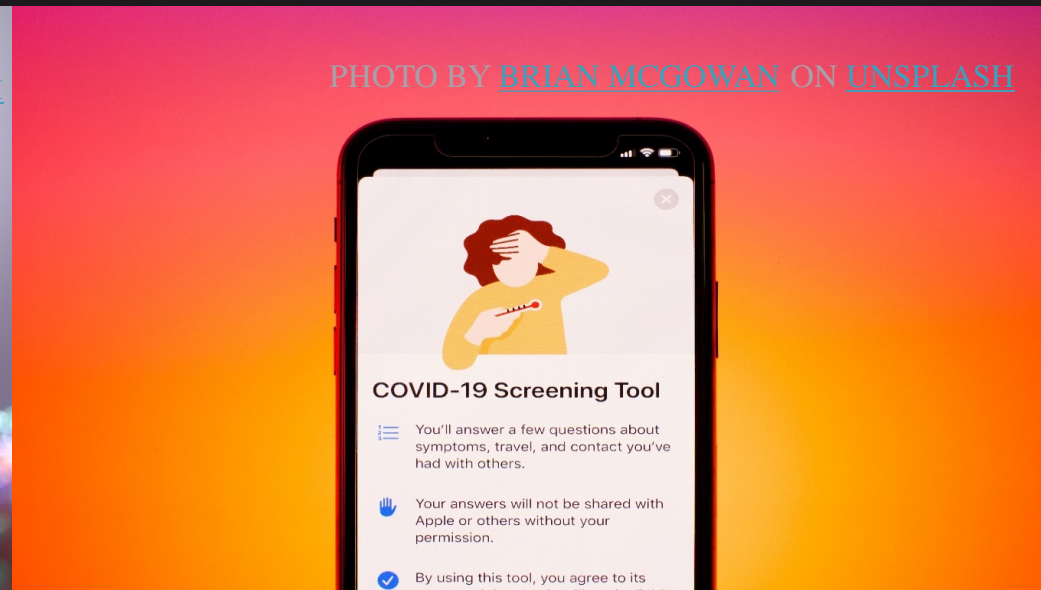
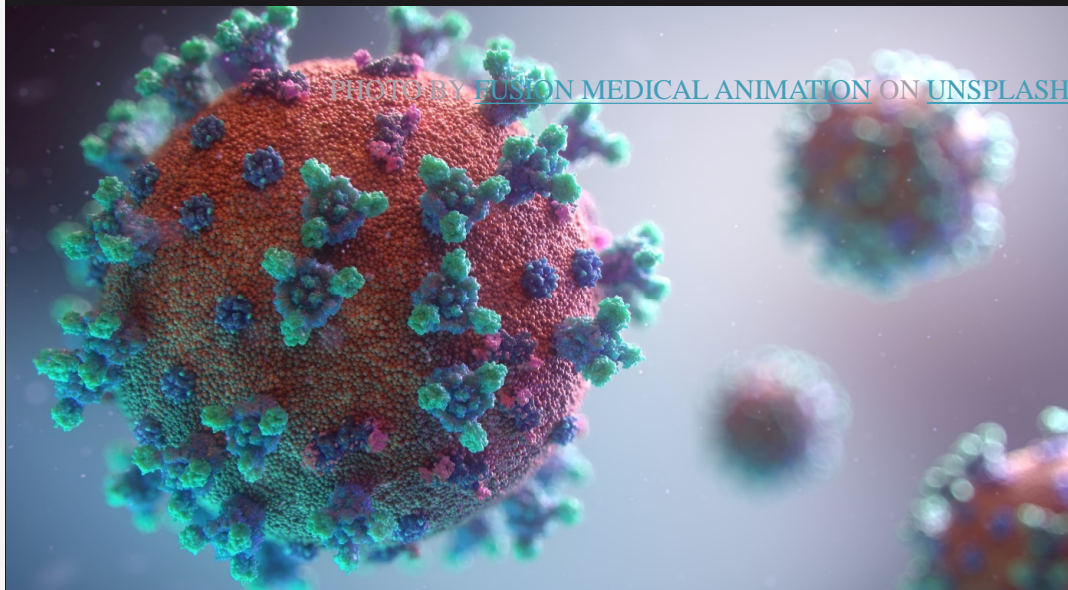


DETECTING COVID-19'S DISEASE FROM COUGH AND SPEECH SIGNAL



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Symptoms of COVID-19



Common Symptoms

- Shortness of breath
- A cough that gets more severe over time
- A low-grade fever that gradually increases in temperature
- Fatigue

The symptoms of COVID-19 are similar in adults and children and can look like other common illnesses, like colds, strep throat, or allergies.

Most common symptoms

- ❖ Fever
- ❖ Cough

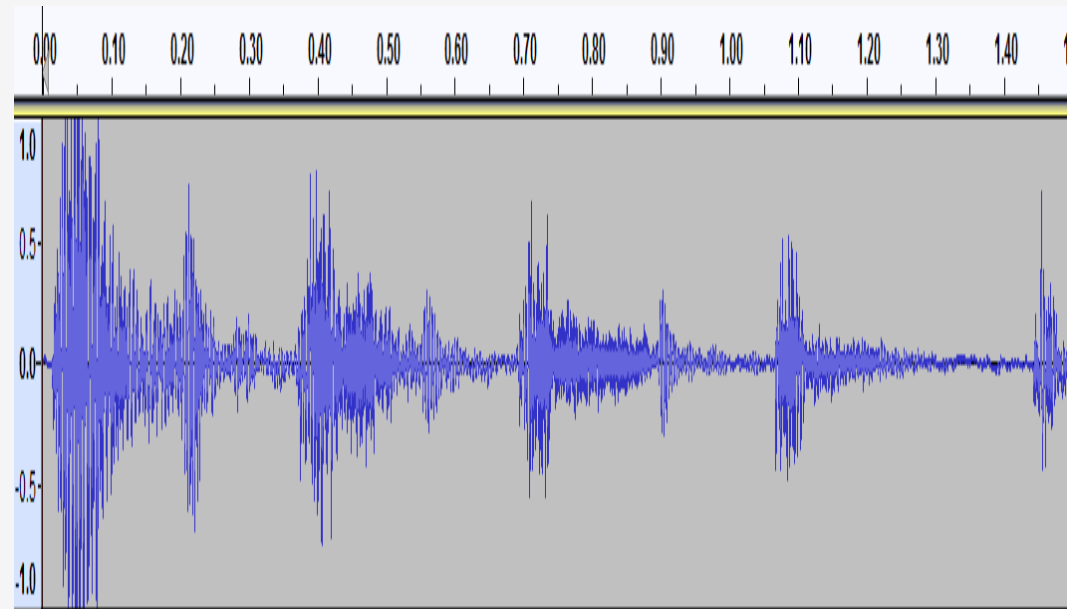
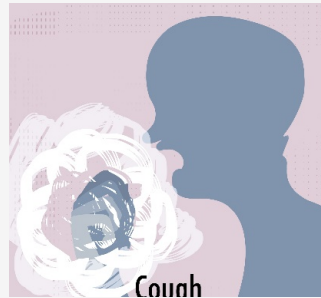
The virus may be carry for 2 days or up to 2 weeks before noticing symptoms.

Cough

A deep inspiration usually starts a classical cough, followed by glottis closure

A common(complicated) symptom of many respiratory infections.

- Asthma
- Pertussis
- Tuberculosis
- Pneu-monia



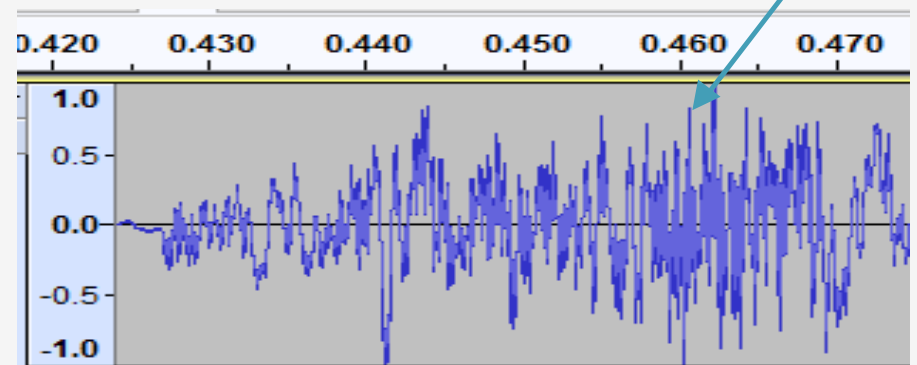
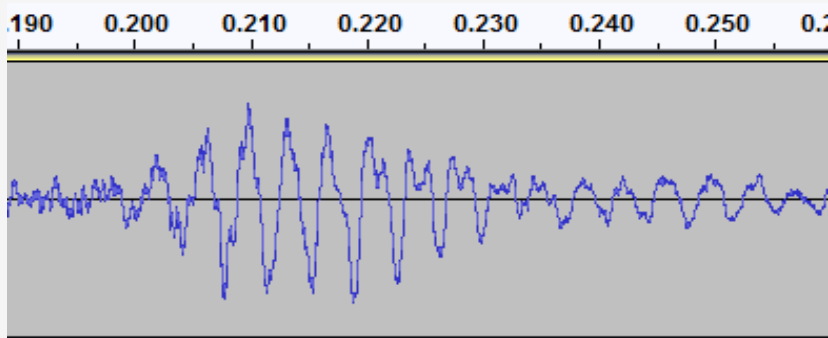
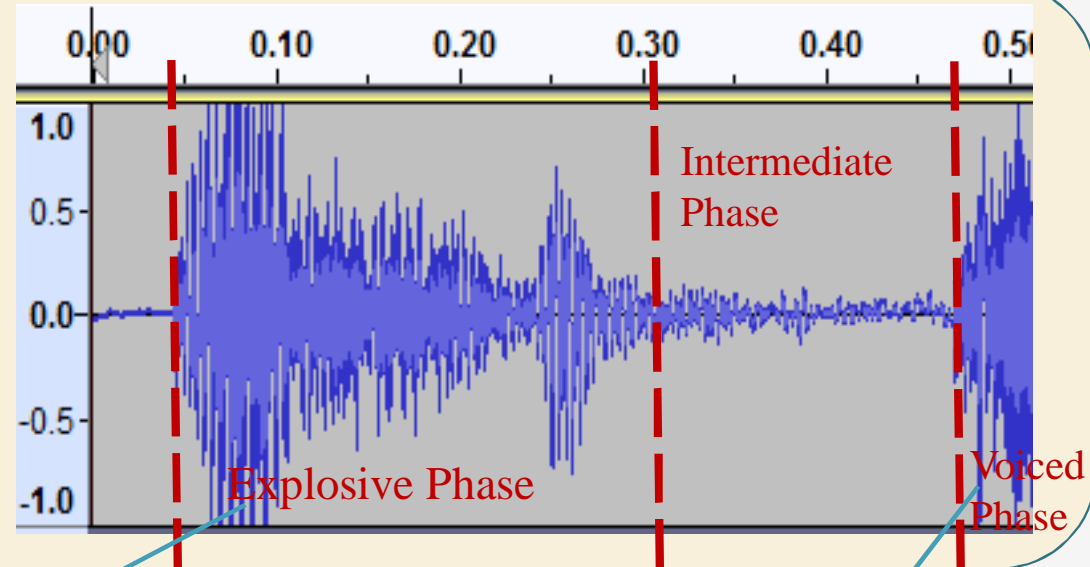
▶ Each cough lasts close to **300ms**.

▶ The spectrum exhibits broad spectral spread over **500Hz, 1.5kHz, and 3.8kHz**.

Temporal Phase of Cough

Cough sound is composed of different temporal phases

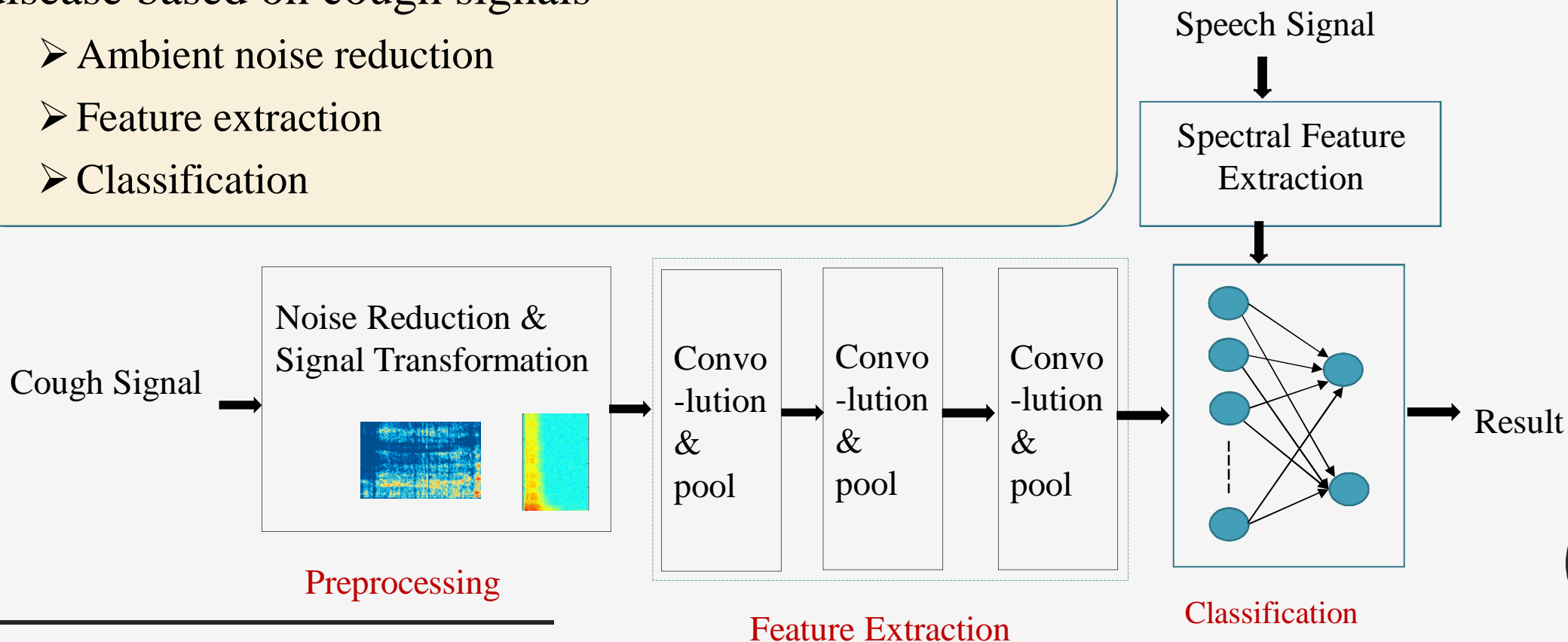
- Explosive
- Intermediate
- Voiced phase



Deep Convolutional Neural Network Model

There are three main parts of detecting Covid'19 disease based on cough signals

- Ambient noise reduction
- Feature extraction
- Classification



Input Layer

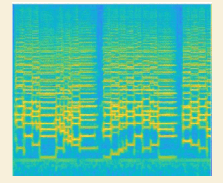
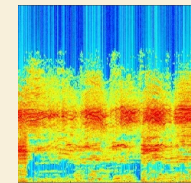
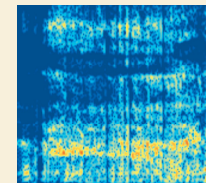
Signal Acquisition

- The sound(cough/speech) signals usually are captured by a microphone.
- The first step aims at removing silence/noise within signals.



Input Layer

- Segmenting the continuous signal into 300ms frames with 50% overlapping factor
- Transforming each frame into (*STFT*) spectrogram image
- Removing the ambient noise by using *Gamma filters*



Spectrogram Transformation

STFT Spectrogram

- Each segment is converted into time-frequency representation by operating Short Time Fourier Transform with Hamming window
 - The STFT spectrogram is better if the signal is monitored reasonably by searching for low energy density at high frequencies.
 - The quadratic time-frequency representation method is simple and fast.

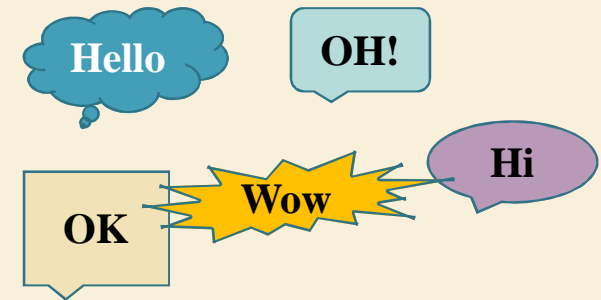
Gammatone-like Spectrogram

- The sub bands of the frequency of the ear expands at higher frequencies while the spectrogram has a constant bandwidth at all channel frequencies.
- The resulted spectrogram is then passed through the gamma filters to reduce noise.

Speech

Clinical Research

- Speech has long been used as an indicator for health.
 - Parkinson's disease
 - Alzheimer disease



Feature Extraction

- Segmenting the continuous signal into windowed frames
- Removing silence/noise by using ZCR/Energy Thresholding methods
- Extracting the MFCC features of each frame

Spectral Feature Options:

- Perceptual linear prediction (PLP)
- Linear prediction coding (LPC)
- Mel-frequency cepstrum coefficients (MFCC)

Convolution & Pooling Layer

Convolution Layer

- Relu method for activation function, He initialization random method for weighted initializer
- First Layer : 128 feature maps, 5x5 filter size, 2x2 stride
- Second Layer: 64 feature maps and 5x5 filter size, 2x2 stride
- Third layer: 32 feature maps and 5x5 filter size, 2x2 stride

Pooling Layer

- Maximum pooling method
-

Fully Connected Layer

The first fully connected layer involves the units (the amount of neurons)

- Weight Initializer: **He** weighted initialization random function
- Activation Function: **Relu** activation function

The second fully connected layer involves the units (the amount of neurons is the number of classes)

- Weight Initializer: **Xavier** initialization random function.
 - Activation Function: **Softmax** activation function
-

Conclusion

Method

- STFT Gammatone-like Spectrogram will be used to transform time-series into 2D texture images
- Their deep hidden features can be learned in the DCNN model together with the speech frequency domain (MFCC) features

To address this major challenge

- The majority of COVID-19 positive individuals show none of the symptoms (asymptomatics)
- They continue to be contagious

Challenges in this system

- ❖ Data Acquisition
- ❖ Differentiation from patient sounds
- ❖ The variability of the cough acoustics
- ❖ Classification of Covid' 19 or seasonal flu

THANK YOU!
