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Retraction

Retracted: Analysis on the Ecological Concept of Ternary Interactive Education in Business English Writing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] Y. Zhang, "Analysis on the Ecological Concept of Ternary Interactive Education in Business English Writing," *Advances in Multimedia*, vol. 2022, Article ID 4294237, 10 pages, 2022.

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Research Article

Analysis on the Ecological Concept of Ternary Interactive Education in Business English Writing

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In order to improve the effect of business English writing education, this paper combines intelligent algorithms to study the ecological concept of ternary interactive education in business English writing and jointly identifies interference and source signals. Moreover, this paper derives the likelihood function of the received signal under the modulation mode of the interference and the source signal and jointly considers the information of the interference. The modulation recognition can well reduce the influence of interference on algorithm performance. In addition, this paper simulates the recognition performance of the likelihood function-based algorithm when the system has frequency offset and asynchronous time offset. Finally, this paper combines experimental research to verify that the business English education system based on the ternary interaction concept proposed in this paper can effectively improve the effect of business English writing education.

1. Introduction

At present, the teaching content cannot meet the actual needs of business. The existing business English writing teaching has explained and practiced various styles of business activities. However, there is no systematic and comprehensive overview of the knowledge of e-commerce and cross-border e-commerce. Business cooperation includes all aspects of commodity transactions, such as commodity quantity, price, attributes, shipment, delivery, and payment. What students receive is mainly English-based writing teaching, not systematic business writing teaching. If it is not in line with workplace needs and business practices, it will be difficult for students to quickly connect with practical business work after class. There is a gap between teaching methods and business practice [1]. Teaching philosophy has not kept up with business practice. Business English writing is highly practical, which makes teachers improve the traditional teaching concept and cannot always use “teacher” as the main body to explain knowledge, and students only accept it passively [2]. Teachers should be led, and students should become the main body of learning and actively participate in the classroom. Moreover, more practical aspects should be integrated into the classroom, and the teaching of business knowledge should be combined with practical teaching. In addition, it is necessary to think about business issues and workplace needs in the classroom and explore and improve workplace coping capabilities [3].

The context of business English determines that the discourse of business English letters has its own characteristics. Business English letters often emphasize one letter, and the content revolves around one theme. Therefore, “subjectline” is generally used in the letter to highlight the subject content and make the recipient clear at a glance. As a communication tool in international trade, business English letters have certain requirements on the genre structure and discourse structure of writing [4]. The business English context plays a certain restrictive role on both the writer and the reader of the letter, and the specific business environment must be referred to when writing. If the writing language of business English letters does not conform to the language habits and cultural habits of the other readers, it will affect the smooth progress of business activities. As large as the international business environment, as small as the business operation environment of a company, etc., all have certain influences and constraints on the writing of business English letters. Therefore, in the teaching of business English writing, teachers must teach students all kinds of contextual knowledge needed in the writing process [5].

Linguistic context is what is traditionally called contextual context. It plays a restrictive and explanatory role on the vocabulary, sentence structure, paragraph and chapter structure, and habitual expressions of business letter writing. In business English letter writing, many students do not consider the context and often make the following mistakes: the meaning of the words used does not match the context; the referential relationship of pronouns is confused; the transition between paragraphs is lacking; and conjunctions are used indiscriminately [6]. Therefore, when teaching business English letter writing, teachers should make students understand that the language used in business English letters has its own unique language rules. It may be inappropriate or even wrong to tell students that when choosing words and sentences in writing, they must consider the context, because each language unit in the letter is not isolated and disconnected, but contacts and influences each other, so that the written letters can become a coherent and smooth, organic unity [7].

Language and culture are closely related. As a communication tool for international trade, business English letters are deeply influenced by cultural backgrounds. The thinking habits, history, culture, religion, and other factors of both sides of the trade constitute a complex business context background, which is the basis for forming their own code of conduct and trade practices. The cultural context in business English letters includes the age, gender, values, and living habits of the writer and recipient [8]. The cultural factors of different countries constitute different and complex business contexts, which affect their behavioral habits, ways of thinking, and language characteristics. The cultural context restricts and affects the writing style of business English letters and the use of specific situational language [9]. In the teaching of business English letter writing, teachers should organically combine language teaching and cultural teaching, make students familiar with the culture of the relevant country, encourage students to conduct comparative research on other's culture and their own culture, and ask them to pay attention to the the language which should conform to the thinking habits and language habits of people in the target language country and must not simply copy or imitate the style and language of a certain letter writing model [10].

As a kind of English for Special Purposes (ESP), business English has the basic attribute of language essence and is a common language used in business activities [11]. It poses a lot of challenges for teachers' professional quality and teaching level, students' mastery of knowledge at all levels, timeliness of textbook content, and classroom teaching validity. In general, from the author's classroom practice, the current business English teaching in our school has the following problems [12]. Before the establishment of "Business English Writing," our school has already offered preliminary courses, such as "Elementary English Writing," "Intermediate English Writing," and its business series courses. Students already have a relatively solid language foundation and certain writing knowledge: master the basic writing skills and abilities such as planning, transition, and coherence, be able to identify the established writing content style, and be able to use English proficiently to express ideas. There is still a need for further regulation, and there is still a distance from the goal of reading and writing international trade correspondence with certainty and freedom [13]. Specifically, the current situation of business English writing teaching is that students have poor English foundation, self-learning ability needs to be improved, teaching methods are single, and evaluation subjects and standards are too single. The teaching method of business English writing is relatively traditional, but the common disadvantage is that it ignores that business English writing is a very practical course: the learning feedback lags behind, the lack of in-depth interaction between teachers and students, the low authenticity of teaching materials and tasks, etc. [14]. In the process of writing teaching, teachers should clearly know that the writing process is a continuum. In short, in the writing process, teachers should guide students to discover problems in time and overcome difficulties, not just focus on the finished product. The process teaching method is an efficient method in the teaching of business English writing, and its effect is still questioned by many scholars. The genre-based teaching method lacks imagination in the teaching process. In addition, this kind of teaching method is boring, which can easily lead to the disadvantages of the students' finished products with different styles, which is not conducive to the cultivation of students' creativity and autonomous learning ability [15]. Based on the EQ teaching platform independently developed by our school, we adopt a blended teaching model, creatively apply the new dual-class teaching model based on the principles of cognitive psychology, design business English writing teaching links, and implement the "teacher-led, student-led" teaching practice and "subject" teaching philosophy. In the actual teaching process, each teaching link always takes students as the main body, gives play to the leading role of teachers, focuses on the training of students' writing process and writing ability, and cultivates students' independent thinking and analysis, problem solving, teamwork, etc., in order to achieve the three integration of knowledge goals, ability goals, and quality goals.

This paper studies the ecological concept of ternary interactive education in business English writing combined with intelligent algorithms, improves the effect of business English teaching, and effectively improves the practical effect of modern business English.

2. Data Processing of Ternary Interactive Teaching of Business English

2.1. The Mathematical Principle of Modulation Mode Recognition Based on Likelihood Function. When using ALRT to calculate the likelihood function of the modulation scheme, the unknowns of the channel parameters are set as random variables, and its prior probability distribution is known. Therefore, the likelihood function of receiving business English teaching signals under a certain modulation mode M_i is as follows:

$$\Lambda_A^{(i)}[r(t)] = \int \Lambda[r(t)|v_i, M_i]p(v_i|M_i)\mathbf{dv}_i. \quad (1)$$

Among them, $\Lambda[r(t)|v_i, M_i]$ is the conditional likelihood function of the received business English teaching signal $r(t)$ under the unknown channel parameter v_i and the modulation mode M_i, and i refers to the i-th modulation mode. It can be seen from this formula that in order to calculate the likelihood function of the received business English teaching signal under this modulation mode, the prior probability distribution $p(v_i|M_i)$ of the channel parameter unknown v_i must be known. For the received business English teaching signal under the complex baseband additive white Gaussian noise (AGWN) channel, the conditional likelihood function can be expressed as

$$\Lambda[r(t)|v_i, M_i] = \mathbf{exp}\left[\mathbf{2}N_\mathbf{0}^{-\mathbf{1}}\ \mathbf{Re}\left\{\int_\mathbf{0}^{KT} r(t)s^*(t\,;u_i)dt\right\} - N_\mathbf{0}^{-\mathbf{1}}\int_\mathbf{0}^{KT} |s(t\,;u_i)|^\mathbf{2} dt\right]. \quad (2)$$

Among them, N_0 represents the double-sideband power spectral density of the noise, K represents the number of observed symbols, and T represents the duration of one symbol.

In the MIMO communication system, the received business English teaching signal is a multidimensional vector; each dimension represents a receiving antenna to receive the business English teaching signal, and the received business English teaching signal is observed for a period of time. Therefore, the received business English teaching signal is $Y = [Y_\mathbf{1}, Y_\mathbf{2}, \cdots, Y_N]$, where $Y_k (k = \mathbf{1}, \mathbf{2}, \cdots, N)$ represents the received business English teaching signal vector at the k-th time point. It can be concluded that the likelihood function of the received business English teaching signal about a certain modulation mode M_i can be expressed as

$$\Lambda[Y|M_i, \mathrm{H}] = \int_S \Lambda[Y|M_i, S, H]P[S|M_i]\mathbf{dS}. \quad (3)$$

Among them, $S = [S(\mathbf{1}), \cdots, S(N)]$ is the $\mathbf{nt} \times N$ matrix (nt represents the number of transmitting antennas), which represents the transmitted business English teaching signals in the observation time period. H represents the channel matrix. Using the statistical independence of each time point of the transmitted business English teaching signal, the above formula can be written as

$$\Lambda[Y|M_i, \mathbf{H}] = \prod_{k=\mathbf{1}}^{N} \int_{S(k)} \Lambda[Y(k)|M_i, S(k), H]P\left[S(k)|M_i\right]\mathbf{dS}(k). \quad (4)$$

The constellation point set of modulation mode M_i is Ω_u, and the number of elements of Ω_u is M, and in general, the probability of sending a business English teaching signal to take each position of the constellation point is equal, so $P[S(k)|M_i] = (\mathbf{1}/M)^n t$. The above formula is simplified to

$$\Lambda[Y|M_i, H] = \frac{\mathbf{1}}{M^{N\cdot nt}} \prod_{k=\mathbf{1}}^{N} \sum_{S(k)\in\Omega_u^{nt}} \Lambda[Y(k)|S(k), H]. \quad (5)$$

Among them,

$$\Lambda[Y(k)|S(k), H] = \frac{\mathbf{1}}{(\pi\sigma^\mathbf{2})^{nr}}\ \mathbf{exp}\left[-\frac{\mathbf{1}}{\sigma^\mathbf{2}}\|Y(k) - \mathbf{HS}(k)\|^\mathbf{2}\right]. \quad (6)$$

σ^2 is the noise variance, and nr is the number of receiving antennas. The work of modulation mode recognition is to solve the maximum value of formula (5) under different modulation modes M_i, so the recognition problem is a problem of finding the maximum value.

$$M_c = \underset{M_i\in\Theta}{\mathbf{argmax}}(\Lambda[Y|M_i, H]). \quad (7)$$

GLRT is to use the maximum likelihood value of channel parameter unknowns instead of unknowns to calculate the maximum likelihood function of receiving business English teaching signals. The unknowns of channel parameters include channel reception coefficient, channel noise, and transmitted symbols. The likelihood function identified by the modulation method is transformed into

$$\Lambda_G^{(i)}[r(t)|M_i] = \mathbf{max}_{v_i}\Lambda[r(t)|v_i, M_i]. \quad (8)$$

Because GLRT only uses the maximum likelihood value into the calculation, instead of the statistical average of all possible values like ALRT, it reduces the amount of calculation, but the error caused by this approximation greatly reduces the effect of recognition.

HLRT combines ALRT and GLRT. For the transmitted symbols, the statistical average is still adopted like ALRT, and other unknown channel parameters are replaced by maximum likelihood estimates. Therefore, the maximum likelihood function transforms into

$$\Lambda_H^{(i)}[r(t)|M_i] = \mathbf{max}_{v_{i_1}} \int \Lambda\left[r(t)|v_{i_1}, v_{i_2}, M_i\right]p\left(v_{i_2}|M_i\right)dv_{i_2}. \quad (9)$$

Among them, v_{i_2} represents the transmitted symbol, and v_{i_1} represents the unknown quantity of other channel parameters. HLRT combines the advantages of ALRT and GLRT, its computational complexity is lower than ALRT, and its algorithm performance is better than GLRT.

2.2. Recognition of Modulation Mode of Continuous Relay System Based on Likelihood Function. We assume that the channel information such as the channel reception matrix and noise variance is known, which corresponds to the ideal case of channel conditions. Then, we use ALRT to identify the modulation mode of the business English teaching source signal and study the upper limit of the algorithm performance in the Bayesian sense.

Different from directly treating the business English teaching interference signal as color noise, we directly calculate the part of the business English teaching source signal. For example, for the research in this chapter, the relay node of the continuous relay system receives the business English teaching signal. The mathematical model is transformed as follows:

$$y_{\mathrm{R}} = \sqrt{P_{\mathrm{SR}}} H_{\mathrm{SR}} x_{\mathrm{S}} + n_{\mathrm{ZR}}. \quad (10)$$

The likelihood function of the received business English teaching signal about a certain modulation method degenerates into the likelihood function of the modulation method recognition of the two-point MIMO communication system. The specific formula is as follows:

$$\Lambda[y_{\mathrm{R}}|M_{\mathbf{1}i}, H_{\mathrm{SR}}] = \frac{\mathbf{1}}{N_{\Omega}^{N\cdot nt}} \prod_{k=\mathbf{1}}^{N} \sum_{x_{\mathrm{S}}(k)\in\Omega_u^{nt}} \Lambda[y_{\mathrm{R}}(k)|x_{\mathrm{S}}(k), H_{\mathrm{SR}}]. \quad (11)$$

N_{Ω} is the constellation point number of modulation mode $M_{\mathbf{1}i}$, and N is the number of received business English teaching signal symbols. Among them,

$$\Lambda[y_{\mathrm{R}}(k)|x_{\mathrm{S}}(k), H_{\mathrm{SR}}] = \frac{\mathbf{1}}{\left(\pi\sigma_{\mathrm{ZR}}^2\right)^{nr}} \ \mathbf{exp}\left[-\frac{\mathbf{1}}{\sigma_{\mathrm{ZR}}^2}\left\|y_{\mathrm{R}}(k) - \sqrt{P_{\mathrm{SR}}} H_{\mathrm{SR}} x_{\mathrm{S}}(k)\right\|^2\right]. \quad (12)$$

In the above formula, nt is the number of antennas of the source node, and nr is the number of antennas of the receiving relay node. In this paper, nt = nr = M, and n_{ZR} is the noise including interference. Therefore, the classification result is

$$M_{\mathbf{1}c} = \underset{M_{\mathbf{1}i}\in\Theta}{\mathbf{argmax}}\left(\Lambda[y_{\mathrm{R}}|M_{\mathbf{1}i}, H_{\mathrm{SR}}]\right). \quad (13)$$

For the modulation method recognition algorithm of the business English teaching source signal for joint recognition of interference proposed in this paper, the likelihood function used to calculate the received business English teaching signal needs to consider all possible symbolic forms of the transmitting business English teaching signal including the source node and another interfering relay node. Compared with the likelihood function of receiving business English teaching signals in the two-point MIMO communication system, it has one more condition variable (the interference node sends symbols). The likelihood function of receiving a pair of modulation modes about a business English teaching source signal and the business English teaching interference signal is as follows:

$$\Lambda\left[y_{\mathrm{R}}|M_{\mathbf{1}i}, M_{\mathbf{2}j}, H_{\mathrm{SR}}, H_{\mathrm{R}}\right] = \frac{\mathbf{1}}{\left(N_{\Omega_1}\cdot N_{\Omega_2}\right)^{N\cdot nt}} \prod_{k=\mathbf{1}}^{N} \sum_{x_{\mathrm{S}}(k)\in\Omega_{\mathbf{1}u}^{nt} z_{\mathrm{R}}(k)\in\Omega_{\mathbf{2}u}^{nt}} \Lambda[y_{\mathrm{R}}(k)|x_{\mathrm{S}}(k), z_{\mathrm{R}}(k), H_{\mathrm{SR}}, H_{\mathrm{R}}]. \quad (14)$$

Among them,

$$\Lambda\left[y_{\mathrm{R}}(k)|x_{\mathrm{S}}(k), z_{\mathrm{R}}(k), H_{\mathrm{SR}}, H_{\mathrm{R}}\right] = \frac{\mathbf{1}}{\left(\pi\sigma^2\right)^{nT}} \mathbf{exp}\left[-\frac{\mathbf{1}}{\sigma^2}\left\|y_{\mathrm{R}}(k) - \sqrt{P_{\mathrm{SR}}} H_{\mathrm{SR}} x_{\mathrm{S}}(k) - \sqrt{P_{\mathrm{R}}} H_{\mathrm{R}} z_{\mathrm{R}}(k)\right\|^2\right]. \quad (15)$$

In the above formula, M_{1i}, M_{2j}, respectively, represents the modulation mode of the business English teaching source signal and the business English teaching interference signal, forming a modulation pair. This formula is only a likelihood function of receiving a pair of modulation modes about a business English teaching source signal and the business English teaching interference signal. In the end, what we need to obtain is the likelihood function about a certain business English teaching source signal modulation method; then, we apply the Bayesian formula to calculate the marginal probability about the business English teaching source signal modulation method. Moreover, we assume that each modulation mode of the interference node is equal probability, so the likelihood function of the modulation mode of the business English teaching source signal is as follows:

$$\Lambda_{\mathbf{prop}}[y_{\mathrm{R}}|M_{\mathbf{1}i}, H_{\mathrm{SR}}] = \frac{\mathbf{1}}{N_{\Omega_2}} \sum_{M_{2j}\in\Omega_{2u}} \Lambda\left[y_{\mathrm{R}}|M_{\mathbf{1}i}, M_{\mathbf{2}j}, H_{\mathrm{SR}}, H_{\mathrm{R}}\right]. \quad (16)$$

Therefore, the final decision expression is

$$M_{\mathbf{1}c} = \underset{M_{\mathbf{1}i}\in\Theta}{\mathbf{argmax}}\left(\Lambda_{\mathbf{prop}}[y_{\mathrm{R}}|M_{\mathbf{1}i}, H_{\mathrm{SR}}]\right). \quad (17)$$

2.3. Performance Analysis of Modulation Mode Recognition Algorithm Based on Likelihood Function. We first take the logarithm of the likelihood function as formula (11), and ignore some expression terms that do not affect the result, so formula becomes

$$\ln\left(\Lambda[y_{\mathrm{R}}|M_{1i}, h_{\mathrm{SR}}]\right) = \sum_{k=1}^{N}\left(\ln\left(\sum_{x_{\mathrm{S}}(k)\in\Omega_{1u}}\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}x_{\mathrm{S}}(k)\right\|^{2}\right]\right)+\ln\left(\frac{1}{N_{\Omega}\mathbf{nt}}\right)\right). \quad (18)$$

Under the discussion in this section, the business English teaching source signal only takes BPSK and QPSK. For BPSK, the business English teaching source signal form is +1 and -1. For QPSK, the business English teaching source signal form is +1, i, -1, and $-i$.

Therefore, specifically, under the two assumptions, the above equation becomes

$$\begin{aligned}\ln\left(\Lambda[y_{\mathrm{R}}|\mathbf{BPSK}, h_{\mathrm{SR}}]\right) &= \sum_{k=1}^{N}\left(\ln\left(\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)\right\|^{2}\right]+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)\right\|^{2}\right]\right)+\ln\left(\frac{1}{2}\right)\right),\\ \ln\left(\Lambda[y_{\mathrm{R}}|\mathbf{QPSK}, h_{\mathrm{SR}}]\right) &= \sum_{k=1}^{N}\left(\ln\left(\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)\right\|^{2}\right]+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(i)\right\|^{2}\right]+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-i)\right\|^{2}\right]\right.\right.\\ &\quad\left.\left.+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)\right\|^{2}\right]\right)+\ln\left(\frac{1}{4}\right)\right).\end{aligned} \quad (19)$$

The decision expression is

$$\begin{aligned}&\ln\left(\Lambda[y_{\mathrm{R}}|\mathbf{BPSK}, h_{\mathrm{SR}}]\right) > \ln\left(\Lambda[y_{\mathrm{R}}|\mathbf{QPSK}, h_{\mathrm{SR}}]\right), \mathbf{BPSK\ classified},\\ &\ln\left(\Lambda[y_{\mathrm{R}}|\mathrm{BPSK}, h_{\mathrm{SR}}]\right) < \ln\left(\Lambda[y_{\mathrm{R}}|\mathbf{QPSK}, h_{\mathrm{SR}}]\right), \mathbf{QPSK\ classified}.\end{aligned} \quad (20)$$

We set

$$a_{1}(k) = \ln\left(\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)\right\|^{2}\right]+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)\right\|^{2}\right]\right)+\ln\left(\frac{1}{2}\right),$$

$$\begin{aligned}a_{2}(k) = \ln\Bigg(&\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)\right\|^{2}\right]\\ &+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(i)\right\|^{2}\right]\\ &+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-i)\right\|^{2}\right]\\ &+\frac{1}{\pi\sigma_{\mathrm{ZR}}^{2}}\exp\left[-\frac{1}{\sigma_{\mathrm{ZR}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)\right\|^{2}\right]\Bigg)\\ &+\ln\left(\frac{1}{4}\right).\end{aligned} \quad (21)$$

The judgment is

$$\sum_{k=1}^{N} l(k) = \sum_{k=1}^{N}\left(a_{1}(k)-a_{2}(k)\right)\begin{cases}>\mathbf{0}, \mathbf{BPSK\ classified},\\ <\mathbf{0}, \mathbf{QPSK\ classified}.\end{cases} \quad (22)$$

We assume that the mean of $l(k)$ is $\mu_l = \mathbb{E}[l(k)]$ and the variance of $l(k)$ is $\sigma_l^2 = \mathbb{E}[l(k)^2] - \mu_l^2$. According to the central limit theorem, $(\mathbf{1}/N)\sum_{k=\mathbf{1}}^{N} l(k)$ satisfies the normal distribution $\mathcal{N}(\mu_l, \sigma_l^2/N)$.

Therefore, the misrecognition probability can be obtained as

$$P(\mathbf{error}|\mathbf{BPSK}) = P\left(\frac{\mathbf{1}}{N}\sum_{k=\mathbf{1}}^{N} l(k) < 0|\mathbf{BPSK}\right) = Q\left(\mu_l\sqrt{\frac{N}{\sigma_l^2}}|\mathbf{BPSK}\right). \quad (23)$$

Among them, $Q(x) = \int_{x}^{+\infty}\exp\left((-(\mathbf{1}/\mathbf{2}))x^2\right)dx$.

Since the analytical closed-form expressions of μ_l and σ_l^2 are difficult to obtain, numerical methods are generally used to calculate their approximate results.

We also take the logarithm of the likelihood function as formula (14), and it becomes

$$\begin{aligned}\ln\left(\Lambda\left[y_{\mathrm{R}}|M_{1i}, M_{2j}, h_{\mathrm{SR}}, h_{\mathrm{R}}\right]\right) &= \sum_{k=1}^{N}\left(\ln\frac{1}{\left(N_{\Omega_1}\cdot N_{\Omega_2}\right)^{nt}}\right.\\ &\quad+\ln\left(\sum_{x_{\mathrm{S}}(k)\in\Omega_{1u}^{nt}\sum_{\mathrm{R}}(k)\in\Omega_{2u}^{nt}}\frac{1}{\left(\pi\sigma_{\mathrm{R}}^{2}\right)^{nr}}\exp\right.\\ &\quad\left.\left.\cdot\left[-\frac{1}{\sigma_{\mathrm{R}}^{2}}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}x_{\mathrm{S}}(k)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}z_{\mathrm{R}}(k)\right\|^{2}\right]\right)\right).\end{aligned} \quad (24)$$

Theoretical performance curve of the algorithm based on the likelihood function is shown in Figure 1 .In the discussion in this section, the business English teaching source signal only takes BPSK and QPSK, and the business English teaching interference signal only takes BPSK. For BPSK, the business English teaching source signal form is +1 and -1. For QPSK, the business English teaching source signal form is +1, i, -1, and $-i$. The interference with business English teaching signal form is +1 and -1. Therefore, specifically, under the two assumptions, the above equation becomes

$$\begin{aligned}
&\ln\left(\Lambda_{\mathbf{prop}}[y_{\mathrm{R}}|\mathbf{BPSK}, h_{\mathrm{SR}}]\right) = \\
&\sum_{k=1}^{N}\Bigg(\ln\Bigg(\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(+1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(+1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(-1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(-1)\right\|^2\right]\Bigg)+\ln\left(\frac{1}{4}\right)\Bigg). \\
&\ln\left(\Lambda_{\mathbf{prop}}[y_{\mathrm{R}}|\mathbf{QPSK}, h_{\mathrm{SR}}]\right) = \\
&\sum_{k=1}^{N}\Bigg(\ln\Bigg(\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(+1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(+1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+i)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(+1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-i)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(+1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(-1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(+i)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(-1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-i)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(-1)\right\|^2\right] \\
&+\frac{1}{\pi\sigma_{\mathrm{R}}^2}\exp\left[-\frac{1}{\sigma_{\mathrm{R}}^2}\left\|y_{\mathrm{R}}(k)-\sqrt{P_{\mathrm{SR}}}h_{\mathrm{SR}}(-1)-\sqrt{P_{\mathrm{R}}}h_{\mathrm{R}}(-1)\right\|^2\right]\Bigg)+\ln\left(\frac{1}{8}\right)\Bigg).
\end{aligned} \tag{25}$$

The formula in the summation symbol of formula (25) is $a_{1,\mathbf{prop}}(k)$, and the formula in the summation symbol of formula (25) is $a_{2,\mathbf{prop}}(k)$. Therefore,

$$\begin{aligned}
\ln\left(\Lambda_{\mathbf{prop}}[y_{\mathrm{R}}|\mathbf{BPSK}, h_{\mathrm{SR}}]\right) &= \sum_{k=1}^{N} a_{1,\mathbf{prop}}(k), \\
\ln\left(\Lambda_{\mathbf{prop}}[y_{\mathrm{R}}|\mathbf{QPSK}, h_{\mathrm{SR}}]\right) &= \sum_{k=1}^{N} a_{2,\mathbf{prop}}(k).
\end{aligned} \tag{26}$$

Therefore, the decision expression is

$$\sum_{k=1}^{N} l_{\mathbf{prop}}(k) = \sum_{k=1}^{N}\left(a_{1,\mathbf{prop}}(k)-a_{2,\mathbf{prop}}(k)\right)\begin{cases} >0, \textbf{BPSK classified}, \\ <0, \textbf{QPSK classified}. \end{cases} \tag{27}$$

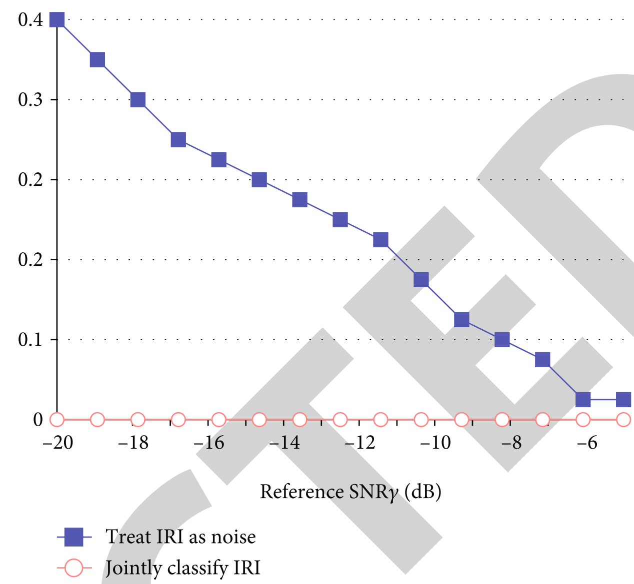

Figure 1: Theoretical performance curve of the algorithm based on the likelihood function.

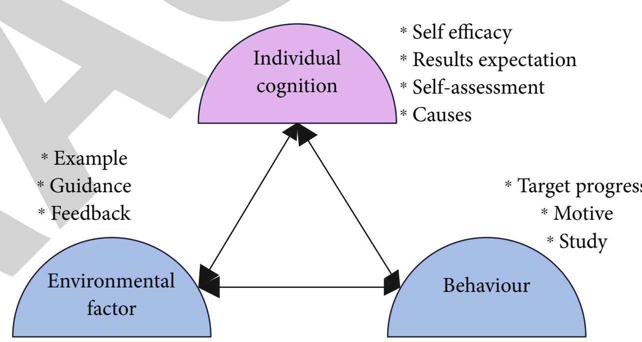

Figure 2: The "ternary interactive determinism" model.

We assume that the mean of $l_{\mathbf{prop}}(k)$ is $\mu_{lp} = \mathbb{E}[l_{\mathrm{prop}}(k)]$ and the variance of $l_{\mathbf{prop}}(k)$ is $\sigma_{lp}^2 = \mathbb{E}[l_{\mathrm{prop}}(k)^2] - \mu_{lp^\circ}^2$. From the central limit theorem, it can be seen that $(\mathbf{1}/N)\sum_{k=1}^{N} l_{\mathbf{prop}}(k)$ satisfies the normal distribution $\mathcal{N}(\mu_{lp}, \sigma_{lp}^2/N)$. Therefore, the misrecognition probability can be obtained as

$$\begin{aligned}
P(\,\mathbf{error}\,|\mathbf{BPSK}) &= P\left(\frac{\mathbf{1}}{N}\sum_{k=1}^{N} l_{\mathbf{prop}}(k) < \mathbf{0}|\mathbf{BPSK}\right) \\
&= Q\left(\mu_{lp}\sqrt{\frac{N}{\sigma_{lp}^2}}|\mathbf{BPSK}\right).
\end{aligned} \tag{28}$$

Since the analytical closed-form expressions of μ_{lp} and σ_{lp}^2 are difficult to obtain, numerical methods are generally used to calculate their approximate results.

3. The Ternary Interactive Education Model in Business English Writing

The ternary interactive determinism is an effective mechanism research paradigm to explain the behavioral results of

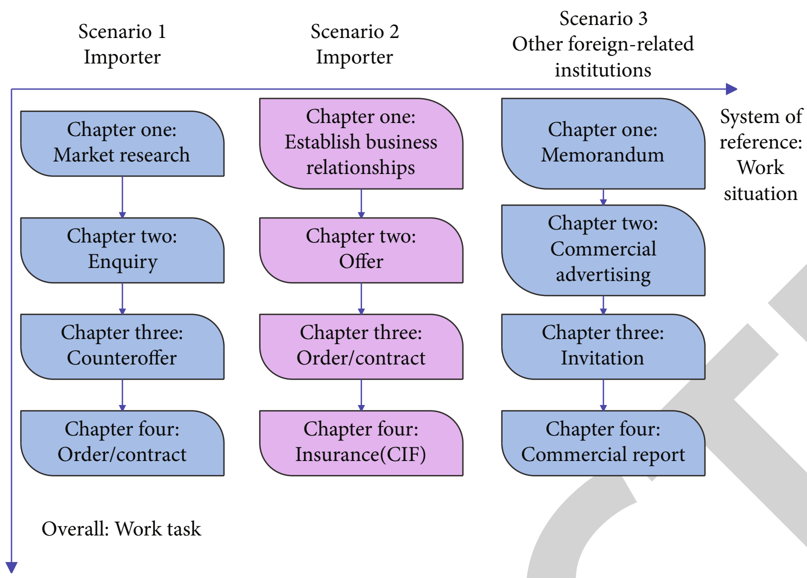

Figure 3: The content of business English writing teaching with systematic work process.

individuals due to the action of internal and external factors. Its model is shown in Figure 2.

According to the person in charge of different tasks in the actual work process, the working situations of these three are different, so they are regarded as a frame of reference for horizontal alignment. From a vertical point of view, the work of the above three has certain commonalities, so we regard the tasks in charge of the three as the carrier, thus forming a three-dimensional structure. Through the study and practice of these 3 situations, we weave the rules of job growth and English writing tasks into a web. When students practice each step, they also use action thinking to understand various informations and make various decisions and plans. At the same time, they also completed the three major steps of inspection and evaluation. Students can master the specific workflow of different roles, as shown in Figure 3.

4. Simulation Verification

After constructing the above business English writing teaching system, several simulations are carried out to verify the performance of the modulation method recognition algorithm based on the likelihood function in the case of interference in the continuous relay system proposed in this paper. The modulation methods of the signals we use for verification mainly include BPSK, QPSK, 8PSK, 4PAM, and 8PAM. These modulation methods are commonly used in the actual system, so they have practical significance. Of course, the more elements in the candidate modulation mode set, the more complex the system, and the lower the speed of algorithm classification. We choose three modulation mode candidate set elements for each verification. To verify the effectiveness of our algorithm, we conduct experiments on the following two candidate sets of modulation methods:

$$\mathcal{M}_1 = \{(\mathbf{mod}_1, \mathbf{mod}_2) | \mathbf{mod}_1, \mathbf{mod}_2 \in \{\mathbf{BPSK}, \mathbf{QPSK}, \mathbf{8PSK}\}\},$$
$$\mathcal{M}_2 = \{(\mathbf{mod}_1, \mathbf{mod}_2) | \mathbf{mod}_1, \mathbf{mod}_2 \in \{\mathbf{BPSK}, \mathbf{4PAM}, \mathbf{8PAM}\}\}. \quad (29)$$

In order to calculate the correct recognition rate of the algorithm in the test set $\mathcal{M}_1$ or $\mathcal{M}_2$, it is necessary to test all 9 modulation pairs, and then average the recognition rate. The calculation formula is as follows: $P_c = N_c/N_{\mathbf{total}}$. N_c is the number of correct recognitions, and $N_{\mathbf{total}}$ is the total number of tests.

As shown in Figure 4, we simulated the performance curve of the correct recognition rate of the modulation method recognition algorithm based on the likelihood function with the reference signal-to-noise ratio γ. The abscissa is the value of γ, and the ordinate is the correct recognition rate P_c of the algorithm under a certain modulation mode candidate set. The curve of label Proposed is the recognition performance curve of the algorithm for joint recognition of interference proposed in this chapter, and the curve of label Traditional is the traditional algorithm recognition performance curve that regards interference as color noise. The solid line is the simulation result under the modulation mode candidate set $\mathcal{M}_1$, and the dashed line is the simulation result under the modulation mode candidate set $\mathcal{M}_2$. Compared with the modulation method recognition algorithm, the recognition performance of the algorithm based on ALRT is obviously higher than that of the algorithm in Chapter 4. At $\gamma = -\mathbf{6dB}$, the correct recognition rate of the algorithm for joint recognition of interference is above 95%. Moreover, comparing the performance curves of the algorithm for joint recognition of interference and the algorithm that treats interference as colored noise, it can be clearly seen that the modulation method for joint recognition of interference greatly improves the recognition performance of the source signal modulation method. This

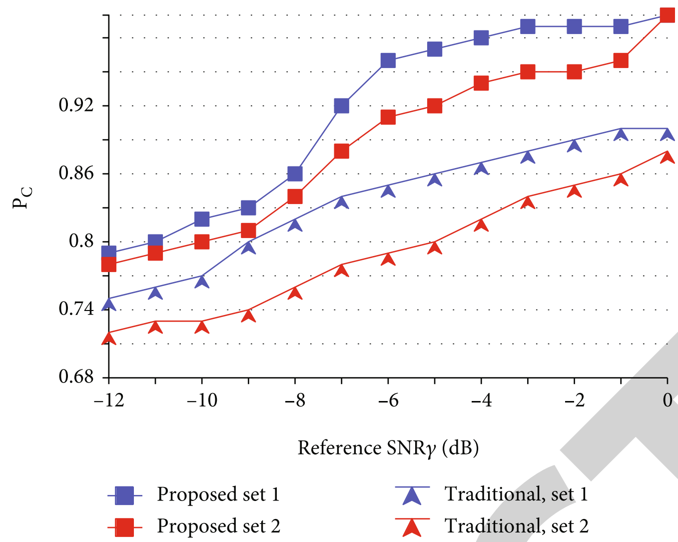

FIGURE 4: The recognition probability of the algorithm based on the likelihood function on the signal-to-noise ratio.

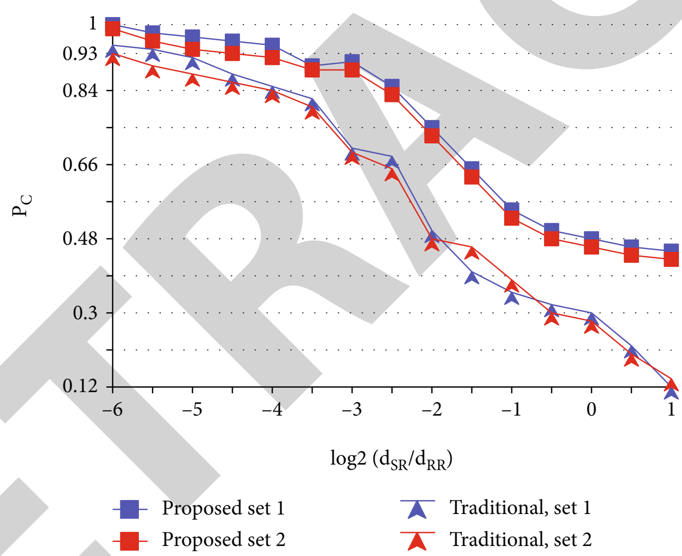

FIGURE 5: Influence of distance on the algorithm based on likelihood function.

conclusion holds no matter in the candidate set $\mathcal{M}_1$ or $\mathcal{M}_2$, and with the increase of the signal-to-noise ratio, the difference between the two algorithms becomes larger and larger.

As shown in Figure 5, we simulate the performance of the modulation method recognition algorithm based on the relative distance from the source node to the relay node and between the relay nodes.

As shown in Figure 6, we study the relationship between the recognition performance of the algorithm and the number of signal symbols, and we only conduct simulations under the modulation mode candidate set $\mathcal{M}_1$. From the simulation results, with the increase of the number of signal symbols, the correct recognition probability of the algorithm will increase. This is because the number of signal symbols increases, the statistical characteristics are more obvious, and the similar variance corresponding to the probability distribution of the received signal will decrease. Therefore, the difference between the various modulation methods is more obvious, and the classification accuracy will increase. Of course, the correct recognition rate of the algorithm is also related to the signal-to-noise ratio. When the signal-to-noise ratio is high, in order to reduce the recognition time of the algorithm, a smaller number of symbols can be appropriately selected. For example, in the algorithm in this chapter, when $\gamma = -\mathbf{4dB}$, it is enough to choose 150 signal symbols. When $\gamma = -\mathbf{8dB}$, the number of signal symbols needs to be more than 300.

Of course, there are often mismatches in system parameters (frequency offset, phase offset, and timing offset) in the actual system, and sometimes these offsets will seriously

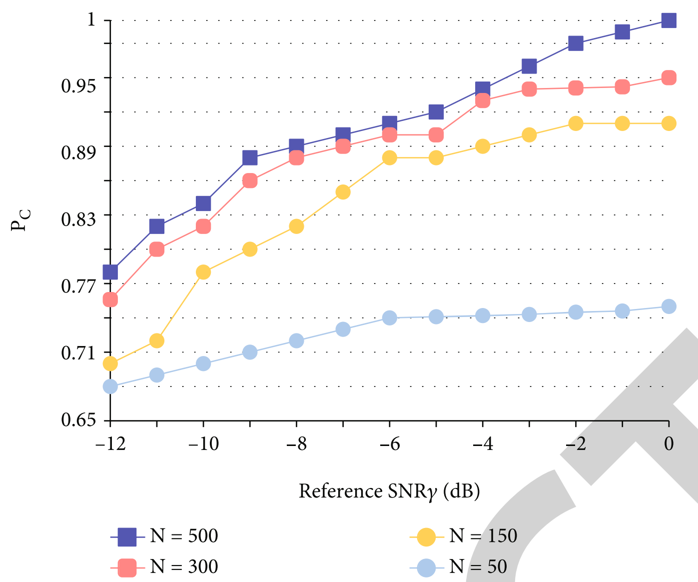

Figure 6: The influence of the number of symbols on the algorithm based on the likelihood function.

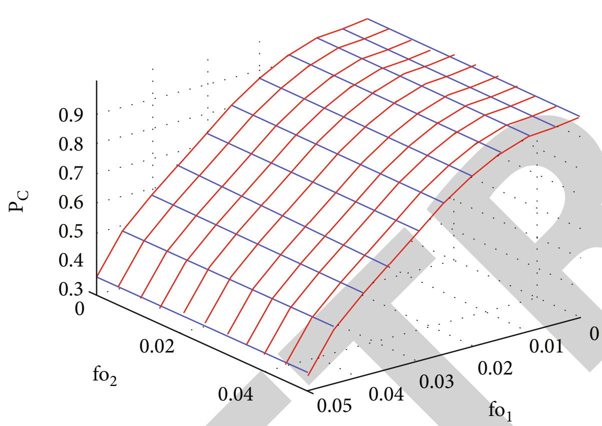

Figure 7: The influence of frequency offset on the algorithm for joint recognition of interference.

affect the performance of the algorithm. Therefore, we simulated the performance of the source signal modulation method recognition algorithm for joint recognition of interference based on the likelihood function when the frequency offset occurred in the system. The simulation results are shown in Figure 7.

Through the above experiments, it is verified that the system algorithm proposed in this paper has a good operating effect. On this basis, the simulation system is used to test the ecological concept of ternary interactive education in business English writing, and the effect of the business English writing education system based on the ternary interactive concept is verified. The results shown in Table 1 below are obtained.

Through the above research, it can be seen that the business English education system based on the ternary interaction concept proposed in this paper can effectively improve the effect of business English writing education.

Table 1: Verification of the effect of business English writing education system based on ternary interaction concept.

Num	Educational effect	Num	Educational effect	Num	Educational effect
1	83.54	21	86.45	41	87.89
2	84.59	22	81.46	42	86.79
3	87.83	23	85.66	43	87.26
4	85.19	24	86.23	44	81.16
5	87.67	25	80.66	45	82.60
6	82.59	26	81.22	46	84.00
7	83.28	27	87.16	47	81.68
8	83.63	28	87.71	48	85.96
9	79.31	29	87.09	49	81.48
10	82.47	30	83.34	50	86.97
11	87.29	31	81.29	51	81.48
12	82.17	32	83.61	52	81.76
13	82.91	33	79.77	53	81.54
14	80.21	34	87.12	54	81.36
15	84.74	35	81.09	55	84.85
16	79.81	36	84.98	56	82.93
17	87.85	37	85.10	57	80.35
18	84.80	38	83.91	58	85.70
19	84.41	39	80.00	59	85.64
20	80.59	40	82.82	60	81.72

5. Conclusion

The training goal of the business English writing course is to enable students to use English proficiently to deal with business matters in the workplace. The traditional teaching method, on the one hand, makes business English writing class become monotonous, and the classroom is difficult to be vivid, and the students' willingness to learn in this area will be reduced. On the other hand, it makes the knowledge explanation of business English writing only stay at the level of learning and reception, lack of practicality, less connection between theory and practice, and students' ability to make achievements in practice will be insufficient. This paper combines intelligent algorithms to study the ecological concept of ternary interactive education in business English writing, so as to improve the effect of business English teaching. Through the experimental research, it can be seen that the business English education system based on the ternary interaction concept proposed in this paper can effectively improve the effect of business English writing education.

Data Availability

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

Conflicts of Interest

The author declares no competing interests.

Acknowledgments

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