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Real-time Digital Signal Processing Laboratory

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Lab 5

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Dey 01

Contents

Abstract

In this lab we shall firstly perform hand analysis on the **DFT** of a given wave, then we shall compute the **FFT** of three signals using a C program and plot the results using MATLAB.

1 Fourier Transform of part 6-4-2 wave

We shall compute the DFT of the following signal.

$$x[n] = \sin\left(2\pi \times 2000 \times \frac{n}{16000}\right)$$

The **DFT** is as follows.

$$DFT\left[x[n]\right] = \sum_{i=0}^{n-1} x[n] e^{-\frac{j2\pi n}{N}k} = \sum_{i=0}^{n-1} \sin\left(2\pi \times 2000 \times \frac{n}{16000}\right) e^{-\frac{j2\pi n}{N}k}$$

$$\longrightarrow \sum_{i=0}^{n-1} \sin\left(2\pi \times 128 \times \frac{n}{1024}\right) e^{-\frac{j2\pi n}{N}k} = \frac{1}{2j} \sum_{i=0}^{n-1} e^{-\frac{j2\pi n}{N}(k-128)} - e^{-\frac{j2\pi n}{N}(k+128)}$$

$$DFT\left[x[n]\right] = \begin{cases} \frac{N}{2j}, & k = 128, 896 \\ 0, & O.W \end{cases}$$

2 FFT of signals with C and plotting with MATLAB

In this part we used a C program to calculate the **FFT** of the signals included below then we went to plot then using MATLAB.

$$x[n] = \sin\left(2\pi \times 2000 \times \frac{n}{16000}\right)$$
$$x[n] = \cos\left(2\pi \times 2000 \times \frac{n}{16000}\right)$$
$$x[n] = exp\left(j \times 2\pi \times 2000 \times \frac{n}{16000}\right)$$

2.1 Plot for $\sin\left(2\pi \times 2000 \times \frac{n}{16000}\right)$

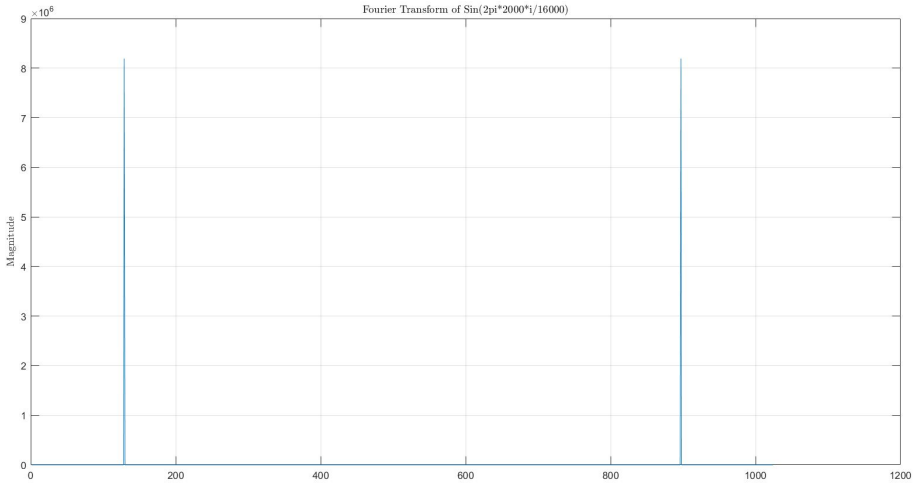

Figure 1: $\mathcal{FFT}\left(\sin\left(2\pi \times 2000 \times \frac{n}{16000}\right)\right)$

2.2 Plot for $\cos\left(2\pi \times 2000 \times \frac{n}{16000}\right)$

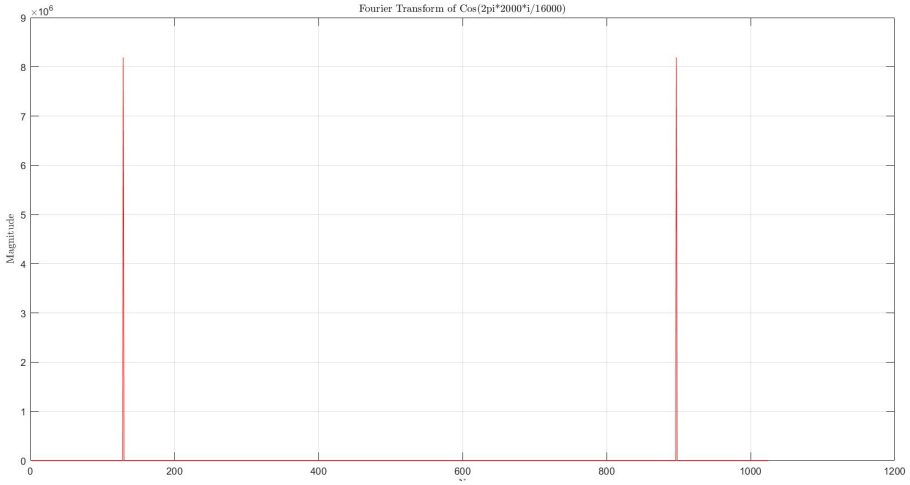

Figure 2: $\mathcal{FFT}\left(\cos\left(2\pi \times 2000 \times \frac{n}{16000}\right)\right)$

2.3 Plot for $\exp\left(j \times 2\pi \times 2000 \times \frac{n}{16000}\right)$

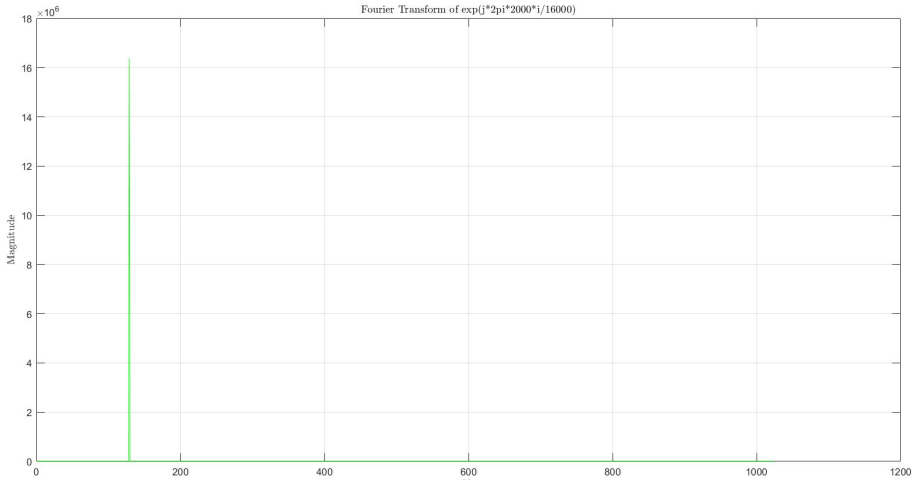

Figure 3: $\mathcal{FFT}\left(exp\left(j \times 2\pi \times 2000 \times \frac{n}{16000}\right)\right)$

References

[1] Vahid Shah-Mansouri, *Real-time Digital Signal Processing Laboratory lab notes, Fall 01*

[2] Mohammad Ali Akhaee, *Digital Signal Processing lecture notes, Spring 01*