Signal Processing - LAB 4 Report

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We solidify our concepts of the discrete time Fourier transform (DTFT) by numerically computing the DTFT's of different input signals and then we branch out into studying a few discrete-time LTI systems.

QUESTION 1

a) The function *X = DT_Fourier(x,N0,w)* is implemented using the formula:

$$X\left(e^{j\omega}\right) = \sum_{-\infty}^{\infty} x[n]e^{-j\omega n}$$

- x → discrete time signal of finite duration
- N_0 → location of the x[0] sample in the input array
- w → the frequency vector

The function should return the X , a complex vector corresponding to the DTFT.

b) Each signal has 4 plots each, corresponding to the magnitude, phase, real and imaginary parts of the DTFT of the signals.

c) The signal and its corresponding DTFT are plotted for the different values of b = 0.01, 0.5, 0.99

QUESTION 2

a,b) The impulse response of the moving average filter is a discrete-time LTI system.

2. a) $$y[n] = \frac{1}{M} \sum_{m=0}^{M-1} x[n-m]$$

For impulse response,

$$h[n] = \frac{1}{M} \sum_{m=0}^{M-1} \delta[n-m]$$

$$= \frac{1}{M} \left[\delta[n] + \delta[n-1] + \dots + \delta[n-M+1] \right]$$

$$= \frac{1}{M} \left(u[n] - u[n-M] \right)$$

c) The required plots are made and the noise signal v[n] is found using the *randn( )* function.

d) We use the convolution property to implement the system in MATLAB.

The convolution function *conv ( ),* is used to convolute the impulse response and the input signal to give the output signal of the system.

e) We notice that when M is changed, as M increases, the convolution output becomes more accurate to the original signal. However, the tradeoff in this case is that there is also a shift in the output when the value of M increases.

f) The DTFT plot of the noisy and filtered signal is plotted and compared.

g) The impulse response of this new systems is found.

Q. (g) $y[n] = x[n] - x[n-1]$

For impulse response,

$h[n] = \delta[n] - \delta[n-1]$

The same steps as before are taken to find the DTFT plots for this system.

QUESTION 3

a) The inverse DTFT of signals is found using the formula

$$x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\, e^{j\omega n}\, d\omega.$$

NOTE:

- I made a separate function script to find the inverse DTFT and called the function in the main script

The expected value of x[n] is complex, and hence the imaginary, real, absolute and phase of the signal are plotted.

b) The value of wc is varied and we notice that as wc approaches pi, the magnitude of the real part becomes 1.

c) The DTFT of the new band pass signal is plotted and observed