Exercise 5 in SSY135 Wireless Communications: Diversity

Feb 11, 2020

1. [G-7.17] Consider a fading distribution $p(\gamma)$ where $\int_0^\infty p(\gamma)e^{-x\gamma}d\gamma = 0.01\overline{\gamma}/\sqrt{x}$. Find the average $\bar{P}_b$ for a BPSK modulated signal where (a) the receiver has two-branch diversity with MRC combining and (b) each branch has an average SNR of 10 dB and experiences independent fading with distribution $p(\gamma)$.

2. This problem shows the superiority of MRC over SC for diversity combining. Consider a receiver with 2 branch diversity, where each branch has i.i.d. fading with SNR γ_i that is uniformly distributed between 0 and 10 (linear units, not dB), i.e. $\gamma_i \sim U[0, 10]$, $i = 1, 2$.

   (a) Find the distribution $p(\gamma_\Sigma)$ of the SNR at the combiner output under both SC and MRC. You can plot the distribution or give a formula.

   (b) Assume DPSK modulation. What is the outage probability for $P_b = 0.1$ under both SC and MRC? ($P_{b,\text{AWGN}} = \frac{1}{2}e^{-\gamma_b}$)

3. [2018 Exam Q] Consider a SIMO system in which the receiver is equipped with two antennas. The receiver has two modes: 1) using maximum ratio combining (MRC), 2) using selective combining (SC). Furthermore, suppose that the received SNRs corresponding to each receiver antenna defined as γ_1, γ_2, respectively. The distribution of the received SNR for each receiver antenna is shown in Fig. 1

   (a) Calculate the distribution of the combined SNR for each combining mode of the receiver.

   (b) Suppose that the system quality of the service restricts us to have minimum receive SNR of 0 dB. Calculate the outage probability of each combining mode in part a. Which combining mode is better? Motivate your answer.

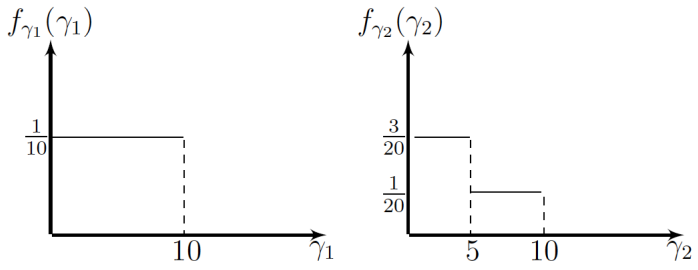

Figure 1: The distribution of the received SNR γ_1 and γ_2