浙江大学

本科实验报告

课程名称： 通信原理

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2023 年 6 月 12 日

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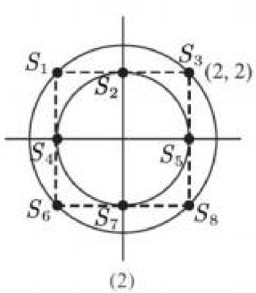
浙江大学实验报告

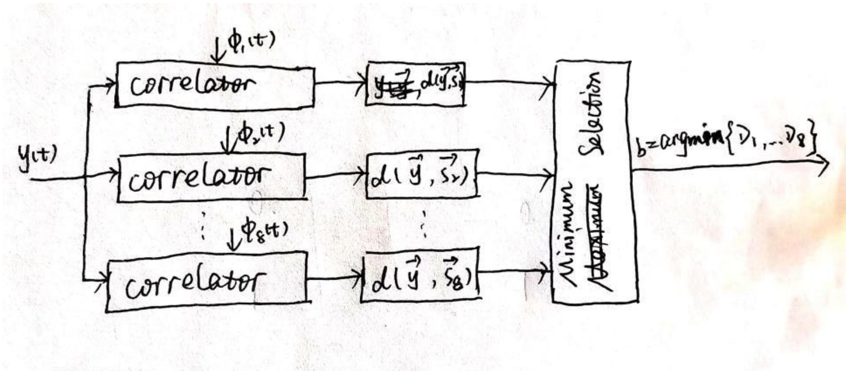
课程名称：_____通信原理____指导老师：_____刘安______成绩：___________
实验名称：____Signal Constellations and A Priori Probabilities____

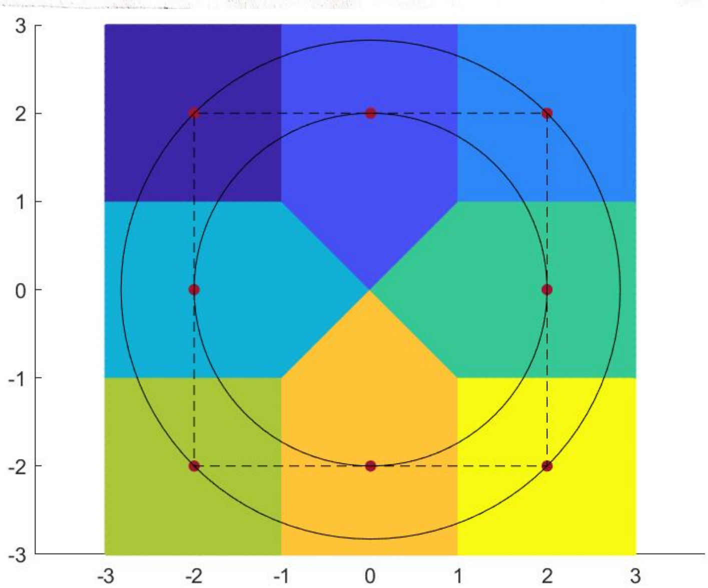
Signal Constellations:



Task 0 – Minimum Distance Detector

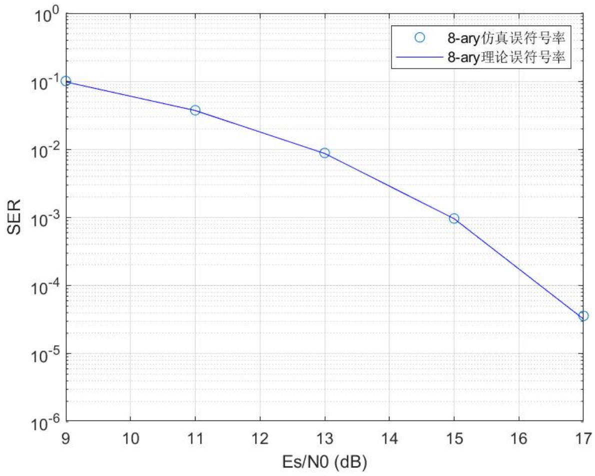
1、The receiver block diagram and the associated decision region are shown below.





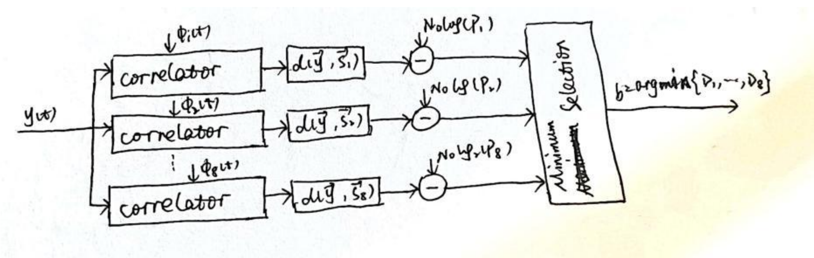
As can be seen from the figure above, when the receiver selects the minimum distance detector, the decision boundary is the perpendicular bisector of the line connecting the two constellation points in the constellation diagram.

2、The graph of SER versus E_s/N_0 is shown below. The simulated bit error rate is basically consistent with the theoretical bit error rate. When the E_s/N_0=17, SER is lower than 10^{-4} and the simulation SER is slightly higher than the theoretical SER.

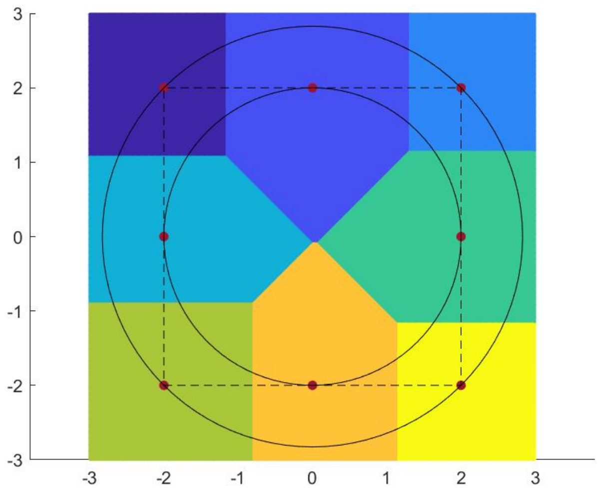


Task 1 – SER Optimal Detector

1、The block diagram is shown below.

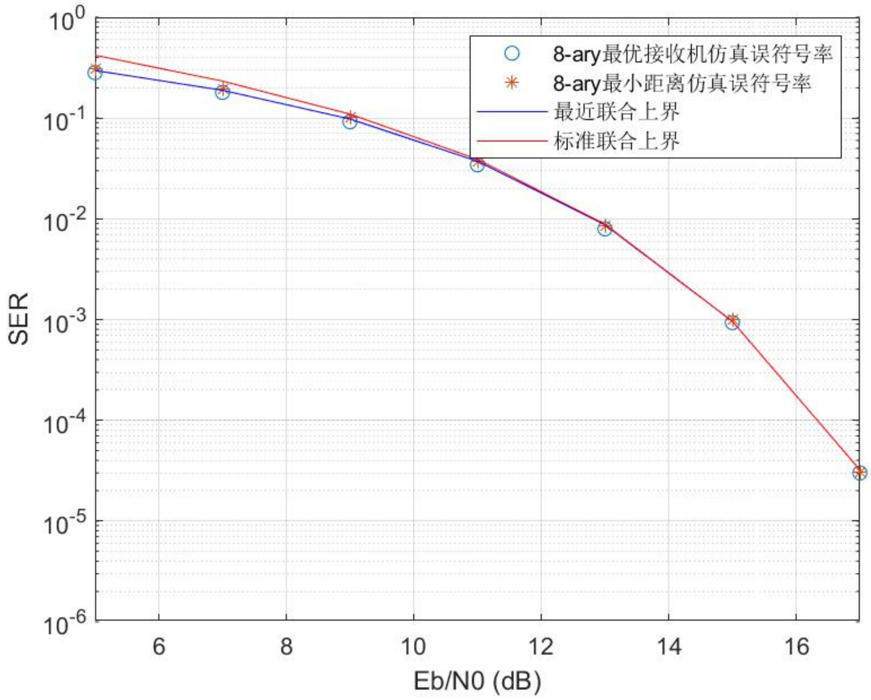


2、The decision regions of the optimal detector is shown below.From the graph, it can be observed that when the receiver selects the Optimal Detector, the decision boundary changes. This is because the selection of the decision boundary is related to the transmission probability. For constellation points with higher probabilities, there is a greater chance that they will be determined as the closest received signal distance when calculating distance=-0.9*log(Pc(w))+norm(dot(t) - send_set(w))^2, so their decision region will be larger. Similarly, the decision region for constellation points with smaller probabilities will be smaller.



Task 2 – SER Simulation using Optimal Detector

The graph of SER versus E_s/N_0 is shown below. From the graph, it can be seen that when E_s/N_0 is small, the theoretical bit error rate of the standard union upper bound is higher than that of the nearest union upper bound. However, when E_s/N_0 increases to around 13, the theoretical bit error rates of the two bounds are almost the same. This is because as E_s/N_0 increases, becomes smaller and the impact of the Q function on the results decreases, causing the two curves to approach each other. Similarly, when the E_s/N_0=17, SER is lower than 10^{-4}. At low E_s/N_0, the SER of the optimal detector is lower than that of the minimum distance detector. As the E_s/N_0 increases, the two values of SER become similar.



Task 3 – Bit Mapping Design

The graph of BER versus E_s/N_0 is shown below. According to the constellation map, there are only two other constellation points closest to a certain constellation point. Therefore, the optimal encoding chooses Gray code because there is only one bit difference between two Gray codes. In contrast, when using random coding, the number of bits that may be incorrect during demodulation can be 2 or 3, greatly increasing the bit error rate. From the graph, it can also be seen that the theoretical bit error rate of the optimal encoding, i.e. Gray code encoding, is lower than the theoretical bit error rate of random encoding.

$$P_e/3 = P_{b-Gray} \leq P_{b-random}$$