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ECE 101 Lab 4

Introduction:

The purpose of this lab was to explore the relationship between a sampled audio file in the time domain, and the corresponding Fourier transform of that signal. Also I explored the relationship of a time domain signal constructed from manipulations of the frequency domain representation.

Results:

Problem a – I used the fast Fourier transform (fft) function to construct a frequency domain sampling of the “splat” audio file, as well as a the fftshift function to reorder the samples in an ascending order. As the fft and ifft are prone to roundoff errors, leaving an insignificantly small imaginary value, I then took just the real component when I reconstructed the original time domain sampling.

Problem b – For this part, I used the frequency sampling, Y, and constructed a new vector, Y1, out of the conjugate of Y. Because the conjugate of a complex exponential, e^jwt, is simply e^-jwt, this had the effect of reversing the ordering of the vector from the original. Upon reconstructing the time domain version, y1, the frequencies were reversed in time as well, producing the original audio clip played backward.

Problem c – To analytically demonstrate that Y2(jw) = |Y(jw)| whenever y(t) is real, I realized that if y(t) is real, then Y(jw) = Y\*(-jw), and the magnitudes of both of these must be the same, as it should be an even function of w.

To demonstrate that Y3(jw) = e^jφw, when y(t) is real, once again, conjugate symmetry would suggest that e^jφw = e^-jφ(-w). Or in other words, on the complex plane, the a+jb produces an angle φ and a-jb produces -φ, but the magnitude of both of these points is exactly the same because it’s a location on the unit circle.

Problem d – I constructed a signal, Y2, from the magnitude of Y, using the abs() function, and this resulted in an audio playback that was a combination of the time domain signal played forward and backward.

Problem e – Finally I constructed a signal, Y3, from the phase of Y, which resulted in a mostly inaudible sound clip. I produced this signal by using array multiplication of the inverse of Y’s magnitude, and Y itself. Basically, I started with Y(jw) = |Y(jw)|e^jΨ(Y(jw)) and divided out |Y(jw)|, leaving a vector, Y3 = e^jΨ(Y(jw)).

Problem f – It would appear from the quality of the reproduction of Y2 and Y3, that the most important part to reconstructing a signal from the frequency domain is the magnitude of the signal.