EE3025 ASSIGNMENT- 1

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Download all python codes from

https://github.com/adi2000pedavegi/ee3025−idp/ tree/master/Assignment−1/codes

and latex-tikz codes from

https://github.com/adi2000pedavegi/ee3025−idp/ tree/master/Assignment−1

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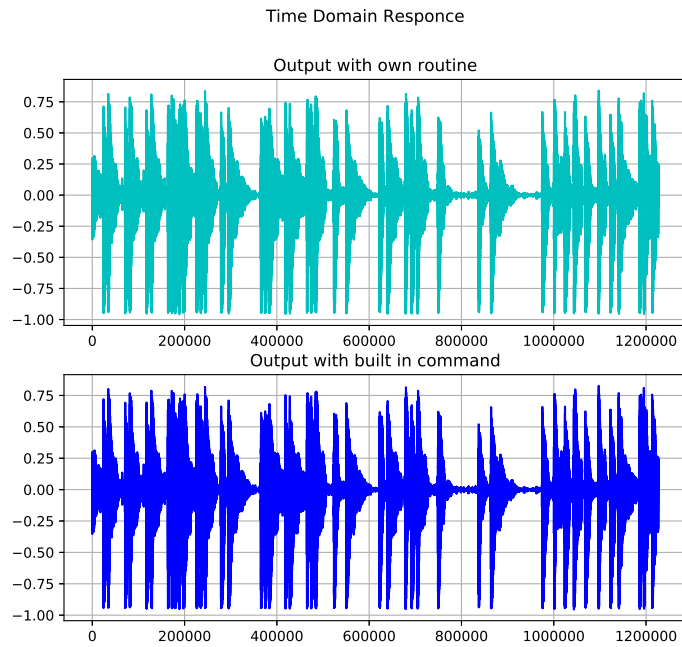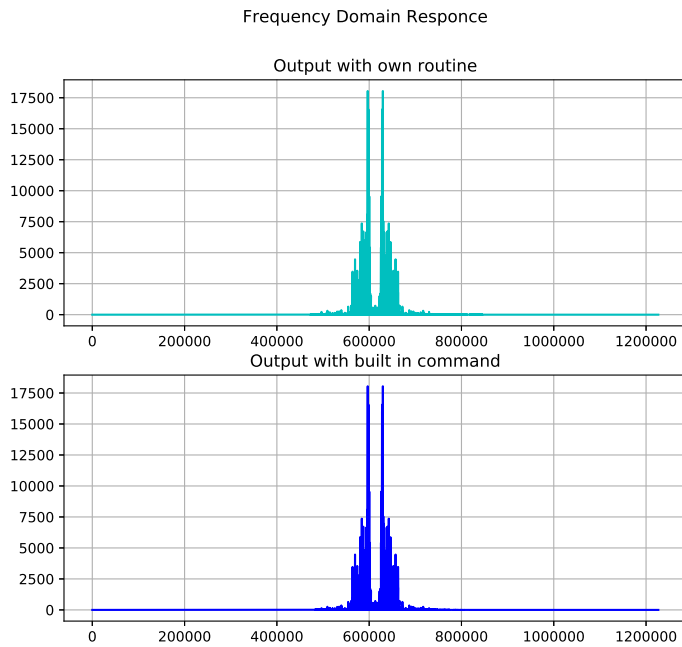Plotting the frequency domain response evaluated from both own routine and signal.filtfilt

Fig. 0: Time domain response

Fig. 0: Frequency domain response