Research on Communication Signal Modulation Recognition Technology

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Abstract: The modulation recognition algorithm of digital communication signals based on decision theory is to extract characteristic parameters of the signal to be identified, manually preset a decision threshold, and compare the characteristic parameters with the decision threshold to identify the modulation mode of the signal. The instantaneous parameters of the signal are extracted, and the extracted results are converted into characteristic parameters. This process mainly uses the zero center normalization algorithm. Simulate the real work scene, and select the decision threshold after a large number of simulation experiments. The decision threshold is used to compare the characteristic parameters of the signal to be identified, and then the identification result is obtained. In the simulation experiment of the algorithm using MATLAB, the algorithm can effectively complete the signal recognition work. The algorithm used in this article obtains more and more comprehensive characteristic parameters for identification and comparison from the three parameters of amplitude, phase, and frequency. The recognition rate of the algorithm is improved to a certain extent, while retaining the real-time characteristic of the decision theory algorithm.

1. Introduction

The basic purpose of communication is to transfer information to each other, and to make the transfer process safe, accurate, fast, and effective. With the rapid development and wide application of communication technology, how to make full use of bandwidth in a limited channel to achieve high-speed and stable data transmission is a huge challenge for signal modulation technology. Network communication has developed from the early XDSL technology of the telephone network to optical fiber access, so that the 3G and 4G technologies of the wireless communication network have fully utilized the signal modulation technology, from simple analog modulation to digital modulation, and from simple single modulation. Signal modulation to complex multi-signal modulation, signal modulation technology has also been greatly developed, and it is also popular and respected so far. According to the different range of use, signal modulation technology can be roughly divided into two directions, civilian and military. In the civilian field, it can be used for data transmission and can also be applied to the field of radio management. With the widespread application of radio technology, its management becomes more and more difficult, and modulation mode, as an important indicator of wireless communication, can be fully utilized to complete wireless communication management, monitor and detect illegal wireless communication signals, and give timely control to avoid causing Serious loss. In terms of military affairs, with the development of information technology, informationized troops have become the top priority in today's military field. How to obtain local information, disrupt local communications, and implement informationized attacks has become an important means of attack in military operations, and signal modulation as an important symbol of wireless communication, starting from its application to military deployment is also an important topic in today's wireless communication and military science and technology research fields.

2. Basic Modulation Technology of Digital Communication Signal

Signal preprocessing: Whether it is the recognition of modulation methods or the recognition of other data information, in essence, it is a comparative analysis of one or more parameters of the largest difference between the recognition objects themselves, and then determine which one or one

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they belong to. Predictive samples of the class. The process of preprocessing is to make the recognized object highlight its own parameters with large differences, weaken or ignore the parameters with small differences, and lay a working foundation for the subsequent work, simplify the algorithm complexity from the aspect of reducing the parameters, and adapt it to practical applications. Feature extraction: through preprocessing, highlight the data parameters that the recognition system values, which is called features. Since the recognition process requires processing methods such as parameter feature comparison, gate valve determination, etc., the feature parameters of the modulation signal itself must be extracted. This process is called feature extraction. Classification and recognition: This process is the top priority in the field of data recognition technology. Whether it is image recognition, speech recognition or the modulation mode recognition discussed in this topic, a large number of researchers in related fields have proposed a large number of methods and algorithms, and the pattern classification recognition method has become a more symbolic method. The method first presents the pattern samples, and performs algorithmic processing on the recognition objects, and classifies them according to the processing results, which can effectively reduce the algorithm complexity and ensure that the recognition results have a higher recognition rate. This subject also uses the above three steps to effectively identify the modulation method, and proposes an improved algorithm to achieve better stability and real-time performance under the premise of ensuring the recognition rate. In the signal pre-processing link, since it is a multi-signal multi-channel environment under actual working conditions, the pre-processing separates the signals to ensure that a single signal appears in the same channel; in the feature extraction link, the algorithm in this subject first performs instantaneous Parameter extraction, namely instantaneous phase, instantaneous frequency, instantaneous amplitude. On this basis, feature parameter extraction is performed. In this article, Fourier transform, Hilbert transform, in-phase quadrature component method and zero-crossing detection method are mainly used; in the classification and recognition link, the current commonly used methods are based on threshold judgment There are two classification forms: tree classifier and neural network classifier. The threshold decision-based tree classifier uses artificially present thresholds. After multiple comparisons, the modulated signal is classified, and then the modulation method is determined. This method has a simple algorithm, Good real-time performance. However, due to the poor adaptive ability of manually set thresholds, the recognition rate of complex signals is average. The neural network classifier itself has a certain learning ability. It can effectively recognize complex signals based on past experience. It performs well in recognition rate and has strong stability, but its algorithm complexity is high, and the system performs generally in real-time.

3. Basic Modulation Method of Digital Communication Signal

The concept of modulation (modulation) can be regarded as adjustment. When the signal after source and channel coding may not pass through the channel unhindered, it is necessary to increase the frequency range of the signal through modulation. The sine wave is used as the carrier, so that the modulated band-pass signal is transmitted normally in the channel. The most commonly used in the current communication field is analogy modulation, digital modulation and pulse modulation, of which digital modulation is the focus of this article. Binary amplitude keying refers to the digital modulation method in which the amplitude of the sinusoidal carrier changes with the binary baseband signal. The baseband signal is a sequence of binary “0” and “1”, and is a unipolar non-return to zero code (Non-Return to Zero, NRZ). In the process of digital signal transmission, “0” and “1” are represented by a variety of voltage levels, and the so-called unipolar non-return-to-zero code means that in the digital signal, it is “0” when there is no voltage. State, the fixed voltage is “1”, it uses the threshold determination method, that is, the threshold is assumed to be 0.5, that is, half-amplitude voltage. When the symbol is between 0 and 0.5, it is determined as “0”, and when the symbol is between 0.5 and 1, it is determined as “ 1”. Figure 2-2 shows two methods of 2ASK signal generation. The first method is to use an analogy multiplier to multiply the binary baseband signal and the cosine signal t0cos to obtain 2ASK. The second method uses a logic switch circuit to

generate 2ASK. One input of the switch input is a cosine signal t0cos, and the other is grounded. The binary baseband signal is used to limit the input. When the baseband signal is “1”, connect t0cos; it is “0” When the switch is grounded, the intermittent 2ASK is obtained. The main difference between the two methods is that when the first method uses an analogy multiplier, the baseband signal is not necessarily a binary digital signal, but also a raised cosine signal, etc., as long as the intermittent 2ASK is generated after the multiplication process. In the second method, the baseband signal, as the control input of the logic circuit, must be a standard binary digital signal, otherwise the logic circuit chip will not be able to recognize it, and the 2ASK signal will not be generated.

With the development of signal modulation technology, binary amplitude keying can no longer meet the actual needs of the communication field. In the process of data wireless communication, the complexity of the signal gradually increases, and the information transmission rate requirements are getting higher and higher, so the binary amplitude keying Based on the theory of keying, multi-level modulation technology has been gradually developed. It is directly felt from the frequency spectrum that the MASK spectrum is much more complicated than 2ASK, and with the increase of M, its spectrum structure is more complicated. But starting from the principle, MASK is formed by the superposition of M 1 2ASK. Similarly, both the waveform and its power spectrum are formed by the superposition of M 1 2ASK, so the bandwidth of MASK is the same as that of the ASK modulated signal. Property, regardless of the value of M, its bandwidth MASKB is twice the bandwidth of the baseband signal, where ft = 1/T.

Binary frequency shift keying refers to a digital modulation method in which the frequency of a sine wave changes with a binary baseband signal. The baseband signal is a sequence of binary “0” and “1”. The sequence generates two signals of different frequencies from two frequency sources. 0f and 1f represent “0” and “1”, respectively, the frequency 0f represents “0”, and the frequency 1f represents “1”. There are two main methods for 2FSK signal generation. The first one uses a frequency modulation chip to modulate a binary baseband signal into two output signals with different frequencies; the second one uses a switch circuit whose input ends are divided by two signals with different frequencies are composed of a signal with a frequency of 0f and a signal with a frequency of 1f. The baseband pulse signal is used for switching control to generate a 2FSK signal, as shown in Figure 2-4. The output signals generated by the above two 2FSK signal generation methods are roughly the same. The only difference is that the first method generates 2FSK signals and adjacent symbols are continuous, while the second method generates 2FSK signals from two frequency sources. There is no continuity between adjacent symbols.

4. Inter-Class Recognition of High-Order Cumulants

This chapter extracts characteristic parameters from the high-order cumulant of the signal to realize the identification of digital modulation signals. The extracted characteristic parameters are different combinations of high-order cumulant modulus. For 2ASK, 4ASK, 2PSK, 4PSK, 2FSK, 4FSK, 16QAM the specific algorithm for signal classification is as follows: In the first step, the results of binary amplitude keying and binary phase shift keying are the same after the cumulant algorithm is processed, so this algorithm cannot be used to identify these two communication signal modulation methods. In the subsequent identification analysis, these two signals are classified into one category. In the second step, based on the above-mentioned signal intra-class analysis, taking into account the computational complexity of the 6th-order cumulant, this chapter combines the 2nd and 4th-order cumulants to extract the following 3 characteristic parameters, and according to Table 4-1 and Table 4-4 Perform theoretical value calculations based on characteristic parameters for 2ASK, 4ASK, 2PSK, 4PSK, 2FSK, 4FSK, and 16QAM signals. Tables 5-1 to 5-3 are the calculation results.

The third step is to use the basic modulation method of 1T communication signal to identify. The characteristic parameter 2T identifies 4PSK, 16QAM and MFSK signals, and 3T is used to identify the different modulation methods of amplitude keying. At the same time, phase shift keying and phase shift keying can be identified. Quadrature amplitude keying is used for identification. On this

basis, 3T is processed by cumulant mathematical processing, and the calculated results can be used to identify different modulation modes of frequency shift keying.

A high-order cumulant algorithm is used to make a simulation based on MATLAB software, and 1,000 Monte Carlo experiments are performed independently for each signal, and the average value is taken as the result. From the following table 5-4, it can be seen that the algorithm performs well under the condition that the interference source parameter in the simulated working environment is 10dB, and can accurately complete the modulation method classification. The signal can be completely distinguished when the signal-to-noise ratio is 15dB. Therefore, the recognition effect of the algorithm in this paper is obvious under the low signal-to-noise ratio.

The above experiments are conducted on the same sample by using the decision theory algorithm introduced in Chapter 3 and the algorithm described in this chapter. Under the same simulation conditions, comparing the recognition rates of Table 3-1 and Table 5-4 under the same signal-to-noise ratio, it can be seen that when the signal-to-noise ratio is high (15dB), the recognition algorithm based on decision theory and the description in this chapter The algorithm performed well in the experiment process; when the parameter is low (15dB), the algorithm discussed in this chapter performs better, which shows that the application range of this algorithm is wider and wider, and as the parameter decreases, the better the performance . Decision theory algorithms need to select appropriate parameters and thresholds. The selection of parameters and the determination of thresholds for different signals are particularly important. The position and sequence of the parameters will have a great impact on the recognition effect. The application of the high-order cumulant method is very convenient. You can freely combine the cumulants with different orders and the cumulants of the same order but with different conjugate terms in the definition, and choose the classification features reasonably according to the different signals It has become a research focus. In addition, the modulation recognition algorithm of high-order cumulants requires the signal length to be long enough, so the experimental conclusions obtained by using this algorithm are in better agreement with expectations.

5. Conclusion

The paper compares and analyses the recognition rate of the same multiple signals under the same simulation conditions based on decision theory and high-order cumulants. The characteristic parameters of different modulation types can be identified efficiently by using decision theory, and the computational complexity can be reduced. Aiming at the theoretical analysis of the identification of the modulation signal within and between classes, it is given that the high-order cumulant method can realize the rapid and effective identification of modulation parameters in the environment of low signal-to-noise ratio.

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