數位信號處理導論 (DSP) 2021/10/14

Homework #4 Due: Oct. 27, 2020 (Wednesday)

Fast Fourier Transform, FFT

1. Please establish your computing capability for DFT, inverse DFT (IDFT), FFT, and inverse FFT (IFFT). You may write down your own computer program (in MATLAB, for example) for DFT and IDFT, and you can find out some available programs for FFT and IFFT (in MATLAB, for example) which you can directly use.

(a). $h(t)= cos(2\pi t)$ is sampled with $T=0.1$ and yield a digital sequence $h[n]=h(nT)$, $n = 0,1,2,3,\ldots,15$, (i.e. N=16). Please calculated the FFT of $h[n]$ and plot the results. (the amplitude and phase of $H[k]$)

(b). redo (a) with n = 0, 1, 2, 3,…, 31, (i.e. N=32)

(c). for (a) and (b), compare your results from DFT and FFT algorithms, are they the same?

(d) for (a) and (b), do inverse DFT and inverse FFT on $H[k]$ to recover the $h[n]$, can you get the original $h[n]$ back?

2. It is understood that the computer speeds for DFT and FFT can be different by a factor of

$$\frac{N^2}{\frac{N}{2}\log_2 N}=\frac{2N}{\log_2 N}=\frac{2N}{p}=\begin{cases}200, & for\ N=2^{10}=1024\\ 700, & for\ N=2^{12}=4096\\ 2300, & for\ N=2^{14}=16384\\ 8000, & for\ N=2^{16}=65536\end{cases}$$

Can you test in your computer to verify this estimation?