**实验报告三交报告时间：before 2024.06.09(Wed) 23:59:59**

**Task list:**

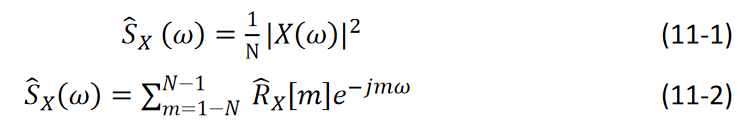
**Basic 1 (40 points)** : A random signal

where =100, =150, is zero mean White Gaussian Noise.

1. Under =0.1, generate the signal for 2s (signal length), and use appropriate sample rate to do the sampling. Plot the Periodogram with different window (rectangular and hamming), and compare the results, describe the differences.

2) Analyze the effects of sampling rate, signal length, FFT length and the value of (now you can change the value of ) on the estimation of the power spectrum using the Periodogram.

3) According to (11-1) and (11-2), design your own Periodogram and Correlogram function (write the function in Matlab yourself). Replace these two functions with the default Periodogram function in 2), and plot the figures/tables in 2) using your own Periodogram and Correlogram, and show the comparison between your own Periodogram and Correlogram function and the default Periodogram function in 2):



* **Requirement**：You should submit your codes that can generate the figures in 3). The codes should be runnable!

**Basic 2 (20 points)**: Now the signal becomes

where =100, =150, is zero mean White Gaussian Noise with . is the interference, and uniformly distributed in [50, 80]

1) Set =0.1 and use appropriate sample rate to do the sampling. For M=100 runs, in each run, generate the signal for 2s, compute the periodogram (11-1) (use this only, do not use the default periodogram of Matlab), and take the average of these M runs to get the power spectrum. Plot the periodogram of the 1st, 50nd, 100nd run and the power spectrum. (there are totally four figures).

2) Show the power spectrum result for different and provide analysis. (at least select 4 values of , at least one should be small so that will not effect the observation of , and at least one should be large so that it is hard to observe ).

* **Requirement**：you should submit your codes that can generate the figures in 1). The codes should be runnable!

**Advance (40 points)**:

A chirp signal (𝑡) = , where =1000Hz, =12000Hz, and the signal starts from 0 to 0.1s (). The frequency of chirp signal will change with time. Here we use a sampling frequency 50000Hz.

The chirp signal is sent out by a radar, and reflected by a target. We ignore any attenuation here, and assume that we receive a signal , where is a shift of 𝑋(𝑡). The duration of is also 0.1s, but the end point is located between 0.11s and 1s in receiving system, or says, following a uniform distribution between [0.11, 1]. (in many radar, a ultra close target cannot be detected). You are required to:

(Hint: you can use the chirp signal (𝑡) with time shifting to get .)

1) Design a matched filter for chirp signal in Matlab. Use this matched filter to estimate the end time of this signal; and test it under different signal-to-noise ratios (SNR = ), where is the average power spectrum. SNR should be designed by yourself. Finally, calculate the MSE and success rate of this system. **(25 points)**

Formula Definition:

a. MSE = , is estimated time, is true time

b. Success rate P =K/N, when <0.03s, it is successful, otherwise, it is failed. K represent the number of successes.

In the above, N is the number of tests, you can use .

* **Requirement**：You are required to submit your code, and your code should directly give all the tables or figures in 1.2).

1.1) Please plot your system flow chart in your report.

1.2) Give your MSE and success rate results, and analysis, under different SNR. (Hint: use table or figure, and you should choose an SNR range that can at least see ‘100% success’ and ‘100% fail’)

2) Note that 1) is based on the ‘match filter’. Now, assume that you did not send out any signal, but a target sent out such a signal. And, you do not know what signal the target sent, but you know that the duration is 0.1s. The end time of the signal is still in [0.11, 1]. Please use the periodogram (can use the Matlab default one or yours) to detect the end time of the signal, test it under different signal-to-noise ratios, and calculate the MSE and success rate of this new method. **(15 points)**

* **Requirement**：You are required to submit your code, and your code should directly give all the tables or figures in 2.2).

1.1) Please plot your algorithm flow chart in your report.

1.2) Give your MSE and success rate results, and analysis, under different SNR, and compare the results with 1). (Hint: use table or figure, and you should choose an SNR range that can at least see ‘100% success’ and ‘100% fail’)