Processamento Digital de Sinais
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Introduction to MatLab

Matlab is an interpreted programming language that allows an easy manipulation of matrices and vectors. Furthermore, it also has a set of powerful toolboxes for specific areas such as Signal Processing, System Control, Optimization, Statistics or Neural Networks.

This Lab work aims to provide a hands on introduction to the manipulation and visualization of discrete signals with Matlab. This work is not evaluated.

Experimental work

1. Create three vectors with samples of the following finite signals and visualize them.

   (a) $x(n) = \begin{cases} 1 & 0 \leq n \leq 63 \\ 0 & 64 \leq n \leq 127 \end{cases}$ x=[ones(1,128) zeros(1,128)];

   (b) $y(n) = \cos(\omega n), \ \ n = 0, \ldots, 127, \ \ \omega = 0.1\pi$ n=0:127; w=0.1*pi; y=cos(w*n);

   (c) $z(n) = e^{-an}, \ \ n = 0, \ldots, 127, \ \ a = 0.05$ n=0:127; a=0.05; y=exp(-a*n);

   Comment: you can use the command plot() to visualize data and the command axis() to control the axis parameters. You can represent data with a solid line, marks or both. Suggestion: plot(n,y,n,y,'o');

2. Consider the following segments of sinusoids

   (a) $x(n) = \cos(\frac{2\pi}{128} \times 5n), \ \ n = 0, \ldots, 127$

   (b) $y(n) = \cos(0.5n), \qquad n = 0, \ldots, 127$

   Visualize them and check if any of them is periodic (assuming that it extends from $-\infty$ to $+\infty$).

3. The discrete Fourier transform represents any finite signal $x(n)$, with length N, into a sum of N harmonic complex exponentials with coefficients $X(k)$. The Fourier transform computes the coefficients $X(k)$ and can be obtained using the Matlab function fft(): X=fft(x,N).

   Compute the discrete Fourier transform of the two sinusoids defined in the previous problem and visualize the module and phase of $X(k), Y(k)$ using w=2*pi*(0:N-1)/N; plot(w,abs(X)); plot(w,angle(X));

   (a) check if you obtain large peaks close to the sinusoid frequency ω and close to $2\pi - \omega$. The spectrum of amplitude is symmetric with respect to π.

   (b) try to explain why one of the sinusoids has all the coefficients equal to zero (except 2 of them) while the other has non-zero coefficients.

4. Represent in the same window two plots: the sinusoid $x(n) = \cos(\omega n), \ \ n = 0, \ldots, 255$ and the module of the Fourier coefficients. Assume the following values for the sinusoid frequency: $\frac{2\pi}{8}k$ with $k = 1, \ldots, 15$. Explain the behavior of the two spectral peaks.

   Suggestion: use a cycle (for k=1:15, ... end) to change the frequency value and use the subplot(211), subplot(212) commands to display multiple plots in the same window.