Spectral estimation methods

Lab 11, SDP

Objective

Students should use some well-known spectral estimation methods and one of its applications.

Theoretical notions

Exercises

1. Find the average value and the autocorrelation function of the signal $x[n]$ obtained as the output of an ARMA(1,1) random process with the following difference equation:

$$x[n] = \frac{1}{2}x[n-1] + w[n] + w[n-1],$$

   where $w[n]$ is white noise with variance σ_w^2 and average value 0.

2. The autocorrelation function of an AR random process $x[n]$ is:

   $\gamma_{xx}[m] = \frac{1}{4}^m$.

   Find the difference equation of the random process $x[n]$. Is this unique? If not, find more than one possible solution.

3. In Matlab, create a script file which implements a live spectrum analyzer.

   a. Load the signal `music.wav` with the function `audioread()`.
   b. Use the function `buffer()` to split the signal into windows of length 30ms.
   c. Use the functions `psd()` and `spectrum.periodogram()` to estimate and plot, successively,the spectrum of each window signal.

d. Localize and plot the dominant frequency from the spectrum of each window. Convert the frequency to the corresponding musical note and output it.
e. Repeat the previous requirements, but replace the periodogram method with the Yule-Walker method (`spectrum.yulear()`).

Final questions

1. TBD