The Simulation of the Direct Sequence Spread Spectrum Based on SystemView

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Abstract: Spread spectrum communication is an important branch of the communication channel and the development direction of the communication system. It includes the direct sequence spread spectrum and the frequency hopping. On the DS system, the RF bandwidth is very wide, the spectral density is very low, and the impact on other systems is small, so it has the good performance. DS now is widely used in many fields such as wireless networks and computer technology. Systemview is a simulation analysis platform used in modern engineering and scientific design and dynamic system. It has the friendly interface and provides the users with a accurate embedded analysis tools. This paper analyses the principle and characteristics of the direct sequence spread spectrum. According to this research the author studied the direct sequence spread spectrum system simulation system based on SystemView software environment, designed the simulation model, and gave the simulation results.

Keywords: SystemView; the direct sequence spread spectrum;,communication; simulation

1. Introduction

Spread spectrum technology is a kind of information transmission, and in general it refers to really taking much more than the signal bandwidth to transmit information. Spread spectrum technology has the advantages of strong anti-jamming ability, good secrecy, easy to realize multi-access communication etc, so this technology is more and more paid attention. In recent years, with the development of large scale integrated circuit, microprocessor technology and some new components, the application of spread spectrum communication technology has a new level, not only in the military communications occupies an important position but also rapidly permeates personal communication and computer communication etc in civil field, and it has become the most potential of the communications technology. Common types: direct sequence spread spectrum, frequency hopping, jumping time and linear frequency hopping pulse, etc.

2. The principle of direct sequence spread spectrum

The direct sequence spread spectrum is referred to as the way straight expansion. In transmitter the high rate of spread spectrum sequence expanded the spectrum of the signal, and in receiver using the same spread spectrum code sequences to spread spectrum, so that the expansion spectrum signal becomes the original spectrum signal reduction. The direct sequence spread spectrum directly applies with false noise sequence modulate carrier. In the transmitter side, data needed to be sent firstly is encoded through the channel, then is added with the pseudo-noise sequence PN code for module 2 to generate complex code to modulate carrier. [1] Usually balance modulator is needed to improve the efficiency and the transmitter's emission power for spread spectrum systems. The balance modulation is favorable that inhibit carrier to improve the anti-detection ability of anti-very for spread spectrum signal. In the receiver side, when the receiver receives transmission signal, and it firstly acquires the exact phase of pseudo codes through the circuit of the pseudo-code synchronization capture, while produces the exactly same pseudo-code phase with pseudo-code sent by transmitter as the local de-spreading signal so that it can timely recover of the data information and complete the Direct Sequence Spread Spectrum signal reception.

Figure 1 is the block diagram of direct sequence spread spectrum communication system. The digital signal $a_k(t)$ for transmission through information modulation (usually PSK modulation) become narrow-band modulated signal $b_k(t)$ It is again modulated (spread spectrum modulation)with the very high chip rate spreading code $c_k(t)$, at this time spectrum bandwidth of the output signal is expanded, and the signal is $s_k(t)$. This process is known as spread spectrum. Spread spectrum signal $s_k(t)$ then is transformed into RF signal and transmitted out. There is opposite process for the receiving end.

3. The characteristics of direct sequence spread spectrum system

A*) Strong anti-interference ability*

Spread spectrum demodulator is actually a correlator. Spread spectrum signal through the correlator is able to effectively restored, but interference signal is not related with the local PN code so that it is inhibited out of the correlator.

B*) Strong anti-multipath interference ability*

In the process of radio waves propagation, the multipath interference can cause a serious decline of communication systems or even unable to go to work. By the

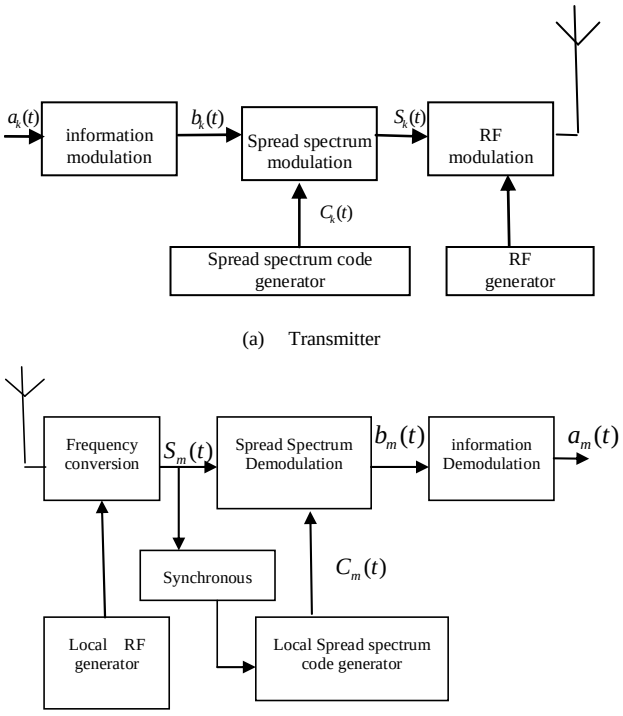

Figure 1. Block diagram of direct sequence spread spectrum

characteristics of spreading spectrum sequence auto-correlation function, when the relative time of two received signal sequence is longer than codes width, the output signal of correlator is just yards countdown so that it was largely inhibited. Direct sequence spread spectrum technology has a more advanced RAKE reception technology, and it can achieve multipath diversity and make received signal to strengthen. It not only avoided the higher multipath interference also strengthened received signal strength.

C*) Little interference to other radio stations, strong anti-interception capability*

Theoretical analysis shows that the detection probability of signal is proportional to the ratio between signal power and noise power spectral density, and inversely proportional to the signal bandwidth. DS signal just have these two advantages, and its power spectral density is low, the energy per unit time is very small, while its frequency band is wide. Therefore, it has the strong anti-intercept capability.[2]

D) *Can work with the same frequency*

As a result of the relevant de-spreading, so long as each communication' de-spreading code is different, several communication equipment can use the same frequency, but there won't have mutual interference, just add a little background noise.

E) *Easy to realize multi-access communication*

Due to that the different spread-spectrum codes are orthogonal or close to orthogonal, and interact with each other is small, so the different spread-spectrum codes can be use as the users' address codes, namely easily realize CDMA communication.[3]

4. The introduction of System View

SystemView is the visualization software tools for system simulation analysis based on the windows environment studied by U.S. ELANIX company. It has friendly interface and is easy to use. SystemView is a signal system simulation software, mainly used for circuit and communication system design and simulation. It is a powerful dynamic system analysis tool, and it can complete digital signal processing, filter design, complex communication systems design and simulation in different levels. It can simulate various complex analog, digital, mixed-signal and multi-rate systems, and it can be used for all kinds of linear and nonlinear control system design and simulation. SystemView has the following characteristics: simulating a lot of application system, rapidly convenient for dynamic system design and simulation, easily join the conclusion in the SystemView report, providing the design based on the organizational structure chart, providing more rate system and parallel system, completely designing filters and linear system, advanced signal analysis and data block processing, strong extensibility, perfect self-diagnosis function. Anyhow, SystemView is a powerful dynamic simulation tools based on personal computers for the communication system, and it still can realize complex communication system design and simulation without advanced equipment.[4]

5. The simulation of direct sequence spread spectrum system

In order to further illustrate the characteristics of spread spectrum communication, this paper carried out the simulation of direct sequence spread spectrum system using the SystemView software. **Figure 2** showed simulation diagram for direct sequence spread spectrum system. The author did not used conventional direct sequence spread spectrum principle to modeling in accordance with the actual engineering, but used concise structure model and immediate way. Data source used a lower frequency of random sequence through a 1KHZ low-pass filter instead. Spread spectrum PN code used the 10KHZ PN code, so in theory it can get 10 times spreading gain. Spread spectrum modulation directly modulated data signals with PN code through the multiplier, and synthetic spread spectrum composite signal is also directly modulated by higher frequency carrier and is launched, so that it eliminated the need for the balance of conventional modulation steps. To observe the anti-jamming performance of spread-spectrum system, the author used a interference signal source. The interference signals can be single-frequency narrow-band interference, also can be a broad-band sweep-frequency signal, or gauss noise. It can be

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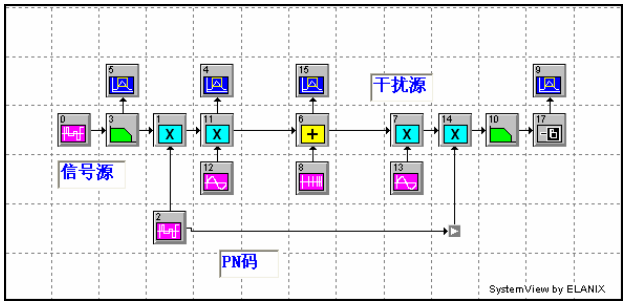

Figure 2. Simulation diagram of the direct sequence spread spectrum

selected depending on the type and magnitude of circumstances interference signal. The default interference signal source is the 90 KHZ ~ 120 KHZ sweep pulse signal source.

6. Conclusions

The results of simulation as shown from **Figure 3** to **Figure 6. Figure 3** is shown as input signal waveform through the prior filter, the **Figure 4** is the reshaping output signal waveform after de-spreading. **Figure 5** is modulated signal spectrum without interfering signal. **Figure 6** is modulated signal spectrum already with interfering signal. From these graphs we can clearly observe

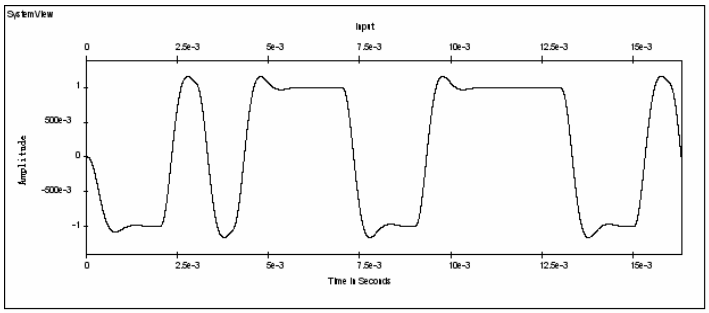

Figure 3. The input signal waveform after pretreatment

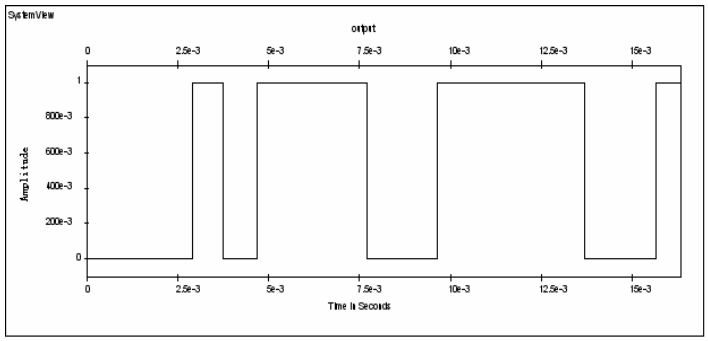

Figure 4. The output signal waveform after the integer

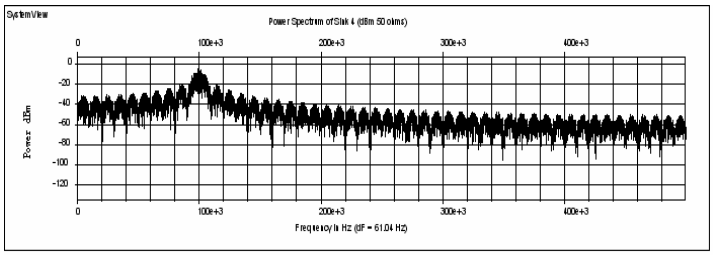

Figure 5. The modulated signal spectrum before that interference is not added

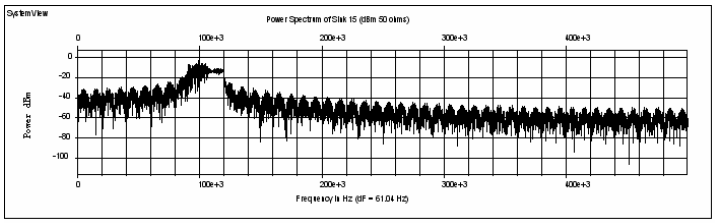

Figure 6. The modulated signal spectrum after adding interference

that there are strong interference near 100 KHz, but de-spreading signal is basically same as the input signal, completely without interference effect. When we increased amplitude noise or interference system, if it achieved the threshold, it can interfere with the original signal, and the original signal won't be restored accurately.

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