Vol. 1, No. 1; Jan – Mar (2022)

Quing: International Journal of Innovative Research in Science and Engineering

Available at https://quingpublications.com/journals/ijirse

Classification of Coronavirus Disease (COVID-19) using Convolutional Neural Networks (CNN) Architecture

Dr. S. Bhuvaneswari[★]

Assistant Professor, Dept., of Computer Applications, Annai College of Arts and Science, Kumbakkonam, TN, IND.

G. Asha

Associate Professor, Dept., of Computer Applications, Don Bosco College (Arts & Science), Thamanangudy, PY, IND.

ARTICLE INFO

Received: 04-02-2022
Received in revised form: 17-03-2022
Accepted: 25-03-2022
Available online: 30-03-2022

Keywords:

3D Volumetric Image Processing;
Corona Virus Disease - 2019 (COVID-19);
Convolutional Neural Networks (CNN);
Deep Learning Techniques.

ABSTRACT

An infectious illness caused by a recently identified virus is known as Coronavirus Disease (COVID-19). COVID-19 infection is usually associated with mild to moderate respiratory disease, and no specific treatment is usually required. A higher risk of severe sickness exists among the elderly and in individuals who have primary medical issues such as chronic respiratory disease, diabetes, cancer, and cardiovascular diseases. If the information needed for a diagnosis or prognosis can only be retrieved via 3D volumetric imaging under these conditions, this becomes a significant asset for coronavirus affected patients. In this research, we present a novel technique for detecting the 3D volumetric respiratory image and categorising COVID-19 infection. We have utilised 3D image processing and the methods of deep learning for the procedure of classification and detection.

DOI: https://doi.org/10.54368/qijirse.1.1.0007

1.0 INTRODUCTION

An infectious illness caused by a recently identified virus is known as "Coronavirus Disease-2019 (COVID-19)". This infection is usually associated with mild to moderate respiratory disease, and no specific treatment is usually required (Xu *et al.,* 2020). A higher risk of severe sickness exists among the elderly and in individuals who have primary medical issues such as chronic respiratory disease, diabetes, cancer, and cardiovascular diseases.

In order to prevent and minimise transmission, it is essential to be thoroughly aware about the Virus COVID-19, its cause and its development. Wash your hands regularly or frequently use

★ *Corresponding author's e-mail:* drbhuvanamagesh@gmail.com (Dr. S. Bhuvaneswari)

alcoholic based sanitizer, and don't touch your face, mouth and eyes, protecting yourself and others from infection (Chen *et al.,* 2020). Corona Virus Disease is more likely to be spread through saliva or nasal discharge when a person who is sick is snorting or sneezing, thus exercising proper hygiene is very important (for example, when you cough cover your mouth with your elbow).

A new respiration virus, termed the new Coronavirus in 2019, or COVID-19, headlines worldwide for an epidemic of breathing diseases (Wang *et al.,* 2020). The epidemic began in Hubei Province of Wuhan, China and quickly spread to the United States and beyond. Thousands of sick and public health authorities are carefully monitoring the illness' progress (Xie *et al.,* 2020). A broad family of viruses called coronaviruses are present in both humans and animals, and they are the primary cause of many respiratory illnesses throughout the world. Many known coronaviruses infect individuals, generally causing very minor respiratory diseases such as the common cold (Ai *et al.,* 2020).

The illness can be verified with the RT-PCR test for polymerase reverse transcription chain reactions. When you want to identify those who have "COVID-19 using the RT-PCR to confirm the positive cases of COVID-19 (Fang *et al.,* 2020). RT-PCR is used to find out the positive cases quickly and also helps to find out the high rates of false results as well as poor sensitivities can get in the way of early detection and treatment (Huang *et al.,* 2020)."

2.0 RELATED WORKS

For the diagnosis, evaluation and staging of COVID-19 infection, CT imagery is critical. For disease development, follow-up scans every 3-5 days are usually advisable. Bilateral and peripheral ground glass of opacification (GGO) with or without consolidation have been found to be predominantly CT results for COVID-19 patients. However, only qualitative print and crude descriptions of the diseased regions are currently utilized in radiological reports due to the shortage of automated quantification techniques. This study develops a DL segmentation method to quantify the areas of infection of interest and their volumetric ratios with regards to of the lung automatically (Shan *et al.,* 2020). For the objective of evaluating the performance of the system, we first compared the output of lungs CT images that were automatically segmented and manually designated infection zones. In order to speed up the identification of training samples and accomplish manual interventions with automated results, a Human-In-The-Loop (HITL) approach has been used for assisting infection area segmentation radiologists, which decreased the overall segmentation time significantly up to four minutes after three rounds (Li *et al.,* 2020).

The approach of the analysis of medical pictures has rapidly become deep learning algorithms, particularly convolutional networks. This article examines the main deep learning principles relevant to the analytics of medical picture and summarizes over 300 inputs, most of them last year. They examined the use of extensive training to classify the image, recognize objects, segment them, register and other tasks. Here you will find concise studies in the areas of the digestive system, central nervous system, retina, lungs, heart, abdomen, and musculoskeletal system. Finally, they concluded by summarising the present state of art and suggestions for further studies implications (Litjens *et al.,* 2017).

Xu *et al.,* (2020) found that "the Reverse Transcription-Polymerase Chain Reaction (RT-PCR) had a modest positive rate of detection of viral RNA from sputum or nasopharyngeal swabs in the early years. A Computed Tomography (CT) scan termed COVID-19 can show signs of viral pneumonia that aren't the same as those seen in other viral infections, like viral influenza-A pneumonia. As a result, doctors are advocating that this new strain of pneumonia be discovered at an earlier stage.

The goal of this study was to create a deep-learning CT screening model that could distinguish pneumonia COVID-19 from viral influenza-A-pneumonia and healthy people. As a first step, a 3-D detailed computed tomography (CT) scan of the lungs was used to isolate an possible infection sites. A location attention model was used to classify these images into COVID-19, viral influenza A and unrelated to infection groups. Overall trust in this CT instance was determined using a Noisy or Bayesian function."

3.0 METHODOLOGY

In this paper, we want to identify regions where chest CT data is automatically infected by computer tomography data taken from a number of scanners and institutions. Patients may also be diagnosed based on the results of the COVID-19 detection process. Additionally, "we are the first to experimentally validate that CT-based radiological findings corroborate our deep neural network models' ability to distinguish COVID-19 from Non-Pneumonia (NP) and Community-Acquired Pneumonia (CAP) scans."

This study investigated the presence of COVID-19, CAP, and NP utilising CT 3D volumetric images. Following the recommendations of the Chinese National Health Commission, COVID-19 patients are divided into four clinical categories: mild, moderate, severe, and critical (depending on the diagnosis and treatment programme). We were able to complete all of our CT scans in three days, which meant that all of the patients at COVID-19 were in serious or critical situations. This group of patients, identified by randomly selecting patients from cooperating hospitals, was composed of CAP and other NPs (patients who did not have lung disease, chronic inflammation, lung nodules, or chronic obstructive lung disease); Patients who have acquired pneumonia in adults as a result of the American Thoracic Society guidelines for treatment of acquired pneumonia are included in CAP registries.

To find the diagnosis of CAP, you should concentrate on finding the characteristics, such the presence of a cold, of a fever, or of new sputum and pain in the chest. In addition, X-rays and CT are often used to do a pulmonary examination, and this is done in our instance. To determine if someone has chronic cough and fever (i.e., chronic pneumonia, bronchitis, or tuberculosis), doctors will utilise a chest radiograph to see whether the individual has a condition called chronic cough and fever. NP patients have not been shown to have any issues on lungs, such as chronic obstructive pulmonary disease, chronic inflammatory diseases, lung nodules, or other similar conditions. In the context of normal CT, it should be emphasised that no obvious abnormalities have been detected in the two lungs in CT tests.

The image intensity modification remains throughout the entire scope of the data type. An excellent contrast image has a clear black-and-white distinction. The high contrast image shows stronger highlights and darker shadows appear. In the addition of a binary image Zeros becomes zero. We have reversed the white and the black. Additionally, the picture is processed in grayscale or colour, and the particular pixel values are added to the image's highest-class value for that pixel (or 1.0 for double-precision images). The differences are because the pixel values of the output frame are all different. A dark area in the image will lighten and a light area will darken in the final image. In colour pictures, reds will become cyan, greens will turn magenta, blues will turn yellow, and the other colours will remain as they are. In the field of image processing, morphology refers to a broad variety of operations performed on pictures that have a shape. Every pixel in the image is modified according to the value in the neighbourhood for a morphological procedure. Selecting the size and shape of the

neighbourhood allows you to create a morphological operation that detects a certain kind of picture shape in the input image.

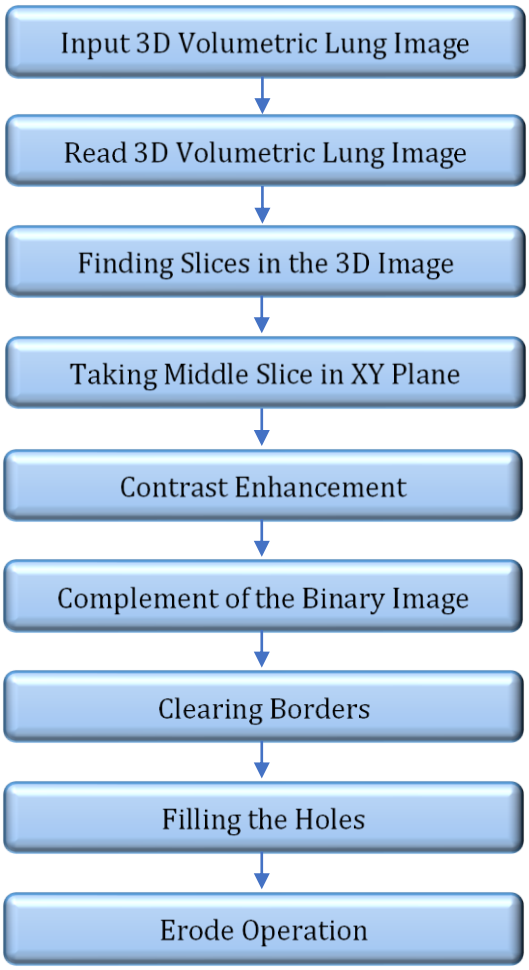

Figure 1 – Lung Segmentation

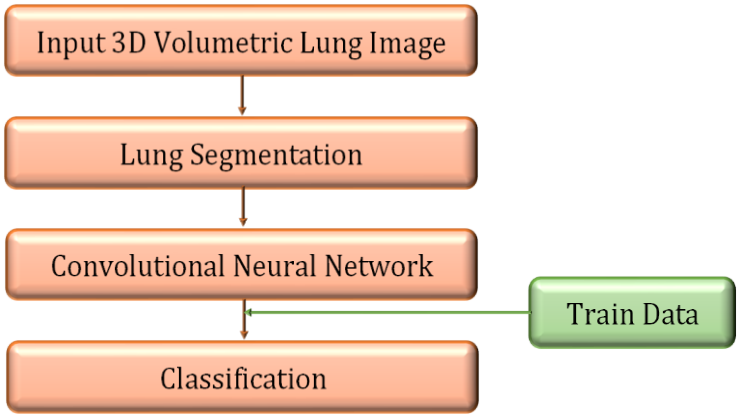

Figure 2 – Flow of Proposed Method

As far as machine learning is concerned, the artificial neural network works quite effectively. In different classifying tasks such as image, audio and word, artificial neural networks are employed. Various Neural network types are applied to different objectives, such as predicting the sequence of words that we use more precise LSTM recurrent neural networks, and similarly using Convolution

Neural Network for the image categorization. In this we will create a fundamental CNN building piece. One or more Convolutional layers can be used as a Convolutional Neural Network. The number and complexity of the data relies on the number of Convolutional layers.

An artificial neural network works extremely well when it comes to Machine Learning (ML). Images, video, and words are classified using Artificial Neural Networks (ANNs). In order to anticipate word sequences, Recurrent Neural Networks are employed. Image classification is accomplished via the use of Convolutional Neural Networks (CNN). In this project, we're going to lay the foundation for CNN's development. One or more convolutional layers can be used in a neural network with convolutional layers. How many layers there are in a convolution depends on the amount and complexity of the data being processed.

Similar to previous work is the major goal of this project. We shall propose a new CNN model due to the poor accuracy rate of the existing model. The data collection consists of over 30 images. Stochastic Gradient Descent (SGDM) optimizer will be the solver of the training network. The number of epochs is going to be 30. The initial training rate will be 0.1. Every epoch will be the option to shuffle data. Network validation frequency will be 10 in number of iterations (positive integer).

Table 1 – Description about Layers

Sl. No.	Name of the Layer	Filter Size, No. of Filters	Stride, Padding
1	Image Input Layer [28 28 1]	-	-
2	Convolutional 2D Layer	3, 8	1, Same
3	Batch Normalisation	-	-
4	ReLU Layer	-	-
5	Max Pooling Layer	2	2
6	Convolutional 2D Layer	3, 16	1, Same
7	Batch Normalisation	-	-
8	ReLU Layer	-	-
9	Max Pooling Layer	2	2
10	Convolutional 2D Layer	3, 32	1, Same
11	Batch Normalisation	-	-
12	ReLU Layer	-	-
13	Max Pooling Layer	-	-
14	Softmax Layer	-	-
15	Classification Layer	-	-

Model accuracy will be high (nearly 85%), low in misclassifications and applications are diagnosis and prognosis of COVID-19.

4.0 EXPERIMENTAL RESULTS

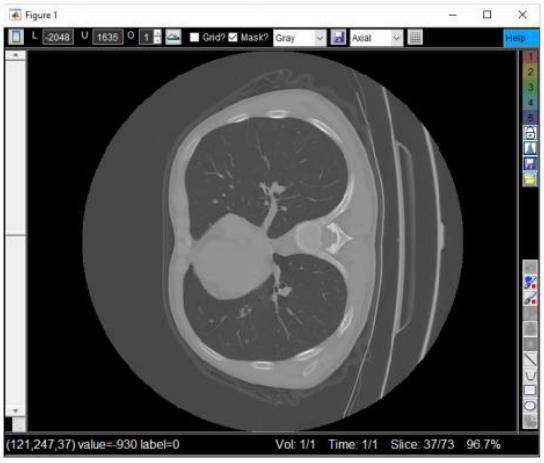

Figure 3 – 3D Volumetric lung Image

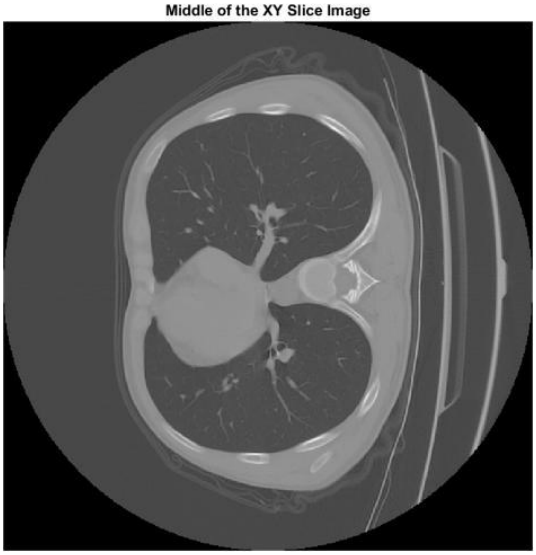

Figure 4 – Middle Slice Image

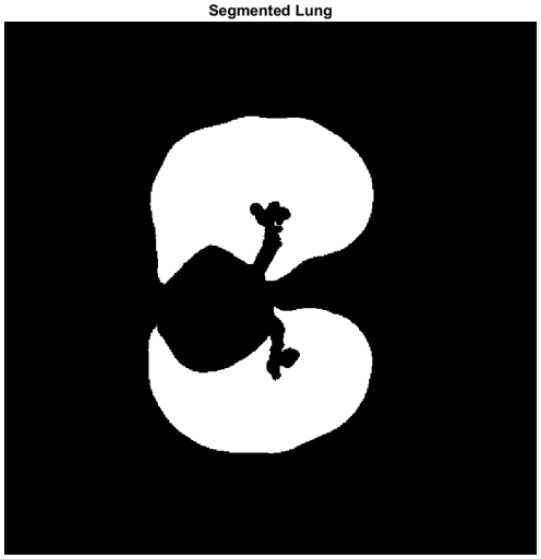

Figure 5 – Lung Segmentation

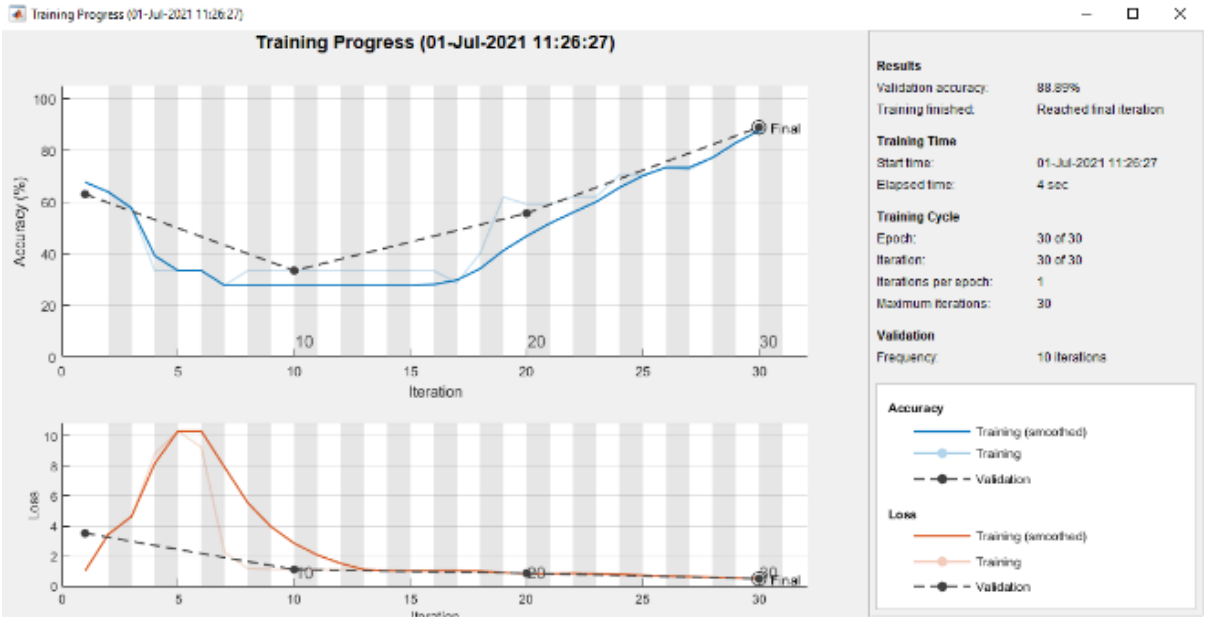

Figure 6 – Training Progress

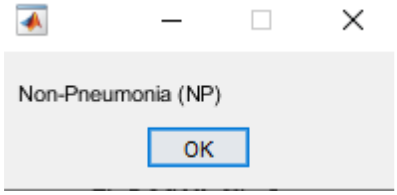

Figure 7 – Output Message Box

Table 2 – Accuracy Comparison

Sl. No.	Existing Method in %	Proposed Method in %
1	48.15	74.07
2	37.04	74.07
3	33.33	92.59
4	33.33	70.37
5	48.15	92.59
6	40.74	88.89

5.0 CONCLUSION

Approximately 90% of individuals infected with COVID-19 will suffer respiratory failure that may be considered moderate to severe, and some of these patients will be able to recover without any therapy. The elderly people are more probably suffering from severe illnesses such as persistent disorders such as chronic respiratory disease, asthma, cardiovascular diseases and cancer. In certain conditions, 3D volumetric imaging has been a valuable technique for COVID-19 patients' diagnosis and prognosis. The findings of this study enabled us to recommend a novel diagnostic method for COVID-19 infection using 3D volumetric lung imaging. For the detection and classification procedure,

we utilised 3D volumetric image processing and deep learning techniques. While comparing with the current models, we found that our experimental is seems to be superior.

REFERENCES

Ai, T., Yang, Z., Hou, H., Zhan, C., Chen, C., Lv, W., Tao, Q., Sun, Z., & Xia, L., (2020, Feb) "Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases." *Radiology,* 296(2), pp. E32-E40. https://doi.org/10.1148/radiol.2020200642.

Chen, J., Wu, L., Zhang, J., Zhang, L., Gong, D., Zhao, Y., Chen, Q., Huang, S., Yang, M., Yang, X., Hu, S., Wang, Y., Hu, X., Zheng, B., Zhang, K., Wu, H., Dong, Z., Xu, Y., Zhu, Y., Chen, X., Zhang, M., Yu, L., Cheng, F., & Yu, H., (2020, Nov) "Deep Learning-based Model for Detecting 2019 Novel Coronavirus Pneumonia on High-Resolution Computed Tomography", *Sci Rep,* 10(1), p. 19196. https://dx.doi.org/10.1038%2Fs41598-020-76282-0.

Fang, Y., Zhang, H., Xie, J., Lin, M., Ying, L., Pang, P., & Ji, W., (2020, Aug) "Sensitivity of Chest CT for COVID-19: Comparison to RT-PCR." *Radiology,* 296(2), pp. E115-E117. https://doi.org/10.1148/radiol.2020200432.

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M., Xiao, Y., Gao, H., Guo, L., Xie, J., & Wang, G., (2020, Feb) "Clinical Features of Patients Infected with 2019 Novel Coronavirus in Wuhan, China." *The Lancet,* 395(10223), pp. 497-506. https://doi.org/10.1016/S0140-6736(20)30183-5.

Li, L., Qin, L., Xu, Z., Yin, Y., Wang, X., Kong, B., Bai, J., Lu, Y., Fang, Z., Song, Q., Cao, K., Liu, D., Wang, G., Xu, Q., Fang, X., Zhang, S., Xia, J., & Xia, J., (2020, Mar) "Artificial Intelligence Distinguishes COVID-19 from Community Acquired Pneumonia on Chest CT." *Radiology,* p. 200905. https://dx.doi.org/10.1148%2Fradiol.2020200905.

Litjens, G., Kooi, T., Bejnordi, B. E., Setio, A. A. A., Ciompi, F., Ghafoorian, M., Van Der Laak, J. A., Ginneken, B. V., & Sánchez, C. I., (2017, Dec) "A Survey on Deep Learning in Medical Image Analysis" *Medical Image Analysis,* 42, pp. 60-88. https://doi.org/10.1016/j.media.2017.07.005.

Shan, F., Gao, Y., Wang, J., Shi, W., Shi, N., Han, M., Xue, Z., Shen, D., & Shi, Y., (2020, Nov) "Abnormal Lung Quantification in Chest CT Images of COVID-19 Patients with Deep Learning and its Application to Severity Prediction." *Medical Physics: The International Journal of Medical Physics Research and Practice,* 48(4), pp. 1633-1645. https://doi.org/10.1002/mp.14609.

Wang, D., Hu, B., Hu, C., Zhu, F., Liu, X., Zhang, J., Wang, B., Xiang, H., Cheng, Z., Xiong, Y., Zhao, Y., Li, Y., Wang, X., & Peng, Z., (2020, Feb) "Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China". *Jama,* 323(11), pp. 1061-1069. https://doi.org/10.1001/jama.2020.1585.

Xie, X., Zhong, Z., Zhao, W., Zheng, C., Wang, F., & Liu, J., (2020, Feb) "Chest CT for Typical Coronavirus Disease 2019 (COVID-19) Pneumonia: Relationship to Negative RT-PCR Testing." *Radiology,* 296(2), pp. E41-E45. https://doi.org/10.1148/radiol.2020200343.

Xu, X., Jiang, X., Ma, C., Du, P., Li, X., Lv, S., Yu, L., Ni, Q., Chen, Y., Su, J., Lang, G., Li, Y., Zhao, H., Liu, J., Xu, K., Ruan, L., Sheng, J., Qiu, Y., Wu, W., Liang, T., & Li, L., (2020, Oct) "A Deep Learning System to Screen Novel Coronavirus Disease 2019 Pneumonia". *Engineering,* 6(10), pp. 1122-1129. https://doi.org/10.1016/j.eng.2020.04.010.