**Experimental Report 2 - Task List:**

**交实验报告时间：2024.05.11（周六）23:59:59前**

**Basic 1 (10 points)**:

A random signa, where=60Hz, =150Hz, 𝑁(𝑡) is white Gaussian Noise with mean 0 and variance =0.1. Generate a signal sampled at 1 kHz for 3 seconds. Plot the signal, and the autocorrelation , and Cross-Correlation . ( Hint : see practice 1, 2.)

* **Requirement**：

1. Please provide your code, they must be runnable (no error, warning accepted), otherwise, 0 point. All figures should be come with titles.
2. Your code should be run on Matlab, and give the figures on your report.

**Basic 2 (40 points)**:

construct a sinusoidal signal with Gaussian noise, such as , where is white Gaussian noise with mean 0 and variance = 0.1, and you can choose other parameters (for example, frequency , phase , sampling rate, sampling time, etc.).

* Use characteristics of **autocorrelation** to estimate your signal frequency. (Hint: )
* For =0.5, 1, 5 (you can try more), plot the figure of Autocorrelation for one run.
* Test the accuracy of **your estimation of signal frequency** using autocorrelation for **100 independent runs**, show the results using table(s) or figure(s), and give analysis.
* **Requirement**：

1. Your code must be runnable (no error, warning accepted), otherwise, 0 point. All figures should be come with titles.
2. Explain why it is possible to estimate the **signal frequency** through **autocorrelation**.
3. Output the figures, and give analysis.

**Advance Part 1(20 points)**:

Follow the settings of 4 microphones with (SNR=30/10/-10, Is\_add\_special\_noise=0) {microphone locations: (0,0)m, (20,0)m, (0,10)m and (20,10)m; source located at (1,1)m}:

* **Requirement**：

1. Correctly add the signals from the 4 microphones with correctly estimated lags (this is your method), explain your method with necessary texts, equations, and/or flowchart.

Hint:

1. you can calculate the cross-correlation between microphones 1&2, 1&3 and 1&4, and move the signal received from microphones 2,3,4 by delaying some samples or adding some zeros; and then you can sum them up to get a good clean speech.
2. Therefore, you should change the ‘main.m’ file to achieve this task.

2. Show the figures under 3 SNR cases (SNR = 30,10,-10dB)

2.1. The four signals received from 4 microphones, with four colors, in one figure. (Please refer to page 25 in ‘Lesson 7 experiment.pdf’)

2.2. The signal the after ‘correctly add the signals from the 4 microphones with correct lags ’. (Please refer to page 27 in ‘Lesson 7 experiment.pdf’)

3. Give necessary analysis

**Advance Part 2(30 points)**:

You are given 8 microphones, with id = 0:1:7. These microphones are located at (0, 0+0.085\*id)m. The source is now located at least 60 meters away. (It is far field source in engineering). The sampling rate of the signal is . (use the sound signal given)

* **Requirement**：

1. With only microphones with id 0 and 1(two microphones), use cross-correlation to calculate the lag (range: [-11, 11]). Please list the corresponding DOAs for all lags from -11 to +11 in one table. (there are totally 23 numbers)

2. Now, assume that the signal comes from one of the 23 DOAs from above (randomly in every independent run), together with random Gaussian noise (zero mean), and now you are going to estimate the DOA! Design your main function to describe this system as well as your method to estimate the DOA. Please give the flow chart of your program, the estimation result (correct detection percentage\* or other indicators) of the DOA versus SNR(dB), and your analysis.

\*: if the estimated DOA is exactly equals to the true DOA, this is one correct detection. In 1000 independent runs, if correct 980 times, then the correct detection percentage is 0.98; 1.0 correct detection percentage means the methods can correctly estimate the DOA in this SNR case.

Note that the larger the SNR, the higher the ‘correct detection percentage’

3. Now, assume that the signal comes from one of the 23 DOAs from above (randomly in every independent run), together with random Gaussian noise (zero mean), and now you are going to estimate the DOA using all the 8 microphones! Design your main function to describe this system as well as your method to estimate the DOA. Please give the flow chart of your program, the estimation result (correct detection percentage or other indicators) of the DOA versus SNR(dB), and your analysis. Note that you can compare your result here to point 2 above and give analysis.

**Extra part 2(10 points)**:

You are given 8 microphones, with id = 0:1:7. These microphones are located at (0, 0+0.085\*id)m. The source is now located at least 60 meters away. (It is far field source in engineering). The sampling rate of the signal is . (use the sound signal given).

Now, assume that the signal comes from (randomly in every independent run), as describe above, the grid base method can only estimate 23 DOAs. If the real DOA is not in the 23 DOA grid, the error will be large! Is there any method to get better estimation? Please try it and give your result, **including flow chart of your program, explanation of your method, the estimation result (correct detection percentage or other indicators) of the DOA versus SNR(dB), and your analysis.**