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B4M1 課題レポート 第 1 回目

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Technical Report for B4M1 Labwork 1-st

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Abstract　In this first labwork, C programming language is used to simulate the process of transmission and reception in OPSK communication system. And the channel is AWGN channel, which means Gaussian noise is added to the transmitted signal, causing the wrong code. I will simulate the bit error rate and compare it to the theoretical BER.

1. Introduction

Quadrature Phase-shift keying (QPSK) is a digital modulation process which conveys data by changing (modulating) the phase of a constant frequency reference signal (the carrier wave). The modulation is accomplished by varying the sine and cosine inputs at a precise time. QPSK uses four points on the constellation diagram, equispaced around a circle. With four phases, QPSK can encode two bits per symbol, shown in the diagram with Gray coding to minimize the bit error rate (BER) – sometimes misperceived as twice the BER of BPSK.

2. Struction and principles

The QPSK signal contains 2 bits of information per symbol, and a and b represent these two bits. The two bits have a combination of 4 clocks: 00,01, 10, 11. The relationship between symbol and the phase ϕ is usually arranged by the regularity of the Gray code.

Table 1　Mapping table of changed phase

ab	$\Delta\theta_i$
00	$\frac{\pi}{4}$
01	$\frac{3\pi}{4}$
11	$\frac{5\pi}{4}$
10	$\frac{7\pi}{4}$

After the binary information converted from serial to parallel, different levels are generated on the two paths according to the phase mapping relationship. In the in-phase path,signal is modulated by cosine signal, and the signal is modulated by sine signal on the -quadrature path. The sum of the two signal is the modulated signal we want.

$$s(t) = s_I(t)\cos\omega_c t + s_Q(t)\sin\omega_c t \qquad (1)$$

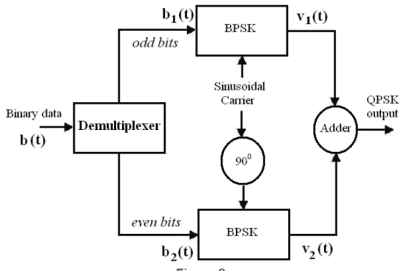

Fig. 1　QPSK Modulation System

At the receiving terminal, due to the natural noise and thermal noise in the amplifier, in the ideal case, the signal will be added with Gaussian white noise, resulting in a wrong judgment in the sampling decision.I will use C language to simulate Gaussian white noise and calculate the bit error rate at different SNR.

3. Computer simulation

Firstly, in the transmission side, the program randomly

produces bits. Secondly, two bits will be combined together and converted to output level in Gray code. And then, one combination of bits will be transmitted on two path,which one is in-phase path and another is quadrature path.

After modulation, signal will be interfered by Gaussion noise in AWGN channel. In the simulation, Box-Muller Transform is used to generate the Gaussion noise. And we could use maximum likelihood estimation(MLE) to get original signal from interfered signal. Finally, we get the information seguence after demodulation and Gray convert.

I have consulted the BER and compared it with the theory.

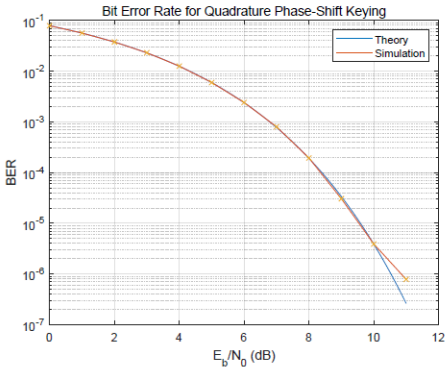

Fig. 2 QPSK BER

4. Conclusion

It can be seen from fig 2 that the simulation results are basically consistent with the theoretical values.Through this simulation, I understand that in the communication system, we can reduce the bit error rate by increasing the signal power.

But this will increase the cost of the transmission, because according to the Shannon formula, the increase in capacity by increasing the SNR is not as good as increasing the system bandwidth.