

EE3025 ASSIGNMENT- 1

SAI KARTHIK R - EE18BTECH11037

Download all python codes from

<https://github.com/karthik-ramneti/ee3025/assignment1/codes>

and latex-tikz codes from

<https://github.com/karthik-ramneti/ee3025/assignment1>

1 PROBLEM

The command

```
output_signal = signal.lfilter(b,a,
    output_signal)
```

in Problem 2.3 is executed through following difference equation

$$\sum_{m=0}^M a(m) y(n-m) = \sum_{k=0}^N b(k) x(n-k) \quad (1.0.1)$$

where input signal is $x(n)$ and output signal is $y(n)$ with initial values all 0. Replace **signal.filtfilt** with your own routine and verify

2 SOLUTION

Let $X(z)$ and $Y(z)$ be the respective z-transforms of $x(n)$ and $y(n)$ respectively. Using the properties of z-transform

$$\mathcal{Z}\{x(n-k)\} = z^{-k}X(z) \quad (2.0.1)$$

$$\mathcal{Z}\{y(n-m)\} = z^{-m}Y(z) \quad (2.0.2)$$

Applying z-transform to the both sides of the difference equation

$$Y(z) \left(\sum_{m=0}^M a(m) z^{-m} \right) = X(z) \left(\sum_{k=0}^N b(k) z^{-k} \right) \quad (2.0.3)$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{\sum_{k=0}^N b(k) z^{-k}}{\sum_{m=0}^M a(m) z^{-m}} \quad (2.0.4)$$

$H(K)$ is evaluated from (2.0.4) using the coefficients b, a .

$X(z)$ is evaluated using a built in fft command, since the manual code written will be of order $O(n^2)$ where n (length of the given signal) is large. So, it takes too much time.

$Y(z)$ is evaluated by multiplying $X(z)$ and $H(z)$.

$$Y(K) = H(K) X(K) \quad (2.0.5)$$

$y(n)$ is evaluated using a built in ifft command from $Y(z)$ because of the same reason, i.e, manual code written takes too much time

The python code used to obtain the output signal and draw the plots is

`codes/ee18btech11037.py`

Below is the soundfile constructed from output signal y using own routine filter

`codes/Sound_With_ReducedNoise_ownroutine.wav`

3 VERIFICATION

Both the output signals obtained using builtin `signal.filtfilt` command and own routine method sounds the same.

Plotting the time domain output signal evaluated from both own routine filter and `signal.filtfilt` command

Plotting the frequency domain response evaluated from both own routine and `signal.filtfilt`

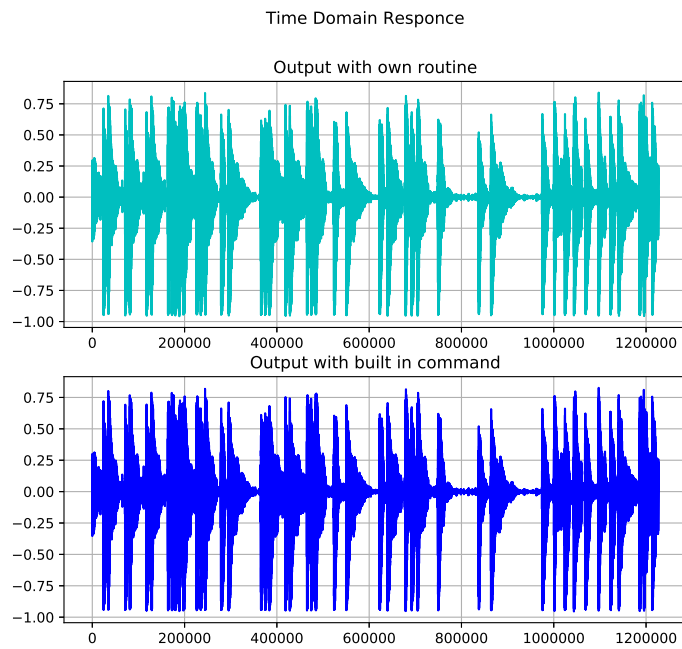


Fig. 0: Time domain response

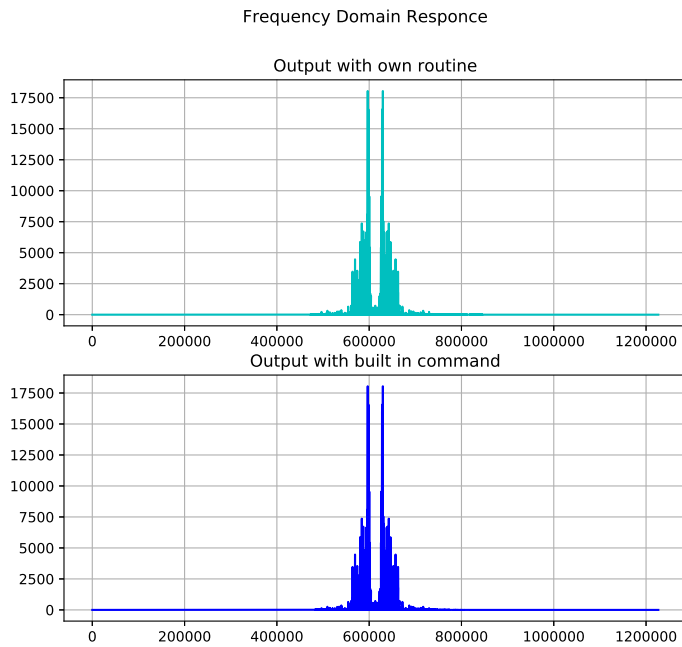


Fig. 0: Frequency domain response