Processamento Digital de Sinais
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Lista de exercícios 4 – Transformada Discreta de Fourier (DFT)

P5.1 Compute the DFS coefficients of the following periodic sequences using the DFS definition, and then verify your answers using MATLAB.

1. $\tilde{x}_1(n) = \{4, 1, -1, 1\}$, $N = 4$
2. $\tilde{x}_2(n) = \{2, 0, 0, 0, -1, 0, 0, 0\}$, $N = 8$
3. $\tilde{x}_3(n) = \{1, 0, -1, -1, 0\}$, $N = 5$
4. $\tilde{x}_4(n) = \{0, 0, 2j, 0, 2j, 0\}$, $N = 6$
5. $\tilde{x}_5(n) = \{3, 2, 1\}$, $N = 3$

P5.3 Let $\tilde{x}_1(n)$ be periodic with fundamental period $N = 40$ where one period is given by

$$\tilde{x}_1(n) = \begin{cases} 5\sin(0.1\pi n), & 0 \le n \le 19 \\ 0, & 20 \le n \le 39 \end{cases}$$

and let $\tilde{x}_2(n)$ be periodic with fundamental period $N = 80$, where one period is given by

$$\tilde{x}_2(n) = \begin{cases} 5\sin(0.1\pi n), & 0 \le n \le 19 \\ 0, & 20 \le n \le 79 \end{cases}$$

These two periodic sequences differ in their periodicity but otherwise have the same nonzero samples.

1. Compute the DFS $\tilde{X}_1(k)$ of $\tilde{x}_1(n)$, and plot samples (using the `stem` function) of its magnitude and angle versus k.
2. Compute the DFS $\tilde{X}_2(k)$ of $\tilde{x}_2(n)$, and plot samples of its magnitude and angle versus k.
3. What is the difference between the two preceding DFS plots?

P5.10 Plot the DTFT magnitude and angle of each of the following sequences using the DFT as a computation tool. Make an educated guess about the length N so that your plots are meaningful.

1. $x(n) = (0.6)^{|n|}\,[u(n+10) - u(n-11)]$.
2. $x(n) = n(0.9)^n\,[u(n) - u(n-21)]$.
3. $x(n) = [\cos(0.5\pi n) + j\sin(0.5\pi n)][u(n) - u(n-51)]$.
4. $x(n) = \{1, 2, 3, \underset{\uparrow}{4}, 3, 2, 1\}$.
5. $x(n) = \{-1, -2, -3, \underset{\uparrow}{0}, 3, 2, 1\}$.

P5.33 Given the following sequences $x_1(n)$ and $x_2(n)$:

$$x_1(n) = \{2, 1, 1, 2\}, \quad x_2(n) = \{1, -1, -1, 1\}$$

1. Compute the circular convolution $x_1(n)$ N $x_2(n)$ for $N = 4$, 7, and 8.
2. Compute the linear convolution $x_1(n) * x_2(n)$.
3. Using results of calculations, determine the minimum value of N necessary so that linear and circular convolutions are same on the N-point interval.
4. Without performing the actual convolutions, explain how you could have obtained the result of P5.33.3.

P5.38 An analog signal $x_a(t) = 2\sin(4\pi t) + 5\cos(8\pi t)$ is sampled at $t = 0.01n$ for $n = 0, 1, \ldots, N-1$ to obtain an N-point sequence $x(n)$. An N-point DFT is used to obtain an estimate of the magnitude spectrum of $x_a(t)$.

1. From the following values of N, choose the one that will provide the accurate estimate of the spectrum of $x_a(t)$. Plot the real and imaginary parts of the DFT spectrum $X(k)$.
   (a) $N = 40$, (b) $N = 50$, (c) $N = 60$.

2. From the following values of N, choose the one that will provide the least amount of leakage in the spectrum of $x_a(t)$. Plot the real and imaginary parts of the DFT spectrum $X(k)$. (a) $N = 90$, (b) $N = 95$, (c) $N = 99$.

Fonte: Ingle/Proakis, Digital Signal Processing Using Matlab - 3ª Edição.