Principles of Biomedical Ultrasound and Photoacoustics
hw03: Photoacoustic Depth Profiling and SO2 Measurement

Due on Tuesday, Dec 12, 2017

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1 Part I

1.1 Repeat Fig.1 in reference paper

In the reference paper, they had simulated an acoustic wave of forward and backward wave. In this problem, we need to reproduce this fig. Figure 1 shows the result.

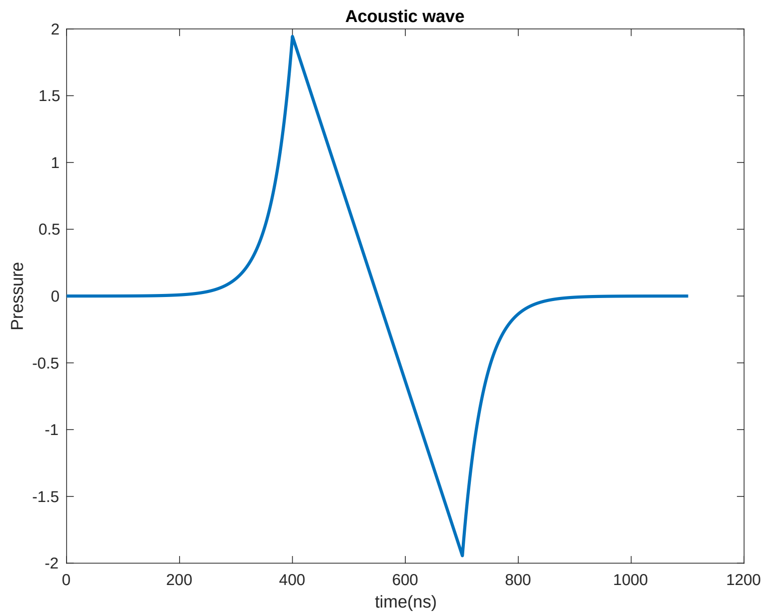

Figure 1: Acoustic Wave

Because the part between positive and negative wave is implicit, I only use a straight line connecting the two peak points by dynamically solving a linear equation and make the space between them 300 ns.

1.2 Repeat Fig.2 in reference paper

Now add a gaussian noise to our signal which the ratio of standard deviation of the noise to the peak of the simulated photoacoustic signal is 5%. Figure 2 shows the noisy signal and Figure 3 shows the exponential decay of siganl.

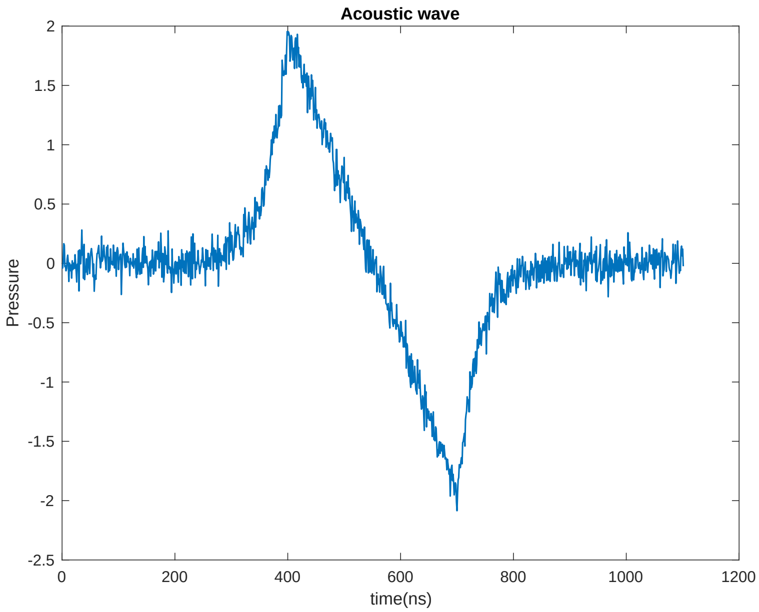

Figure 2: Acoustic Wave with noise

In the reference paper, there is a equation for curve fitting this decay from author's experimental result.

$$p(z) = 9.5 \exp^{-185z}$$

Because the parameters I used is different, I adjust the amplitude from 9.5 to 1.94 as shown in Equation 1.

$$p(z) = 1.94 \exp^{-185z} \tag{1}$$

Now Figure 3 show the noisy decay and curve of Equation 1.

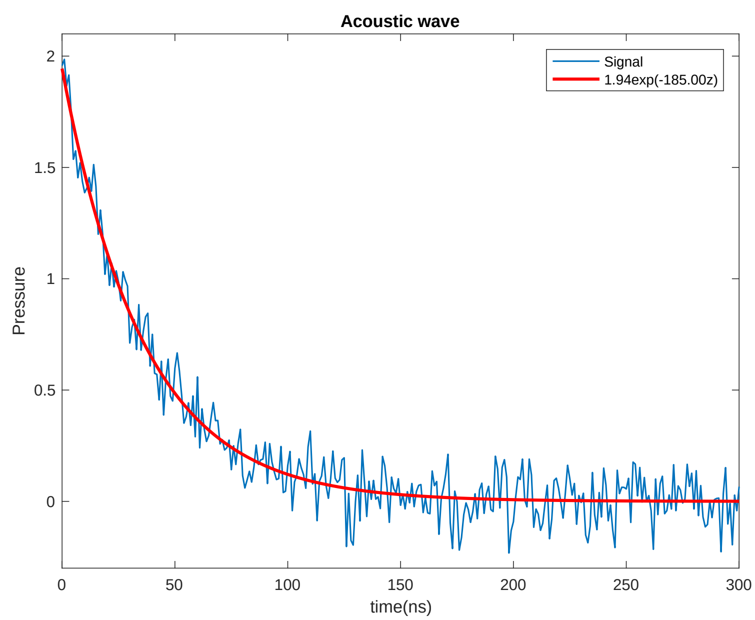

Figure 3: Acoustic Wave with noise

In this figure, we can find that Equation 1 is fitting well.

1.3 Curve fitting for absorbtion coefficient

Now from Figure 3, we apply curve fitting and get our estimated μ_a of noisy signal. Figure 4 shows the estimated curve and noisy signal.

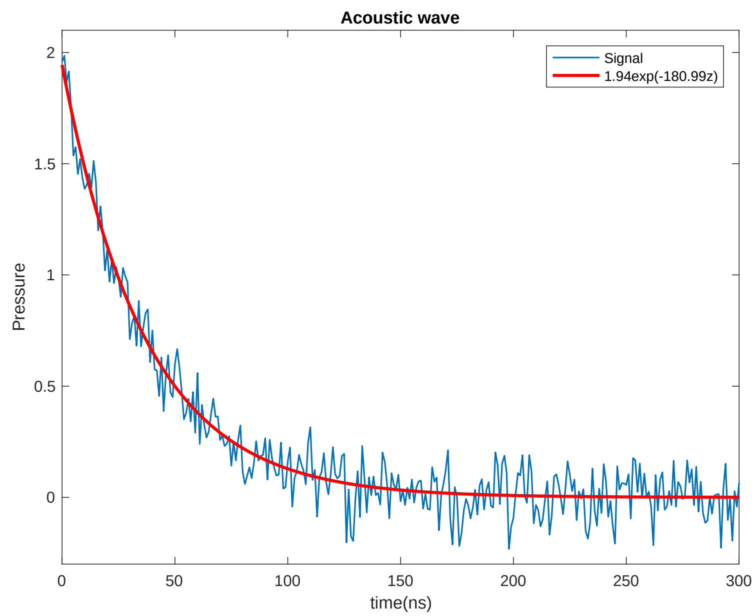

Figure 4: Curve fitting for absorbtion coefficient

From my experimental result, the range of estimated μ_a is from 178 to 182 and the real μ_a I used is 180. As a result, the curve fits the signal pretty well I think.

1.4 Peak value vs absorbtion coefficient

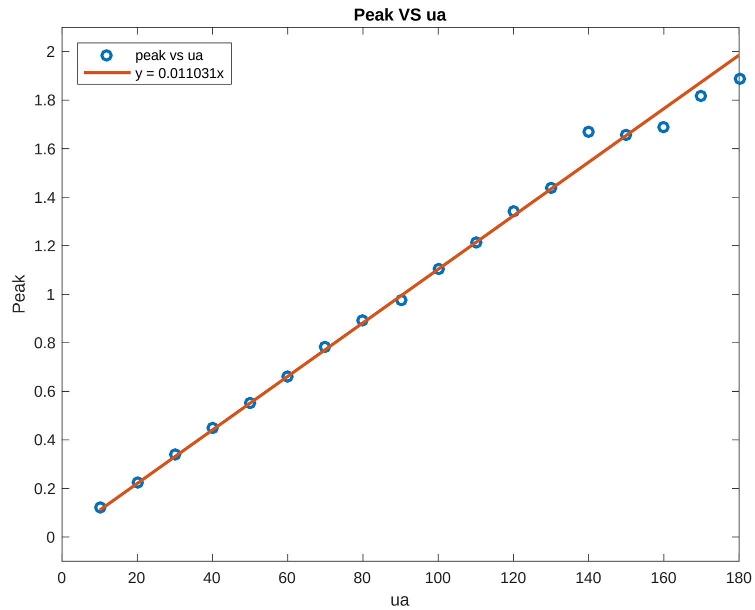

Figure 5: peak vs absorbtion coefficient

1.5 μ_a (estimated) vs μ_a (real)

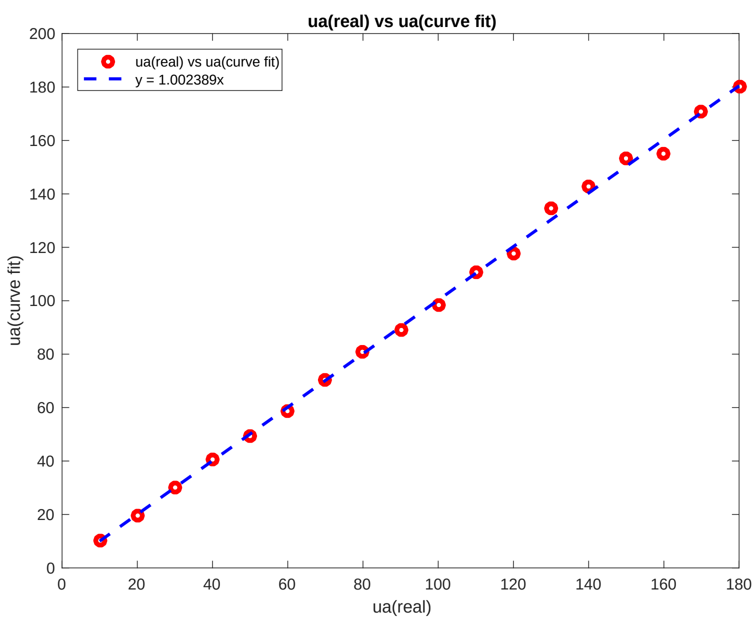

Figure 6: μ_a (estimated) vs μ_a (real)

1.6 Repeat 4 and 5 with transducer impulse response

1.6.1 Peak value vs absorbtion coefficient

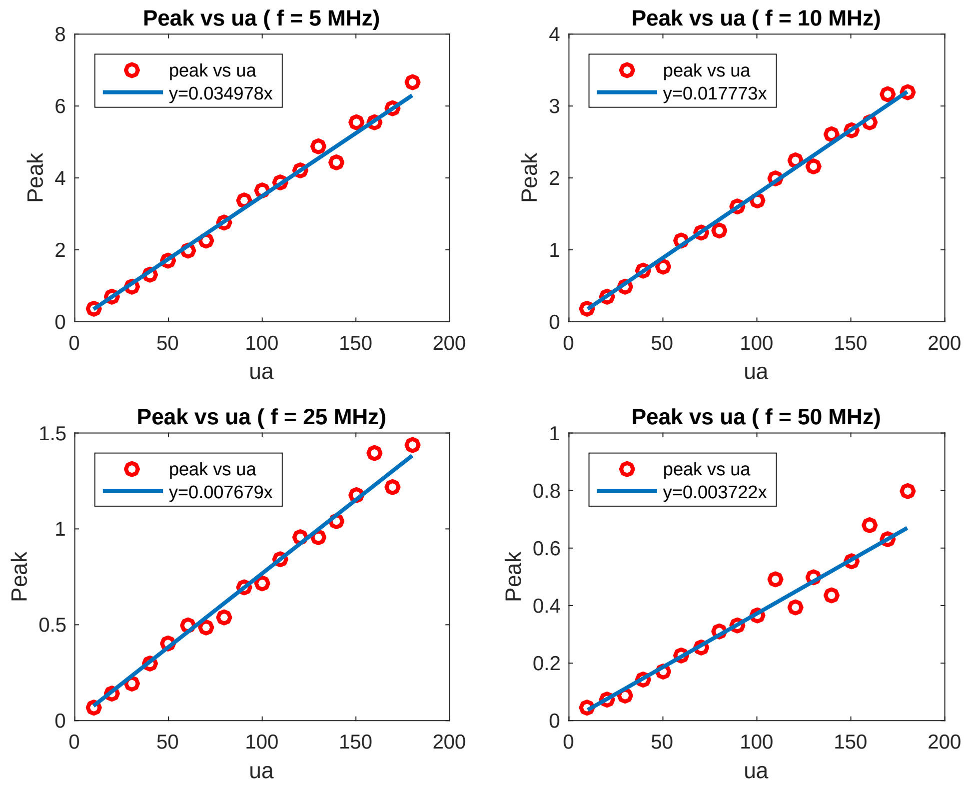

Figure 7: Peak value vs absorbtion coefficient

1.6.2 μ_a (estimated) vs μ_a (real)

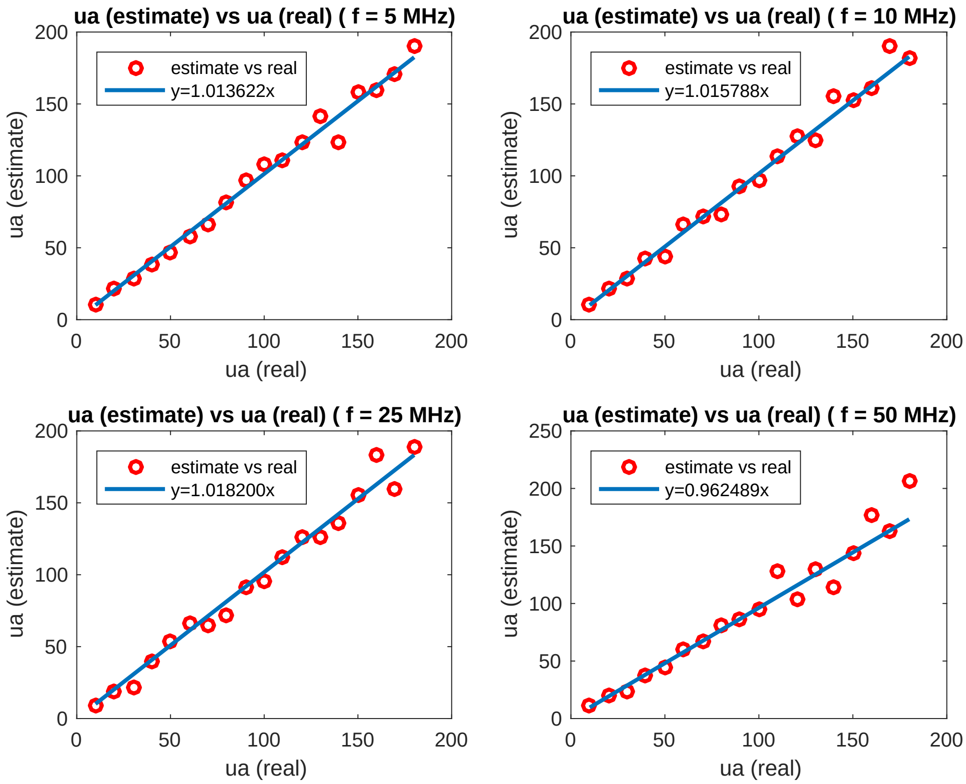

Figure 8: μ_a (estimated) vs μ_a (real)