EE3025 ASSIGNMENT- 1

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Download all python codes from

https://github.com/Aashrith20/IDP−3015/tree/main/codes

and latex-tikz codes from

https://github.com/Aashrith20/IDP−3015

1 Problem

The command

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

in Problem 2.3 is executed through following difference equation

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

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

Converting the difference equation into its z-transform equation

$$Y(z) \sum_{m=0}^{M} a(m)\, z^{-m} = X(z) \sum_{k=0}^{N} b(k)\, z^{-k} \tag{2.0.1}$$

where $X(z)$ and $Y(z)$ are the respective z-transforms of $x(n)$ and $y(n)$ respectively.
Property of z-transform used for conversion is

$$\mathcal{Z}\{x(n-k)\} = z^{-k} X(z) \tag{2.0.2}$$

From (2.0.1)

$$\frac{Y(z)}{X(z)} = \frac{\sum_{k=0}^{N} b(k)\, z^{-k}}{\sum_{m=0}^{M} a(m)\, z^{-m}} \tag{2.0.3}$$

$$\frac{Y(z)}{X(z)} = H(z) \tag{2.0.4}$$

$$H(z) = \frac{\sum_{k=0}^{N} b(k)\, z^{-k}}{\sum_{m=0}^{M} a(m)\, z^{-m}} \tag{2.0.5}$$

From the coefficients b,a and from (2.0.3) evaluating $H(K)$
Finding $X(K)$ from $x[n]$ by using in-built fft command

From

$$Y(K) = H(K)\, X(K) \tag{2.0.6}$$

Finding $y[n]$ from $Y(K)$ by using in-built ifft command
Python code for the above question

codes/ee18btech11035.py

Soundfile constructed from output signal y using defined filter

codes/7_1Sound_With_ReducedNoise.wav

3 Verification

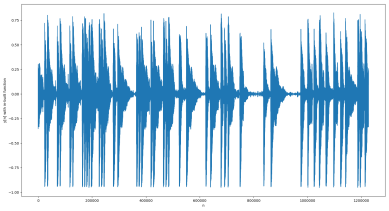

Fig. 0: Time domain response from signal.filtfilt command

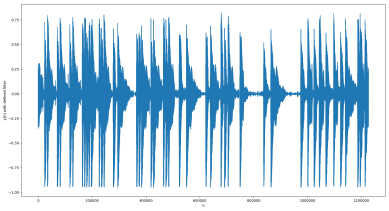

Fig. 0: Time domain response from defined filter

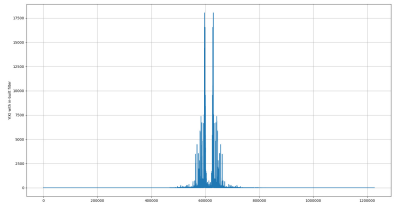

Fig. 0: Frequency domain response from signal.filtfilt command

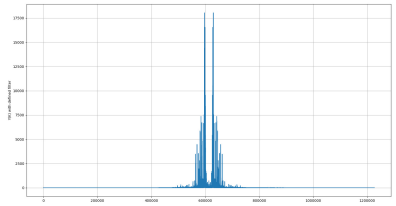

Fig. 0: Frequency domain response from defined filter

4 Computing using fft algorithm in C

First store the x[n] values in a.dat file and load in c program Below is the following python code for storing the data

codes/ee18btech11035−fft−data.py

Run the following code in C to get y[n]

codes/ee18btech11035−fft.c

Plotting the time domain output signal obtained from fft in C and constructing audio file

codes/ee18btech11035−fft−output.py

Below is the audio file for the above output y(n)

codes/7.1_Sound_With_ReducedNoise_using_c.wav

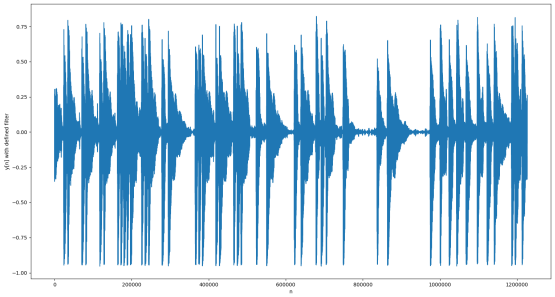

Fig. 0: Time domain response using c