

Digital Transmission Methods S-72.2205

Matlab homework 2

Fading channel

Fading is described as a distortion (scaling) of the signal amplitude due the impact of the channel. Such process can be modeled as a multiplication of the transmitted signal amplitude with the channel coefficient. The channel coefficient has to have distribution describing the fading. In this exercise we study Rayleigh distributed fading channel and simulated BPSK and QPSK modulation performance in such a channel.

Analytical part of the assignment

1. Assume a complex Gaussian process where the real and imaginary part of the signal has Gaussian distribution with mean 0 and variance σ^2 . $h = h_r + h_i \cdot j$ where

$$p(h_r) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(h_r-0)^2}{2\sigma^2}} \quad \text{and} \quad p(h_i) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(h_i-0)^2}{2\sigma^2}}.$$

Describe the random variable in polar coordinates. (For that you have to make transformation of random variables).

- 1.1 What is the mean of the amplitude?
- 1.2 What is the mean power?
- 1.3 What is the distribution of the phase?

Simulation

2. Generate in Matlab a complex random variable with real and imaginary part having Gaussian distribution with mean 0 and variance 1.
 - 2.1 Plot the histogram of the amplitude and the phase.
 - 2.2 Compare the histogram of the amplitude with the Rayleigh distribution having the same mean as the generated random variable.
 - 2.3 Compare the analytically calculated mean and variance with the simulated mean and variance.
3. Simulate and plot SER and BER curves for BPSK QPSK modulated signal in the Rayleigh fading channel. The signal after the channel has a form $y_i = h \cdot s_i + n_i$ where s_i is transmitted symbol h Rayleigh distributed channel amplitude n_i channel noise having variance corresponding to SNR ratio.
4. Diversity rate γ is defined as slope of the BER (or BLER) curve in the loglog plot against the signal to noise ratio in dB: $BER = f(SNR^{-\gamma})$. Essentially describes the slope of the BER curve in the loglog plot. Calculate γ for Rayleigh channel based on your simulations.