Multipath Propagation

I. Analytic

Look over the solution to Problem #8.64 in [1].

II. Numerical

Fix $n_0 = 4$ and use the same vertical axis dynamic range on all FFT plots since the desire is to compare them. Use ω (radians/sample) or f (cycles/sample) as the frequency axis rather than k (FFT bin index). There is no need to plot the negative frequencies.

Note: $H_1(k) = \dfrac{1}{H(k)}$ samples the Fourier transform of the true inverse system $H_i(z) = \dfrac{1}{H(z)}$

A. Plot h(n) and the zero locations of H(z). Augment h(n) with zeros out to NFFT = 256, FFT, and plot linear magnitude and phase of H(k) vs. f to illustrate the amplitude and phase distortion caused by the multipath.

B. Let N = 16

1. Obtain the N-point FFT H(k) of h(n) and the N-point FFT $H_1(k)$ of $h_1(n)$. Plot linear magnitude and phase of H(k) and $H_1(k)$ vs. f.

2. Obtain $h_1(n)$ and plot $h_1(n)$ and the zero locations of $H_1(z)$.

3. Augment $h_1(n)$ with zeros out to NFFT = 256, FFT, and plot linear magnitude and phase of $H_1(k)$ vs. f.

4. Obtain the linear convolution $h_2(n) = h(n) * h_1(n)$ via FFT (2N = 32 point result).

5. Plot $h_2(n)$ and zero locations of $H_2(z)$. Note: Trailing zeros in the 2N-point result for $h_2(n)$ should be truncated prior to determining zero locations for $H_2(z)$.

6. Augment $h_2(n)$ with zeros out to NFFT = 256, FFT, and plot linear magnitude and phase of $H_2(k)$ vs. f to see how well $h_1(n)$ has equalized the channel.

C. Let N = 64

Repeat II B [1 - 6]. Note that $h_1(n)$ closely resembles $h_i(n)$ out through n = 63. Part (4) yields a 2N = 128 point result. In C6, add a pair of plots that blows up the region near $|H_2(k)| = 1$ and $\arg\{H_2(k)| = 0$ to show the residual distortion.

References

[1] A. Oppenheim, R. Schafer, and J. Buck. *Discrete-Time Signal Processing*. *2nd Ed*. Prentice-Hall (1999). Note same as Problem #8.67 in *Discrete-Time Signal Processing* 3rd Ed. (2010).