Department of Electrical Engineering

EE 764: Wireless and Mobile Communications (Spring 2018)

Course Instructor: Prof. Abhay Karandikar

Simulation Assignment 3

Due Date: 15$^{\text{th}}$ Mar, 2018

Instructions:

- *Use either MATLAB or SciLab for simulations in this assignment. You are NOT ALLOWED to use Simulink or the Communications toolbox from MATLAB or any such equivalent tools.*
- **Please Note: This assignment is NOT a group assignment and has to be submitted by each student individually.**
- Submit a tarball with the following files:
  1. Plots wherever asked for.
  2. Discussion of results and your inferences in the form of a PDF file.
  3. Simulation code files for assignment with detailed comments.

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1. In this problem, you are required to simulate a point-to-point wireless link along with a Transmitter (Tx) and a Receiver (Rx) block located at a distance of 100 m from each other. Consider the wireless link to be a slow flat fading Rayleigh channel with parameter $1/\sqrt{2}$. Assume that the Tx and the Rx are static. The path loss is given by $128.1 + 37.6 \log_{10}(R)$ dB, where R is the distance between the Tx and the Rx in kms. At the transmitter, a bitstream is generated and the signals are modulated using Quadrature Phase Shift Keying (QPSK) with a carrier frequency $f_c = 800$ MHz. The symbols are transmitted using rectangular pulses, where 0 and 1 are represented by voltage levels $+A$ and $-A$, respectively. Assume all signals to be equally likely. At the receiver, the received signals are decoded using a Maximum A Posteriori (MAP) detector. Once you have successfully created the transmitter and receiver blocks and modeled the channel appropriately, you are then required to do the following.

   (a) Transmit a train of 10000 QPSK modulated signals through the channel. Assume that the transmitted signal is affected by zero mean Additive White

Gaussian Noise (AWGN) with Noise Power -100 dBm at the receiver. Decode the signal received using MAP detector and compute the probability of error P_e at the receiver. Consider symbol time 1 μs and symbol amplitude $A = 1$ mV.

(b) Vary the signal amplitude from 1 mV to 10 mV in steps of 1 mV. Plot the Probability of Error (P_e) v/s Tx SNR (Ratio of the bit energy to the noise power).

(c) The Rx is said to be in outage if the received signal strength is below a pre-defined threshold, T. Consider $T = -135$ dBm and determine the outage probability for the given setup.

2. Assume the channel and noise models to be the same as in Problem 1. For this problem, assume that the receiver has 3 antennas that are receiving the same symbol through 3 different paths that have independent channel gains. In order to detect the received symbol, select the path with maximum received SNR (known as selection combining) and then decode the symbol. Run the simulation for 10000 symbols.

   (a) Vary the signal amplitude from 1 mV to 10 mV in steps of 1 mV and plot the BER v/s Tx SNR. Compare this with the plot from Problem 1.

   (b) Determine the outage probability for the same value of T as in Problem 1.

3. Consider transmission of signal over the point-to-point link with channel and noise models as in Problem 1. In this problem, we use the concept of time diversity. Assume that the channel coherence time is of the order of the symbol duration. We transmit 3 copies of the same symbol consecutively. Run the simulation for 10000 symbols. At the receiver, use a MAP detector followed by majority decoding to decode the symbols. For example, if two out of three copies of the symbol are detected to be '01' and one is detected to be '00', the receiver will decide that the symbol '01' was transmitted.

   (a) Vary the signal amplitude from 1 mV to 10 mV in steps of 1 mV and plot the BER v/s Tx SNR. Compare it with the plots from Problems 1 and 2.

   (b) Determine the outage probability for the same value of T as in Problem 1 and compare it with the outage probabilities computed in Problems 1 and 2. What do you conclude about the schemes used in Problems 2 and 3?