ADSP HW1

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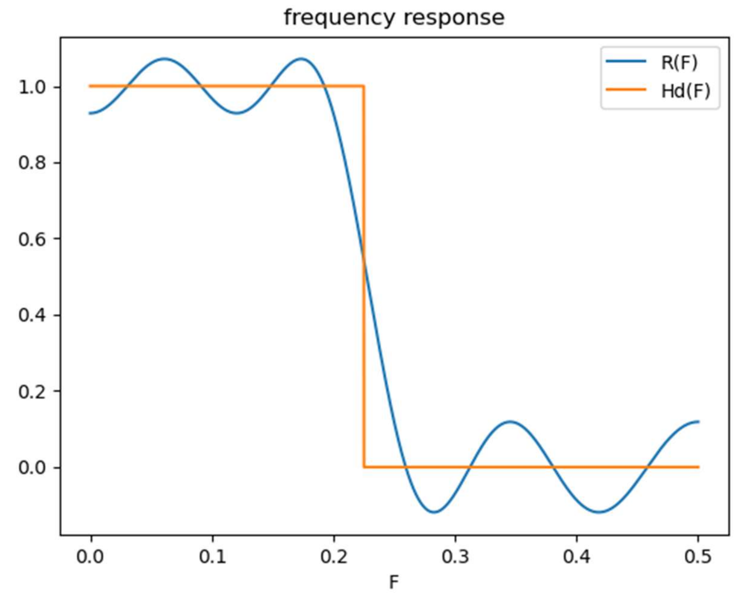
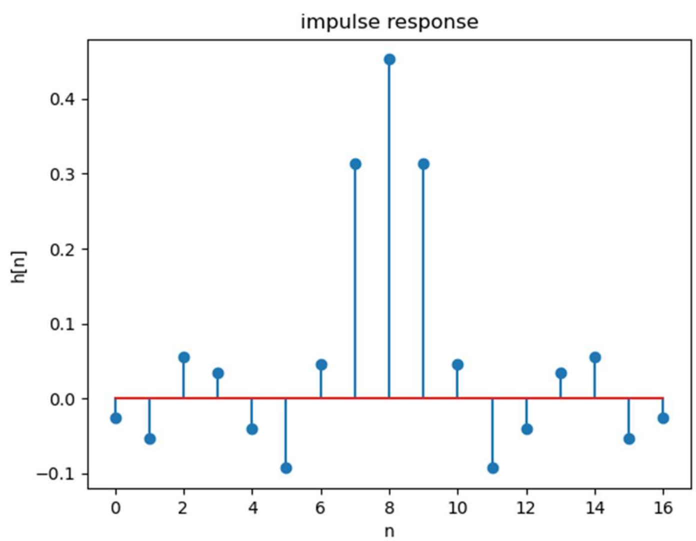
(1)



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iteration  1  max error =  [0.17144926]
iteration  2  max error =  [0.07887961]
iteration  3  max error =  [0.07125551]
iteration  4  max error =  [0.07120729]
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(2)

(2)

$y[n]=x[n]*(0.8^n u[n]+0.5^n u[n])$ ，令 $h[n]=0.8^n u[n]+0.5^n u[n]$

$$\Rightarrow H(z)=\sum_{n=-\infty}^{\infty} h[n]z^{-n}=\sum_{n=-\infty}^{\infty}(0.8^n u[n]+0.5^n u[n])z^{-n}=\sum_{n=0}^{\infty}(0.8^n+0.5^n)z^{-n}$$

$$=\sum_{n=0}^{\infty}(0.8z^{-1})^n+\sum_{n=0}^{\infty}(0.5z^{-1})^n=\frac{1}{1-0.8z^{-1}}+\frac{1}{1-0.5z^{-1}}=\frac{2-1.3z^{-1}}{(1-0.8z^{-1})(1-0.5z^{-1})}$$

$$Y(z)=X(z)H(z)=\frac{2-1.3z^{-1}}{(1-0.8z^{-1})(1-0.5z^{-1})}X(z)\Rightarrow Y(z)\cdot(1-1.3z^{-1}+0.4z^{-2})=X(z)\cdot(2-1.3z^{-1})$$

inverse

$$\Rightarrow y[n]-1.3y[n-1]+0.4y[n-2]=2x[n]-1.3x[n-1]$$

$$\Rightarrow y[n]=1.3y[n-1]-0.4y[n-2]+2x[n]-1.3x[n-1]$$ #

(3) (a) two main advantages :

① good for spectrum analysis

② 可以把 convolution 變成乘法，以減少運算量及分析上的複雜度

convolution -> multiplication

$y(t)=x(t)*h(t)$ $Y(f)=X(f)H(F)$

(b) two main problems :

① not real operation，複數乘法的運算量是實數乘法的四倍，不利於運算

② irrational number multiplication

(4)

(4)

$f_s=\frac{1}{0.002}=500\,Hz$, $N=2000$

(a) $m=200$ $\therefore f=m\frac{f_s}{N}=200\times\frac{500}{2000}=50\,Hz$ #

(b) $m=1600>\frac{N}{2}=1000$ $\therefore f=1600\times\frac{500}{2000}-500=-100\,Hz$ #

(5)

(a) Step invariant 透過做積分的方式來壓低頻率較高的成分，以減小 aliasing effect 的影響

(b) bilinear transform 利用 mapping function(arctan)強制將頻率限制在 $\pm\frac{f_s}{2}$ 之間，使訊號在做取樣時不會產生 aliasing effect

(6)

(a) usually even : (i) Notch filter, (ii) highpass filter, (v) differentiation 4 times

(b) usually odd : (iii) edge detector, (iv) integral

(7)

(1)

$$S[0] = \int_{-\frac{1}{2}}^{\frac{1}{2}} H_d(F)dF = \int_{-0.25}^{0.25} dF = 0.5$$

$$S[n] = 2\int_{-\frac{1}{2}}^{\frac{1}{2}} \cos(2\pi nF) H_d(F)dF = 2\int_{-0.25}^{0.25} \cos(2\pi nF)dF = 2\cdot\frac{1}{2\pi n}\sin(2\pi nF)\Big|_{-0.25}^{0.25}$$

$$= \frac{1}{\pi n}\cdot\left(\sin\left(\frac{\pi n}{2}\right) - \sin\left(\frac{-\pi n}{2}\right)\right) = \frac{2\sin\left(\frac{\pi n}{2}\right)}{\pi n}$$

$$k = \frac{7-1}{2} = 3$$

$$\therefore h[k] = h[3] = 0.5$$

$$h[k+n] = h[3+n] = \frac{S[n]}{2},\ h[k-n] = h[3-n] = \frac{S[n]}{2} \text{ for } n = 1,2,3$$

$$\Rightarrow h[4] = h[2] = \frac{S[1]}{2} = \frac{2\sin\left(\frac{\pi}{2}\right)}{\pi} = \frac{2}{\pi}$$

$$h[5] = h[1] = \frac{S[2]}{2} = \frac{2\sin(\pi)}{2\pi} = 0$$

$$h[6] = h[0] = \frac{S[3]}{2} = \frac{2\sin\left(\frac{3\pi}{2}\right)}{3\pi} = \frac{-2}{3\pi}$$

$$h[3] = 0.5$$

Also, $h[n] = 0$ for $n < 0$ and $n \geq 7$ #

學號尾數 7 的 bonus 問題：

Least MSE, mini-max 哪個方法所設計出的濾波器比較穩定？也就是說誤差可控制在一個範圍內？(平均而言誤差比較小)

答：Least MSE，其關心的是最小化平均誤差