Lab 1 report - Mapping and Demapping

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Exercise 1.2 - The BSC channel

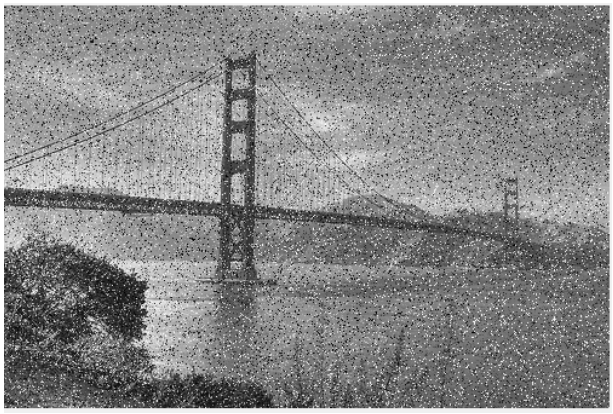
See Matlab code in file *bscgood.m*

number of bits	poor version	optimized version
1000	0.006406 seconds	0.000472 seconds
10000000	3.45 seconds	0.0486 seconds

Table 1: Time measurements

Exercise 1.4 - part 1

See Matlab code in file *exercise1.m*



(a) SNR 3 dB

(b) SNR 6 dB

(c) SNR 10 dB

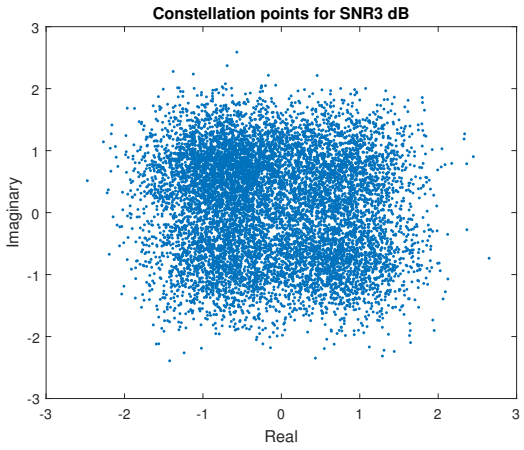
(d) SNR 20 dB

Figure 1: Image with different SNR values

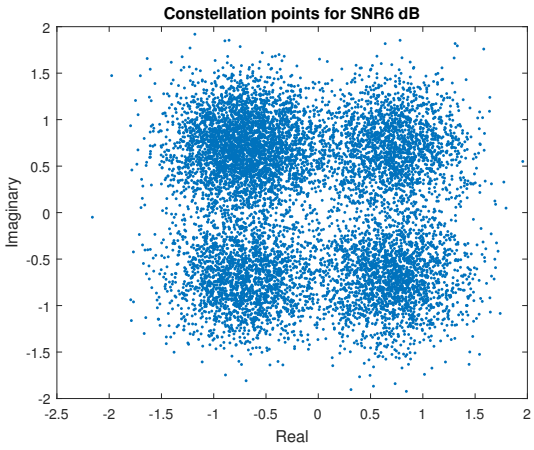
Exercise 1.4 - part 2

See Matlab code in file *exercise1.m*

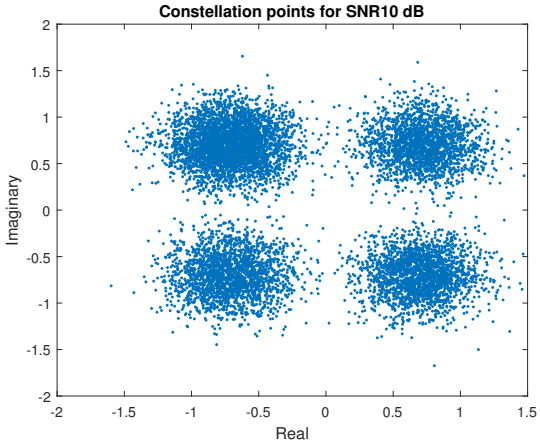
If the SNR ratio is higher, the constellation points will be more concentrated in the desired points $\pm 0.7071 \pm 0.7071i$. A detection mistake is made if a symbol is in the wrong quadrant. As can be seen in the plots, the chance for an error is much higher if the SNR is low, because the points of the received signal are scattered over a larger area.



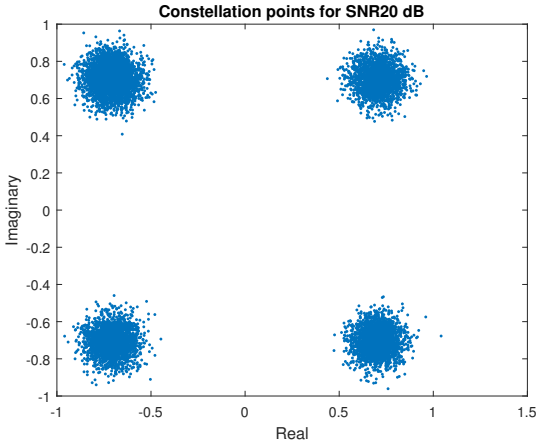
(a) Constellation points for 3 dB



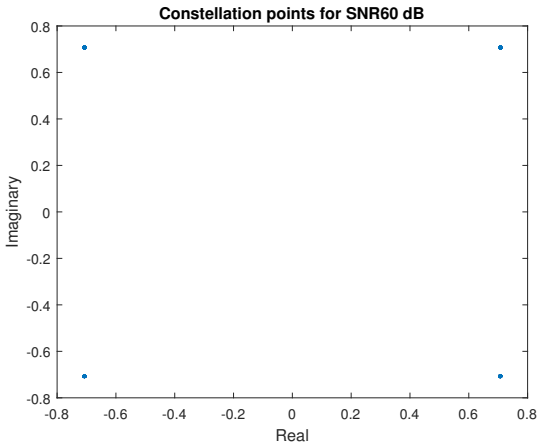
(b) Constellation points for 6 dB



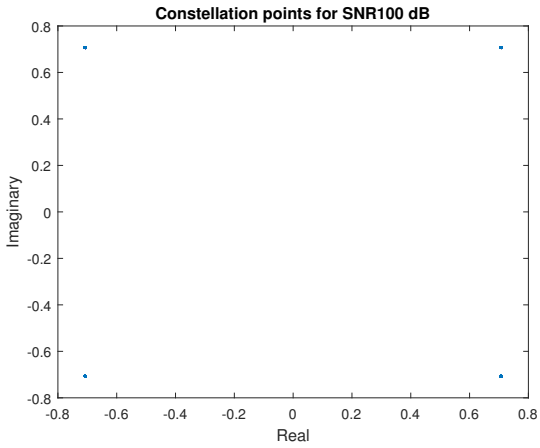
(c) Constellation points for 10 dB



(d) Constellation points for 20 dB



(e) Constellation points for 60 dB



(f) Constellation points for 100 dB

Figure 2: Constellation points for different SNR values

Exercise 1.4 - part 3 and 4

See Matlab code in file *generate_BER.m*

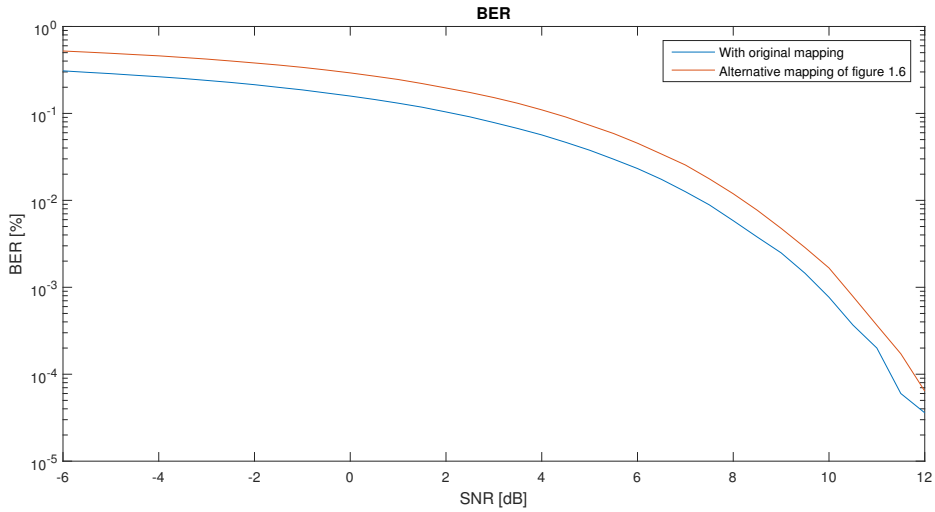


Figure 3: Bit Error Rate for original mapping and alternative mapping of *figure 1.6* in the assignement

The alternative symbol mapping has a higher BER for the same SNR, so it performs worse.

Due to the noise, the symbol will be received in a different point in the complex plane compared to the original constellation point. If the deviation from the original symbol is so large that it is received in another quadrant, a detection error is made.

In the original mapping, the smallest distance was chosen between two symbols that have only 1 bit difference. These distances are indicated in blue in Figure 4. If for example 01 (with constellation point $-0.707 + 0.707i$) is sent and 11 is detected at the receiver side, only 1 bit is wrong. Between symbols with two different bits, the diagonal distance (indicated in green) is relatively large, so the chance for an error is smaller.
In the alternative mapping, the distance between two symbols with two different bits is relatively small, as indicated in red in figure 5. For example: if the symbol sent from $-0.707 + 0.707i$ is detected in the first quadrant, two bits are wrong.
So the original mapping is better, because it has a lower bit error rate.

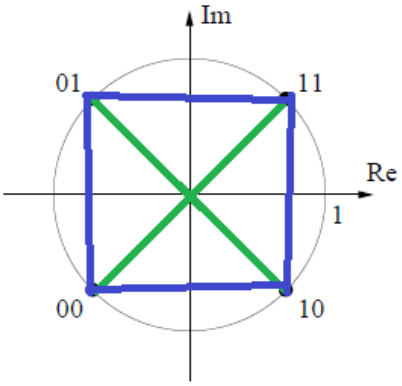


Figure 4: Original mapping

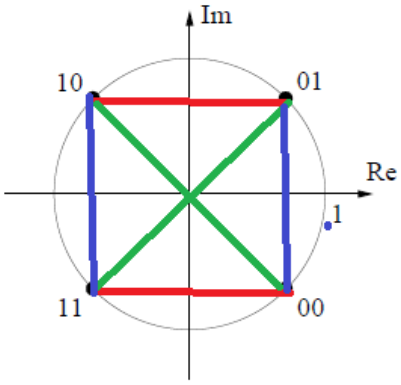


Figure 5: Alternative mapping of Figure 1.6 in assignment

Exercise 1.4 - part 5

See Matlab code in file *compressed_image.m* for the corrected and working version. This version can be tested by running the file *test_compressed_image.m*