EE617 Introduction to Wireless and Cellular Communications
July-December 2008

Computer Assignment #1 (Due on Oct 6,2008)

1. [Problem 2.9, Tse & Vishwanath] Consider the two-path example in Section 2.1.4(Tse & Viswanath) with $d = 2km$ and the receiver at $1.5km$ from the transmitter moving at velocity 60km/h away from the transmitter. The carrier frequency is 900MHz.

   (a) Plot in MATLAB the magnitudes of the taps of the discrete-time baseband channel at a fixed time t. Give a few plots for several bandwidths W so as to exhibit both flat and frequency-selective fading.

   (b) Plot the time variation of the phase and magnitude of a typical tap of the discrete-time baseband channel for a bandwidth where the channel is (approximately) flat and for a bandwidth where the channel is frequency-selective. How do the time-variations depend on the bandwidth? Explain.

2. Simulation of Non-coherent Binary Signaling over a Rayleigh fading channel in MATLAB

   Use simple orthogonal modulation scheme of Section 3.1.1,Tse & Viswanath. Randomly generate a large number of bits and encode them using the given table .

symbol[m]	$x[2m]$	$x[2m+1]$
+1	a	0
-1	0	a

   The channel is defined through the equation $y[m] = h[m] * x[m] + w[m]$ where $w[m] \sim \mathcal{C}N(0,N_0)$ and $h[m] \sim \mathcal{C}N(0,1)$.

   (a) Generate channel parameters and calculate $y[m]$ at each time instant.

   (b) Now using the Maximum Likelihood detector discussed in the class, detect the bits and compare them with input bits.

   (c) Find the BER by averaging over several iterations.

   (d) Repeat the simulation for different SNRs and plot BER(in log scale) vs SNR(in dB) graph.

   (e) Verify the obtained results with the theoretical value provided in the textbook.

3. Simulation of rotation code (L=2,BPSK) (Refer Section 3.2.2, Tse & Viswanath)
   In this form of transmission,every two bits of BPSK are paired and encoded using the rotation matrix (R) and transmitted in consecutive timeslots

$$\begin{bmatrix} x[m] \\ x[m+1] \end{bmatrix} = R \begin{bmatrix} u[m] \\ u[m+1] \end{bmatrix}$$

   where $u[k] = \pm a$ and $R = \begin{bmatrix} cos\theta & -sin\theta \\ sin\theta & cos\boldsymbol{\theta} \end{bmatrix}$.

   Use the folowing assumptions :

   (a) Assume the channel to be the same as that of the previous problem
   (b) Use a high SNR .
   (c) Detect the transmitted bits at the receiver assuming that the channel is known at the receiver.
       Find the angle θ that minimizes the BER for the given value of SNR.

4. Simulation of Coherent QPSK over a Rayleigh fading channel

   Let the QPSK symbols be

Bits	00	01	10	11
QPSK Symbols	$ae^{j\frac{\pi}{4}}$	$ae^{j\frac{3\pi}{4}}$	$ae^{-j\frac{\pi}{4}}$	$ae^{-j\frac{3\pi}{4}}$

   Generate a random sequence of QPSK symbols. Use the channel defined in Problem 2.

   Assuming that the channel is known at the receiver,use the maximum likelihood detector to detect the symbols. After sufficient averaging,obtain the BER vs SNR plot.