IC-PBL Activity II

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, for simplicity, we consider the QPSK modulation.

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 simulators in the **IC-PBL-Activity 1**.

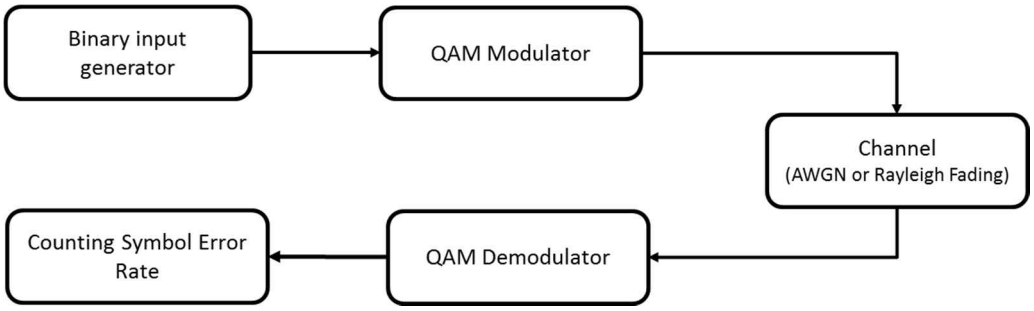

Figure 1. Block Diagram for Matlab Simulation.

Recall. IC-PBL-Activity 1- 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).

Problem 1 (**Alamouti Scheme**). Build up MATLAB (or Python) simulator to compute the SER of Alamouti Scheme with 2Tx antennas. (SNR range: 0 ~ 25dB: 2.5dB step)

(a) Plot the SER as a function of SNR

(b) Compare the results with MRC Gain (in the above IC-PBL-Activity 1 - Problem 3).

Problem 2 (MIMO Channel: CSI at Both Tx and Rx). Consider the following MIMO channel:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 0 \\ 2 & 1 & 0 \\ 0 & 0 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} z_1 \\ z_2 \\ z_3 \end{bmatrix}$$

where $x_i \in \{\text{QPSK constellation}\}$ and $|x_i|^2 = 10$ for $i = 1,2,3$, and $z_i \sim CN(0,1)$ for $i = 1,2,3$. The channel matrix is only available at both transmitter and receiver.

(a) Describe the three parallel channels obtained by multiplying the precoding matrix at Tx and the combining matrix at Rx. Namely, define the $\tilde{y}_i = h_i x_i + \tilde{z}_i$, where you need to find h_i and the variance of $\tilde{z}_i$.

(b) Compute the symbol error rate (SER) for each stream.