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Retraction

Retracted: Modulation of Multichannel Electronic Communication Signal Parameters Based on a Nonlinear Phase Principle

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] L. Zhao, “Modulation of Multichannel Electronic Communication Signal Parameters Based on a Nonlinear Phase Principle,” *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 2311263, 7 pages, 2022.

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Research Article

Modulation of Multichannel Electronic Communication Signal Parameters Based on a Nonlinear Phase Principle

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In order to solve the difficulty of the optical fiber communication system and network as the infrastructure of the global communication network, which is faced with the requirement of large capacity and high speed, the author proposes a method to modulate the parameters of multichannel electronic communication signals based on the nonlinear phase principle. The method includes multichannel electronic communication signal search, multichannel electronic communication signal parameter modulation, and multichannel electronic communication signal automatic acquisition algorithm realization. Experimental results show that under the conditions that the sampling frequency is set to $f = 8.145$ MHz, the length of the C/A code period is set to 1 ms, and the 1 ms data packet contains 8145 sampling points, under the same experimental conditions, the capture probability of this experiment reaches 100% and the traditional algorithm has a capture probability of up to 70%. Modulation of multichannel electronic communication signal parameters based on nonlinear phase principle has a positive guiding role in building a high-speed optical fiber communication system and network with long distance, large capacity, high elasticity, high reliability, and low delay.

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1. Introduction

At present, the development trend of Internet technology is becoming more and more vigorous. Especially in June 2019, my country issued a 5G commercial license, and 5G technology has officially entered the commercial period. The development of new technologies has spawned a large number of new network services, such as virtual and augmented reality, navigation, and unmanned driving [1]. At the same time, in order to meet the growing number of Internet users, as well as the growth of new bandwidth-demanding services such as cloud computing and real-time multimedia services (HD video streaming, Internet of Things, webcasting, etc.), all require communication network systems to have ultrahigh speed, ultrahigh reliability, ultralow latency, and ultralarge connections. This is a huge challenge for the fiber-optic backbone network that carries the main traffic of the Internet. Therefore, as the infrastructure of the global communication network, optical fiber communication systems and networks are also faced with the requirements of large capacity and high speed [2]. While commercial products with constellation diagram shaping and powerful forward error correction technology are being built and elastic optical networks are proposed, it also aimed at building a high-speed optical fiber communication system and network with long distance and large capacity, high elasticity, high reliability, and low delay [3]. To meet this purpose, the establishment of a reliable real-time optical communication parameter monitoring system is essential. The nonlinear phase noise accumulated by the Kerr effect in long-distance optical communication is a difficult problem facing the development of optical networks at present. The nonlinear effect monitoring of damage signal has also become an important topic in the field of optical communication [4]. Artificial intelligence algorithms, especially machine learning algorithms, have developed rapidly in the past few years and have been introduced into optical communications to solve various problems. Before applying machine learning to the field of optical performance monitoring, most of the traditional optical performance monitoring methods need to add additional hardware conditions and a lot of manual operations; the process is cumbersome and is not conducive to the improvement of accuracy. Some technologies need to modify or add restrictions to the transmission signal, which will have high requirements on optical communication equipment, which is not conducive to their application in practical scenarios. Most of the technologies require complex iterative algorithms, which consume a lot of computing time and memory capacity, and are very limited in practical communication scenarios [5]. In this environment, based on the nonlinear phase principle to modulate the parameters of multichannel electronic communication signals, it is of theoretical significance for building a reliable real-time optical communication parameter monitoring system.

2. Literature Review

Early research on MPSK signal mostly used this method. Zhou used the maximum likelihood criterion to complete the derivation and modulation identification of MPSK signal under the Gaussian white noise channel [6]. Based on the generalized likelihood ratio classification method, Antonelli et al. designed BPSK and OPSK signal classifiers in the Gaussian white noise environment, which improved the classification accuracy under low SNR [7]. Ghosh et al. used the phase deviation and baseband symbols as random variables to estimate the signal power with maximum likelihood and then used the mixed likelihood ratio method to modulate and identify BPSK and QPSK signals [8]. Alzamil et al. collected the eye diagram of the transmitted signal as the input of the neural network model, so as to realize the monitoring of the system parameters [9]. In their research in 2018, Gok et al. used the constellation image in Stokes space to successfully identify the modulation code pattern [10]. Different types of modulated signals show different statistical characteristics of instantaneous information and have great differences in instantaneous amplitude, phase, and frequency; it is feasible to modulate and identify signals by constructing instantaneous features. Such feature parameters are less constrained by prior information and are easy to extract, but their antinoise performance is not ideal. Yong et al. extracted five information features such as instantaneous amplitude, instantaneous frequency, and nonlinear phase of the signal; when the signal-to-noise ratio was 10 dB, the recognition rate of 2ASK, 4ASK, 2PSK, 4PSK, 2FSK, and 4FSK signals was 90% above [11]. Nine kinds of classical instantaneous information features are successively proposed, which can realize modulation identification of 13 kinds of analog and digital signals. Zhou et al. used the classical phase feature σ and 3 new features to complete the modulation recognition of 6 common digital signals. When the signal-to-noise ratio is not lower than 5 dB, the recognition rate is higher than 99% [12]. Lantz et al. proposed a series of new instantaneous information features combined with support vector machine classifiers to successfully complete the modulation identification of 12 kinds of digital signals [13]. Yang et al. realized the modulation recognition of ASK, PSK, and FSK signals by improving the traditional instantaneous information features and increased the recognition rate by 15% under the same conditions [14]. In 2015, Bruyn and Gao applied multiorder cyclic cumulants to the classification of multiuser modulations [15]. Chen et al. selected the second-order to eighth-order cumulants of the signal to complete the modulation and identification of 28 kinds of digital signals; due to the large order of cumulants, the computational complexity is high; however, the signal range and recognition performance are significantly improved compared with the previous ones [16].

In order to meet the needs of users, it is necessary to improve the spectrum utilization rate; however, due to the diversified systems and modulation methods of multichannel communication signals, the signals in the same space are becoming more and more dense. In order to reduce the influence of uncertain factors under strong interference, it is necessary to improve the traditional acquisition algorithm, so that reliable acquisition can still be carried out under strong interference. The traditional acquisition algorithm is to wait for reception on a known acquisition method, but the acquisition signal will be affected by strong interference, which is difficult to be used for automatic acquisition of multichannel electronic communication signals; therefore, it is proposed to modulate the parameters of multiple electronic communication signals based on the nonlinear phase principle. The automatic acquisition algorithm of multichannel electronic communication signal can solve the problem of slow acquisition speed caused by long pseudocode period. The algorithm uses the DSSS communication method to process the multichannel electronic communication signal, so that the obtained carrier frequency and pseudocode phase are more accurate, and then the frequency change rate is introduced to modulate the parameters of the multichannel electronic communication signal; finally, according to the algorithm requirements, an algorithm with higher acquisition efficiency is selected, the designed algorithm is studied in detail, and the principle of the automatic acquisition algorithm for multichannel electronic communication signals is analyzed [17].

3. Methods

3.1. Characteristic Parameters Based on Higher-Order Cumulants. The author needs to use higher-order cumulants for intraclass recognition of MASK, MQAM, and MPSK ($M = 4$, $M = 8$). Assuming that the received digital modulated signal sampling complex sequence in the Gaussian white noise environment can be expressed as

$$S(t) = \sqrt{E}\sum_{n} a_n g(t - nT_s) e^{j(\omega_c t+\theta_c)} + n(t). \tag{1}$$

In the formula, E is the energy of the transmitted symbol waveform, a_n is the symbol sequence, $g(t)$ is the transmitted symbol waveform, T_S is the symbol duration, ω and θ are the frequency and phase of the carrier, respectively, and $n(t)$ represents complex white Gaussian noise with zero mean. In the case that the receiver knows the carrier frequency information, the received signal $S(t)$ is subjected to down-conversion and timing synchronization processing, the

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symbols of the above signal are synchronously sampled, and the complex signal can be expressed as

$$\mathbf{S}_{\text{MASK}}(k) = \sqrt{E}e^{j\theta}a_k + n_{k,}a_k \in \{2m - 1 - M, m = 1, 2, \cdots, M\}, \quad (2)$$

$$\mathbf{S}_{\text{MPSK}}(k) = \sqrt{E}e^{j\theta}a_k + n_{k,}a_k \in \left\{\exp\left(\frac{j2\pi(m-1)}{M}\right), m = 1, 2, \cdots, M\right\}, \quad (3)$$

$$\mathbf{S}_{\text{MQAM}}(k) = \sqrt{E}e^{j\theta}a_k + n_{k,}a_k = a_{I,k} + ja_{Q,k} = \sqrt{a_{I,k}^2 + a_{Q,k}^2} \cdot e^{j\varphi_k}. \quad (4)$$

The theoretical value of each order cumulant of MASK, MPSK ($M = 4$, $M = 8$), and MQAM.

3.1.1. Intraclass Identification of MASK Signals. For the intraclass identification of MASK, the construction of characteristic parameters mainly utilizes the fourth-order cumulant and sixth-order cumulant of the signal; the specific definitions are as shown in equations (1) to (5).

$$A_1 = \frac{|C_{60}^2|}{|C_{40}^3|}, A_2 = \frac{|C_{63}^2|}{|C_{40}^3|}. \quad (5)$$

The MASK signal features are shown in Table 1.

3.1.2. Data Volume Impact Analysis. When studying the influence of data volume, the influence of Gaussian white noise is not considered, the number of symbols starts from 32 and appears in the form of an exponential of 2, the maximum setting is 4096, and 100 simulation experiments are carried out at each data point to investigate variation of characteristic parameters with the number of symbols.

For the feature of nonlinear phase crest factor PF, the peak strength of different signals is different. When the amount of simulated data is large enough, the PF feature of the signal and the amount of data show a linear relationship. The switching of the numerator part of the characteristic parameters, that is, the continuous accumulation of discrete spectral line quantities in the differential nonlinear phase and the average processing of the denominator part on the differential nonlinear phase, eliminates the influence of the data volume. When the amount of data changes, different modulation methods show different slopes in the parameter PF, among which the MSK signal has the smallest slope and is significantly different from other signals. This means that the larger the amount of data, the easier it is to identify the MSK signal. From the PF simulation value alone, when the amount of data is 1024 symbols, the difference between the MSK signal and the PF simulation value of the nearest 16QAM signal is more than 1000, and there is a good degree of discrimination. As the amount of data continues to increase; the difference between the MSK signal and the other ten signals is more obvious. Therefore, the parameter PF requires that the amount of simulation data is not less than 1024 symbols.

Table 1: MASK signal feature quantity.

Parameter	2ASK	4ASK	8ASK
A_1	32	27.38	27.7
A_2	0	33.35	41.23

3.2. Design of Automatic Capture Algorithm for Multichannel Electronic Communication Signals

3.2.1. Multichannel Electronic Communication Signal Search. There are two kinds of pseudocodes for multichannel electronic communication signals, namely, CL and CM, which need to be realized by CL before capturing, but it is not feasible to directly capture CL code. So it is necessary to search for multichannel electronic communication signals first, limit the pseudocode length, and frequency offset range to reduce the capture time. The search range of multiple electronic communication signals is shown in Figure 1.

The search process is as follows: randomly select a channel for correlation detection; if the detection result is greater than the threshold value, the search is successful. If the detection result is less than the threshold value, the search fails. When the pseudocode phase is delayed by 1/2 chip, the search needs to be repeated.

3.2.2. Multichannel electronic communication signal parameter modulation. After completing the multichannel electronic communication signal search, it is necessary to modulate the parameters of the multichannel electronic communication signal under strong interference to reduce the rate of the pseudorandom code, the multichannel electronic communication signal parameter modulation process is shown in Figure 2.

It can be seen that the autocorrelation function in the range of one chip is relatively obvious, and there is almost no peak value, indicating that the multichannel electronic communication signals have good correlation. When the pseudocode phases in Figure 2 are completely aligned, the peak value of the correlation function will be very obvious, if the phase deviation of the pseudo code exceeds the time length of 1 chip, the correlation value is 0 [18]. When the magnitude of the autocorrelation peak of the pseudo-code and the multichannel electronic communication signal is affected by the signal-to-noise ratio, the receiver can be used for automatic acquisition, and the parameters of the multichannel electronic communication signal can be modulated according to the good autocorrelation of the pseudorandom code.

In order to ensure the accuracy of the modulation parameters, it is necessary to modulate the instantaneous phase of the multichannel electronic communication first; the most critical step is to accurately know the carrier frequency; the nonlinear phase part of the multichannel electronic communication signal can be estimated as

$$\phi_{NL}(i) = \phi_{uw} - \frac{2f_c i}{f_c}. \quad (6)$$

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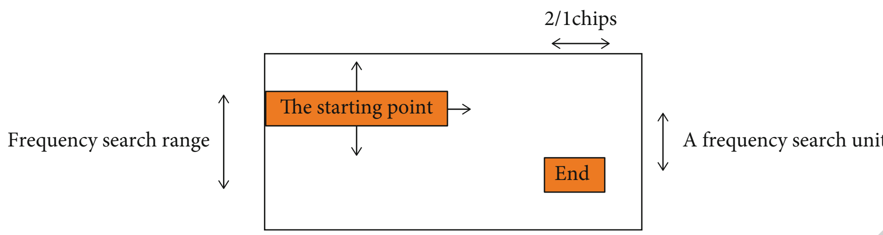

FIGURE 1: Block diagram of multichannel electronic communication signal search.

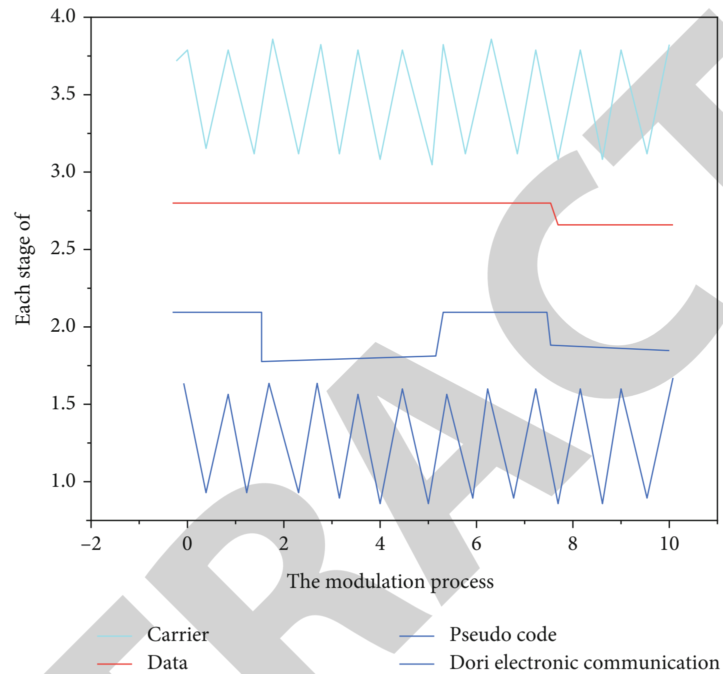

FIGURE 2: Modulation process of multichannel electronic communication signal parameters.

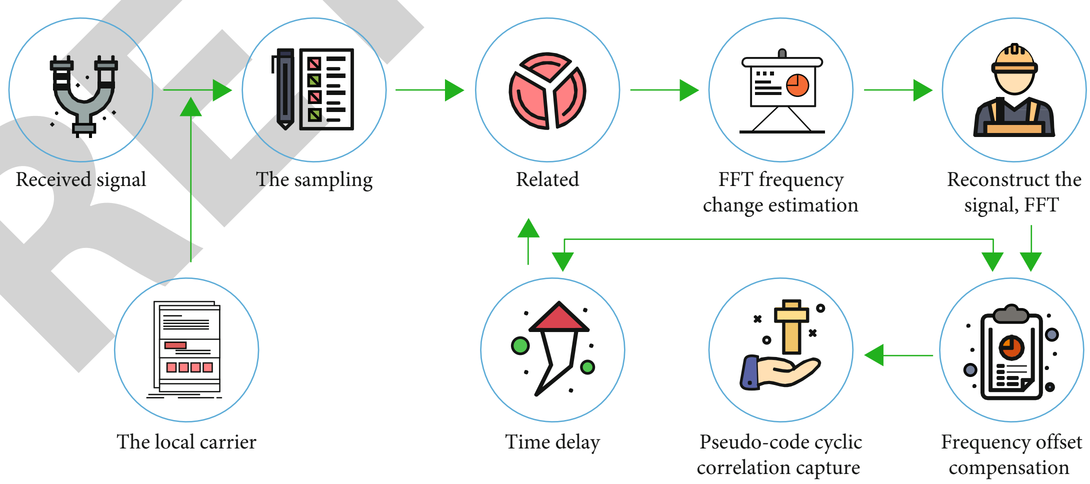

FIGURE 3: Implementation block diagram of automatic acquisition algorithm for multichannel electronic communication signals.

Among them, ϕ_{NL} represents the nonlinear component, i represents the number of samples, ϕ_{uw} represents the standard deviation of the absolute value of the instantaneous phase nonlinear component of the multichannel electronic communication signal, f_c represents the carrier frequency, and φ represents the unformatted phase sequence. Use formula (6) to calculate the carrier frequency to ensure the accuracy of the modulation parameters.

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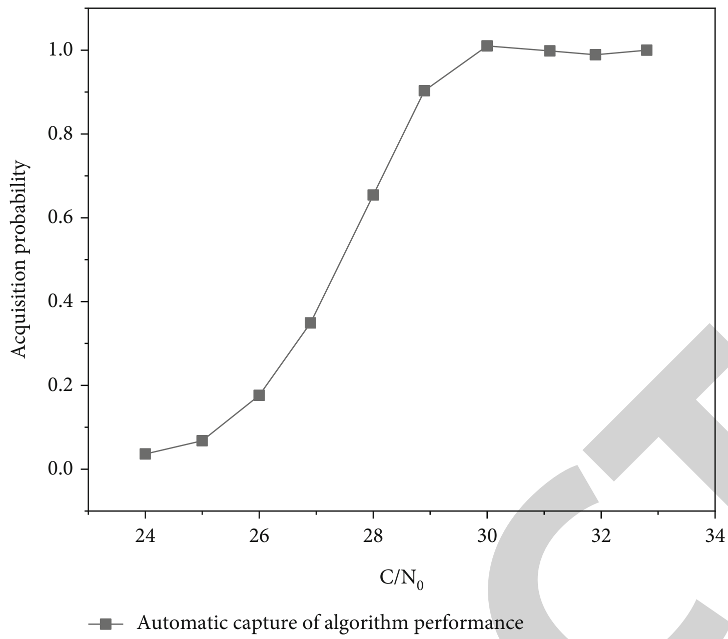

Figure 4: Performance experiment of automatic capture algorithm for multichannel electronic communication signals.

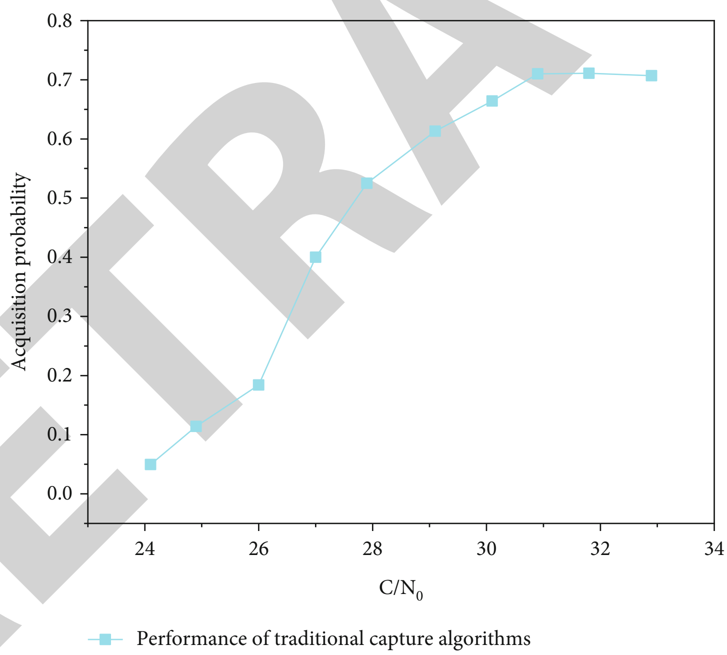

Figure 5: Performance experiment of traditional capture algorithm.

3.3. Implementation of Automatic Capture Algorithm for Multichannel Electronic Communication Signals. By searching for multichannel electronic signals, the capture range is narrowed, and the parameters of multichannel electronic communication signals are modulated to improve capture performance; finally, an automatic acquisition algorithm for multichannel electronic communication signals is applied to correlate the pseudocode and the signal [19]. The automatic acquisition algorithm of multichannel electronic communication signals under strong interference combines the principle of Doppler frequency offset frequency domain compensation algorithm, which makes the search results more reliable by reducing the scope of communication [20]. The algorithm flow is as follows:

(1) The local C/A code sequence is a subcarrier modulated to obtain the C/A code sequence, and after average sampling, the range of the Doppler frequency offset is obtained

(2) Set the sampling signal received by the multichannel electronics as r; first perform sampling processing on

r to form h 2048-point average sampling sequences, and then apply the Doppler frequency domain formula to perform the 2048-point FFT operation

(3) Multiply FFT$\{r\}$ and FFT{local-CA}, and then perform frequency-domain frequency offset operation; the result sequence of the operation is $R_{\text{BOCIPN}}(T/2)$

(4) Combine the operation result sequence according to Figure 3 to obtain the reconstructed correlation function R_{proposed}

(5) Compare the maximum value of the reconstructed correlation function with the threshold; if the maximum value of the new correlation function is less than the threshold value, you need to restart the capture, and repeat steps 2 to 5; if the new maximum value of the correlation function is greater than the threshold value, the capture is successful, and the parameters obtained in the capture stage need to be uploaded to the tracking stage. Thereby, the capture of pseudocode is realized

Considering the problem of acquisition speed under strong interference, the principle of fast acquisition of cyclic spectrum is applied, and the signal frequency is set to f_d, and the communication frequency is

$$x_i(t) = A_C f_d(T) PN(t). \tag{7}$$

Among them, x_i represents the amplitude of the multichannel electronic communication signal, T represents the carrier frequency of the received multichannel electronic communication signal, $N(t)$ represents the received data information, the rate is 40 Hz, P represents the pseudo code, and the nominal rate is 1.025 MHz. The pseudocode rate of the receiving end t is the mean value of 0, and the signal-to-noise ratio $\text{SNR} = A/2\sigma$. In the calculation process, it is necessary to ignore the coding method of the correlation density function and the pseudorandom sequence; otherwise, the rate of the chip will be affected. In essence, the acquisition process of the carrier and the pseudocode is the estimation process of the carrier frequency and the pseudocode rate; let the carrier frequency be f_c and the pseudocode rate be f_d. In order to satisfy the characteristics of cyclostationarity, according to the spectral correlation theory, the spectral correlation density function is obtained as

$$P_x(f) = \frac{A_m^2}{4T_b}. \tag{8}$$

Among them, f represents the spectral frequency, A represents the symbol width, $P_x(f)$ represents the cycle frequency, and T_b represents the estimated value of the carrier frequency of the multichannel electronic communication signal. The relevant parameters such as carrier frequency and symbol rate of the multichannel electronic communication signal are obtained by applying formula (4). Thus, the design of the automatic acquisition algorithm for multichannel electronic communication signals under strong interference is completed.

4. Results and Discussion

Compare and analyze the multichannel electronic communication signal automatic capture algorithm and the traditional capture algorithm. When performing performance comparison and analysis, the capture process in Figure 3 should be used, and other processing steps are the same. In the simulation experiment, the sampling frequency needs to be set to $f = 8.145$ MHz, the length of the C/A code period is set to 1 ms, and the 1 ms data packet contains 8145 sampling points; the two algorithms are simulated, and the experimental results are shown in Figures 4 and 5; under the same experimental conditions, the capture probability of this experiment reaches 100%, while the capture probability of the traditional algorithm is up to 70%.

It can be seen that the entire processing process is gain, and the use of the automatic acquisition algorithm of multichannel electronic communication signals can effectively enhance the signal-to-noise ratio under interference; in terms of acquisition speed, the algorithm designed this time is more dominant than the traditional acquisition algorithm; the automatic acquisition algorithm of multichannel electronic communication signal can reduce the amount of acquisition calculation, further optimize the reliability of automatic acquisition, and will not affect the performance of the algorithm [21]. The performance of the algorithm mainly depends on the detection characteristics of the algorithm; experiments have proved that the automatic acquisition algorithm of multichannel electronic communication signals can achieve effective acquisition under strong interference.

5. Conclusion

The author proposes a method to modulate the parameters of multiple electronic communication signals based on the nonlinear phase principle. Aiming at the problems of traditional acquisition algorithms, this method proposes an automatic acquisition algorithm for multichannel electronic communication signals, which can effectively solve the problem of slow acquisition speed caused by long pseudocode period. Through simulation experiments, the performance of the two algorithms is simulated, and the experimental results show that the application effect of the algorithm is better than the traditional capture algorithm. Specifically, the performance of the algorithm mainly depends on the detection characteristics of the algorithm; experiments have proved that the automatic acquisition algorithm of multichannel electronic communication signals can achieve effective acquisition under strong interference.

Data Availability

The data used to support the findings of this study are available from the author upon request.

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Conflicts of Interest

The author declares that they have no conflicts of interest.

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