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Signals and Systems for Biomedical Engineering

Mini Project #1

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Short Report for Mini Project #1

For this project, I began by writing down the constants used throughout the script. I set w, the angular frequency, to 3*10^8*pi. The period, T, to 2*pi divided by the angular frequency. Then I created a vector called t and set its values from 0 to 5T at an evenly distributed number of n times using the linspace function. I set n equal to 100 times so that the signal can properly imitate a continuous signal. Then I computed part a by setting my signal s(t), s, equal to cos(w*t).

Then for part B, I began continued to use the values and vectors defined in part a to find r(t) at the four values of x_t; 0, 2.5, 7.5, and 10. For each varying value of x_t, I calculated the times t_1 & t_2 by using the given formulas of distance $d_1 = d_{rt}$ & $d_2 = d_{rref} + d_{reft}$. I calculated these two distances to be $d_1 = \sqrt{100 + {x_t}^2}$ and $d_2 = 5 + \sqrt{100 + (x_t - 5)^2}$ and then I simply divided both by the speed of light to find time delays t_1 & t_2. Then I used the equation given for signal r(t) to find the signals r(t) for each different x_t value. I ended part b with four r(t) signals.

For part c, I used a for loop to create the four different plots of s(t) and r(t) for the x values of 0, 2.5, 7.5, and 10m. The for loop was based on variable k from 1 to the length of distance vector x. I used the same formulas for t_1 and t_2, but rather than hardcoding each individual value of x_t, I used the variable x(k). The formulas for t_1, t_2,, and r(t) appeared as follows:

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t1 = sqrt(100+(x(k))^2)/(3*power(10,8));

t2 = (5+sqrt(100+(x(k)-5)^2))/(3*power(10,8));

r = cos(w*(t-t1))+cos(w*(t-t2));
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I then created four subplots in one figure, with each subplot containing the signals of s(t) and r(t) at the values of x_t = [0,2.5,7.5, 10]. The signal of s(t) was plotting using a blue line while the signal of r(t) was plotted using a red line to connect the points. Finally, I completed the project by providing a title, legend, axes labels and caption to my graphs. The figure of the graphs is provided below.

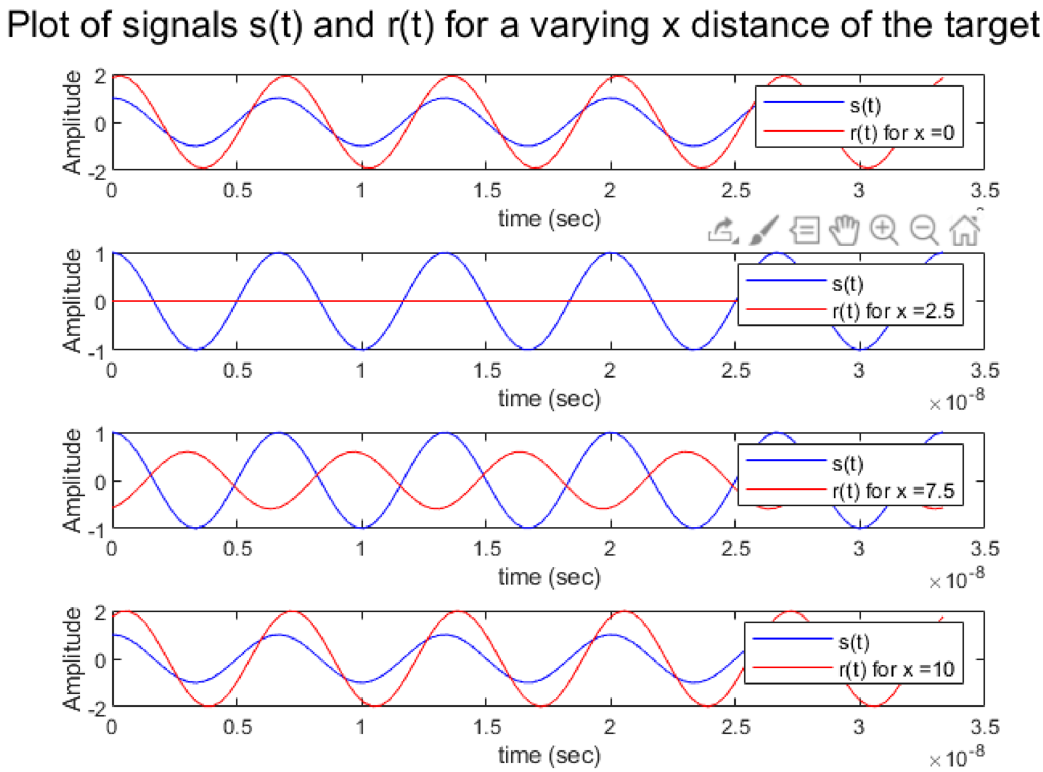

Image – Figure of the four subplots comparing the transmitted sinusoidal signal (s(t)) and the received signal (r(t)) for varying positions of the intended target.

For all the provided subplots, we can see that we have sent the same signal (s(t)) for all situations. It is also observable, that the fundamental period of each signal has stayed the same value (except for r(t) at x = 2.5 which I will discuss further into the report). This is where the similarities end however, As the received signals tend to vary from subplot to subplot. In the first graph, where x = 0m, it's observable that the received signal has shifted to the right by a small phase shift, and has doubled in amplitude. The same effect is observable in subplot four, where x_t = 10m, as we see the same received signal. Subplot three shows a similar received signal, however, one may denote from the figure that the amplitude of the received signal has fallen below one. This is most likely due to the increased difference between t1 and t2 at x_t = 7.5m.

Finally, there is subplot two, In which we see that when the target is at x_t = 2.5m there is an observable blind spot. As the figure of the received signal at this time shows that no signal was received by the target. The cause of this seems to lie in the fact that, at this x-distance, the target is perfectly between the radiator and reflector. Therefore, the two signals are disrupting one another as they have equal amplitude and frequency but are being received from opposite directions. Leading to the two signals canceling one another out and causing no signal to be received by the target.