Digital Signal Processing Homework w1

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***Abstract*—Based on python environment, load the four different signal and hyrbrid it with the noise that produced from a given length, mean and standard deviation. Then visualized those results and calculate the Signal-to-noise ratio to make a comparsion before hybrid the noise and after.**

I. Introduction

Signal-to-noise ratio is indicator that higher SNR value represent the more available signal. In this experiement we use RMS(roos mean square) amplitude to calculate SNR value, the hybrid the four original signal with different noise which show in Table I, based on Table I we have the conclusion that orignal signal have more amplitude variation will have higher SNR value that mean have more available signal.

II. Methodology

A. Signal Hybrid

First of all load four different signal to generate two dimension array, then produce a random two dimension array and hybrid the signal and noise.After that use waveform plot to see the results. Formula(1) is the definition of standard deviation we use in producing noise.

$$\sigma \equiv \sqrt{E[(X-\mu)^2]} = \sqrt{\int_{-\infty}^{+\infty}(x-\mu)^2 f(x)dx}$$
$$= \sqrt{E[X^2]-(E[X])^2} \quad (1)$$

Formula(2) is the definition of Signal-to-noise ratio, where P is average power.

$$SNR = \frac{P_{signal}}{P_{noise}} = \frac{A^2_{signal}}{A^2_{noise}} \quad (2)$$

The Ampltiude mentioned in Formula(2) use RMS(Root mean square) Ampltiude which help to find the effective value of amplitude.

$$x_{rms} = \sqrt{\frac{1}{n}(x_1^2 + x_2^2 + \ldots + x_n^2)} \quad (3)$$

III. Results

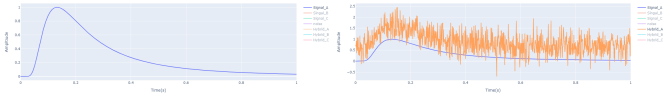

Fig. 1. **Left** : singal A, **Right** : signal A and hybrid with noise
Signal-to-noise ration in Fig 1 SNR is = 0.5654663065721135

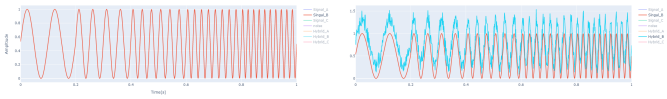

Fig. 2. **Left** : singal B, **Right** : signal B and hybrid with noise
Signal-to-noise ration in Fig 2 SNR is = 0.850442425007969

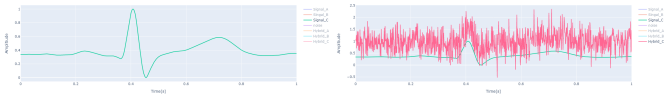

Fig. 3. **Left** : singal C, **Right** : signal C and hybrid with noise
Signal-to-noise ration in Fig 3 SNR is = 0.5699736641414874

IV. Discussion

Based on Table I we can see Hybrid B' Signal-to-noise ratio have higher value than the others in all test condtions, so we look back to the original signal input find out that signal B have much more higher amplitude variation than the others. In this situation, we make a assumption that signal have higher amplitude variation will affect the SNR value which means available signal take more precentage in hybrid signal. Based on the original signal A, B, C, D, the amplitude variation sort from high to low are B, D, C, A.Then we found out on noise1 test case, SNR value sort from high to low are Hybrid B, Hybrid D, Hybrid C, Hybrid A, and also happen in noise 2, 3, 4, 5.

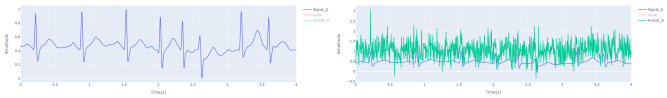

Fig. 4. **Left** : singal D, **Right** : signal D and hybrid with noise
Signal-to-noise ration in Fig 3 SNR is =0.6677983924005297

	noise1	noise2	noise3	noise4	noise5
mean,std	0.6,0.4	3,1	0.5,0.25	3,3	0.5,1.5
Hybrid A	0.565466	0.128944	0.722688	0.095970	0.248516
Hybrid B	0.850442	0.193928	1.086899	0.144336	0.3737597
Hybrid C	0.569973	0.129972	0.728449	0.096735	0.2504969
Hybrid D	0.667798	0.152279	0.853473	0.113338	0.2934897

TABLE I
SNR test

Table I noise1, noise2, noise3, noise4, noise5 correspond with diffrent parameter which constist of mean and standard deviation.

V. Conclusions

Via the experiment, Table I and the IV Discussion we dicussed, original signal has higher amplitude variation whihc means more obviously peak and trough will have higher signal-to-noise ratio.

References

[1] Random.normalvariatefunctioninPython https://www.geeksforgeeks.org/random-normalvariate-function-in-python/

[2] UnderstandingFrequencyPerformanceSpecifications https://www.ni.com/zh-tw/support/documentation/supplemental/06/understanding-frequency-performance-specifications.html