IC-PBL Activity I

The goal of this project is to build up MATLAB (or Python) simulators to compute the symbol error rate (SER) of QAM modulations under AWGN or Fading channel.

In this project, we consider the QPSK and 16QAM as QAM modulations.

For the project, you need to generate the following functions:

1. Random binary source generator
2. QAM modulator
3. Channel (AWGN or Fading Channel)
4. QAM demodulator
5. Counting errors by comparing the transmitted symbols and the decoded symbols

Note that you can reuse the functions 1,2,4, and 5 for both channel models.

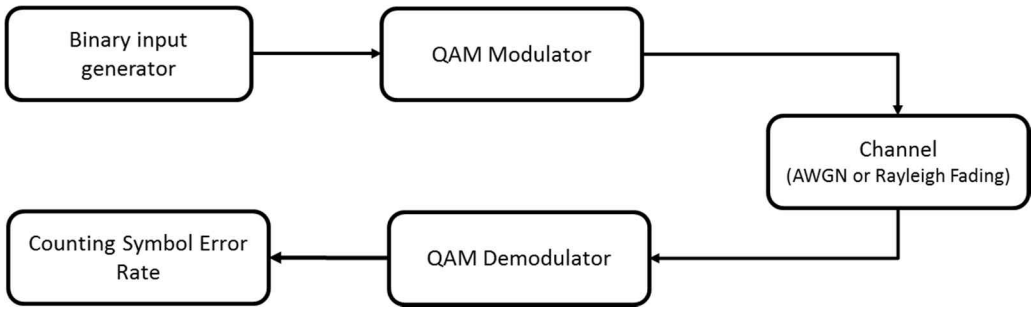

Figure 1. Block Diagram for Matlab Simulation.

Problem 1. Build up MATLAB (or Python) simulator to compute the SER of QPSK and 16-QAM under AWGN channel (SNR range: 0 ~ 25dB: 2.5dB step). Note that the received signal under Rayleigh fading channel is given by

$$y_k = x_k + z_k$$

where $z_k = z_{Q,k} + jz_{I,k}$ with $z_{Q,k}, z_{I,k} \sim N\left(0, \frac{1}{2}\right)$ (Gaussian distribution).

(a) Plot the SER as a function of SNR

(b) Compare the simulation results in (a) with the theoretical results in our lecture note

Problem 2. Similarly to Problem 1, Build up MATLAB (or Python) simulator to compute the SER of QPSK and 16-QAM over Rayleigh Fading Channel (SNR range: 0 ~ 25dB: 2.5dB step). Note that the received signal under Rayleigh fading channel is given by

$$y_k = h_k x_k + z_k$$

where $z_k = z_{Q,k} + jz_{I,k}$ with $z_{Q,k}, z_{I,k} \sim N\left(0, \frac{1}{2}\right)$ (Gaussian distribution), and $h_k = h_{Q,k} + jh_{I,k}$ with $h_{Q,k}, h_{I,k} \sim N\left(0, \frac{1}{2}\right)$.

(a) Plot the SER as a function of SNR

(b) Compare the results with those in Problem 1 (see the impact of Rayleigh fading).

Problem 3 (Maximal Ratio Combining (MRC)). Build up MATLAB (or Python) simulator to compute the SER of MRC. Here, QPSK modulation, Rayleigh Fading, and 2 Rx antennas are considered.

(a) Plot the SER as a function of SNR

(b) Compare the results with those in Problem 2 (see the MRC gain).