with the data sets is identified.

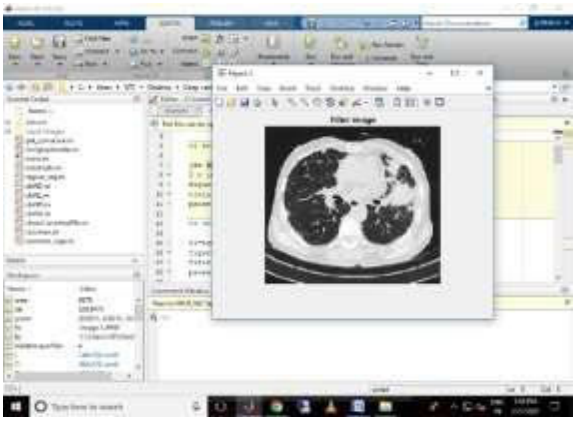

Figure 2: Filter the image

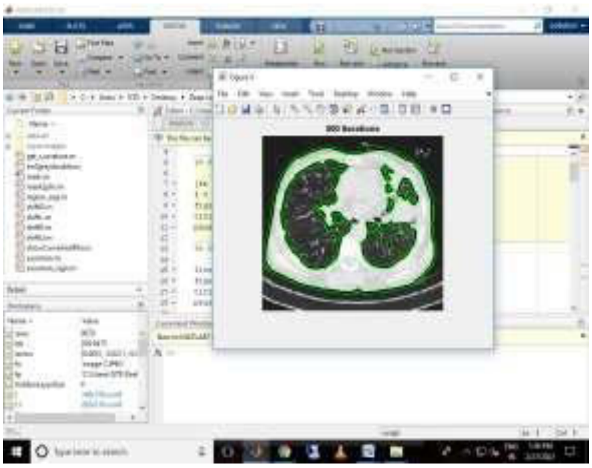

Figure 3: Identify the image features

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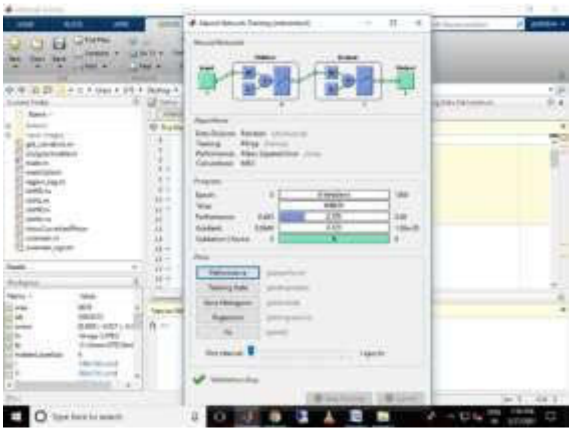

Figure 4: Test with datasets

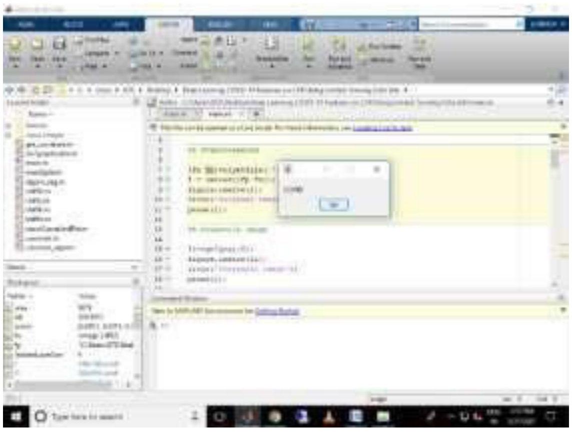

Figure 5: Display the result

In Fig. 4, the collected image features are tested with the datasets using the neural network for many iterations to get high accuracy and the Fig. 5 shows the display of result for the testing whether it is COVID – 19 or not.

V. CONCLUSION

We can detect whether the patient has COVID 19 or not with the use of CXR diagnosis and the patch wise segmentations. This system can be implemented to assist the user to know their condition using CXR, which is more efficient. This will especially be of use during shortage of medical supplies or when the hospitals are overcrowded. The user can login, select their X-ray and view their condition.

VI. FUTURE ENHANCEMENTS

In the future work, we can improve our approach based on new benchmarks such that the accuracy and efficiency of CXR diagnosis increases. More use of various algorithms to enhance the performance of the detection and improvement in accuracy can be added with this system. The user interface can be improved with addition of new features as the current condition, improvements in health of the patient, etc.

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