數位信號處理 (DSP) 2021/12/10

Homework #8 Due: Dec. 24, 2021 (Friday)

1. The impulse response of a FIR filter is, $h[n]=\{\overset{h[0]\downarrow}{-4}, 1, -1, -2, 5, 6, 6, 5, -2, -1, 1, -4\}$, $H(z)=\sum_{n=0}^{N-1} h[n]\cdot z^{-n}$ = z-transform of $h[n]$, also known as "system function" of the FIR filter. $H(e^{j\omega})=H(z)\big|_{z=e^{j\omega}}=\sum_{n=0}^{N-1} h[n]\cdot e^{-j\omega n}$ = DTFT of $h[n]$, also known as "frequency response function" of the FIR filter.

   (a). calculate and plot the magnitude and phase of the frequency response function, $H(e^{j\omega})$,

   (b). calculate and plot the amplitude function, $A(\omega)$, and phase function, $\theta(\omega)$, of $H(e^{j\omega})$,

   (c). determine and plot the pole-zero location of $H(z)$

   (d). let $A_k = A(\omega_k = k\cdot\frac{2\pi}{N})$, k = 0, 1, 2,.., N-1 (what is N in this case ?), derive the relationship between $h[n]$ and A_k which allows direct calculation of $h[n]$ from A_k. Verify this relation by substituting the numbers obtained in (b).

<u>Frequency Sampling Design Method</u>

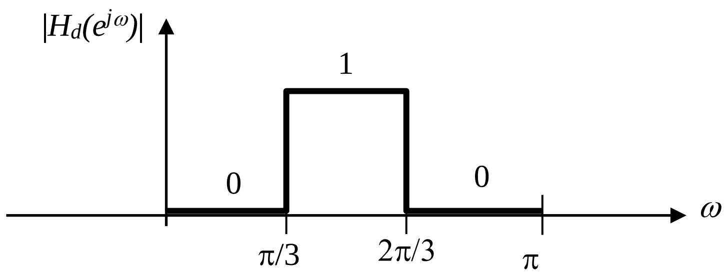
2. Please design a type I linear-phase FIR filter with the frequency sampling method. The $H_d(e^{j\omega})$ is shown below,

   (a). N = 41, no transition point

   (b). N = 41, with one transition point

   (c). N = 41, with two transition points

   List $h[n]$ and plot A_k and $H(e^{j\omega})$. Make comparison and comments on your results.



<u>Window Function Design Method</u>

3. Please design a type II linear-phase FIR filter with the window function method. The $H_d(e^{j\omega})$ is shown below,

   (a). N = 40, with Rectangular window

   (b). N = 40, with Hanning window function (c). N = 40, with Blackman window function

List $h[n]$ and plot A_k, and $H(e^{j\omega})$. Make comparison and comments on your results.