

# Chapter 6

## Summary of Thesis

### 6.1 Conclusion and Summary

The primary goal of this research work is to perform an accurate diagnosis of diseases using widely available imaging modalities such as X-rays and CT. Chest X-Ray and CT scores have been a major source of identification of Covid-19 during pandemic days. While it gives an accurate score in terms of the presence of fluid in the chest, it doesn't guarantee or certainly means that this is only due to Covid-19, as there are various types of pneumonia [128] as well.

CT (computed tomography) scores are used to measure the severity of lung inflammation or damage in patients with respiratory diseases, such as Covid-19 (coronavirus disease) or pneumonia. CT scores are based on the visual appearance of the lungs on a CT scan and are typically determined by a radiologist or other medical professional.

There are several differences between Covid-19 and pneumonia based on CT scores:

1. **Distribution of inflammation:** Covid-19 tends to cause diffuse, bilateral (affecting both lungs) inflammation, while pneumonia tends to cause more focal (localized) inflammation.
2. **The severity of inflammation:** Covid-19 tends to cause more severe inflammation than pneumonia, as measured by CT scores.
3. **Speed of progression:** Covid-19 tends to progress more rapidly than pneumonia, as measured by changes in CT scores over time.

Overall, Covid-19 and pneumonia are two different respiratory diseases that can cause inflammation or damage to the lungs. CT scores can be used to measure the severity of lung inflammation or damage and can help to differentiate between Covid-19 and pneumonia based on the distribution, severity, and progression of the inflammation. However, it is important to note that CT scores are only one aspect of the diagnosis and management of these diseases, and other factors, such as clinical presentation and laboratory test results, should also be considered.

A clear distinction between Covid-19 and Pneumonia is very crucial as they are difficult to diagnose based on CT-score itself. During Covid times, CT scores have been widely used for Covid-19

detection, but due to a lack of full knowledge about Covid-19, the general mass assumed low CT scores as a measure of Covid itself, which is not the only parameter to decide whether its Covid or non-Covid. The consequence of this misunderstanding was, people started medication for Covid while they might be a patient with pneumonia. In this panic situation, they took the wrong medication and also started accumulating the oxygen cylinder at homes, which in turn affected badly to oxygen cylinder supply chain to hospitals and the person in urgent need.

Another major challenge was the doctor-to-patient ratio, which is very less in a developing country like India. So there was a need to find some tools which can assist in the automated diagnosis of Covid-19 just based on the CT score and the report is generated within minutes instead of hours. Deep transfer learning is such a tool that can learn from pre-trained networks and predict the outcome on newer classes after training the network by changing the output layers and hyperparameter tuning.

Considering these valid points for the distinction between Covid-19 and other pneumonia types, it becomes really important to classify them into accurate classes.

To achieve this, we have proposed a transfer-learning-based model for multiclass classification among Covid-19, normal, viral pneumonia, and bacterial pneumonia, which discusses three case studies-

1. Four-Class Classification
2. Three-Class Classification
3. Two-Class Classification

For Case (01), for our proposed model, we have found out the model training and validation accuracy of approx. 88.62% and 89%, respectively, and the testing accuracy on 516 images was approx. 87.32%. We also evaluated other performance parameters for each class as Accuracies – Covid-19 (91.86%), Normal (84.11%), Pneumonia Bacterial (83.91%), and Pneumonia Viral (94.77%).

For Case (02), for our proposed model, we have found out the model training and validation accuracy of approx. 97.13% and 96.48%, respectively, and the testing accuracy on 387 images was approx. 96.89%. We also evaluated other performance parameters for each class as Accuracies – Covid-19 (97.67%), Normal (97.93%), and Pneumonia Bacterial (98.19%).

For Case (03), for our proposed model, we have found out the model training and validation accuracy approx. of 98.50% and 98.63%, respectively, and the testing accuracy on 258 images was

approx. 99.95%. We also evaluated other performance parameters for each class as Accuracies – Covid-19 (99.61%) and Normal (99.61%).

All these performance parameters have been evaluated with the confusion matrices as shown in Figure.3.8 and Figure.3.9. After evaluating the performance parameters, we have seen the overall model performance comparison in Figure.3.16-3.18. We see that our model performed well in most cases and worked well to identify individual classes. The introduction of the **SELU** activation function enabled us to deal with the vanishing gradients and tackle the problem of dying neurons, which might affect the network training.

Although this method has found promising results, there is still scope for performance improvement. With the availability of larger datasets and computational power, this seems achievable. But still, the purpose of this study was to assist in the early diagnosis of Covid-19 from other flu-like symptoms like Viral Pneumonia and Bacterial Pneumonia. An early diagnosis might be helpful to cluster people into several classes and treat them accordingly.

In the second classification approach we used a transfer learning-based approach for the initial identification of infections which leads to the accurate identification of Covid-19 in CT and X-ray images. This work proposed a computer-aided analysis of accurate detection of Covid-19-infected images. The features finely extracted by the MobileNet V2 model paved the way for this research. The obtained results were evaluated using well-known evaluation metrics, and to the best of our knowledge, no study up to now has not compared their method using such a large number of metrics. The advantage of this comparison is that we can be quite sure about the reliability of our results. MCC was used because sometimes accuracy and F score misleads the prediction of classification as mathematically it is a perfect balance between all four parameters of the confusion matrix. Youden's Index, which is quite a trustworthy statistical measure for medical image analysis, shows outstanding improvement, which proves the medical effectiveness of the results obtained by the proposed model. The CT scan and X-ray facilities are common in most medical organizations. Thus the proposed method can help in the initial identification of infections caused by viral pneumonia infections and Covid-19 are almost comparable diseases.

This thesis work also takes into consideration significant improvement in cardiac MRI segmentation using a transfer learning-based approach. Accurate segmentation of biomedical images is required to precisely extract the features related to pathophysiological conditions. Manual segmentation is a tedious and a time-consuming process that requires an expert. To eliminate the existing problems, a weakly supervised segmentation algorithm is proposed where a cascade of conventional (seed

region growing/random walker/K-means clustering) and deep learning method is utilized. There are two datasets that have been used in this work -

1. Automatic Cardiac Diagnosis Challenge[dataset 1]
2. Sunnybrook Cardiac Data [dataset 2]

The original images were first segmented using a conventional method to obtain the primary segmentation of ROI and then the obtained segmentations are used to train the deep learning network. The training split of dataset 1 is used to train the proposed model while the results are predicted on both dataset 1 and dataset 2 separately. For the experiments presented in the manuscript, dataset 2 is always used for cross-validation only. It can be clearly inferred from the obtained results that the proposed algorithm of weakly supervised segmentation is comparable enough to the state-of-the-art supervised method, used earlier in the literature.

Weakly supervised algorithms are machine learning algorithms that are trained on labeled data that is only partially annotated. These algorithms can be used in situations where fully labeled data is not available, or where it is expensive or time-consuming to obtain fully labeled data.

There are several advantages to using weakly supervised algorithms:

1. **Cost and time savings:** Weakly supervised algorithms can be trained on partially annotated data, which can be easier and faster to obtain than fully labeled data. This can save time and resources that would otherwise be spent on manual annotation.
2. **Scalability:** Weakly supervised algorithms can be used to train models on large datasets, which can be useful in situations where fully labeled data is not available for all examples in the dataset.
3. **Improved generalization:** Weakly supervised algorithms can often generalize better to new data than fully supervised algorithms since they are trained on a larger and more diverse dataset.
4. **Increased annotation efficiency:** Weakly supervised algorithms can be used to learn relationships between features and labels, which can help to guide the annotation process and improve the efficiency of manual annotation.

Overall, weakly supervised algorithms can be a useful tool for machine learning tasks where fully labeled data is not available or where it is expensive or time-consuming to obtain. They can save time and resources, improve generalization, and increase the efficiency of the annotation process.

## **6.2 Scope for further Work**

In this present work, we have used a smaller dataset due to the lack of availability of good quality datasets as well as high computational power. We trained our model for four class classifications - Covid-19, normal, viral pneumonia, and bacterial pneumonia. Although there are other types of pneumonia as well. By collecting larger and multiclass datasets, we can retune this model for more class classifications.

