IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

Lung Infection Severity Assessment using Deep Learning Algorithm

Suryavarshini K[1] and Senthamilselvi G[2]
P.G Final Year Student, Department of Electronics and Communication Engineering[1]
Assistant Professor, Department of Electronics and Communication Engineering[2]
Mount Zion College of Engineering and Technology, Pudukkottai, Tamil Nadu, India

Abstract: *A CT scan of the chest is used to find problems such as infection, lung cancer, blockage, pneumonia, and COVID-19. In this work, a CT scan is used to classify the stages of lung infection as normal, mild, moderate, and severe. Computed tomography (CT) is one of the imaging techniques for the diagnosis of lung infections. Fast and accurate screening is possible using computed tomography (CT) scan images. Automated diagnosis of severity level of lung infection from the CT scan pictures can be used by doctors as a quick and efficient method for treating patients to save their lives. In the proposed system, a convolutional neural network is used to classify the stages of lung infection and obtain accurate results.*

Keywords: Convolutional Neural Network (CNN), Computed tomography (CT), Lung, Deep Learning (DL)

I. INTRODUCTION

A lung infection occurs when the lungs are affected by microorganisms. The severity of a lung infection can range from mild to severe. Common symptoms of a lung infection are cough, chest pains, fever, body aches, a runny nose, shortness of breath, fatigue, and wheezing. Some of the lung diseases are asthma, bronchitis, COPD, lung cancer, pneumonia, pulmonary edema, tuberculosis, and recently, COVID 19. Asthma is a condition that causes the airways to narrow and swell, which can produce more mucus. This can make breathing difficult and cause coughing, wheezing, and shortness of breath when exhaling. Bronchitis is when the airways in the lungs become infected and contain mucus. Chronic obstructive pulmonary disease is an inflammatory lung disease that causes obstruction of the airways in the lungs. Lung cancer is a cancer that starts in the lungs, and people who smoke easily get affected. Pneumonia causes inflammation in one or both of the air sacs in the lung, which are filled with fluid or pus. The more fluid in the lungs is called pulmonary edema. Tuberculosis is a serious infectious bacterial disease that affects the lungs, and it is spread when an infected person coughs or sneezes. COVID-19 is an ongoing serious infectious disease that is caused by the Corona virus. Some people infected with this virus will experience mild or moderate illness, but some will be severely affected and require proper medication. Older people and those with underlying problems like cardiovascular disease, chronic respiratory disease, or cancer are more likely to develop serious illnesses. Anybody can get sick or die from COVID 19. In this work, the severity level of the lung infection caused by COVID-19is classified into four grades based on the CT severity score. Four grades are normal (grade 0), mild (grade 1), moderate (grade 2), and severe (grade 3). The lobes on the left and right were assessed. The chest CT severity score is classified as follows: score 1 is less than 5% involvement, score 2 is between 5-25% involvement, score 3 is between 25-50% involvement, score 4 is between 50-75% involvement, and score 5 is greater than 75% involvement. The total CT score is measured by the sum of the individual lobe scores. It ranges from 0 to 25. A deep learning algorithm is the best approach for detecting diseases and their stages.

DOI: 10.48175/IJARSCT-12907

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

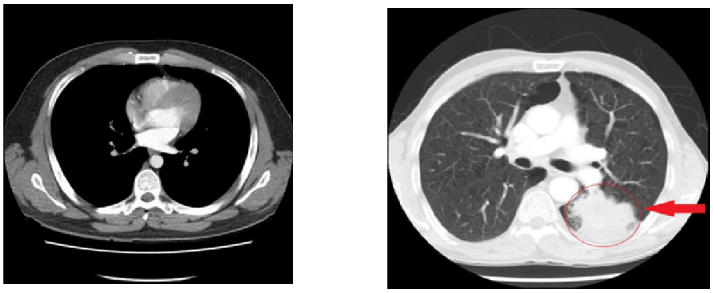

Figure 1. Image of normal and affected lung CT

II. LITERATURE REVIEW

Sevi and Alydin, In the study, it was aimed at detecting the disease in people whose x-rays were taken for suspected COVID-19. The data set contains chest x-rays of patients with COVID-19, viral pneumonia, and healthy patients. The data augmentation method was applied to the data set before classification. The above three groups are classified through multi-class classification deep learning models [4].

Berrimi, Hamdi, Cherif, Moussaoui, Oussalah, and Chabane, chest imaging plays a significant role in this phase, where CT and X-ray scans have proven to be effective in detecting infection within the lungs. In the research, we proposed a deep learning model using transfer learning to detect COVID-19. Both X-ray and CT scans were used to evaluate the proposed methods [5].

Deepa, Sheela, Amutha, and Joyal believe that automated lung infection diagnosis using computed tomography (CT) images has the potential to significantly improve the current healthcare approach. But segmentation of infected regions from CT slices was difficult due to the wide variety and the weak contrast between infected and healthy tissues. This study proposed a convolutional-based deep learning technique for automatically segmenting COVID-19 infection areas and the whole lungs from chest CT images [6].

III. PROPOSED METHOD

Deep learning, a branch of AI, is a family of multilayer NNs that excel at the problem of learning from big data. The word deep defines an increase in the number of layers; a model that uses one or more hidden layers is called a deep model. A convolutional neural network is a type of deep learning algorithm based on multilayer NNs that learns relevant features from images. It is capable of performing several tasks, like object classification, detection, and segmentation.

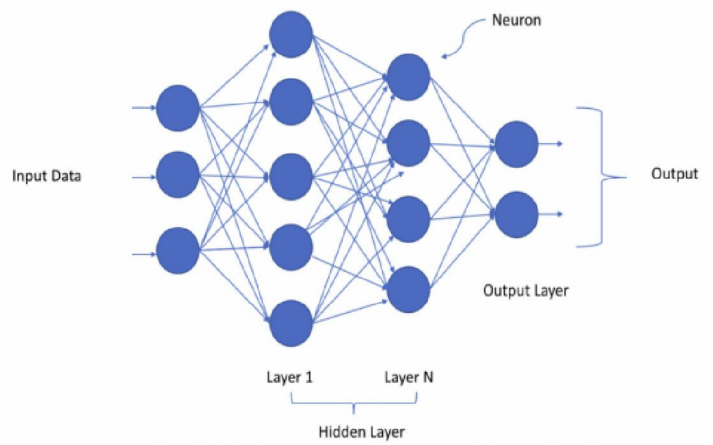

Figure 2. Deep learning

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

3.1 Dataset

Dataset contain normal, mild, moderate and severe CT images.

Figure3. Normal

Figure4. Mild

Figure5. Moderate

Figure6. Severe

3.2 Design

In this design, 7 layers are used. The layers are the input layer, convolution layer, ReLU layer, max pooling layer, softmax layer, and classification layer

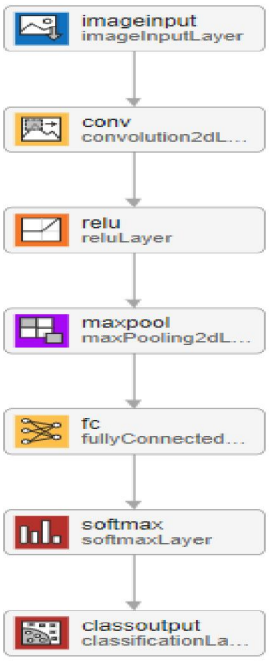

Figure 7. Design

3.3 Convolution layer

Convolutional layers are learned using a series of filters. Convolution layers multiple the input 5*5 matrix and the 3*3 filter matrix. Filters are used to detect certain features or patterns in raw images (input).

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

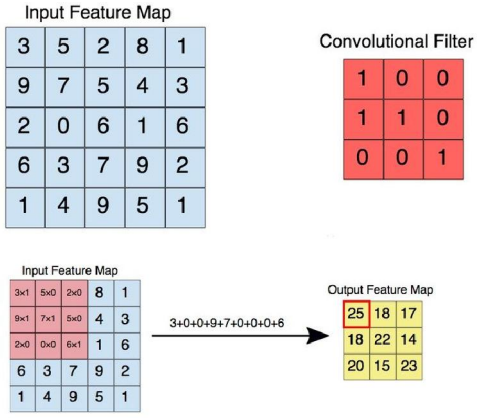

Figure 8. Convolutional layer

3.4 ReLU

This activation function overcomes vanishing gradient problem and allows models to learn faster and helps them to perform well.

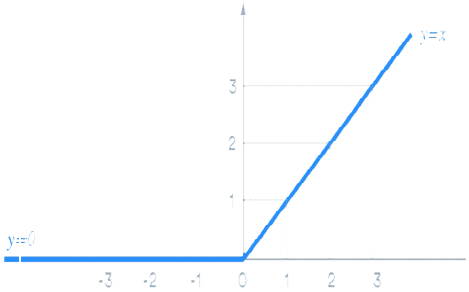

Figure 9. ReLU

3.5 pooling layer

This layer helps reduce the number of parameters and counts in the network and preserves performance by gradually reducing the size of the network. It performs two operations: average pooling and maximum pooling. Here, max pooling is used. It will take out the maximum from the pool.

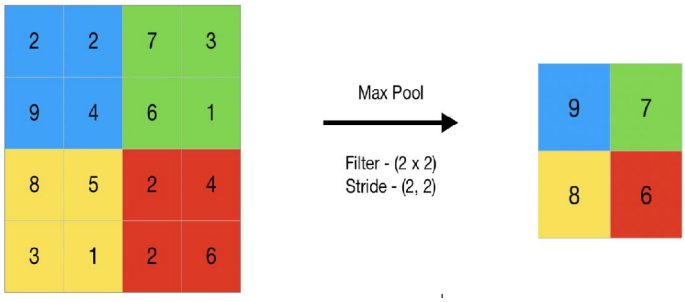

Figure 10. Max pooling layer

3.6 Fully connected layer

This layer connects all the neuron in this layer to all the neurons in the previous layer.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

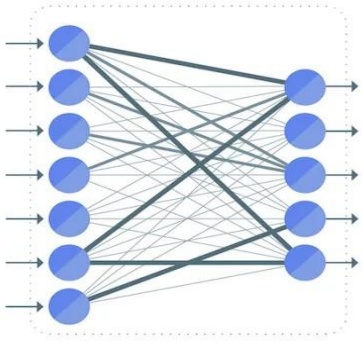

Figure 11. Fully connected layer

3.7 Softmax function

It is used as the last activation function of a neural network that normalizes the output and converts the output into probability. It is used for multiclassification.

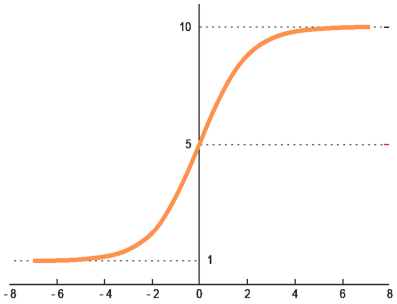

Figure12. softmax function

3.8 Software used

MATLAB 2023a has numerous built-in commands and math functions that help you with mathematical calculations, generating plots, designing apps, performing simulations, and performing numerical methods.

IV. RESULTS

4.1 Sample images of normal, mild, moderate and severe

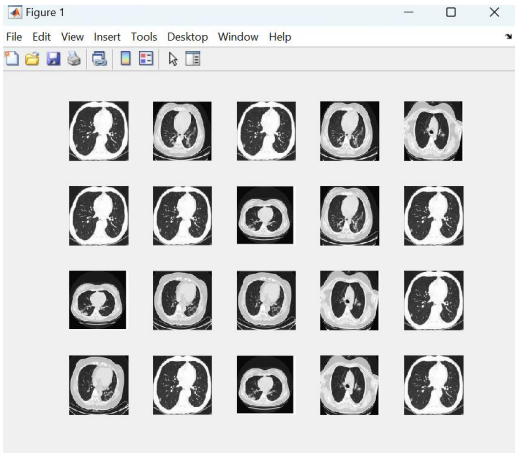

Figure 13. Sample images

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

4.2 Input image

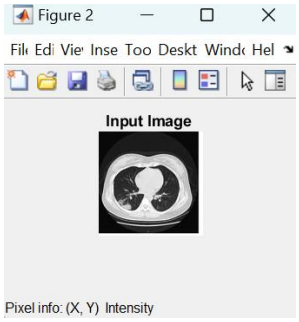

Figure 14. Input image

4.3 First convolution layer

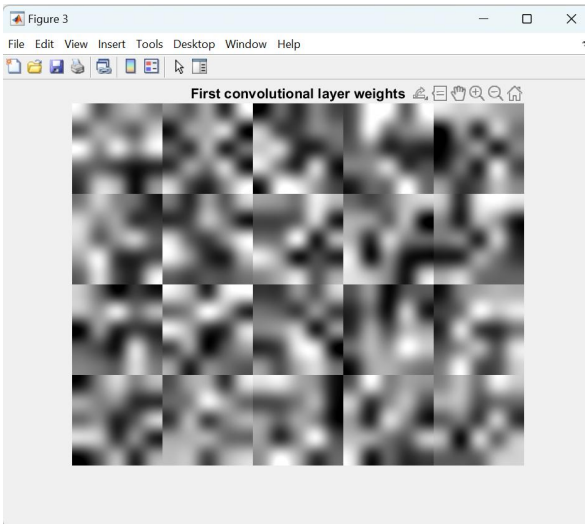

Figure 15: First convolution layer weights

4.4 Training progress

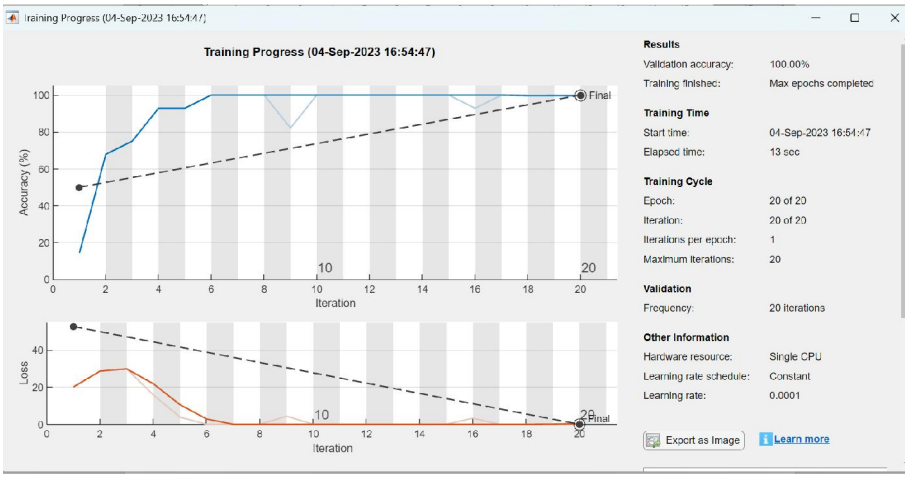

Figure 16: Training

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

4.5 Accuracy

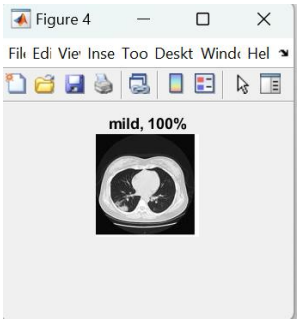

Figure 17. Accuracy

4.6. Classification output

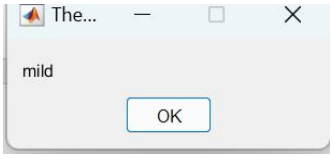

Figure 18. Output

4.7 Top prediction

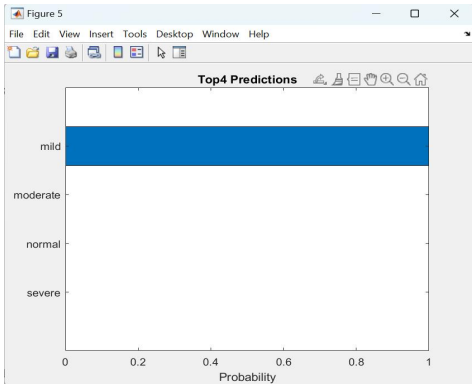

Figure 19. Predicted class

4.8 Evaluation Metrics

A. Accuracy

Accuracy is calculated by the total number of correctly identified samples out of all the samples.
It is defined as:

Accuracy = TP+TN/TP+FP+FN+TN

Where,
True positive (TP) = correctly identified
False positive (FP) = incorrectly identified
True negative (TN) = correctly rejected
False negative (FN) = incorrectly rejected

B. Precision

Precision means determining the number of positive class predictions that actually belong to the positive class.
Precision = TP/TP+FP

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, September 2023

C. Recall

Recall means determining the number of positive class predictions made out of all positive samples in the dataset.

Recall = TP/TP+FN

D. F1-Score

F1-Score is calculated by the average mean of precision and recall.

F1 = 2 (precision + recall)/precision + recall

V. CONCLUSION

In this work, convolutional neural network (CNN) is used for automatically finding the severity level of lung infection from CT scan image. It is classified as normal, mild, moderate, and severe. CNN layers work well, extract the features, and take less time. In this work, 7 layers are used. The layers start with the input layer, ReLU, max pooling, fully connected layer, softmax, and classification layer that produce the predicted class. The proposed architecture achieved 100% accuracy and zero percentage data loss.

REFERENCES

[1] A. D. Gunasinghe, A. C. Aponso and H. Thirimanna, "Early Prediction of Lung Diseases," 2019 IEEE 5th International Conference for Convergence in Technology (I2CT), Bombay, India, 2019, pp. 1-4, doi:10.1109/I2CT45611.2019.9033668.

[2] Y. L. Bouali, I. Boucetta, I. E. I. Bekkouch, M. Bouache and S. Mazouzi," An Image Dataset for Lung Disease Detection and Classification," 2021 International Conference on Theoretical and Applicative Aspects of Computer Science (ICTAACS), Skikda, Algeria, 2021, pp. 1-6, doi:10.1109/ICTAACS53298.2021.9715227.

[3] A. Rehman, M. Kashif, I. Abunadi and N. Ayesha, "Lung Cancer Detectionand Classification from Chest CT Scans Using Machine Learning Techniques," 2021 1st International Conference on Artificial Intelligence and Data Analytics (CAIDA), Riyadh, Saudi Arabia, 2021, pp. 101-104, Doi: 10.1109/CAIDA51941.2021.9425269.

[4] M. Sevi and İ. AYDIN, "COVID-19 Detection Using Deep Learning Methods," 2020 International Conference on Data Analytics for Business and Industry: Way Towards a Sustainable Economy (ICDABI), Sakheer, Bahrain, 2020, pp. 1-6, doi: 10.1109/ICDABI51230.2020.9325626.

[5] M. Berrimi, S. Hamdi, R. Y. Cherif, A. Moussaoui, M. Oussalah and M. Chabane, "COVID-19 detection from Xray and CT scans using transfer learning," 2021 International Conference of Women in Data Science at Taif University (WiDSTaif), Taif, Saudi Arabia, 2021, pp. 1-6, doi: 10.1109/WiDSTaif52235.2021.9430229.

[6] A. R. Deepa, C. J. J. Sheela, S. Amutha and S. Joyal, "Detecting Pneumonia for COVID 19 Patients using Multi-Image Fusion for CT Images," 2022 Sixth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Dharan, Nepal, 2022, pp. 916-925, doi: 10.1109/I-SMAC55078.2022.9987300.

[7] S. S. Raoof, M. A. Jabbar and S. A. Fathima, "Lung Cancer Prediction using Machine Learning: A Comprehensive Approach," 2020 2nd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA), Bangalore, India, 2020, doi:10.1109/ICIMIA48430.2020.9074947.