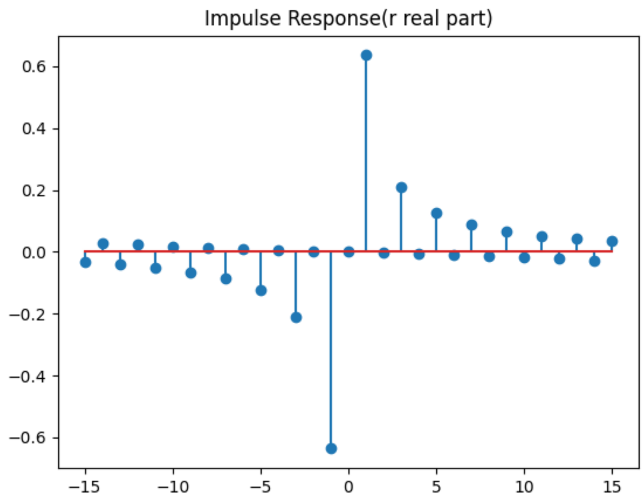
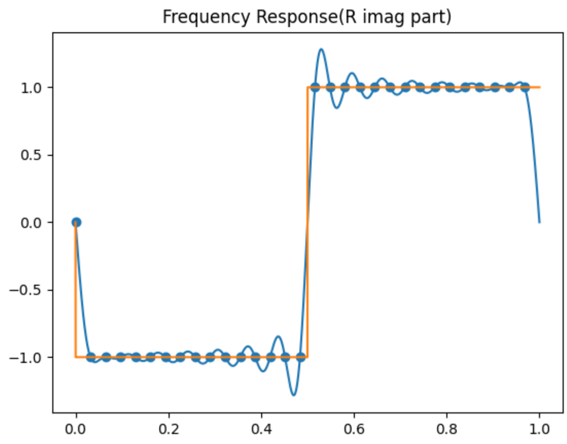
ADSP HW2 P10942A05 鄭閔軒

1. (2k+1)-point discrete Hilbert transform filter

In our python file, we can open it using **python DiscreteHilbert.py 15** the last parameter is an integer number of k





2、

(a) Two main advantages All the poles and all the zeros are within unit circle

(1) stable

(2) Casual

(b) No specific passband and stop band in Wiener Filter (designed base on the statistics of signal and noise)

c)

(1) No phase ambiguity

(2) Able to deal with delay problem

3. $$H(z) = \frac{2z^3+4z^2+z+2}{2z^2+z+1} = \frac{2(z-(-2))\left(z-\left(\frac{\sqrt{2}j}{2}\right)\right)\left(z-\left(-\frac{\sqrt{2}j}{2}\right)\right)}{2\left(z-\left(-\frac{1+\sqrt{7}j}{4}\right)\right)\left(z-\left(-\frac{1-\sqrt{7}j}{4}\right)\right)}$$

(a) Find the cepstrum

$$\frac{2\left(1-\left(-\frac{1}{2}z\right)\right)\left(1-\left(\frac{\sqrt{2}j}{2}\right)z^{-1}\right)\left(1-\left(-\frac{\sqrt{2}j}{2}\right)z^{-1}\right)}{\left(1-\left(-\frac{1+\sqrt{7}j}{4}\right)z^{-1}\right)\left(1-\left(-\frac{1-\sqrt{7}j}{4}\right)z^{-1}\right)}$$

$$\boxed{\begin{aligned} a_k &= \frac{\sqrt{2}}{2}j,\ -\frac{\sqrt{2}}{2}j \\ b_k &= -\frac{1}{2} \\ c_k &= -\frac{1\pm\sqrt{7}j}{4} \end{aligned}}$$

$$\hat{x}[n] = \begin{cases} \log 2 & n=0 \\ \dfrac{-\left(\frac{\sqrt{2}}{2}j\right)^n}{n} + \dfrac{-\left(-\frac{\sqrt{2}}{2}j\right)^n}{n} + \dfrac{\left(\frac{-1+\sqrt{7}j}{4}\right)^n}{n} + \dfrac{\left(\frac{-1-\sqrt{7}j}{4}\right)^n}{n} & n>0 \\ \dfrac{\left(-\frac{1}{2}\right)^{-n}}{n} & n<0 \end{cases}$$

(b)

$$H(z) = \frac{z(\cancel{z-(-2)})(z^2+0.5)}{z(z^2+\frac{1}{2}z+\frac{1}{2})} \times -2\,\frac{z-(-\frac{1}{2})}{\cancel{z-(-2)}}$$

$$= -\frac{4z^3+2z^2+2z+1}{2z^2+z+1}$$

4.

(a) even symmetric

(i) Notch filter (ii) smoother (vi) 2 time of differations

(b) odd symmetric

(iii) edge detectors

(v) 3 times of integrals.

5.

$$y[n] = \alpha_1 x[n] + \alpha_2 x[n-30] + \alpha_3 x[n-40] + \alpha_4 x[n-50]$$

$$p[n] = \alpha_1 \delta[n] + \alpha_2 \delta[n-30] + \alpha_3 \delta[n-40] + \alpha_4 \delta[n-50]$$

$$P[z] = \alpha_1 \left(1 + \frac{\alpha_2}{\alpha_1} z^{-30} + \frac{\alpha_3}{\alpha_1} z^{-40} + \frac{\alpha_4}{\alpha_1} z^{-50}\right)$$

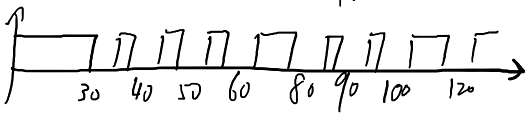
$$\left(\log(1+t) = \sum_{k=1}^{\infty} \frac{(-1)^{k-1}}{k} t^k \right)$$

$$\hat{p}(z) = \log\left(1+\frac{\alpha_2}{\alpha_1}z^{-30}+\frac{\alpha_3}{\alpha_1}z^{-40}+\frac{\alpha_4}{\alpha_1}z^{-50}\right)+\log$$

$$t = \frac{\alpha_2}{\alpha_1}z^{-30}+\frac{\alpha_3}{\alpha_1}z^{-40}+\frac{\alpha_4}{\alpha_1}z^{-50}$$

$$\hat{p}(z) = \sum_{k=1}^{\infty}(-1)^{k+1}\frac{\left(\frac{\alpha_2}{\alpha_1}z^{-30}+\frac{\alpha_3}{\alpha_1}z^{-40}+\frac{\alpha_4}{\alpha_1}z^{-50}\right)^k}{k}+\log\alpha_1$$

$$\hat{p}[n] = \sum_{k=1}^{\infty}(-1)^{k+1}\left[\frac{(\frac{\alpha_2}{\alpha_1})^k}{k}\delta(n-k\cdot 30)+\frac{(\frac{\alpha_3}{\alpha_1})^k}{k}\delta(n-k\cdot 40)+\frac{(\frac{\alpha_4}{\alpha_1})^k}{k}\delta(n-k\cdot 50)\right]+\log\alpha_1$$

lifter 

6、

1. Since $\sum_k |X[k]|^2 B_m[k]$ 有更低机率為0 減少 $l(0)=-\infty$

2. 因 $\sum_k |X[k]|^2 B_m[k]$ 為實數 解決 phase ambigui- problem

3. $B_m[k]$ 和人體對聲音感知相似

4 利用DCT 取代 IFT 減少運算

7、

(1) $\log(0) \to -\infty$

(2) $\log(e^{j\phi}) = j(\phi+2\pi N)$ N可為任意整數，導、phase ambiguity

8.

(a) $\cos(1800\pi t)$ sounds louder than others.

(b) low frequency vocal signal (i) propagates longer

尾數 0.5

$X_a(F) = X(F)$ for $F = 0$