ECEn 665
Antennas and Propagation for Wireless Communication

Homework #24
Due April 17, 2023

1. Implement narrowband MIMO channel estimation by creating a channel matrix $\mathbf{H}$ with your multipath model, an N_{t} by N_{training} matrix $\mathbf{S}$ of randomly chosen QPSK training symbols, and an N_{r} by N_{training} matrix $\mathbf{W}$ of complex circular Gaussian white noise with a given variance. Form a matrix of received signal vectors using $\mathbf{X} = \mathbf{HS} + \mathbf{W}$. (a) For a modest SNR (5 dB), what is the smallest value of N_{training} required to reliably estimate the channel matrix? (The average SNR at the receiver is $\|\mathbf{HS}\|^2_{\mathrm{Fro}}/\|\mathbf{W}\|^2_{\mathrm{Fro}}$.) (b) Vary the SNR over a wide range by changing the transmit power, propagation distance or noise level and plot the relative squared RMS error in the estimated channel matrix $\|\mathbf{H} - \hat{\mathbf{H}}\|^2_{\mathrm{Fro}}/\|\mathbf{H}\|^2_{\mathrm{Fro}}$ as a function of SNR.

2. Use your multipath model to generate a channel matrix for a 10 x 10 MIMO channel. Plot the effective degrees of freedom (EDOF) as a function of SNR in dB. Allow the SNR to range from very small to a ridiculously large value such as 500 dB. Interpret the results.