生醫影像導論

Introduction to Biomedical Imaging

(11020EE 441000)

Homework #1 Part II: Simulation – Experiencing Ultrasound Speckle Noises

Due: 24:00, 04/19/2022

The provided "USImageSim.m" is a MATLAB program, which can simulate an ultrasound B-mode image of a tissue-mimicking phantom with a higher or lower scattering inclusion. Use and modify the MATLAB codes to verify the effects of speckles on the resultant B-mode images

(a) Plot the histograms of the amplitude and intensity in the speckle region for both the speckle background and the inclusion and compare your results with the theoretic statistic distributions. Elaborate your findings.

(b) Calculate the ratio of the mean to the standard deviation of the amplitude and intensity of the image data in the speckle background and the inclusion, respectively. Any difference between the ratios in the speckle background and the inclusion? Compare and justify your results with the theoretical values (i.e., $SNR_E \sim 1.91$, $SNR_I \sim 1$). Will the ratios changes when you change the value of the variable "cystdB" in USImageSim.m?

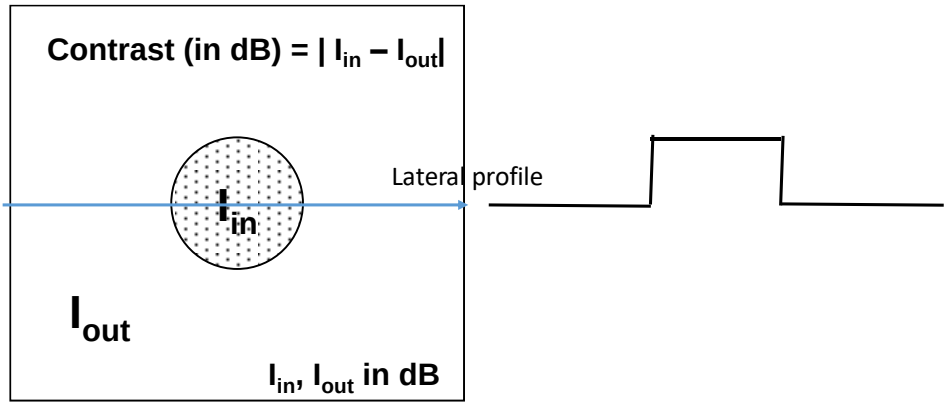
(c) Estimate the standard deviation in dB of the image brightness in the speckle region and the inclusion, respectively. Any difference between the estimated values in the speckle background and the inclusion? Compare with the theoretic value (i.e., 4.34 dB) and justify your results.

(d) Reduce the contrast between the inclusion and background gradually to "see" by your naked eyes what **the minimum detectable contrast** of the ultrasound imaging system is. Compare with the estimated value in (c) and justify your results.

(e) With the contrast between the inclusion and background smaller than the minimum detectable contrast explored in (d), change the diameter of the higher or lower scattering inclusion. Can you detect better the inclusion with a larger diameter? Justify your answer.

(f) Speckle noise reduction by low pass filtering: Apply N by N moving average filter to log compressed data (i.e., **dBData** in the provided sample codes) to suppress the speckle noises. Display the low pass filtered data. Can you see the contrast now even when the contrast between the inclusion and background smaller than the minimum detectable contrast explored in (d)? Elaborate your findings. Plot and compare the lateral profiles across the background and inclusion with and without moving average filtering. The

definition of the lateral profile is illustrated in the following figure. From the lateral profiles, does the low pass filtering restore the original contrast and do you know what price you pay for to "see" or restore the contrast? Notice that moving average filter is a low pass filter and here N is better chosen to be at least 2 times the PSF size in terms of pixel number.



Notice:

1. Please hand in your solution files to the LMS elearning system, including your word file of the detailed solutions, the associated Matlab codes, and all the related materials. It would be nice that you can put your codes with comments side by side along with your answer in the word file.
2. Name your solution files "EE4410_HW1_PartII_StudentID.doc" and "EE4410_HW1_PartII_StudentID.m", and archive them as a single zip file: EE4410_HW1_PartII_StudentID.zip.
3. The first line of your word or Matlab file should contain your name and some brief description, e.g., % EE 441000 王小明 u9612345 HW1 PartII 04/19/2022