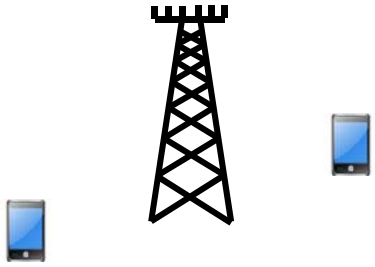
Principles of Wireless Communcations

Lab 2 Part (a)

Multiple antennas for Space-Division Multiple Access

Due 2/22/2015



Overview

This is part 1 of a two part lab assignment on multiantenna technology in wireless networks. We shall consider a network with two transmitters, each with a single antenna, and a receiver with two antennas. This scenario may arise in a mobile network where multiple mobile users are supported by a single base station with multiple antennas.

You can complete this assignment either in MATLAB or some other programing language. Accompanying this assignment are the MATLAB data file 2User2AntennaBS.mat, the raw data files tx1.dat, tx2.dat, rx1.dat and rx2.dat

Signals are transmitted from two separate devices (transmitters 1 and 2) with single antennas and received by a multiantenna receiver with two antennas.

The following is the sequence of the transmitted signals from transmitters 1 and 2, received at antennas 1 and 2 of the receiver.

1. 5000 zero samples from transmitter 1 and 2
2. Transmitter 1 sends 128 pseudo random bits, encoded using BPSK and 40 sample long rectangular pulses, transmitter 2 sends zeros.
3. 5000 zero samples from both transmitters
4. Transmitter 2 sends 128 pseudo random bits, encoded using BPSK and 40 sample long rectangular pulses, transmitter 1 sends zeros.
5. 5000 zero samples from both transmitters
6. Transmitters 1 and 2 send 1024 data bits (they are just randomly generated here), using BPSK and rectangular pulses that are 40 samples each.

The channels are flat fading channels, with additive Gaussian noise. The data were generated with transmitters and receivers being frequency locked, so there is no need to perform timing synchronization.

The complete signals transmitted by each transmitter are given to you for your reference. In practice, you will only know the 128 bit pseudo random sequences, therefore you should not use the data portion of the received signals for any purposes other than checking if your decoding operation is correct.

If you are using the MATLAB data file, the transmitted signals from the transmitters 1 and 2 are in the vectors x1 and x2. The received signals on antennas 1 and 2 of the receiver are in y1 and y2.

If you are using Python, the best option would be to open the files tx1.dat, tx2.dat, rx1.dat and rx2.dat. The data in these files are stored as float32 numbers with the real and imaginary parts alternating. Tx1.dat and Tx2.dat contain the transmitted signal from transmitters 1 and 2. rx1.dat and rx2.dat contain signals received on antennas 1 and 2 of the receiver.

The Assignment

1. *Using MATLAB or a different programming language, decode the data signals from users 1 and 2 using the zero-forcing (ZF) receiver.*

2. *Using MATLAB or a different programming language, decode the data signals from users 1 and 2 using the minimum-mean-square-error (MMSE) receiver.*

3. *Discuss how your answers would change if you had more than two transmitters and more than two antennas.*

You will need to submit a write up which answers the questions above. The writeup should include all code, and relavant plots to illustrate that you were able to recover the data signals from both transmitters. You should clearly explain with the aid of equations, all steps you took in recovering the signals.