DS-CDMA Communication System Based on Sequence Pairs

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Fund Project: Fund Project of Hebei Department of Education (n2014116), Youth Fund of Hebei Normal University (12010q10), Youth Fund of Hebei Normal University (12015q12), Doctoral Fund of Hebei Normal University (12012b15).

Keywords: Sequence pairs; Spread spectrum communication; Code division multiple access; Bit error rate

Abstract. Spread spectrum communication is to use spread spectrum code to modulate the information data to be transmitted in order to realize the frequency spectrum extension, then transmission. The receiver uses the same spread spectrum yards to conduct solution and the related signal processing and restore the original information data. Then CDMA communication system is using the approximate orthogonal characteristics of address codes to distinguish users on the basis of the spread spectrum communication.

Introduction

Sequence pairs are new optimum signals, which is a pair of different sequences meeting specific relationship. This article firstly applies the sequence pairs which meet certain conditions to spread spectrum communication system. Through theoretical analysis and experimental simulation, the article proves that applying sequence pairs to spread spectrum communication system is feasible [1]. Then the article introduces sequence pairs to CDMA system, establishes spread spectrum spread spectrum code division multiple access communication system model and conducts simulation by using visualization tool Simulink provided by MATLAB, and then analyze the different channel bit error rate performance of sequence pairs in different channels of DS - CDMA communication system. The experimental simulation results show that the bit error rate of sequence pairs applied in DS - CDMA communication system is low.

Sequence pairs used in direct sequence spread spectrum system

Taking sequence pairs as spread spectrum code and settlement expansion code of spread spectrum system, make the basic block diagram of the direct sequence spread spectrum communication system of users, which is shown as Fig. 1.

Random sequences BPSK modulation Single polar codes into bipolar codes

The working principle of the above figure is: the random sequence generator outputs binary single polarity random sequence, which is firstly through the BPSK modulation which makes the amplitude of the waveform of the output signal be constant and the phase angle change according to the law of the changes of PN sequence. At this point, real signal changes into complex signal [2]. After being

through the polarity conversion module, the complex signal changes from binary single polar code into binary bipolar codes and it produces with the spread spectrum sequence X which is also converted to the bipolar codes, in order to spread the spectrum of the complex signal. Through channel transmission, the broadband signal is transmitted to the receiver. The receiver is firstly conducted algorithm processing by spread spectrum sequence Y which is converted into bipolar codes and restores the narrowband signal. The complex signal obtained in algorithm processing is conducted BPSK demodulation. The phase of the amplitude of the real signal is constant. After sampling judgment, the real signal can be listed into sequences [3].

According to the basic block diagram in Fig. 1, build a spread spectrum system simulation model.

Single user direct sequence spread spectrum communication system simulation model is shown in Fig. 1.

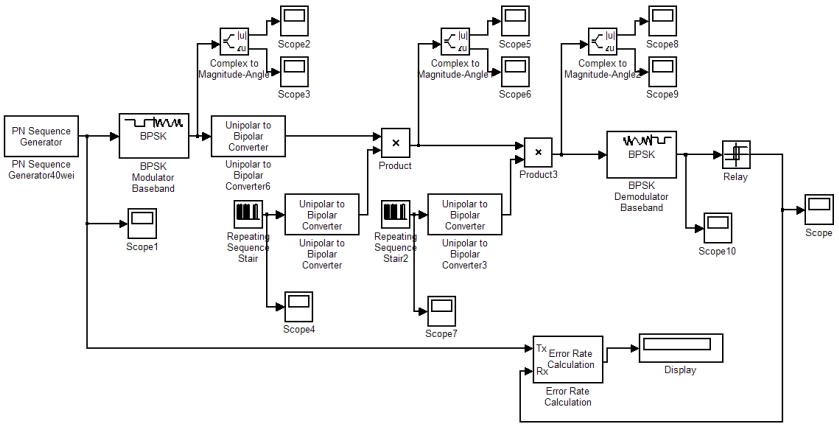

Fig. 1 The simulation model of the single user spread spectrum system

Simulation time of the simulation model is 1000s, and the parameters of each of the module in the model is set as follows.

The parameters of PN sequence generator are the same with the parameter settings which are shown in Table 1.

(BPSK Modulator Baseband)In the module parameter setting of BPSK Modulator Baseband, the initial phase is 0.The sampling time of Complex to Magnitude-Angle module is 1s.The spread spectrum code used in Figure 3 is sequence pairs with 40 bits (X, Y). The sequence X of the launch end is 0110111100010111001010000000001001111100 (which is 6F1728027C when it shown in hexadecimal number). Sequence X uses Repeating Sequence Stair module in Simulink. The sampling time is 1s.

The sampling time of PN sequence generator is 1s. The output waveform is shown in Figure 2.

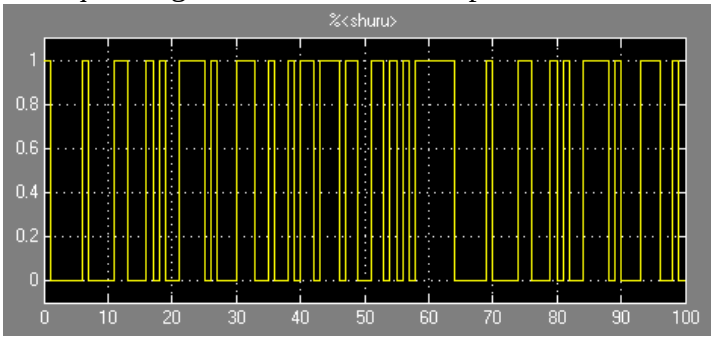

Fig. 2 The outputting waveform of the simulation of sequence generator

After BPSK modulation, the signals of the data outputting from PN sequence generator are complex signals. The complex signals convert them into phase angle module, the amplitude and phase angle of complex signals can be observed separately [4].

Conduct superposition to the simulation model (Fig. 2) in the spread spectrum system of single user. Record the noise resistance to different noises of Gold sequences and sequence pairs, which are shown in Table 1.

Table 1 the bit error rate of Gold sequences and sequence pairs to different noises

	Sequence pairs	Gold sequence
Ideal channel	0.02498	0
Gaussian white noise channel	0.1039	0.08292
Rayleigh noise channel	0.1998	0.1918
Les noise channel	0.3387	0.3337
Uniform noise channel	0.02498	0

Sequence/Bit error rate/Channels

It can be seen in Table 1 that the self- correlation of Gold sequence is better than that of sequence pairs and the anti-noise performance of Gold sequence is more excellent than that of sequence pairs.

The simulation model of DS - CDMA communication system

The system through the ideal channel

Firstly, conduct simulation to the system when it is through the ideal channel. In the simulation, three user model synchronous DS - CDMA communication system is used. At the transmitting end, conduct spread spectrum to outputting sequence of each user through BPSK modulation. The spread spectrum codes of three users are different. In the simulation, the spread spectrum code at the same time has the effect of address code. The broadband signals after spread spectrum is conducted superposition and convert broadband signals. [5]

The broadband signals after the spread spectrum are transmitted through the ideal channel. After they reach the receiving end, the simulation model of the receiving end is shown in Fig. 3.

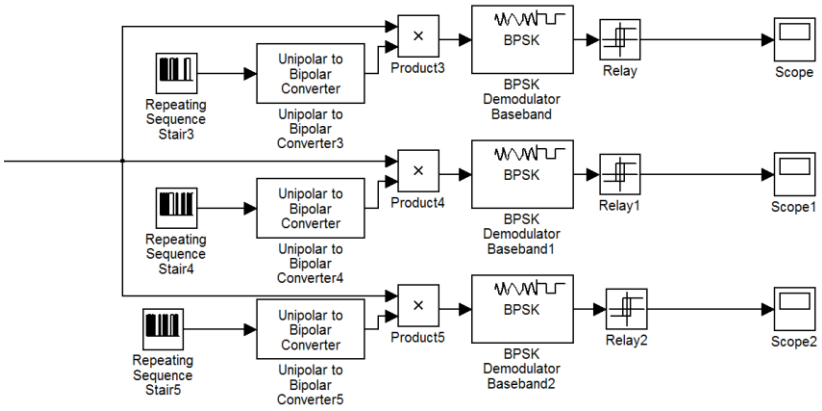

Fig. 3 The receiving end of the simulation model of DS-CDMA system which is through ideal channel

The receiving end conducts algorithm process to the received signals, then outputs signals after BPSK demodulation and sampling judgment. The outputting signals are compared to the inputting signals and then analyzes bit error rate.

Table 2 The bit error rate of multi-users system of sequence pairs and Gold sequences in ideal channels

	Sequence pairs	Gold sequence
User 1	0.2277	0.2617
User 2	0.2871	0.2574
User 3	0.2574	0.4466

Sequence/Bit error rate/Users

It can be seen from Fig. 2 that in the multi-users spread spectrum system in the ideal channel, the cross-correlation performance of sequence pairs is good. When it is used in CDMA system, the interference resistance performance is better in multiple access.

After BPSK modulation, each user's outputting sequences are conducts spread spectrum. The broadband signals of three users after the spread spectrum are conducted superposition. Then the signals are through Gaussian channel, and then added with Gaussian white noise. The receiver received signal waveform amplitude and phase angle (Fig. 4).

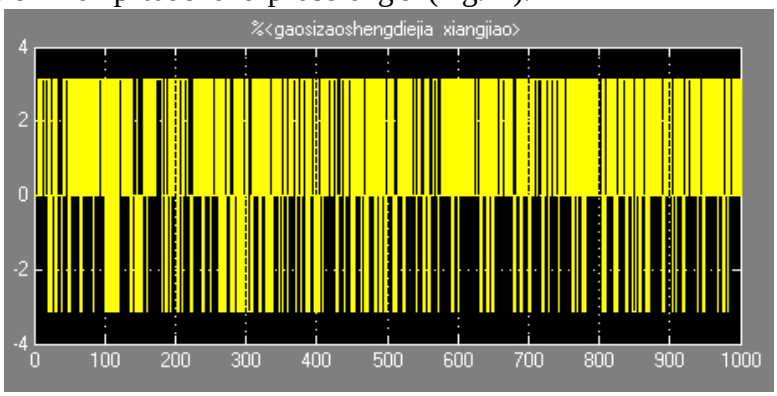

Fig. 4 The waveform phase angle when DS - CDMA system is through gaussian white noise channel

The receiver receives signals then conducts algorithm process, BPSK demodulation and related processing to get outputting sequence. Compare inputting sequences and outputting sequences of each user, The analysis of bit error rate is shown in Table 3.

Table 3 The bit error rate of multi-user system when sequence pairs and gold sequences in Gaussian noise channel

	Sequence pairs	Gold sequence
User 1	0.2376	0.2957
User 2	0.297	0.3007
User 3	0.2475	0.4366

Sequence/Bit error rate/Users

Firstly, conduct simulation to the bit error rate to the system when it through ideal channel. The outputting sequences of each user conduct spread spectrum after BPSK modulation. The superposition signals are through Rayleigh fading channel [6].

The receiver receives the signal then conducts algorithm, BPSK demodulation and related processing, then gets the output sequences. Each user input sequence is compared with output sequence. The analysis of bit error rate is shown in Table 4.

Table 4 the bit error rates of multi-user system of sequence pairs and Gold sequences in Rayleigh channel noise

	Sequence pairs	Gold sequence
User 1	0.3347	0.3047
User 2	0.3127	0.3856
User 3	0.3636	0.4875

Sequence/Bit error rate/Users

The simulation results contrast and analysis of DS-CDMA system noise channel

Change the parameters setting of the noise modules added into the simulation model, when initialization seed values are not at the same time, when the system is through the Gaussian white noise channel and Rayleigh channel noise, the bit error rate results contrast is shown in Fig. 5.

It can be seen from Fig. 28 that when initialization seed changes, the bit error rate fluctuates within a certain range. When adding Gaussian noise into channel and the initialization seed changes, the volatility of the bit error rate of the system is little; when adding Rayleigh noise into channel and the initialization seed changes, the volatility of the bit error rate of the system is large.

What's more, the antinomies performance to different noises of sequence pairs is different. It can be seen from the figure that the bit error rate of the system when it is through Gaussian white noise channel is obviously much lower than that when the system through Rayleigh noise channel.

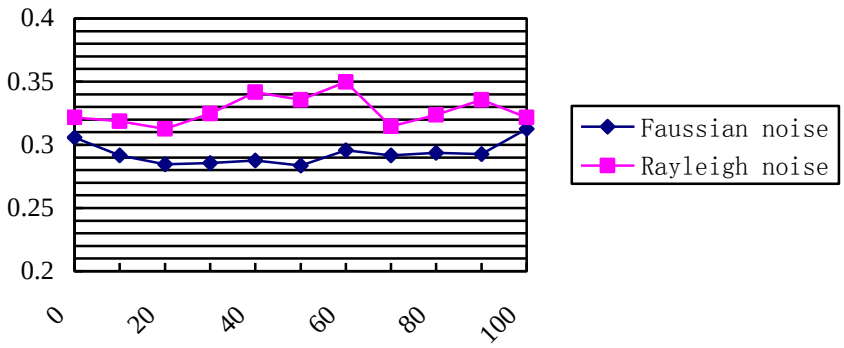

Fig. 5 The simulation results contrast of DS-CDMA system noise channel

The simulation of DS - CDMA communication system fully embodies that the application of sequence pairs in DS - CDMA communication system is feasible. Due to that there is no error control coding in the simulation, the bit error rate producing in the system is relatively high.

When applied to the system which is through white Gaussian noise channel, the bit error rate is approximate to that when it applied to the system which is through ideal channel. It shows that when applied in DS-CDMA system which is through white Gaussian noise channel, the anti-interference performance of sequence pairs to white Gaussian noise is high. However, when Rayleigh noise is added to the channel, the bit error rate of sequence pairs applied in the system is high, which shows that the anti-interference performance of sequence pairs to Rayleigh noise is low when the system is used in DS-CDMA system which is through Rayleigh noise channel.

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