

18D070067_Assignment2

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ASSIGNMENT 2 EE679

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Question

Given the speech segment (aa.wav) extracted from the word “pani” in “machali.wav” (male voice), sampled at 8 kHz, do the following. Report/discuss your observations at each step.

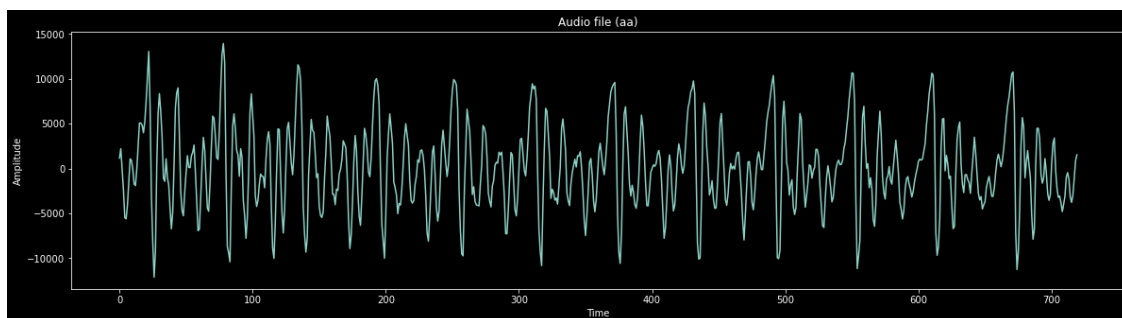
IMPORTS

```
[ ]: import numpy as np
import matplotlib.pyplot as plt
```

```
[ ]: ## Let us first read the given audio file
import scipy.io.wavfile as wav

sampling_rate, aa = wav.read('aa.wav')
```

```
[ ]: ## Visualize the audio file
plt.figure(figsize=(20,5))
plt.plot(aa)
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.title('Audio file (aa)')
plt.show()
```



```
[ ]: sampling_rate
```

```
[ ]: 8000
```

Hence, as mentioned in the question the sampling rate of the audio file is 8 kHz

0.1 Apply pre-emphasis to the signal.

Consider the following pre-emphasis filter

$$H(z) = 1 - \alpha z^{-1}$$

where α is a constant. For this assignment let α be 0.95. Hence, the filter is given by

$$H(z) = 1 - 0.95z^{-1}$$
$$\Rightarrow \frac{Y(z)}{X(z)} = 1 - 0.95z^{-1}$$

Where, $Y(z)$ is the z-transform of the output signal and $X(z)$ is the z-transform of the input signal to the filter.

$$\Rightarrow Y(z) = X(z) - 0.95X(z)z^{-1}$$

Hence, after taking inverse z transform, we get

$$\Rightarrow y[n] = x[n] - 0.95x[n-1]$$

Now, let us find the output when the “aa” signal is passed through the pre-emphasis filter.

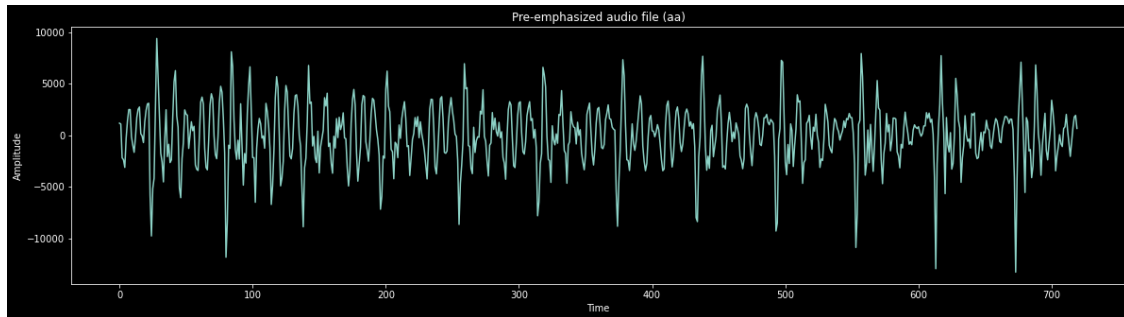
```
[ ]: pre_emphasis_aa = np.zeros(len(aa))

pre_emphasis_aa[0] = aa[0]

for i in range(1, len(aa)):
    pre_emphasis_aa[i] = aa[i] - 0.97 * aa[i-1]
```

0.1.1 Visualization of the pre-emphasized signal

```
[ ]: plt.figure(figsize=(20,5))
plt.plot(pre_emphasis_aa)
plt.xlabel('Time')
plt.ylabel('Amplitude')
plt.title('Pre-emphasized audio file (aa)')
plt.show()
```



0.1.2 Writing the output of pre_emphasis_aa to a file

```
[ ]: from scipy.io.wavfile import write

pre_emphasis_aa_sound = np.int16(pre_emphasis_aa/np.max(np.
    ↪abs(pre_emphasis_aa)) * 32767)
write('pre_emphasis_aa.wav', sampling_rate, pre_emphasis_aa_sound)
```

0.2 Compute and plot the narrowband magnitude spectrum slice using a Hamming window of duration = 30 ms on a segment near the centre of the given audio file.

```
[ ]:
```