Discussion on Application of Commonly Spread Spectrum Technology

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Abstract—Master the working principle of different spread spectrum technology, it is advantageous to the technical personnel in the construction of communication system to choose the reasonable communication method and can improve the communication efficiency and the security of the communication. Through the comparison and analysis of the communication principle of various kinds of spread spectrum technology at this stage, the advantages and disadvantages of different spread spectrum technology and its reasonable application field are obtained. In this paper, we mainly analyze the technical indicators, such as covert communication, anti-jamming, digital mode compatibility, networking capability, spectrum utilization, and the effective use of these techniques to simplify the communication process and improve the security of communication. Research has a wide range of popularization and applicability for engineering and technical personnel to provide a reasonable communication solutions to lay the theoretical foundation.

Keywords-Spread Spectrum Technology; DS; FH; TH; CDMA

I. INTRODUCTION

With the rapid development of wireless communication technology, there are more and more communication problems, narrow channel interference and channel bandwidth, long plagued many scientific research personnel. The emergence of spread spectrum technology, to solve the problem of communication resources crowded, weak anti-jamming, in addition, can also improve the confidentiality of the wireless communication. Spread spectrum communication technology widespread use by us troops in the 40 s, after decades of application and development of spread spectrum communication technology has been play an important role in the high frequency radio transmission line. In the early 70 s began to spread spectrum communication research in China, the spread spectrum communication has become one of China's three major high-tech communication mode.

The communication system using the spread spectrum technology has the following advantages:

anti - jamming performance is good, it has a very strong anti - jamming, narrow band interference, relay and forward jamming ability, which is beneficial to the electronic counter - countermeasure;

the power of the unit bandwidth is very small, the signal power spectrum density is low, because the signal is very wide and the power is small;

It is easy to realize code division multiple access, spread spectrum communication takes up the broadband spectrum resource, improve the anti - jamming ability, improve the utilization rate of the frequency band.

II. BASIC PRINCIPLE OF SPREAD SPECTRUM TECHNOLOGY

In the network communication, the spectrum is used to express the frequency domain of an electric signal, which is a kind of information transmission mode, which is the broadband signal and the receiving end uses the same encoding mode to receive and expand the special spectrum, so as to achieve the purpose of transmitting data. Therefore, the spread spectrum signal has the following characteristics:

bandwidth band width is much larger than the transmission of information;

adopted the method of spread spectrum code modulation spectrum;

The receiver must use the same encoding, the dispread signal receiving

With the wide application of large-scale integrated circuits, especially in the field of communication, spread spectrum communication technology is becoming mature gradually. At this stage, the spread spectrum communication system has the characteristics of low probability of intercept, good performance, good security, easy to implement code division multiple access. As a result, the application of spread spectrum communication technology is becoming more and more extensive, and its prospect is immeasurable.

Spread spectrum communication technology in the transmitter to spread spectrum encoding for spread spectrum modulation, in the receiver to receiver demodulation technology. Since spread spectrum communication is to spread spectrum modulation and spread spectrum modulation to transmit, the signal receiver needs to expand the correlation with the same spread spectrum to the encoding, which provides the basis for frequency reuse and multiple access communication. Full use of the characteristics of different types of spread spectrum encoding between different users of different spread spectrum encoding, you can distinguish between different users of the signal, and is not subject to other users of the interference, frequency reuse.

III. THREE BASIC WAYS OF SPREAD SPECTRUM TECHNOLOGY

According to the different ways of spread spectrum communication, spread spectrum technology can be divided into the following three categories: the most basic direct sequence spread spectrum (DS), frequency hopping spread spectrum (FH), spread spectrum (TH), and jump. Also include linear modulation, but in the actual application, the most widely used is a hybrid mechanism.

A. The principle of DS,FH and TH

Direct sequence spread spectrum system by pseudo noise generator produces sequence of pseudo noise (PN sequence) for the modulation of the carrier signal modulation, again with the baseband pulse data directly multiplied to spread spectrum; Jump in spread spectrum based on the rate of frequency hopping and data bit rate of high and low frequency hopping into slow and fast frequency hopping, it is according to the sequence of pseudo random discrete control the output of the oscillator frequency radio frequency carrier, although the use of the frequency hopping focus is the instantaneous channel bandwidth, namely narrow band, but all possible carrier frequency spectrum area is large, so the same is a wide-band spread spectrum signal; Jump usually use pseudo code sequence to the control transmitter, namely random opening and closing signal emission and duration. For the spread spectrum technology, information transmission bandwidth used by far higher than the bandwidth of the information is the central idea, closely around the theme, has direct sequence and frequency hopping mode is generally used in civil and military aspects.

B. 2.2 The comparison of various ways

Using spread spectrum technology communication system generally has anti-jamming, adaptability, concealment, confidentiality, such as ability, will the most basic mode of three kinds of spread spectrum technology work according to table 1 compare index parameters.

TABLE I. PARAMETER TO COMPARE

parameters	DS	FH	TH
Concealment of the communicatio n	good	poor	better
bandwidth	<100MHz	wide	ultra-wideband
anti-interference	Very strong	strong	strong
Digital and analog compatibility	Compatible with the handles	Compatible with direct communication	Compatible

In addition, in the actual application, direct sequence spread spectrum and frequency hopping spread spectrum technology is one of the most common use, the frequency hopping frequency hopping include slow and fast frequency hopping, because both have very strong anti-jamming performance, itself has other advantages, often compare the characteristics of both to do, as shown in table 2.

TABLE II. COMPREHENSIVE COMPARISON

parameters	DS	SFH	FFH
Networking capability	strong	higher than FFH	higher than DS
Spectrum utilization	High	higher than FFH	higher than DS
Interfere with the threat	higher than FFH	High	higher than SFH
Relay work	higher than FFH	higher than DS	High
Communicati on security	higher than SFH	higher than FFH	High
Comprehensi ve ability	Good	Better	medium

IV. DISCUSSION ON APPLICATION OF THREE BASIC SPREAD SPECTRUM SYSTEM

A. DS

Direct sequence spread spectrum communication is that it has the advantages of the extremely strong artificial broadband interference resistance, is conducive to counter against applications in military communication, and because of the direct sequence spread spectrum using cycle longer pseudo-random code modulation of digital information, make the enemy's ordinary reconnaissance means is not easy to identify, coupled with its own network synchronization, communication security, the superiority of digital and analog exchange, making it not only realizes the CDMA code division multiple access communication, in the field of military communications in recent years, has become a necessary means of communication in the electronic warfare and reverse against. But the future development of more and more rapidly, communication frequency band may be filled with more powerful interference sources, perhaps the general spread spectrum will not be able to withstand the anti-jamming capability.

As the direct spread spectrum system and treat many sound interference solution is adaptive interference, it not only requires good algorithm, high-speed hardware processing is needed. Use of multi-band spread spectrum instead of the traditional binary spread spectrum, in general, the spreading factor and the code rate unchanged, multi-band spread spectrum information rate is about the binary spread spectrum N times; If both information rate remains the same, also spread spectrum factor variable, then the multi-band spread spectrum processing gain can be expanded about N times, so you can better improve the anti-interference ability of the system.

From table 1 shows that the direct sequence spread spectrum characteristics of "far to near effect" in three ways for disadvantage, so generally do not adopt direct sequence spread spectrum radio field time, on the contrary the use of the frequency hopping radio is common. Because usually need to configure several direct spread spectrum communication command center station implement direct contact, but if use spread spectrum radio communication, although the same transmitter power, but because of the influence of the far - near effect, if the jammer take advantage of the distance problem make the interference signals and the ratio of useful signal power more than limit value, will be easy to find, receiving station is usually by other radio interference on the same platform, addressing problems caused.

The synchronized data signal may be a bit or a binary channel encoding symbol, in order to form a chip in the form of a 2 plus mode, and then a phase shift modulation. Received a single user's spread spectrum signal can be expressed as:

$$S = \sqrt{\frac{2E_s}{T_s}}\, m(t)p(t)\cos(2\pi f_c t + \theta)$$

M (T) is a data sequence, P (T) is the PN spread spectrum sequence. Waveform data is a time series on non-overlapping rectangular pulses, each pulse amplitude equal to + 1 or - 1, m (T) sequence in each symbol represents a data symbol, the cycle is Ts. P (T) sequence in each pulse represents a chip, usually rectangular amplitude is equal to +1 or 1, period of Tc.

Measures taken are: so you can replace the CDMA code division multiple access way to switch to TDMA multiple access in spread spectrum communication, each time slot on the same frequency band can only be occupied by the spread spectrum signal, in addition to prevent can produce overlapping part of the signal, it can be retained for a period of the signal time travel time, don't have to convey information; Also can convert FDMA frequency division multiple access or jump way of direct spread spectrum communication, increase jump hybrid spread spectrum system can improve far - nearly effect of interference, technology is also easy to implement.

B. FH

Frequency hopping is one of the most commonly used methods of spreading. Its working principle is that the carrier frequency of the transmitter and receiver can be changed according to the predetermined rules.

From the point of the realization of communication technology, frequency hopping is a code sequence multi frequency shift keying communication mode, the code is also a kind of controlled carrier frequency hopping communication system. From the time domain, frequency hopping signal is a multi-frequency shift keying signal. In the frequency domain, the frequency spectrum of the frequency hopping signal is a very wide band with unequal interval. The frequency hopping controller is the core component, which includes the function of frequency hopping pattern generation, synchronization, and adaptive control and so on.

Compared with the fixed frequency communication, the frequency hopping communication is more subtle and difficult to be intercepted. As long as the other unknown carrier frequency hopping pattern, it is difficult to capture our communication content. At the same time, the frequency hopping communication also has well anti - jamming ability, even if there are some frequency points being interfered, it can still carry on the normal communication at the other frequency points. As the frequency hopping communication system is the instantaneous narrow band system, it is easy to be compatible with other narrow band communication systems.

In data link technology constantly updated and GSM network quantity increase gradually, as well as direct sequence spread spectrum system, the military also is facing severe electromagnetic environment, the average frequency hopping system must ensure that 1/3 of the total number of the interference value in frequency to maintain in the military communication data link of good, so the best way is to use the adaptive frequency hopping technology combined with idle channel search. Itself can realize high speed continuous irregular jump carrier frequency, can effectively avoid being tracked.

In addition, in the application of the wireless Bluetooth in order to realize the reliable information data and voice transmission open specification, should guarantee the normal communication contains noise environment to realize the electrical frequency, according to the Shannon theorem, if great information transfer rate C remains the same, so the bandwidth of the channel W and signal-to-noise ratio is inversely proportional to the S/N, this time under the condition of low signal-to-noise ratio, improve the bandwidth of the channel, namely using instantaneous narrow bandwidth frequency hopping spread spectrum technology will spread spectrum into a range of wide bandwidth, even in the signal transmission rate and the ratio of noise transmission rate is very small, as long as extended bandwidth can also guarantee the reliable communication. Because of fast frequency hopping technology has excellent communication concealment, according to the principle of frequency hopping mechanism, USES the spread spectrum code sequence that frequency change constantly, as on the battlefield with gun on "in place" guerrilla tactics, so it can prevent communications intercepted by other.

C. TH

TH (Hopping) is similar to the frequency hopping (Time), which makes the transmitted signal jump on the time axis. First of all time axis is divided into many pieces. In a frame, the signal is transmitted by a spreading code sequence. Can be understood as: the use of a certain code sequence to select the time when the key control. As a result of the use of a lot of time to send a signal to send a lot of time, relative to say, the spectrum of the signal is also broadened. The following diagram is a diagram of the system's principle. In the beginning, the input data is stored first, and then controlled by the spreading code sequence of the spreading code generator to control the on-off switch, which is modulated by two phase or four phase modulation and then transmitted by the radio frequency modulation. At the receiving end, the intermediate frequency signal output by the RF receiver is controlled by the same spreading code sequence as the same as the originator, and then the second phase or four phase demodulator is sent to the data memory and the output data after the re timing. As long as the two ends at the time of the strict synchronization, you can correctly restore the original data.

For the jump time system, it uses pseudo random code to control signal sending questions, and the difference between the frequencies hopping is that it is controlled by the time factor. Compared with the frequency hopping system, it is the best communication concealment, but jump system when the timing is difficult, due to the instantaneous carrier frequency factors remain the same result in obstruction type or target type interference, is generally not used alone.

Tab .1. shows the spread spectrum system has the characteristics of ultra-bandwidth, so the confidentiality

and anti-interference ability compared with signal enhancement, because of this jump when ultra-wideband impulse radio spread spectrum technology was applied to the simulation, the intensity of high resolving power, can reduce the weak signal, reduce the transmission power requirements. In addition a combination of direct spread spectrum and frequency hopping spread spectrum technology is widely used in many areas at present, it can be combined with the two basic ways have some excellent properties, such as: confidentiality, anti-interference, detection of resistance, far - near effect, such as performance, used in communication field, including underwater acoustic communication system, CBTC train-ground communication, mine mobile communication, etc.

V. SPREAD SPECTRUM TECHNOLOGY DEVELOPMENT PROSPECTS

DS, FH and TH system there are improvements in military communications aspects, adopting adaptive spread spectrum technology improve anti-jamming performance, guarantee the concealment of the communication, and will be more widely applied in military field. Nowadays information communication has entered the fourth generation mobile communication system (4 g communications) era, the new wireless interface technology can realize the spread of the spread spectrum technology, also can be combined with spread spectrum technology to realize spread spectrum; Jump is another development of UWB technology, the spread spectrum has the ultra-bandwidth performance, has been used to simulate the UWB impulse radio, for ultra-bandwidth signal, its ability to resist multipath fading is very strong, so it is of high strength multipath resolution, coupled with very low transmission power, the application prospect in the field of mobile communications will have to be reckoned with.

Decades of development, spread spectrum technology has been from dawn to mature, now to have the good performance has been in the military field and is widely used in the field of communication, but there are still many deficiencies, such as direct sequence spread spectrum radio in the field is not big, but the change of code division multiple access mode can help in a problem. And is the basic work of mix system, the effective complement each other, in the era of rapid development of wireless communication, spread spectrum technology development will be more rapid, the application of spread spectrum technology will be more extensive.

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