EDC310

Practical Assignment 3

30 October 2024

Compiled by Prof HC Myburgh and Mr Fourie

Introduction

You are to develop two simulation platforms to encode and decode modulated information through an AWGN channel (no multipath). Use the code from the simulation platforms developed in *Practical 1* and *Practical 2* to develop the simulation platform to generate encoded data blocks of length N_u.

Question 1

Use a rate $R_c = \frac{1}{2}$ linear block code with generator matrix $\mathbf{G}$ (to be supplied) and $d_{min} = 4$ to encode the uncoded bits in order to yield N_c coded bits. Transmit the encoded bits using BPSK, QPSK and 8PSK through an AWGN channel (no multipath). Use the syndrome decoding method to determine the most probable sequence of uncoded transmitted bits. Plot the BER performance of the system and compare it to the uncoded BPSK, QPSK and 8PSK performance in an AWGN channel.

Question 2

Use the rate $R_c = \frac{1}{3}$, constraint length $K = 3$ convolutional encoder with $\mathbf{g} = [4, 6, 5]$ to encode the uncoded bits in order to yield $N_c = 300$ coded bits. Transmit the encoded bits using BPSK, QPSK and 8PSK through an AWGN channel (no multipath). Use the Viterbi algorithm to develop a decoder in order to determine the most probable sequence of uncoded transmitted bits. Plot the BER performance of the system and compare it to the uncoded BPSK, QPSK and 8PSK performance in an AWGN channel.

Noise normalisation considerations

Add noise to the symbols using a Gaussian random number generator as follows (same as *Practical 1*):

$$r_k = s_k + \sigma n_k, \tag{1}$$

where $n_k = (n_k^{(i)} + jn_k^{(q)})/\sqrt{2}$. $n_k^{(i)}$ and $n_k^{(q)}$ are zero mean, unity variance, Gaussian random variables. In order to normalise the noise standard deviation with respect to the code rate R_c, the noise standard deviation formula is modified as follows:

$$\sigma = \frac{1}{\sqrt{10^{\frac{E_b}{10N_0}} f_{bit}.R_c}}. \tag{2}$$

This is done to spread the energy per uncoded bit across 2 (Q1) or 3 (Q2) encoded bits to ensure a fair comparison to uncoded BPSK performance.

Methodology

For the practical, the methodology is similar to *Practical 1*, except instead of compressing the messages beforehand, codewords are generated so that error correction can be applied. The BER will then also be calculated based on the bits before error correction encoding and after error correction.

Instructions

An evaluation script is provided with pre-defined functions. The evaluation script should be completed to perform the aforementioned tasks. The script should then be uploaded to AMS before the deadline, the 30th of October.

- The last submission will be taken as your final submission.
- Ensure all the Python functions are callable, even if it does not return the correct answer. If the file can not be imported, then it can not be marked.
- Do not copy! The copier and the copyee will receive zero and disciplinary action will follow for both parties.
- For any questions, please make an appointment with Prof. Myburgh or Mr. Fourie.