Advanced Comm. Theory Class Tutorial 1

November 1, 2021

1 Aims

The objective of this MATLAB exercise is to implement and understand two diversity combining schemes (MRC and SC) described in the Topic-2 “Diversity Theory” of the ACT course.

2 Required files

- This handout
- `fImageSink.m` - MATLAB function to convert bitstream into image
- `fImageSource.m` - MATLAB function to convert image to bitstream
- `X_taskA.mat` - data file for task A
- `X_taskB.mat` - data file for task B
- `GoldSeq.mat` - gold sequence for task B

3 Task A:

Assume a SISO system where the transmitter transmits the image in Figure-1, using BPSK modulation (standard constellation, i.e. no phase offset). The Rx antenna receives six paths of the transmitted signal arriving (with different channel fading coefficients) plus AWGN.

Using the data file “`X_taskA.mat`”, implement both the Max Ratio Combining (MRC) and Selection Combining (SC) diversity rules. Display the resultant image using the provided function ‘`fImageSink.m`’ and evaluate the BER. Assess the performance of each method and compare the two.

Figure 1: Image transmitted through channel.

Table 1: Parameters for Task A

Path No.	Beta
1	0.2
2	0.5
3	0.9
4	0.5
5	0.4
6	0.6

Table 2: Parameters for Task B

Path No.	Beta	Delay
1 (direct)	0.2	0
2	0.5	5
3	0.9	11
4	0.5	18
5	0.4	24
6	0.6	29

To evaluate BER, the file '`flamingos.jpg`' should be loaded into MATLAB and use the function '`fImageSource.m`' to convert the image to a bit stream. This function will scale the image by 0.3 which should not be altered.

The received signal provided in the data file takes the form:

$$\mathbb{X} \triangleq [\underline{x}(t_1), \underline{x}(t_2), \ldots, \underline{x}(t_L)] \in \mathcal{C}^{K \times L} \tag{1}$$

where

- K is the number of paths,
- L is the number of samples,
- $\underline{x}(t) \triangleq [x_1(t), x_2(t), \ldots, x_K(t)]^T$ with $x_i(t) = \beta_i m(t) + n_i(t)$ for $i = 1, 2, \ldots, K$.

In Task A, the same image is transmitted K times through a SISO wireless channel with each experiencing different fading coefficient, provided in Table 1, and noise power is $\sigma_n^2 = 0.6$.

4 Task B

The signal is spread using a Gold code and then transmitted through the wireless channel, arriving at the receiver via $K = 6$ multipaths, each with different fading coefficient and delay and noise power $\sigma_n^2 = 0.6$. Using the data file "`X_taskB.mat`", implement a RAKE receiver. Display the resultant image and evaluate BER, compare with a system that is not aware of the multipaths, i.e. receives only the direct path.

The 6 signal paths are now combined at the receiver, each path now includes a delay, detailed in Table 2, which can be used with the Gold code to separate the signals, using a matched filter. The Gold sequence is provided in "`GoldSeq.mat`".

5 Submission

This tutorial will not count toward your module mark. However, it will be reviewed and feedback provided in due course. Students should produce a document with at most 1-page for Task A and 1-page for Task B, which includes final images and discussion and comparison of results for each Task. This document should be inserted and printed in the ACT's OneNote (Section - Class Exercises). No later than Sunday 14th November.

6 Marking

Each tutorial submission will be marked as “Pass” or “Fail”: Pass = 1 mark; Fail = 0 mark.