CS-330 Project
A complete BPSK,QPSK telecommunication system
Phase C

December 12, 2023

1. Error Correction

Our system will make use of the Hamming (3,1) error correction code. This code can correct up to 1 bit per 3 bits. To increase the performance of the error correction, our system utilizes a block interleaver that tries to spread the errors, in order the Hamming (3, 1) decoder to be able to correct more erroneous bits.

1.1 Hamming (3,1) FEC Encoder (10%)

The Hamming (3, 1) code (triple repetition) is a rather simple yet effective code for correcting errors. For every input bit, three identical are produced. In other words, the generated PDU should be three times the received with each bit of the input PDU repeated three times at the output. Provide the implementation of the aforementioned framing scheme at the *lib/fec_encoder_impl.cc* file.

1.2 Hamming (3, 1) FEC Decoder (10%)

The decoder for every three bits received it produces one bit. The value of this bit is decided upon the values of the majority of the three bits. For example 110 should produce 1, whereas 001 should produce 0. Provide the implementation of the decoder at the *lib/fec_decoder_impl.cc* file.

1.3 Block Interleaver (10%)

The purpose of the block interleaver is to spread the transmitted bits across the bit stream, in order to minimize the possibility that consecutive bits are being corrupted, thus allowing the FEC to correct more efficiently errors. The interleaver of the project uses three different block lengths of 96, 192 and 384 bits.

A minor issue with the block interleavers, is that they require an input message length that is a multiple of their block size. Most of the telecommunication protocols, deal with this problem by applying zero padding. Such a technique requires a slightly more complex frame header. In our case, for simplicity you can assume that the input message length after the FEC (if used) should have a size multiple of the block size selected.

The interleaving process is quite easy. Assuming a block size K, input bits are inserted inside an array $A[K][K]$ row by row. The output bit stream is produced by reading the table A column-wise as Figure 1 shows. Provide the implementation of the interleaver at the *lib/interleaver_impl.cc* file.

1.4 Deinterleaver (10%)

The deinterleaver performs the exact opposite operation of the interleaver. Assuming a block size K, input bits are inserted inside an array $A[K][K]$ column-wise. The output bit stream is produced by reading the table A row-wise as Figure 1 shows.

Provide the implementation of the deinterleaver at the *lib/deinterleaver_impl.cc* file.

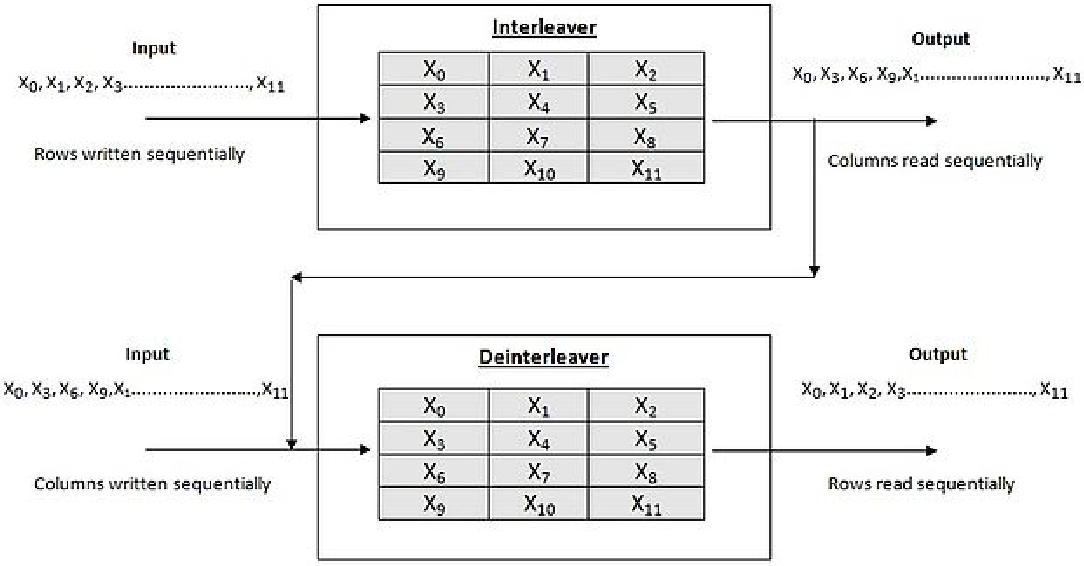

Figure 1: Interleaving and de-interleaving process

2. Bonus Points

2.1 The more the better. Correct? (10%)

Make all the appropriate modifications and support 8-PSK too.

2.2 The force is strong with you (20%)

Except of the Hamming (3,1) FEC, implement the extended (24, 12) Binary Golay Code. This code will provide better error correction and higher data rates for a given bandwidth. You can assume that the input message length will be a multiple of 12 bits. Strong chances of winning if you support this code. The algorithm description can be found at the Chapter 4.6 p.125 of the book **Error Control Coding** (will be provided).