11TH INTERNATIONAL CONFERENCE ON ELECTRICAL AND COMPUTER ENGINEERING (ICECE)

December 17-19, 2020 | BUET, Dhaka, Bangladesh | icece.buet.ac.bd | Conference Record Number: #51571

PAPER ID 778

A Comparative Study of CNN Transfer Learning Classification Algorithms with Segmentation for COVID-19 Detection from CT Scan Images

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Presentation Outline

Introduction

- Thousands of people are being affected by highly contagious COVID-19 every day
- Artificial intelligence and deep learning methods can come to aid in this situation
- A thorough comparison between deep learning models can help understand the possible roadmap of automatic COVID-19 classification

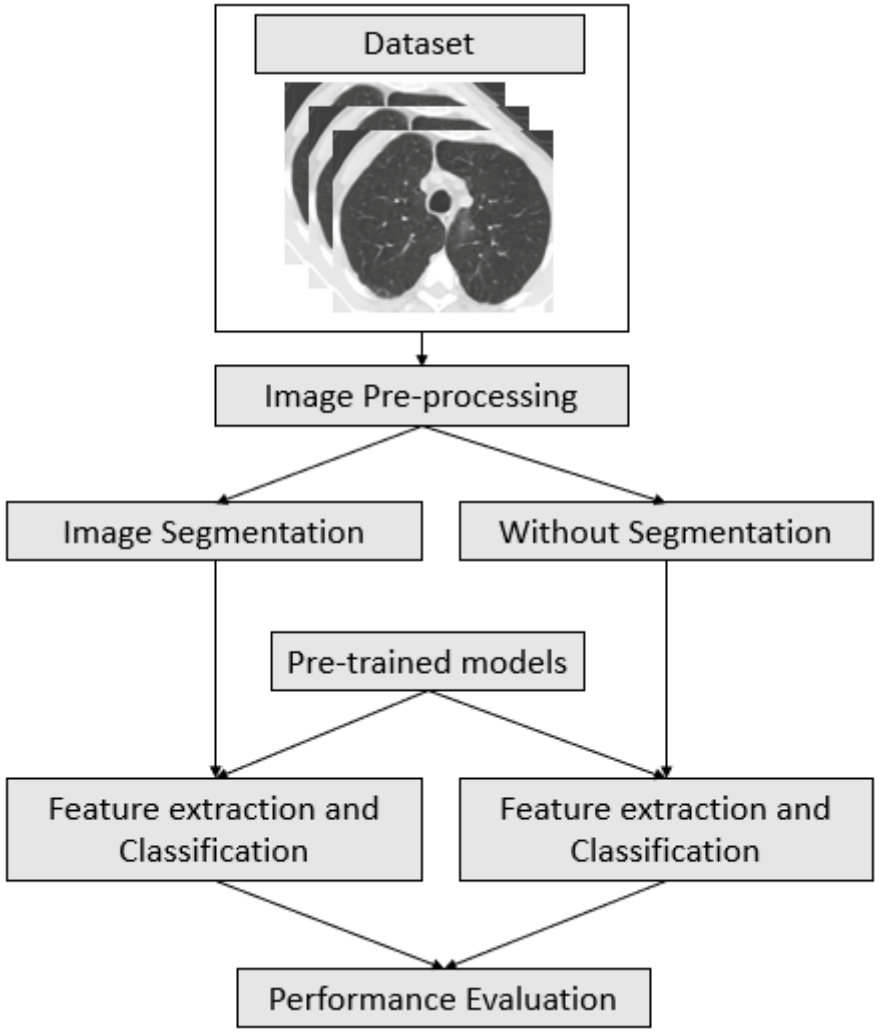
Motivation

- To contain the spread of COVID-19, early detection is very important
- Current testing methods are both time consuming and costly
- Deep learning classification with transfer learning of lungs CT scans can be very useful in this situation
- On top of that, applying segmentation on the images can improve the results by removing extra pixels

Objective

- Experimenting with readily available pre-trained deep learning models on lungs CT scan images
- Applying segmentation on the images to see the comparison of results

Proposed Methodology



A basic architecture of COVID-19 classification

Proposed Methodology (contd.)

1. Dataset:

- SARS-COV-2 CT-Scan dataset from Kaggle
- 2481 CT scan images
- 1252 CT scans are from COVID positive patients
- 1229 CT scans are from COVID negative patients

Proposed Methodology (contd.)

2. Image Pre-processing and Segmentation:

- Resized to the dimension of 224 x 224 x 3 for deep learning models
- Resized to the dimension of 256 x 256 x 3 for segmentation model
- Normalization was applied
- The images were then fed into the segmentation architecture with ImageNet weights to get the segmented images

Proposed Methodology (contd.)

3. Feature Extraction and Classification:

- 12 off-the-shelf Convolution Neural Network (CNN) architectures used
- U-Net as segmentation algorithm
- We replaced the classification layer of CNN models with a distinct layer
- Outputs of this new layer is equal to the binary classes of the CT scan dataset
- Input features in the new layer remained the same as before

Proposed Methodology (contd.)

4. Performance Evaluation

Metric	Working Principle	Formula
Sensitivity	Correct detection of COVID CT scans	$Sensitivity = \frac{TP}{TP + FN}$
Specificity	Correct detection of Non-COVID CT scans	$Specificity = \frac{TN}{TN + FP}$
Precision	Probability of COVID of being indeed COVID	$Precision = \frac{TP}{TP + FP}$
F1 Score	Weighted average of precision and sensitivity	$F1\ Score = \frac{2 * TP}{2 * TP + FP + FN}$
Accuracy	Ratio of correct predictions to total predictions	$Accuracy = \frac{TP + TN}{P + N}$

Experimental Results

1. Performance of transfer learning models without segmentation on test data

Model Name	Sensitivity	Precision	Specificity	F1 Score	Accuracy
AlexNet	82.0 %	80.08 %	79.27 %	81.03 %	80.65 %
VGG 16	68.40 %	95.53 %	96.75 %	79.72 %	82.46 %
VGG 19	71.60 %	89.95 %	91.87 %	79.73 %	81.65 %
ResNet18	**90.80 %**	75.67 %	70.33 %	82.55 %	80.65 %
ResNet50	68.40 %	96.61 %	97.56 %	80.09 %	82.86 %
ResNet101	81.20 %	95.31 %	95.93 %	87.69 %	88.51 %
ResNet152	76.80 %	92.31 %	93.50 %	83.84 %	85.08 %
DenseNet121	70.00 %	**98.31 %**	**98.78 %**	81.78 %	84.27 %
DenseNet169	82.40 %	95.81 %	96.34 %	**88.60 %**	**89.31 %**
DenseNet201	74.40 %	97.89 %	98.37 %	84.55 %	86.29 %
Inception_v3	75.60 %	95.94 %	96.75 %	84.56 %	86.09 %
GoogleNet	82.80 %	81.18 %	80.49 %	81.98 %	81.65 %

Experimental Results (contd.)

2. Performance of transfer learning models with segmentation on test data

Model Name	Sensitivity	Precision	Specificity	F1 Score	Accuracy
VGG 16	83.20 %	83.20 %	82.93 %	83.20 %	83.06 %
VGG 19	84.80 %	77.09 %	74.39 %	80.76 %	79.64 %
ResNet18	80.40 %	**99.50 %**	**99.59 %**	88.94 %	**89.92 %**
ResNet50	80.80 %	92.66 %	93.50 %	86.32 %	87.10 %
ResNet101	82.80 %	95.83 %	96.34 %	88.84 %	89.52 %
ResNet152	77.20 %	91.90 %	93.09 %	83.91 %	85.08 %
DenseNet121	79.60 %	98.03 %	98.37 %	87.86 %	88.91 %
DenseNet169	79.20 %	98.51 %	98.78 %	87.80 %	88.91 %
DenseNet201	**86.80 %**	92.74 %	93.09 %	**89.67 %**	**89.92 %**

Experimental Results (contd.)

3. Performance Comparison of some of the best performing models

	Without Segmentation		With Segmentation	
Models	F1	Accuracy	F1	Accuracy
ResNet18	82.55 %	80.65 %	88.94 %	89.92 %
DenseNet201	84.55 %	86.29 %	89.67 %	89.92 %

Conclusion

- We conducted a comparative analysis with some of the pre-trained CNN models and segmentation algorithm to classify COVID and Non-COVID classes.

- From our study, we see that, using segmentation before classification, improves the overall performance of the models.

Thank You