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Research Article

Iterative Learning-Based PID Precision Control for Sports Performance Analysis

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Traditional function algorithms are contradictory to accuracy and performance. Therefore, taking into account the balance of accuracy and performance, the research of accuracy control-oriented mathematical function algorithms is of great significance to the design of high-precision and high-performance mathematical function algorithms. This paper is aimed at the design of mathematical function algorithm for precision control and has conducted indepth research on traditional PID control algorithm and fuzzy logic control theory. By analyzing the advantages and disadvantages of the two in practical applications, a parameter fuzzy cascade PID control is designed. The algorithm and its performance simulation and comparative analysis provide a theoretical basis for the follow-up accuracy control algorithm research and realization process. The accuracy control algorithm is then used to calculate and statistically analyze the sports performance including speed, strength (comprehensiveness and explosiveness), endurance, sensitivity, and coordination. The results show that the optimized function random point (nonextreme) test calculation accuracy is 99.5%, and the control accuracy improvement rate of the parameter fuzzy cascade PID control algorithm is about 18.24%. It has better control effect, stronger stability, and higher control accuracy. In the test of extreme points, the optimized test results are obviously better than those before optimization, which can effectively calculate sports results with high accuracy.

1. Introduction

With the ever increasing application needs of human beings, precision has become an inevitable requirement for the development of floating point operations. In the extremely accurate exploration of algorithms related to mathematics libraries, and in the exploration, high-precision algorithms have been optimized. And with the development of social economy and science and technology, large-scale numerical processing is increasingly used in various fields of social life. Since the change points are large or very precise, the entire processing and calculation process should not be omitted at all. In the economic life of a country, decision makers need to collect, classify, measure, and analyze various industries and industry-related data, agriculture, and social economy. At the same time, if the computer performs rounding work in this state, large errors will occur in the entire calculation process, which greatly affects the overall performance of the computer system. Therefore, high-precision and high-precision design is very important to perform performance mathematical function algorithms.

Sports performance evaluation, as a way to judge the scientific research ability of college physical education teachers, is of great significance to improving the quality of comprehensive sports scientific research. This article studies the performance evaluation of sports scientific research from the following aspects. First, the basic method for evaluating sports scientific research achievements is given; the second is to put forward performance evaluation indicators and specific analysis indicators; third, the gray ideal domain of the evaluation index is established and the gray correlation coefficient between the evaluation object and the gray ideal domain; the fourth is through the comprehensive analysis method, the index weight is obtained, the weighted gray correlation analysis model of the performance evaluation of sports scientific research is established, and the gray correlation degree of the evaluation object is obtained, which is used to judge the ability and level of sports scientific research. Based on the assumption that fast fading can be compensated by averaging, Han et al. proposed an automatic precision control algorithm to solve the instability of the RSS-based WSN positioning system. With the support of derivation and simulation, this method will improve stability [1]. Oh and Kong proposed that the force control performance of SEA can be improved by using the dynamic model of SEA. To this end, the two-mass dynamic model is used to model and analyze SEA, which is a well-known and widely accepted flexible system model. The disturbance observer and feedforward controller are introduced as the model-based SEA control algorithm to achieve high-precision force control [2]. Hu et al. proposed a practical method that combines adaptive robust control with a disturbance observer based on neural networks. The proposed controller not only considers the uncertainty of parameters but also considers external disturbances. Adaptive control is used to compensate for the former, and a neural network-based interference observer is used to compensate for the latter separately, and the two are integrated through feedforward cancellation technology. Using the linear combination of system tracking error and weight estimation error as the driving signal for parameter adaptation and disturbance, a new parameter adaptation and weight adaptation strategy are designed [3]. The method proposed by Sun can achieve the abovementioned performance without using high static adaptive gain, thereby avoiding the possible negative impact on robustness. Finally, a high-precision motion system model driven by a direct current (dc) motor was simulated to verify the proposed method and prove its effectiveness [4]. Maebashi et al. proposed a method for high-precision sensorless force control of positioning devices for contact operations. Sensorless force control is designed with a sliding mode controller and a contact model, which can provide the required control specifications to compensate for the nonlinear spring characteristics of the contact mechanism. The effectiveness of the proposed control method is verified by numerical simulations and experiments using the prototype [5]. Coyne et al. studied the correlation between acute TL, chronic TL, and ACWR as coupled/uncoupled changes. These variables were also compared using rolling averages and exponentially weighted moving averages to illustrate any potential advantages of one calculation method over another. Results: although there are some significant differences between the coupled and uncoupled chronic TL and ACWR data, their impact is large [6]. Kim et al. studied the relationship between analyzing event-related attributes, overall satisfaction with the event, and overall attitude to the event and focused on the strengths and weaknesses of the event through IPA (importance-performance analysis) assessment. The results can be summarized as follows. First, all three satisfaction factors have a significant impact on the overall satisfaction of the event. Second, overall satisfaction has a positive effect on the overall attitude of the event. Third, several strategic factors for successful event management are provided through I-P analysis [7].

The innovation of this paper is to design a mathematical function algorithm for precise control, analyze the calculation and statistical results of sports performance through the algorithm, conduct a detailed study on the traditional PID control algorithm and fuzzy logic control theory, and analyze the advantages and disadvantages of both. PID fuzzy waterfall parameter control algorithm designs and runs performance simulation and benchmark test. This provides a theoretical basis for the process of research and realization of precision control algorithms.

2. Design of Mathematical Function Algorithm for Precision Control

2.1. Precision Algorithm. When calculating the basic function, it can only be obtained by some kind of approximate calculation. An iterative algorithm can be used to gradually converge to the true value through iteration.

2.1.1. Newton Iteration Accuracy Study. When the variable w satisfies the derivable function $y(w) = 0$, the square root of Y and the current estimated value can give a better estimated value in Newton's method.

$$w_{n+1} = w_n - \frac{y(w_n)}{y'(w_n)}. \quad (1)$$

Among them, $y'(w_n)$ is the derivative of y at $w = w_n$, and the result can be obtained by the derivative. This method is suitable for simple functions with good properties, such as polynomial functions, as long as the first estimate is close enough. Once the estimated value is sufficiently approximated, this method converges twice. In other words, if r is the exact value of the square root and xn is the estimated value that is sufficiently approximated, there is

$$|w_{n-1} - s| \leq (w_n - s)^2. \quad (2)$$

Therefore, each iteration doubles the number of precise numbers. For example, $|w_n - s| \leq 0.001$, then if the first estimate of $|w_{n+1} - s| \leq 0.000001$ is far from each other, then the iteration may converge very slowly, or diverge to infinity, or converge to one. The root closest to the first estimated value may loop indefinitely between certain specific values.

Let us take the integer square root function as an example. In order to extend its application range and avoid the processing of negative parameters, suppose w is unsigned. For floating-point numbers, the square root function is basically calculated by Newton's method. This method first tries to get the initial evaluation value t_0 of $a^{1/2}$. Then, a series of more accurate evaluation values can be obtained by the following formula:

$$t_{n+1} = (t_n + a/t_n)/2. \quad (3)$$

Iterative quadratic convergence: if a point t_n is accurate to n places, then t_{n+1} is accurate to $2n$ places. The program must know when the iteration is sufficient so that it can stop

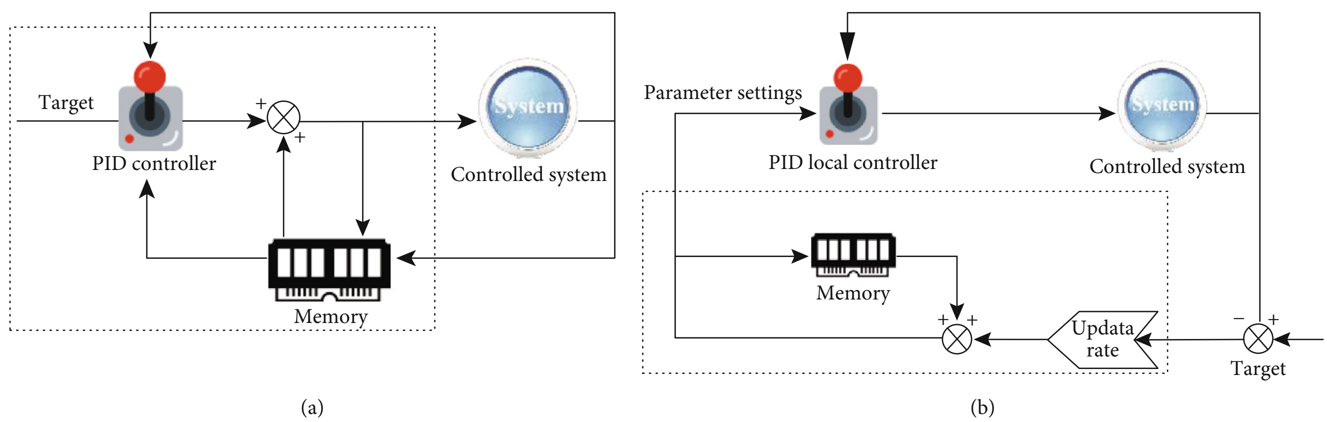

Figure 1: Direct iterative learning and indirect iterative learning.

the iteration. Newton's method has a great effect in the range of integers, which can be better understood by the theorem in Figure 1.

2.2. PID Control Algorithm. The history of PID control theory can be traced back to 1890. After more than a century of development, PID control algorithms have been widely used in many fields such as industry and military [8, 9]. The essence of the PID algorithm is to calculate according to the input deviation value according to the functional relationship of proportional, integral, and derivative, and the calculation result is used to control the output. The PID control algorithm is simple to implement, flexible in structure, robust, and stable, but there are many difficulties in parameter tuning. For the PID control algorithm, the "proportional and derivative control" function generated when the deviation input is controlled. Because the instantaneous change rate of the deviation input is very large, the differential control effect is very strong, and then the differential control effect will quickly weaken. The following will analyze and study the traditional PID control principles and parameter tuning methods [10]. So, we want a kind of controller that can change the parameters according to the actual situation to control him, this kind of controller is also called adaptive controller, and we can use fuzzy PID to realize it.

PID algorithm is a control algorithm with three links of proportional, integral, and differential [11]. The input quantity is the error value of the controlled quantity or the variable derived from the error value.

If $z(a)$ is defined as the control quantity output, the PID algorithm can be expressed as

$$z(a) = P_k e(a) + P_i \int_0^a e(\tau) d\tau + P_d \frac{d}{da} e(a). \quad (4)$$

The general form of the PID controller transfer function is

$$T(b) = \frac{R(b)}{S(b)} = P_k \left(1 + \frac{1}{A_i b} + A_d b\right), \quad (5)$$

where e is the error and is equal to the difference between the set point and the feedback value; a is the current time, τ is the integral time variable, and its range is from 0 to the current time. Closed loop control is a control method that corrects according to the output feedback of the controlled object. It corrects according to the quota or standard when the deviation between the actual and the plan is measured. For example, to control the speed of a motor, you must have a sensor that measures the speed and feed the result back to the control route. When it comes to closed loop control algorithms, I have to mention PID, which is the simplest kind of closed loop control algorithms. PID is the abbreviation of Proportion, (Integral), and (Differential coefficient), which, respectively, represent three control algorithms. The combination of these three algorithms can effectively correct the deviation of the controlled object so that it can reach a stable state.

The proportional term, integral term, and derivative term in the PID control algorithm can be flexibly combined according to the needs of the system, and these three calculation links have different control functions [12]. The function definitions are introduced below.

2.2.1. Proportional control items. The proportional control item is mainly concerned with the current error of the system, and the error is multiplied by a positive constant P_k as the output of the proportional item. The output expression is

$$K_{out} = P_k e(a). \quad (6)$$

Proportional control can be approximated as an error amplifier with adjustable gain. If the proportional coefficient increases, the output will also increase under the same error condition, but if the gain is too large, the system will experience unstable oscillation. If the proportional coefficient decreases, the output will also decrease in the same way, but if the gain is too small, when there are interference factors in the system, the control signal will be too small to correct the interference. Proportional control has the characteristics of simple calculation and fast control speed, but in the case of pure proportional control, the system is prone to steady-state errors.

2.2.2. Points Control Item. The integral control term is mainly concerned with the past error, and the sum of the past period of time error value is multiplied by a positive constant (P_i) as the integral term output. The output expression is

$$I_{\text{out}} = P_i \int_0^a e(\tau) d(\tau). \quad (7)$$

It can be known from the transfer function that the longer the integral time, the stronger the integral action, and the smaller the integral time, the weaker the integral action. If the integral action is enhanced, the steady-state error of the system will be reduced.

2.2.3. Differential Control Term. The differential control term is mainly concerned with the future error, and the first derivative of the error is multiplied by a positive constant (P_d) as the differential control term output. The output expression is

$$D_{\text{out}} = P_d \frac{d}{da} e(a). \quad (8)$$

The use of differential control is mainly used to improve the dynamic performance of the system, and its output is only related to the change of error; so, pure differential control is not a noncausal system. In the controller, the differential term output is equivalent to the lead output, and the lead time is dT. If dT increases, the derivative action will increase, and the system dynamic response speed will increase, but if dT is too large, the stability of the system will be reduced, and the adjustment time will be prolonged.

The above is a single-loop PID controller, which is a relatively classic control structure, but for the application platform, this article uses a cascade PID structure as the control basis. Its principle is basically the same as that of a single-loop PID. The specific composition structure and control method will be discussed in subsequent articles. The traditional PID control algorithm has a flexible structure, but in practical applications, it has greater limitations in the face of nonlinear and time-varying systems. The unity of parameters cannot be adjusted according to different control indicator and makes the accuracy impact even greater. The control algorithm in this article will not have this problem.

2.3. Discretization Processing of PID Control Algorithm

2.3.1. Positional PID Control Algorithm. The positional PID algorithm can be expressed as

$$u(p) = P_k e(p) + P_i \sum_{j=0}^{p} e(j) + P_d(e(p) - e(p-1)). \quad (9)$$

Among them, the number of sampling $p = 1,2,3 \cdots$

It is necessary to accumulate a large amount of $e(p)$ in the calculation, which has higher requirements for the computing power and data storage capacity of the computer in practical applications, and it is not suitable; so, this article does not do too much research on it.

2.3.2. Incremental PID Control Algorithm. Incremental PID algorithm does not have the problem of excessive calculation data and is more suitable for the use of UAV control systems. Based on formula (5), it is easy to get the output value of the PID algorithm at the last moment:

$$u(p-1) = P_k e(p-1) + P_i \sum_{j=0}^{p-1} e(j) + P_d(e(p-1) - e(p-2)). \quad (10)$$

By subtracting formulas (6) and (7) , we can get

$$\varpi u(p) = P_k[e(p) - e(p-1)] + P_i e(p) + P_d[e(p) - e(p-1) + e(p-2)]. \quad (11)$$

To further simplify the formula (8), we can get

$$\varpi u(p) = P_k\left[\left(1 + \frac{a}{A_i} + \frac{a_d}{A}\right)e(p) - \left(1 + 2\frac{a_d}{A}\right)e(p-1) + \frac{a_d}{A}e(p-2)\right]. \quad (12)$$

It can be seen from equation (9) that when the gain parameter is determined, the control increment can be obtained by only calculating the error value of the previous three times, and it can be obtained by $u(p) = u(p-1) + \omega u(p)$.

2.3.3. Conventional Parameter Tuning Method. PID parameter tuning is performed by professionals based on experience and the current status of system response to adjust the process of determining the gain coefficient of the controller. The tuning of PID controller parameters has always been a relatively difficult process [13, 14]. Most of the currently applied PID parameter tuning methods require manual experimentation and trial-making. This process is not only tedious and time-consuming but also requires debuggers to have certain tuning experience. Even so, sometimes, it is often unable to achieve a better control effect [15, 16].

Since the control effect of PID algorithm depends to a large extent on the choice of controller parameters, the result of parameter tuning directly determines the level of control accuracy.

2.3.4. ISTE Optimization Parameter Tuning Method. In different applications, due to the different control purposes, the controller's choice of performance indicators is often different [17, 18]. Different control parameters are formulated for different performance indexes, which is of great significance in practical applications. The more common is the error-based performance index, and the general formula of the optimized performance index can be expressed as

$$X_m(\varepsilon) = \int_0^{\partial} \left[a^m e(\varepsilon, a)^2\right] da. \quad (13)$$

Table 1: Optimal tuning method parameter value rule.

ω/A	0.1 ~ 1.0			1.0 ~ 2.0		
Guidelines	ISE	ISTE	ISTRE	ISE	ISTE	ISTE
a_1	1.048	1.042	0.968	1.154	1.142	1.061
a_2	-0.897	-0.897	-0.904	-0.567	-0.579	-0.583
a_3	1.195	0.987	0.977	1.047	0.919	0.892
b_1	-0.368	-0.238	-0.253	-0.22	-0.172	-0.165
b_2	0.489	0.385	0.316	0.49	0.384	0.315
b_3	0.888	0.906	0.892	0.708	0.839	0.832

Among them, when $m = 0$, $m = 1$, and $m = 2$, they are called ISE, ISTE, and IST^{2}E criteria, respectively.

In engineering applications, the most representative one is the ISTE criterion, which represents the integral performance index of the product of time and error squared. From the PID control function, the parameter setting formula can be obtained as

$$\begin{cases} P_k = \dfrac{a_1}{p}\left(\dfrac{\iota}{A}\right)^{b_1}, \\ A_i = \dfrac{A}{a_2 + (\iota/A)b_2}, \\ A_d = a_3 A\left(\dfrac{\iota}{A}\right)^{b_3}. \end{cases} \quad (14)$$

The value rules are shown in Table 1.

According to theory and engineering practice, PID parameters obtained based on ISTE performance indicators can make the controller have a better closed-loop response, and at the same time, it can also shorten the adjustment time of the system when the control is large deviation. Especially when the/value of the controlled object increases, this performance index shows a more superior performance. According to the above analysis, although the PID controller has the advantages of simple method, flexible structure, and high reliability, in practical applications, it has greater limitations in the face of nonlinear and time-varying systems, which are mainly manifested in the single parameter. Because the control system cannot adjust the parameters according to different control indicators, the traditional PID controller cannot face the changing application conditions, and it also has a greater impact on the control accuracy.

2.3.5. Membership Function. In the controller, the input and output variables are expressed by fuzzy language. This paper divides the error e into three levels of large, medium, and small and considers its zero state and changes in positive and negative directions; so, the input and output variables can be obtained by fuzzy sub. The set is (negative large, negative medium, negative small, zero, positive small, positive middle, positive large), abbreviated as (NB, NM, NS, ZO, PS, PM, PB). Membership function is a mathematical tool used to characterize fuzzy sets. In order to describe the membership relationship of the element u to a fuzzy set on U, due to the ambiguity of this relationship, it will use the value taken from the interval [0, 1] to replace the two values of 0, 1 to describe it, which means the "degree of truth" that an element belongs to a fuzzy set. For the convenience of quantitative calculation, this article is based on the PID controller parameter tuning experience, and the intuitive diagram of the error membership function is shown in Figure 2.

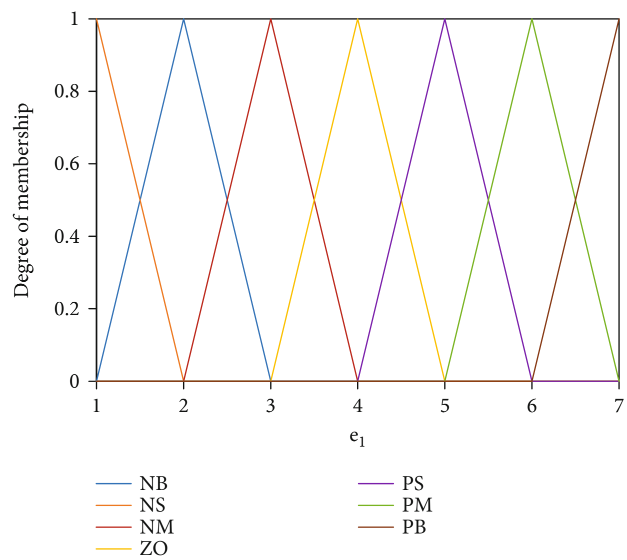

Figure 2: Input variable membership function.

2.4. Precision-Oriented Algorithm Optimization. Open the arc and tangent function into Maclaurin's polynomial to solve

$$g \tan (y) = 1 + y + y^2/2! + y^3/3! + y4/4! + \cdots + y^m/m! + \cdots. \quad (15)$$

For using this method to solve, only need to calculate the true value of a part of the term before the polynomial, you can get a certain precision asymptotic value, which is not conducive to the use of the result.

In order to deal with the above problem, you can first choose a positive integer $x \geq 1$ and reduce the input parameter y.

$$y = M \ln (2)/2^x + s. \quad (16)$$

$NIn(2)/2^x$ takes the truth value closest to w, so that r is as small as possible, and then

$$s \in [-\ln (2)/2^x, \ln (2)/2^x + 1]. \quad (17)$$

$g \tan (y)$ can be calculated with the following formula:

$$g \tan (y) = g \tan (N \ln (2)/2^x + s) = 2^{M/2^x} g \tan (s). \quad (18)$$

At this time, the calculation of the function $g \tan (y)(y)$ can be converted into the calculation of the arctangent function including $2^{N/2^x}$, and the parameter is a relatively small range, which can alleviate the problems mentioned above. The process of converting x to s is called reduction; g tan (y) can be calculated by a polynomial with a smaller term, that is, approximation; next, the $g\tan(y)$ and N and X values are reconstructed $g\tan(y)$.

In the experimental environment, enter a floating-point number y, which has the following formula:

$$N = round(y * \ln\_X), \ln\_X = 2^X/\ln(2), s = y - M/\ln\_X. \tag{19}$$

Depending on the environment of the machine, it is worth noting here that the semantics of round is the rounding mode semantics specified in the IEEE 754 standard, not the rounding semantics in C or Fortran.

In order to calculate the value of $2^{N/2^X}$, it can be transformed into a formula:

$$\begin{aligned} 2^{M/2^X} &= 2^\alpha \times 2^{\gamma/2^X}, \\ \gamma &= \mathrm{mod\ ulo}(M, 2^x), \kappa = (M-j)/2^a. \end{aligned} \tag{20}$$

Here γ, α are integers, where $\gamma = 0,1,2,\ 2^x$, so that 2^α can be obtained only by shifting operations; so, $2^{\gamma/2^x}$ has 2^x corresponding values. Here, the table look up method is used to calculate the value of $2^{\gamma/2^x}$ corresponding to each γ in advance and store it in an empty table. Floating point operations are real-number operations. Because computers can only store integers, real numbers are all round numbers; so, floating point operations are very slow and have errors. Most machines are 32 bits, which means that if 32 bits are used to represent integers, then for unsigned integers, it is 0 to 2^{32}-1, and for signed integers, it is -2^{31} to 2^{31}-1. Then, in floating point operations, you only need to look up the table to get the value you need, reducing computational power consumption. The optimization of the precision algorithm mentioned in this article refers to the large-scale data in the integer part of the floating-point operation research, and the higher-precision floating-point data type is used to represent the floating-point number.

2.5. Parameter Fuzzy Cascade PID Control Algorithm Design

2.5.1. Fuzzy Logic Control Principle. Fuzzy logic control, referred to as fuzzy control for short, is a computer intelligent control strategy based on fuzzy mathematics, fuzzy linguistic variables, and fuzzy logic inference. Fuzzy control rules are part of the knowledge base in fuzzy controllers, and fuzzy control rules are based on language variables. Fuzzy control rules are the core of the fuzzy controller. Its correctness directly affects the performance of the controller. The number of them is also an important factor to measure the performance of the controller. Its main purpose is to solve the ubiquitous fuzzy phenomenon in the real world. Fuzziness is an expression with imprecision, incompleteness, and randomness. For example, when people are asked about the temperature of the weather, the answer is often "high temperature" or "low temperature" instead of the precise temperature value [19, 20]. In the real world, it is a unique way for humans to understand the world. The fuzzy answer combines perception, experience, objective phenomena, and other conditional factors and is finally derived by the brain to make reasonable inferences [21, 22]. This kind of decision-making method is different from the control thought of "non-zero or one" in traditional control. It contains richer content, more accurate descriptions of phenomena, and more in line with objective reality. Therefore, humans have "fuzzy answers to certain questions.". "Often there are better performances." Applying similar principles to automatic control has formed today's fuzzy control theory [23].

2.5.2. Fuzzy Logic Control Structure. Compared with traditional control methods, the control thinking of fuzzy logic is closer to human thinking activities. It has a better ability to cope with complex, high-order, nonlinear time-varying systems and can be used without the need for mathematics of the controlled object. When the model has a clear and accurate understanding, the uncertain system is logically controlled based on manual experience [24]. In addition, compared with other intelligent control algorithms, such as neural network, deep learning, and fuzzy logic control, its realization is relatively simple. Under the condition of relying on human experience and intelligence, only simple conditional judgment calculations and table lookup operations are needed. Realization, in this way, the requirements of the control algorithm on the hardware equipment are reduced, the overall computing efficiency of the system is improved, and a relatively perfect balance is found between the high-performance, high-precision control effect and the low-power, high-real-time system requirements [25]. A basic fuzzy control system includes fuzzy controller, execution unit, controlled object, controlled quantity detection transposition, and other parts [26, 27], and its principle structure diagram is shown in Figure 3.

Fuzzy control is a control based on fuzzy set theory, fuzzy language, and fuzzy logic. It is an application of fuzzy mathematics in a control system and is a kind of nonlinear intelligent control. The basic structure of the fuzzy controller includes four parts: knowledge base, fuzzy inference, input fuzzy, and output precision.

3. Experimental Design

3.1. Research Object. This article takes the physical performance of 126 freshmen majoring in physical education at a university as the research object and takes the performances of track and field, gymnastics, basketball, volleyball, football, and swimming as the main research objects. The specific situation is shown in Figure 4:

The main courses of professional technical courses are as follows: track and field, including track and field, outdoor sports, orienteering, field life survival, and other courses. Ball games include basketball, volleyball, football, and other courses. Gymnastics includes basic gymnastics, aerobics, dance, and other courses.

3.2. Research Methods. This article uses the multivariate statistical software SPSS to process the data and analyzes the variables between the sports scores and the scores of the main courses, such as the relationship between the variables and the correlation coefficients between the variables and the

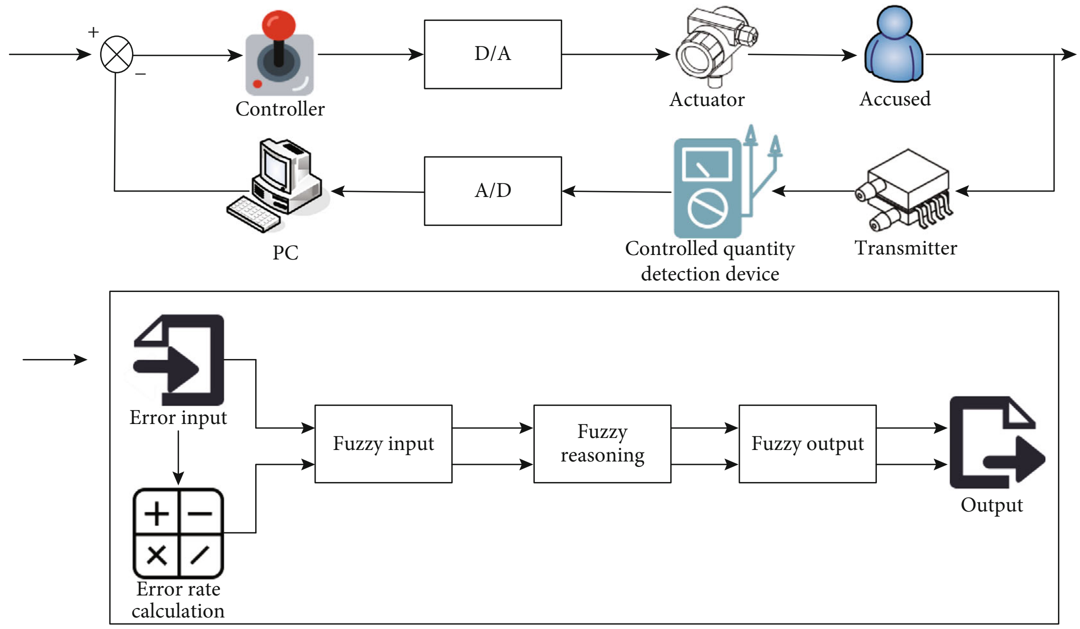

FIGURE 3: Parameter fuzzy cascade PID control algorithm principle structure diagram.

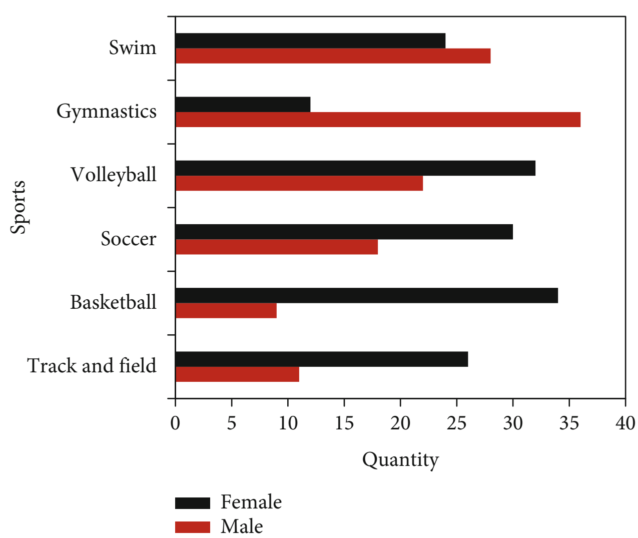

FIGURE 4: The specific situation of the research object.

TABLE 2: Correlation matrix of six main courses.

	A1	A2	A3	A4	A5	A6
A1	1.000	0.953	0.46	0.823	0.138	0.62
A2	0.616	1.000	0.424	0.817	0.545	0.121
A3	0.44	0.247	1.000	0.059	0.662	0.362
A4	0.664	0.323	0.688	1.000	0.698	0.415
A5	0.349	0.325	0.691	0.698	1.000	0.633
A6	0.026	0.184	0.517	0.047	0.095	1.000

typical variables,. Then, use precision control algorithms to logically reason about sports scores, summarize, analyze, and deduct the data and analyze the relationship between sports scores and the performance of the main courses of the university [28].

3.3. Data Collection. This article uses manual entry method to collect students' sports scores, uses the precision control algorithm of this article to calculate the entered scores, and then statistically analyzes the students' sports scores through SPSS statistical software. The purpose of the experiment has been completed.

4. Calculation and Statistical Analysis of Sports Performance by Precision Control Algorithm

4.1. Precision Control Algorithm in the Calculation and Statistics of Sports Performance. As the information channel of input and output in the fuzzy control system, the main role is to realize the data exchange between the computer and the real world, that is, the conversion between digital and analog signals. The output is not only related to the current input value but also related to the output at the previous moment is related; so, it is necessary to accurately feedback and detect the control effect of the control system.

Define the 6 courses as A1, A2, A3, A4, A5, and A6, corresponding to track and field, basketball, football, volleyball, gymnastics, and swimming. In Table 2, the correlation between the 6 main courses can be drawn.

The respective sports performances of all participating athletes can be effectively read in the table. We can see from Table 2 that the performances of these six main courses basically show a positive correlation trend, which also reflects their relevance. The correlation between track and field scores and basketball scores is 0.953, and there is a positive correlation between track and field scores and basketball scores. In other words, students who have good track and field performances also have relatively good basketball

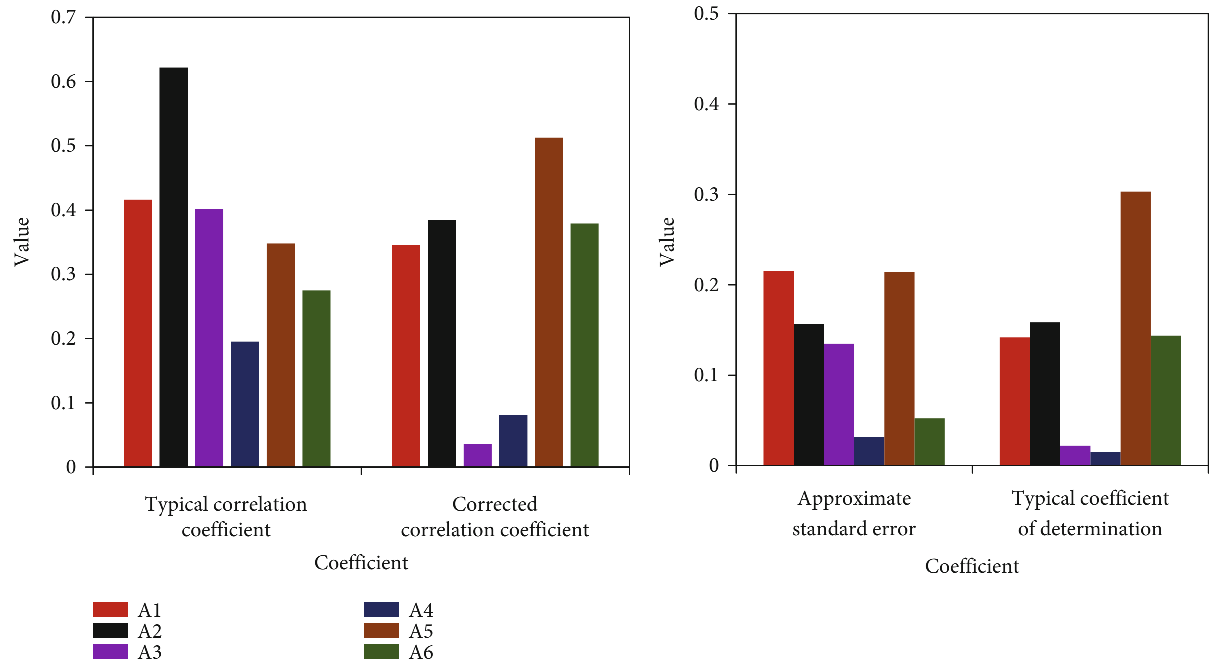

Figure 5: Correlation coefficient of typical variables.

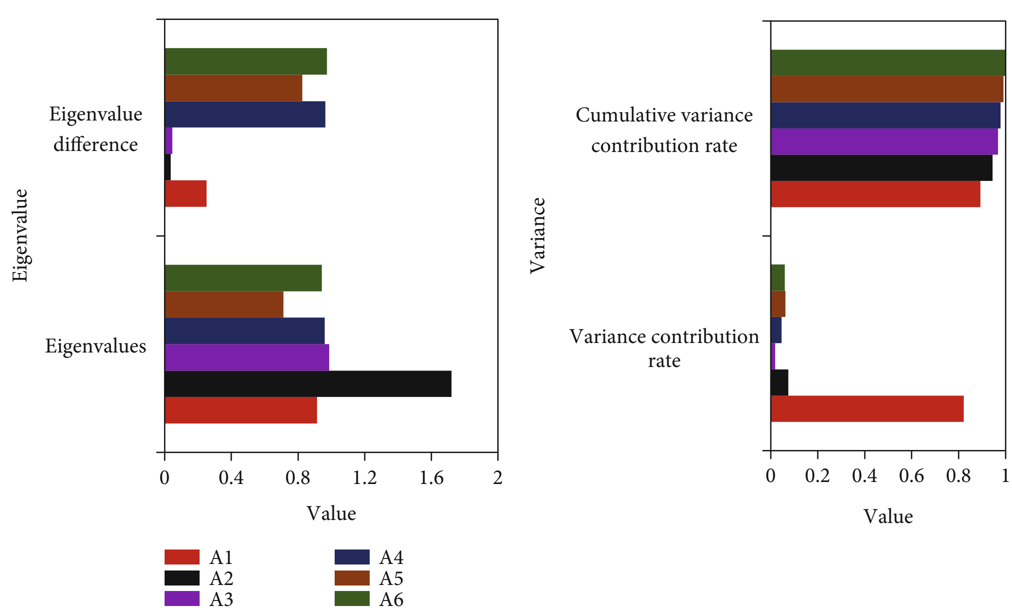

Figure 6: Principal component analysis of matrix.

Table 3: Chi-square test of the likelihood of typical variables.

Likelihood ratio	F value	Degree of freedom 1	Degrees of freedom 2	Pr > F (significance level)
0.6158697	4.12	32	356.22	<0.0001
0.9980174	1.83	24	289.16	<0.0001
0.7131166	1.04	16	160.45	0.5473
0.9124785	0.97	6	124.72	0.6236
0.8321001	0.82	2	102.56	0.7379

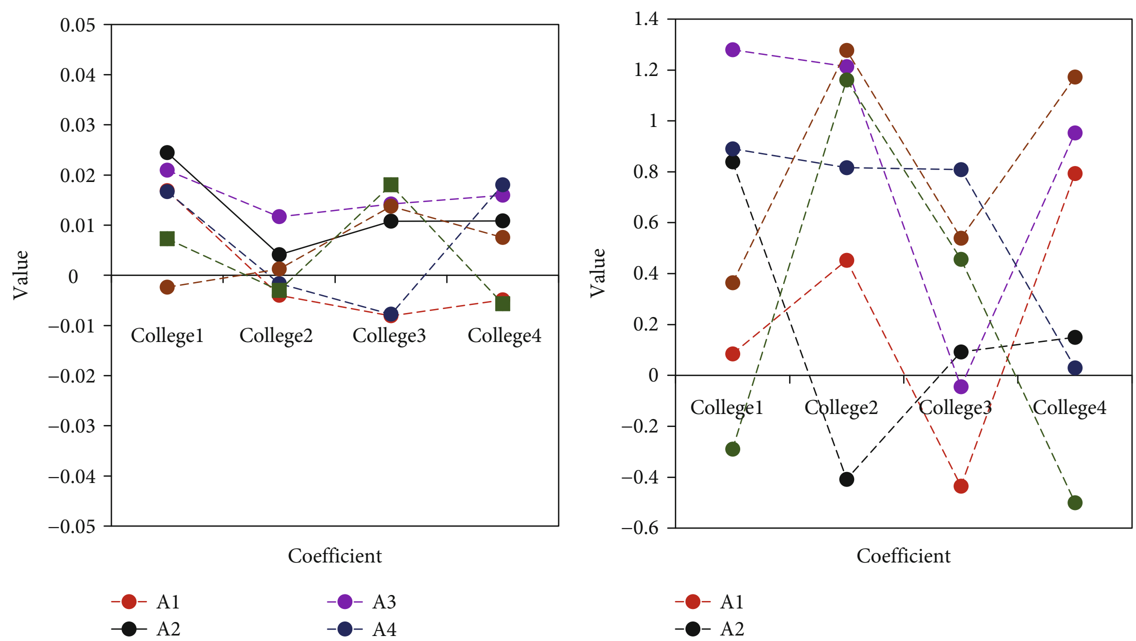

Figure 7: The coefficients of the original canonical variables of the main course grades and the numbers of the standardized system of canonical variables.

Table 4: The original variance of the main course performance variable and the ratio of the typical variable explanation.

Typical variables	Typical variables of main course performance Contribution rate	Cumulative contribution rate	Canonical correlation coefficient squared	Approximate standard error	Typical coefficient of determination
1	0.961	0.565	0.975	0.554	0.458
2	0.168	0.818	0.595	0.345	0.495
3	0.708	0.164	0.587	0.088	0.452
4	0.376	0.179	0.003	0.615	0.943

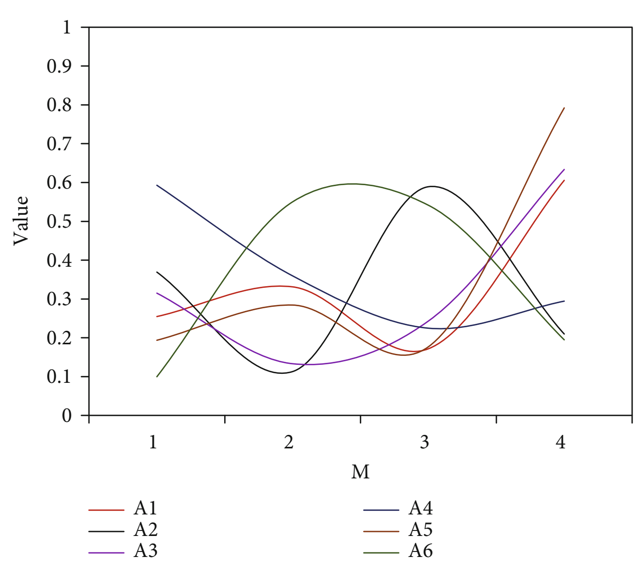

Figure 8: Multiple correlation squares of typical variables in the main course.

performances. The correlation between gymnastics performance and swimming performance is 0.633, and the two are positively correlated. The better the gymnastics performance, the better the swimming performance of the students. Gymnastics scores and volleyball scores are also positively correlated, with a correlation of 0.698. Students with good gymnastics scores also have better volleyball scores. Track and field results show students' comprehensive physical fitness. Compared with other main courses, basketball performance requires students to have more comprehensive physical fitness, including strength, speed, endurance, coordination, and agility, which may cause students' track and field performance and basketball. The results are positively correlated. Gymnastics performance can better reflect the coordination and agility of students, while volleyball and swimming performances depend to a large extent on the coordination and flexibility of students. Therefore, gymnastics is positively related to swimming and volleyball.

4.2. Result Output of Canonical Correlation Analysis. Figure 5 shows the correlation coefficient values of typical variables.

What starts after the original correlation coefficient is the result output of the canonical correlation analysis. The

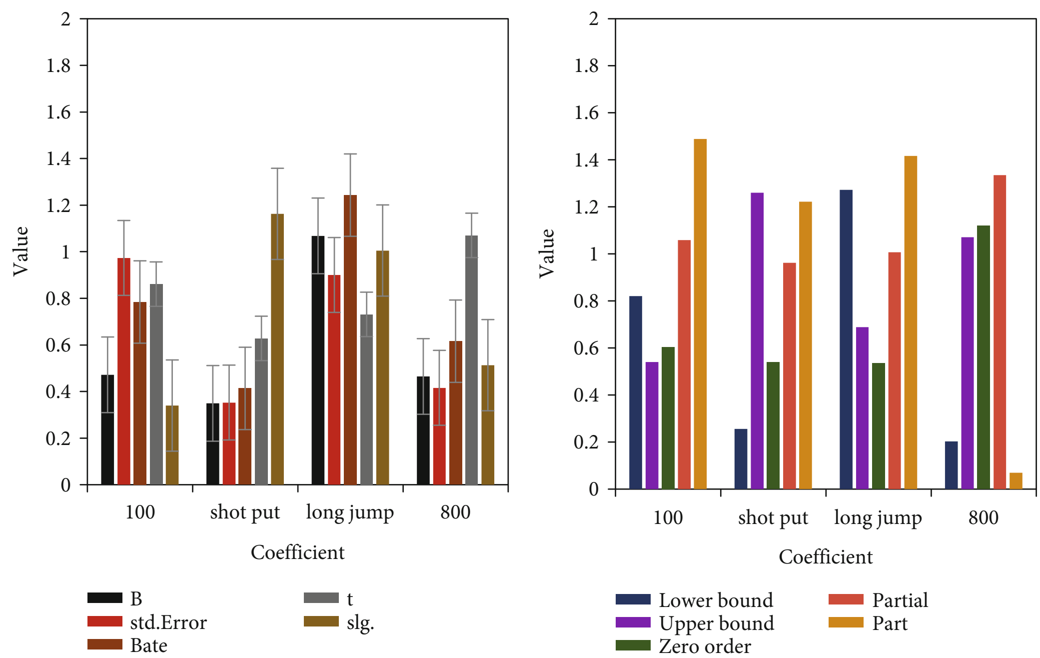

Figure 9: Regression coefficient of main course physical education performance.

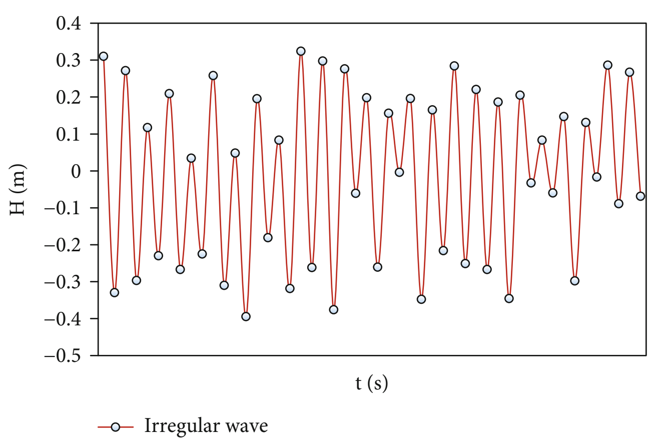

Figure 10: Motion position time series diagram.

output is the canonical correlation coefficient, the corrected canonical correlation coefficient, the characteristic root, and the test result of the coefficient including approximate standard error and typical coefficient of determination. As shown in Figure 5, a total of 4 canonical correlation coefficients are extracted. Including ourselves, we can also read from the figure that there is almost no error between the two linear combinations with the largest coefficients. This experimental data is quite accurate, and the research content is also suitable for the theme. They are in line with the first Correlation between typical variables.

Figure 6 shows the eigenvalues of a typical equation. It can be seen from the figure that the four columns of values are the characteristic root, the difference between two adjacent characteristic roots, the proportion of the variance information occupied by the characteristic root, and the proportion of the cumulative variance information. Through the comparison of the data in the figure, the difference in the characteristic value can be seen, and the percentage and the cumulative percentage can be explained.

Table 3 is the output of the typical equation significance test results. It can be seen from the table that the values of the likelihood ratios of the five typical equations are 0.615, 0.998, 0.713, 0.912, and 0.832. The chi-square test values of the likelihood ratios of the first group of typical variables are all less than 0.0001, indicating that the first two typical equations have reached significant level. The likelihood ratio chi-square test values of the third pair of typical variables, the fourth pair, and the fifth pair of typical variables did not reach the significant level; so, only the first pair of typical variables and the second pair of typical variables need to be considered.

Figures 7(a) and 7(b) are the coefficients of the original typical variables of the main course performance and the coefficients of the standardized typical variables of the main course performance, respectively. It can be seen from the Figure 7 that the difference between the coefficients of the typical variables of the two is affected by the performance of the main course, and there is a correlation between each main course. And only it needs to consider the first pair of typical variables and the second pair of typical variables.

4.3. Typical Redundancy Analysis. In this part of the study, we focus on calculating standardized typical coefficients to achieve the research purpose. This is because the analysis required for canonical correlation research is based on the correlation matrix; so, if you want to clarify the redundancy coefficients, you can only use standardized typical coefficients.

Table 4 shows the proportion of the original variance of the main course performance variables explained by the typical variables. In this paper, the canonical correlation

Table 5: Comparison of test results before and after optimization.

Function name (exp)	Minimum negative value (ulp)	Maximum positive value (ulp)	The absolute value of the extreme value is 0.5 ulp Percentage of normal numbers within
Before optimization	-0.4191	0.4103	97.9%
Optimized	-0.4046	0.4025	99.5%

research is based on the analysis of the prerelevant matrix. From the table, we can see that the ratio of the standardized variance from the main course performance variable explained by the first canonical variable is 14.23.

Figure 8 is the top M typical variables extracted from each variable in the main course sports performance variable group, explaining the cumulative percentage of variation, that is, multiple sums of squares. It can be seen from Figure 8 that only track and field performance can be predicted, and other sports have almost no predictive ability. Descriptive analysis statistical graphs are like using satellites to look down on the earth. Commonly used methods include central tendency analysis, such as mean, median, and mode; deviation analysis, such as quarter deviation, mean deviation, variance, and standard deviation; and correlation analysis, such as positive correlation and negative correlation.

In this section, the main course track and field performance is used as the dependent variable, and the 100-meter running performance, shot put performance, and standing triple jump performance are analyzed. Using SPSS software, the regression analysis was performed using the all-in-one method, and the regression results are listed in Figure 9.

Figure 9 lists the zero-phase correlation coefficient, partial correlation coefficient, and partial correlation coefficient of the independent variable and the dependent variable. According to the partial correlation coefficient and partial correlation coefficient, it can be judged which independent variable has a greater influence on the dependent variable.

4.4. Analysis of Parameter Membership Function and Fuzzy Control Rules. Fuzzy control rules and membership functions are the main basis of the fuzzy reasoning process, and a reasonable and accurate design of them is an important guarantee for the quality of reasoning. Before that, it is necessary to determine the input and output variables of the fuzzy controller.

Perform simulation analysis on the obtained motion position time series and mark the positions of the peaks and troughs as shown in Figure 10 below.

In the simulation analysis of the motion position time series, the effective wave height of the simulation result is statistically calculated according to the numerical value of the wave crest and wave trough and compared with the input effective wave height. The detailed comparison data is as follows. It can be seen from Figure 10 that the significant wave height of the simulation result is calculated and calculated according to the numerical value of the wave crest and wave trough, and the approximate significant wave height can be obtained. Compared with the input significant wave height, the error of the significant wave height can be obtained as 1.52%, the result is less than 5%, and the accuracy is improved by 18.24%, which meets the requirements of high precision.

ucbtest is a software package used to test the accuracy of floating-point arithmetic conforming to the IEEE 754 standard. The software package provides a mature method for testing the accuracy of mathematical library functions. The user can provide the math library function to be tested as a parameter to ucbtest and measure the accuracy result of the function. According to engineering requirements, select 200,000 random data points, including 416 extreme points, and test the accuracy of the EXP function before and after optimization. Table 5 shows the extreme value distribution table of the test results.

As shown in Table 5, through the test, it can be seen that the test accuracy of the optimized function random point (nonextreme value) is controlled within 0.5ulp, accounting for 99.5%, while only 97.9% before the optimization, and in the test of extreme points. The test result after optimization is obviously better than before optimization. Of course, with the improvement of calculation accuracy, we need to pay attention to two issues, whether the amount of calculation will also increase and whether the corresponding calculation time will increase, and the author can also clearly say that it will increase, but in controllable within range.

5. Conclusions

With the continuous growth of application requirements, ultra-high-precision control operations have become an inevitable trend in the development of precision calculations. This paper has carried out precision research on the algorithms of the mathematics library, and the research has achieved high-precision algorithm optimization. Through the test and comparison, the accuracy-based algorithm analysis and optimization effect are verified. In order to achieve precision control, it is necessary to conduct more detailed and close research on the basis of the original algorithm and combine the hardware architecture to make the mathematical library achieve higher precision and performance requirements. The experimental results of this paper prove that the optimized function random point test accuracy is controlled at 99.5%, the parameter fuzzy cascade PID control algorithm control accuracy increase rate is about 18.24%, and in the extreme point test, the optimized test result is obviously better before optimization. However, there are still some shortcomings in this study. The number of control rules provided by the fuzzy inference process is directly related to the level density of the fuzzy parameter division. This does not mean that the finer the parameter division, the more the number of rules. The higher the control accuracy produced, the accuracy of the control rules is more dependent on the fuzzy judgment of human beings to a large extent, and more indepth research is needed in the follow-up.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author states that this article has no conflict of interest.

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