EE477 Homework 2a

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I. MATLAB

A. 1

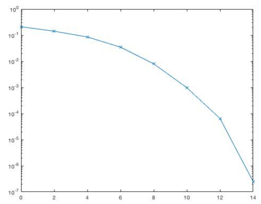

Fig. 1: max_nframe = 1000 and ferlim = 10

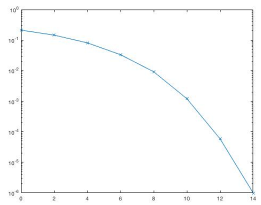

Fig. 2: max_nframe = 1000 and ferlim = 100

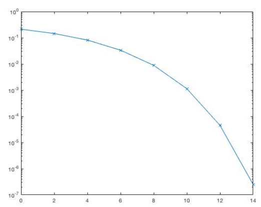

Fig. 3: max_nframe = 1000 and ferlim = 200

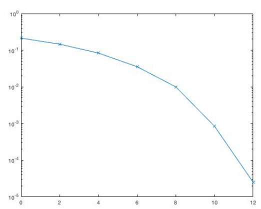

Fig. 4: max_nframe = 10

On figures 1,2 and 3 one can see the effect of increasing *ferlim*. On figures 4 and 5 one can see the effect of increasing *max_nframe*. These are limiting factors of our while loop. If the SNR is high, then we expect that the max_nframe parameter will be the driving factor. If the SNR is small, then we expect that the ferlim parameter will be the driving factor. Changing the simulation from BER performance versus Es/N0 to BER performance versus Eb/N0 shifts our curve to left 3dB. 3 dB shift can also be seen on figure 6 This effect also can be seen considering the equation between Es/N0 and Eb/N0.

$$\frac{E_s}{N_0} = \frac{E_b}{N_0} \times log_2 M \tag{1}$$

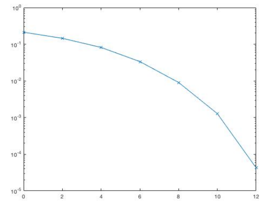

Fig. 5: max_nframe = 100

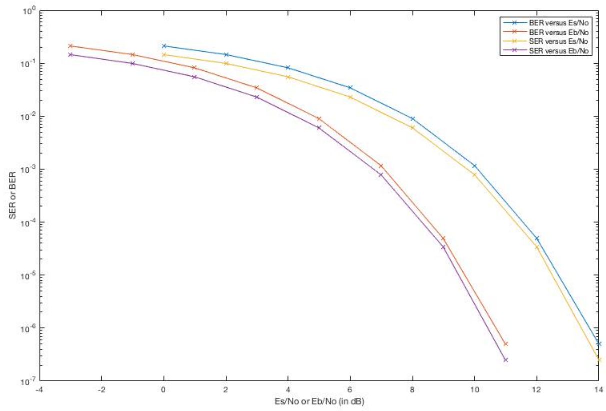

Fig. 6: QPSK, BER und SER as a function of both Eb/N0(in dB) and Es/N0(in dB)

M is 4 in our case for QPSK.

$$10log_{10}\frac{E_s}{N_0} = 10log_{10}\frac{E_b}{N_0} + 3.0103dB \tag{2}$$

As one can see on figure 6, SER is slightly less than BER. This because one symbol consists of 2 bits. If the received symbol is different than the original one, the counter of symbol error increases by one. But what if the bit error is bigger than one? Consider the case between *01* and *10*. There is only one unit symbol difference, but two units bit difference. Although this event does not occur frequently, it's a thing to take into account.

B. 2

BER performances of QPSK and BPSK are largely equivalent as one can see on figures 6 and 7. The reason for that is the similarity between QPSK and BPSK. Considering the constellation diagrams QPSK can be implemented as a pair of two orthogonal BPSK systems. To be more precise the imaginary component is one BPSK system and the real component is one BPSK system. Since they are othogonal, they do not interfere.

C. 3

In Gray mapping the sequential points on constellation diagram differ only by one bit. It's also called minimum change code. This property is useful for some applications. Consider the case between binary codes *'11'* and *'00'*. On constellation diagram they are neighbors, so it's more likely that a white gaussian noise will cause a *'11'* to be detected as *'00'* rather than *'10'*. But the data loss in terms of bits is much higher. Shortly gray mapping provides smaller BER.

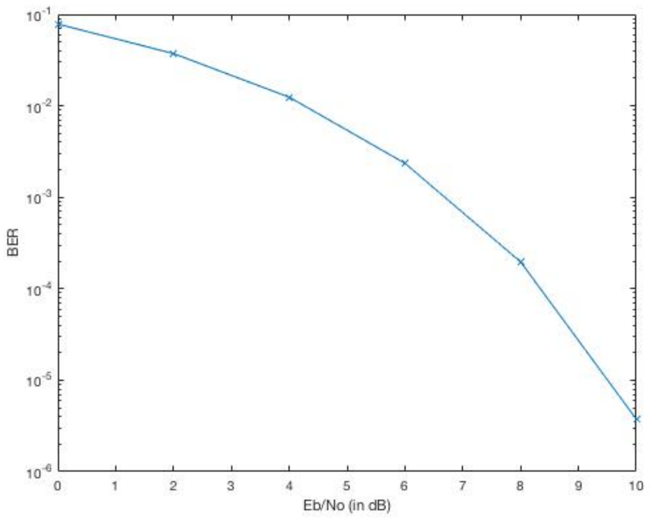

Fig. 7: BPSK, BER as a function of Eb/N0(in dB) with AWGN

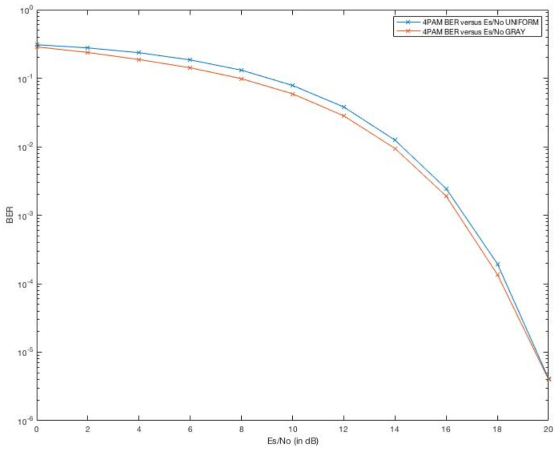

Fig. 8: 4-PAM, BER as a function of Es/N0(in dB) with gray and uniform mapping

D. 4

No change as expected because of the bit amounts.

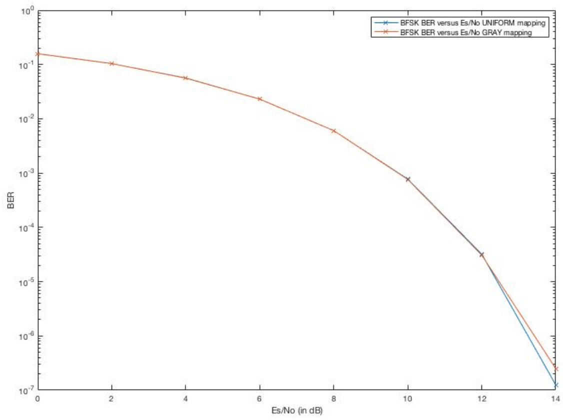

Fig. 9: BFSK, BER as a function of Es/N0(in dB) with gray and uniform mapping