

Chapter 8

Summary

The COVID-19 pandemic has caused severe respiratory tract infections that have rapidly spread through contact with infected individuals, resulting in devastating loss of life and economic damage worldwide. The high rate of transmission has put tremendous pressure on healthcare systems to develop fast and accurate methods for diagnosing the disease. Convolutional Neural Networks (CNNs) have shown success in various computer vision tasks, but they are scale-variant and computationally expensive. In this thesis, we proposed novel architectures for multiscale feature extraction and classification, as well as a lightweight architecture for COVID-19 diagnosis.

The proposed lightweight CNN model, referred to as CNN-I, exploits spatial kernel separability to significantly reduce the number of training parameters, and regularizes the model to only learn linear kernels. To maintain network stability and reduce overfitting, residual connections and batch normalization are extensively used. We trained this lightweight architecture on the QaTa-Cov19 benchmark dataset, achieving 100% accuracy, sensitivity, precision, and F1-score with a parameter count of only 150K, which is significantly lower than other methods in the literature. As future work, attention and context attention can be explored to further enhance performance, and evaluating atrous convolution in the context of spatial separability may be beneficial.

Our second proposed architecture, CNN-II, learns multiscale features using a pyramid of shared convolution kernels with different atrous rates, making it scale-invariant. An attention-based mechanism is used to guide and select the correct scale for each input. CNN-II is an end-to-end trainable network that exploits a novel augmentation technique, Texture Augmentation, to reduce overfitting. This architecture achieved an F1-score of 0.9929 when tested on the QaTa-Cov19 benchmark dataset, with a total of 5,040,571 trainable parameters. We suggest that the SWASPP (Spatial Pyramid Atrous Spatial Pyramid

Pooling) can show great performance for segmentation, especially atrous convolution originating in the segmentation literature. Additionally, this work can be extended to classify various types of pneumonia.

In conclusion, this thesis proposes novel architectures for COVID-19 diagnosis that address the limitations of traditional CNN models. These architectures achieved high accuracy while reducing computational cost and parameter count. Further research can explore attention mechanisms and evaluate the use of atrous convolution in the context of spatial separability to improve performance. This work has the potential to improve COVID-19 diagnosis and aid in the development of fast and effective methods to combat future pandemics.

- **Chapter 1:** briefly discussed the history of COVID-19 and the importance of automating COVID-19 detection.
- **Chapter 2:** includes required Background to understand the Thesis.
- **Chapter 3:** includes and illustrates the recent and related work in the COVID-19 detection literature.
- **Chapter 4:** presents the proposed work I which presents a lightweight classification model.
- **Chapter 5:** presents the proposed work II which includes the scale invariant model for COVID-19 classification.
- **Chapter 6:** illustrates the experimental results for both proposed work I and II and quantitative analysis of the proposed work I and II is provided.
- **Chapter 7:** concludes the thesis and provide planning for the future work as extension of the proposed approach