# 스마트 서비스 응용

Multi-classification of Respiratory Diseases through Dimension Combinations

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# Disease diagnosis using respiration data

# Introduction

- Research on classification of respiratory data for multiple classification of lung diseases is actively underway.
- In previous studies, methods such as spectrogram and gammatongram, which are 2D image conversion methods, are used.
- However, the performance for respiratory disease multi-class classification is still poor.

⇒ Conduct multi-classification study of respiratory diseases through combination of 1-dimensional and 2-dimensional features

⇒ Advantage of fast learning speed of 1D model + Advantage of high accuracy verification of 2D model

⇒ Improved model learning speed and accuracy compared to using only the existing 2D converted image

# Method

- Disease diagnosis using respiration data (ICBHI 2017 Challenge Dataset)

① Pathological data classification task (Normal/Abnormal)

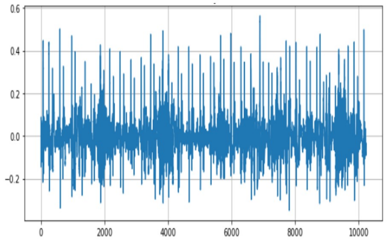
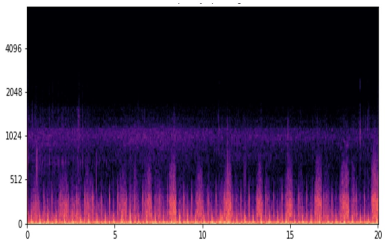
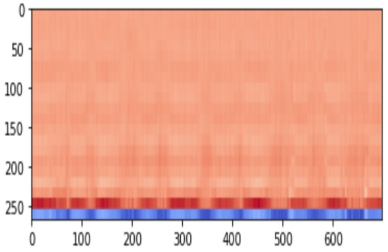
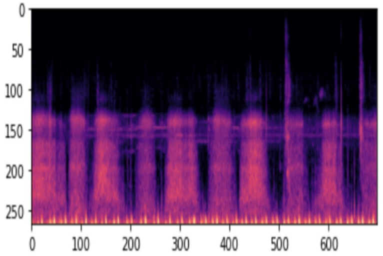
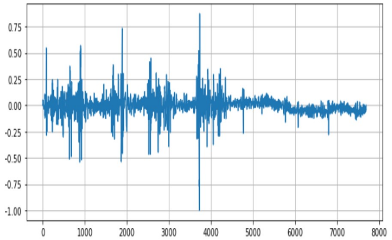
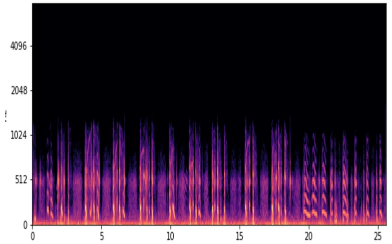
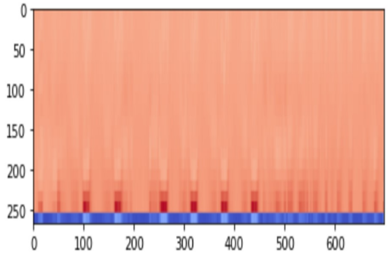
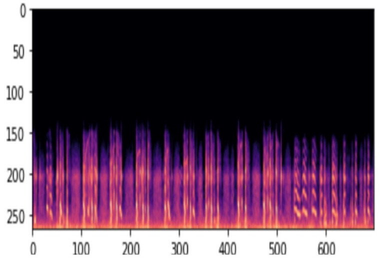
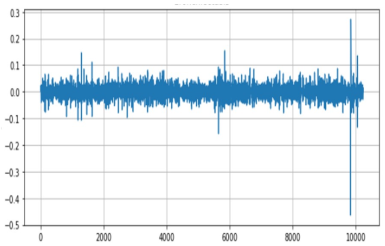
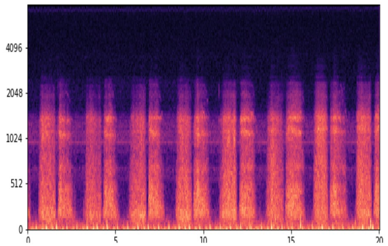
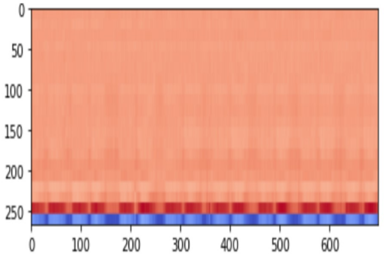
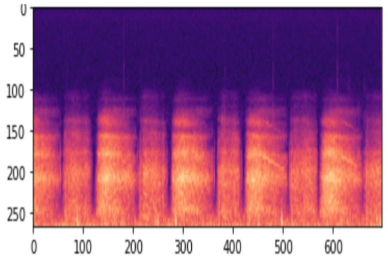
1) Learning by converting to one-dimensional value
2) Learning by converting to 2-dimensional images (spectrogram, gammatongram, MFCC)
3) Learning using a combination of 1D and 2D features

② Disease multi-classification task

1) Learning by converting to one-dimensional value
2) Learning by converting to 2-dimensional images (spectrogram, gammatongram, MFCC)
3) Learning using a combination of 1D and 2D features

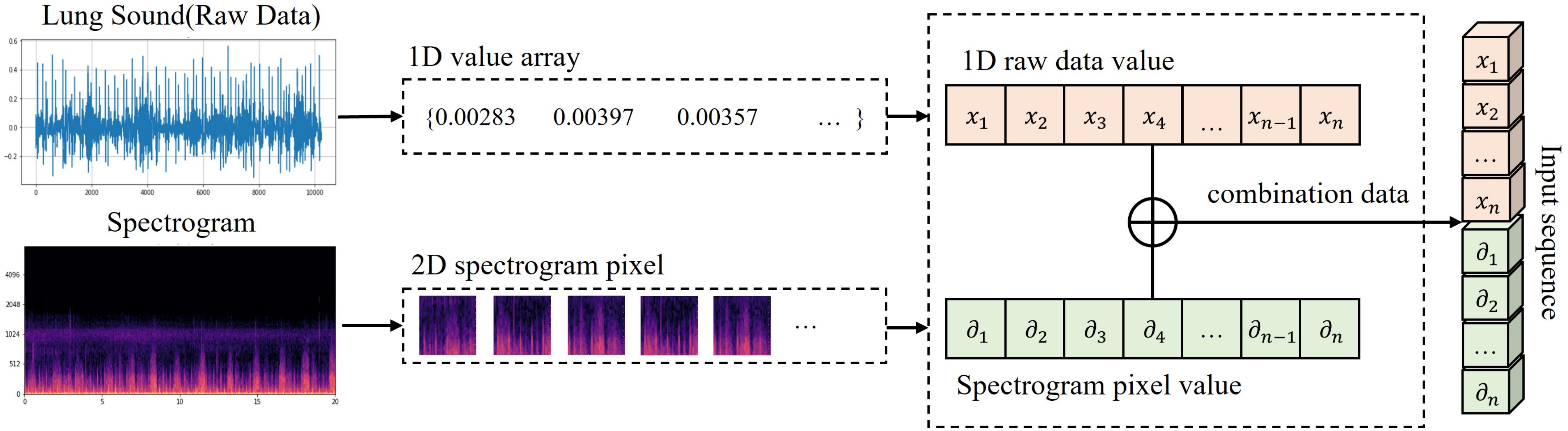
# Method

1) Learning by single data

| | Loud sound | Spectrogram | MFCC | Gammatongram |
|---|---|---|---|---|
| Healthy |  |  |  |  |
| COPD |  |  |  |  |
| Bronchiectasis |  |  |  |  |

# Method

2) Learning using a combination of 1D and 2D features

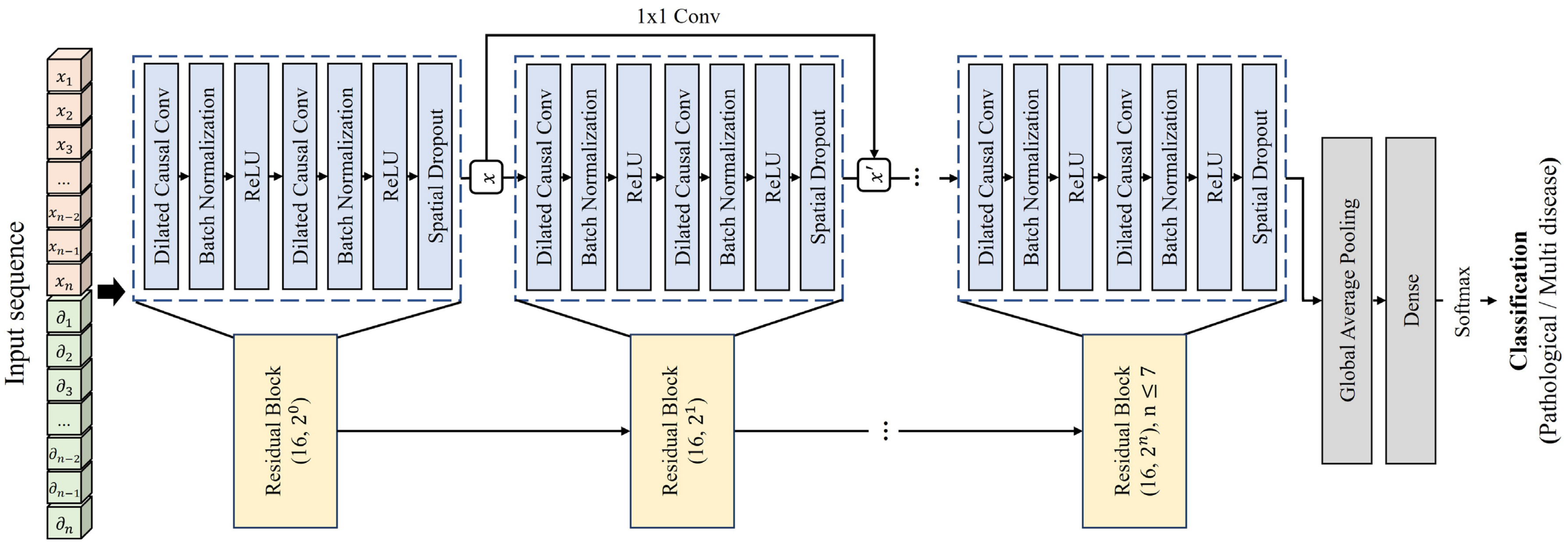


# Method

- Time series models

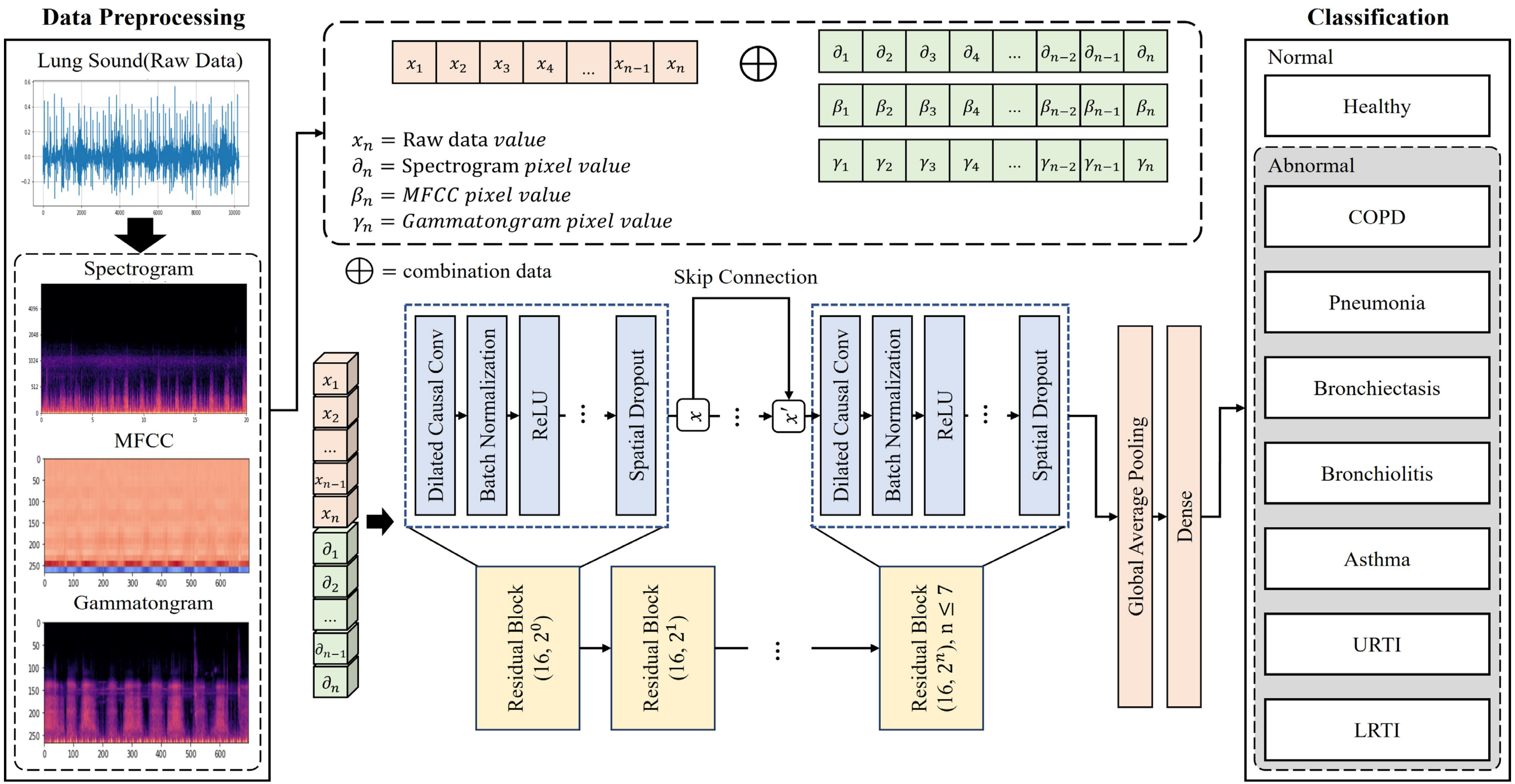
1. TCN(Temporal Convolutional Network)

   - It is a cnn-based model proposed in 2018 and used for processing time-series data such as natural language and music.
   - Characteristics of parallel processing and flexible receptive field size
   - It shows longer effective memory and higher performance than rnn-based LSTM/GRU.



# Method

- Process



# Experiment Result

- Comparison of experiment results

1) Disease classification

① Accuracy

| | | | |
|---|---|---|---|
| TCN | ICBHI | Signal | 88.04% |
| Wavenet | | | 87.03% |
| Bi-LSTM | | | 75.00% |

1D Model+1D Data(Vector)

| | | | |
|---|---|---|---|
| VGG | ICBHI | Spectrogram | 92.93% |
| Resnet | | | 90.76% |
| Transformer | | | 89.13% |

2D Model+2D Data(Spectrogram)

| | | | |
|---|---|---|---|
| VGG | ICBHI | Gammatongram | 91.30% |
| Resnet | | | 89.13% |
| Transformer | | | 87.50% |

2D Model+2D Data(Gammatongram)

| | | | |
|---|---|---|---|
| VGG | ICBHI | MFCC | 91.85% |
| Resnet | | | 90.21% |
| Transformer | | | 87.52% |

2D Model+2D Data(MFCC)

| | | | |
|---|---|---|---|
| TCN | ICBHI | Signal + MFCC | 88.58% |
| Wavenet | | | 88.04% |
| Bi-LSTM | | | 88.50% |

1D Model+(1D Data+MFCC)

| | | | |
|---|---|---|---|
| TCN | ICBHI | Signal + Spectrogram | **92.934%** |
| Wavenet | | | 90.22% |
| Bi-LSTM | | | 87.50% |

1D Model+(1D Data+Spectrogram)

| | | | |
|---|---|---|---|
| TCN | ICBHI | Signal + Gammatongram | 91.30% |
| Wavenet | | | 90.76% |
| Bi-LSTM | | | 87.50% |

1D Model+(1D Data+Gammatongram)

② Training time(100 epoch)

| Model | VGG | Resnet | Transformer | TCN | Wavenet | BiLSTM |
|---|---|---|---|---|---|---|
| Training Speed | 350.31s | 260.03s | 280.17s | 89.35s | 199.64s | 99.07s |

# Experiment Result

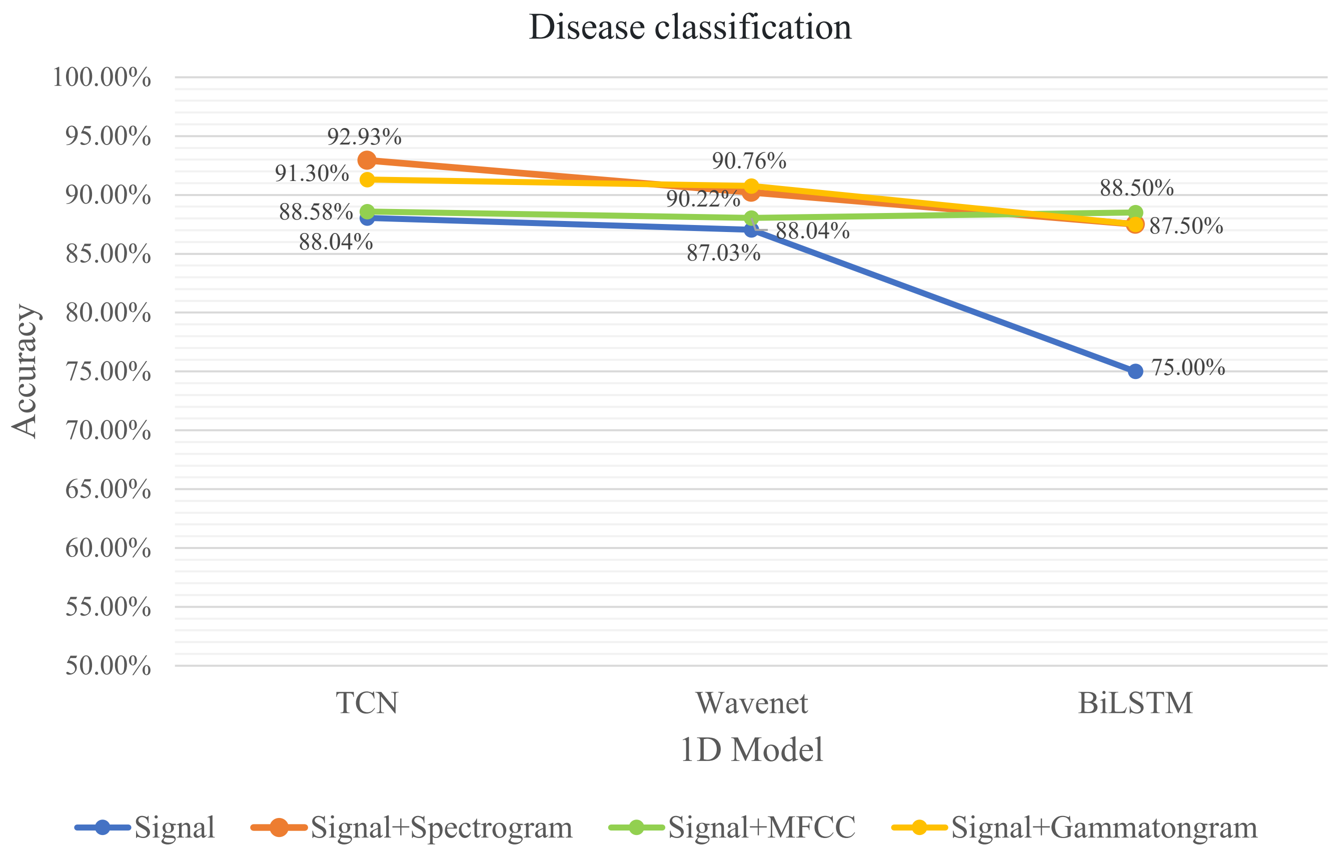
- Comparison of experiment results

| Task | Data | Model | Data Type | Auccuracy |
|---|---|---|---|---|
| Disease classification | ICBHI | TCN | Signal | 88.04% |
| | | Wavenet | | 87.03% |
| | | Bi-LSTM | | 75.00% |
| | | VGG | Spectrogram | 92.93% |
| | | Resnet | | 90.76% |
| | | Transformer | | 89.13% |
| | | VGG | Gammatongram | 91.30% |
| | | Resnet | | 89.13% |
| | | Transformer | | 87.50% |
| | | VGG | MFCC | 91.85% |
| | | Resnet | | 90.21% |
| | | Transformer | | 87.52% |
| | | TCN | Signal+Spectrogram | **92.934%** |
| | | Wavenet | | 90.22% |
| | | Bi-LSTM | | 87.50% |
| | | TCN | Signal+Gammatongram | 91.30% |
| | | Wavenet | | 90.76% |
| | | Bi-LSTM | | 87.50% |
| | | TCN | Signal+MFCC | 88.58% |
| | | Wavenet | | 88.04% |
| | | Bi-LSTM | | 88.50% |

# Experiment Result

- Comparison of experiment results

2) Accuracy (1D Model)



# Conclusion

- Improvement of respiratory disease multi-classification accuracy by considering both 1D data features and 2D data features
- Speeding up learning using 1D models
- Accuracy improvement using 2D data features
- 4.63% accuracy improvement over existing studies in multi-disease data classification
- Federated learning can be applied for personal information protection