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THE APPLICATION OF MATLAB IN THE MATHEMATICS TEACHING OF COMPUTER MAJORS

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Abstract. Under the background of new engineering courses, professional mathematics teaching needs to keep pace with the times and improve the progressiveness and scientific nature of teaching methods.In order to improve the mathematics teaching effect of computer majors, This article constructs a new teaching environment through simulation system construction methods, analyzes the shortcomings of traditional teaching models through comparative analysis methods, and improves the teaching platform based on the actual needs of mathematics professionals in current society. The curve interpolation technology is improved, and a forward-looking real-time Matlab simulation algorithm is designed. Through the evaluation and analysis, it can be seen that the mathematics teaching system for computer majors based on MATLAB can effectively improve the intuitive effect of advanced mathematics teaching, and help to improve the teaching quality of advanced mathematics.

Key words: MATLAB; computer; mathematics teaching; model

1. Introduction. MATLAB is a programming language for analyzing data, developing and applying algorithms. It has powerful data visualization and mathematical statistical analysis functions, and the programming environment is simple and easy to use, making it an important auxiliary tool for mathematics learning. In European and American countries, MATALB has become a basic teaching tool for advanced courses such as applied linear algebra, automatic control theory, mathematical statistics, digital signal processing, and dynamic system simulation. In addition, it has become a basic skill that must be mastered by undergraduates and master students pursuing degrees. In design research units and industrial sectors, MATLAB is widely used to research and solve specific practical problems [1].

MATLAB language is the preferred computer mathematics language for scientific researchers in many engineering and computer fields, and it is also widely used in mathematics branches such as calculus, linear algebra, integral transformation, interpolation, probability and statistics [2]. In higher education teaching, there are some explorations and studies on how to use MATLAB software to assist professional course teaching in the teaching links such as curriculum design training and curriculum practice training. However, there are not many practical researches directly introducing MATLAB language into classroom teaching [3]. How to really introduce the MATLAB language into classroom teaching, the process of introducing it into classroom teaching and the teaching effect after the introduction will be the key issues for the transformation of MATLAB-assisted teaching from theory to practice. There are a large number of exercises in the theoretical teaching of advanced mathematics courses that need to be calculated involving limits, differential derivation, integration, series, etc. In addition, there are many two-dimensional and three-dimensional functions that need to be displayed by drawing and understand the characteristics of function trajectories, which can help Students better understand the theory [4]. The MATLAB software package contains instructions for differentiation, integration, and limit. You can directly input the corresponding instructions in the command window, and you can get the desired results with one key. In addition, loops and conditional statements in MATLAB can well complete repetitive and loop calculations, which is beneficial to improve students' enthusiasm for problem-solving and explore methods of solving problems [5]. Reference [6] takes the advanced mathematics course as an example to explore the feasibility and teaching effect evaluation of MATLAB-assisted advanced mathematics teaching, in order to enrich the teaching methods and means of this course, improve the teaching effect of this course, and lay a solid foundation for the cultivation of applied talents. a more solid foundation.

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Advanced mathematics is an important basic course for university majors in science, engineering and management. Students generally find it difficult to study this course. One of the main reasons is that advanced mathematics is more abstract than elementary mathematics. Therefore, teachers need to use some methods or means to visually display abstract knowledge to students in the teaching process [7]. There are more obvious implications in terms of comprehension and teaching [8].

Matlab can not only draw static graphics to help teachers explain functions and theorems, but also can easily achieve graphics animation effects to help students understand the effects of changes in functions or parameters. For example, the arbitrary smallness in the concept of limit, the volume of the rotating body in the application of definite integral, the forming process and transformation process of the curve and surface in analytic geometry, etc., it is difficult to express it vividly and vividly through the traditional teacher's teaching and the blackboard static diagram. [9]. Matlab shows the process and results in a visual and dynamic form, which can not only effectively improve students' interest in learning, make students' understanding more profound and thorough, but also greatly improve the teaching effect [10].

In the process of teaching "Mathematical Modeling and MATLAB", teachers should guide students to look at the world and society through the innovative method of mathematical modeling, and apply this innovative method to their learning and life. Schools can select relevant teachers to offer remedial classes for students who are interested in modeling or directly offer professional courses in mathematical modeling [11]. Using the principle of comparison, students of different ages and grades are selected for mathematical modeling training. The performance and ability of this part of students are tested for a long time and irregularly, and compared with students in the same circle who have not participated in mathematical modeling learning, analyze whether participating in mathematical modeling learning can improve students' innovative ability, and obtain a specific relationship curve , to analyze the speed and extent of the improvement of innovation ability of students with different foundations through mathematical modeling learning [12].

For students who are interested in modeling, teachers can select through the mock test to determine the excellent team members, and let the students experience the fun of mathematical modeling in the mock test. Peiyou team members can form a team freely at the beginning. Under normal circumstances, students will choose people they are familiar with to form a team. At this time, students from the same major usually form a team [13]. Analyze the strengths and weaknesses of a single discipline team in continuous learning and simulation training. In addition, schools should encourage interdisciplinary teams to form several teams with members from different disciplines through the influence of the school, and analyze the strengths and weaknesses of interdisciplinary teams through continuous learning and simulation training. Of course, during this process, students can change teammates at any time to achieve the purpose of optimizing team formation [14].

Teachers can use the winter and summer vacations to organize mathematical modeling enthusiasts to conduct intensive training to learn basic theoretical knowledge, including mathematical models, MATLAB and other commercial teaching software, paper writing, literature retrieval, and graph drawing. In the second stage, intensive training will be carried out, and students will learn advanced mathematical models, intelligent algorithm design and implementation, thesis writing skills, model method innovation paths, etc. in a targeted manner. In the third stage, simulation training is carried out, in the form of a competition team, according to the competition requirements, simulating the actual competition process, conducting thesis defense, review and revision, circular advanced training, and gradually improve students' teamwork and innovation ability [15].

On the basis of pre-competition intensive training, select teams with both profound theoretical foundation and strong innovative ability, organize to participate in provincial, national and international mathematical modeling competitions at different levels, and further exercise students' innovative ability during the competition. And constantly sum up the experience and lessons of the competition, explore the innovative path to solve practical application problems through mathematical modeling, and summarize the inherent laws of the mathematical modeling competition to improve the innovative practice ability of college students [16].

Prove the growth law of students' innovative ability at different stages such as mathematical modeling courses, pre-competition training, and competition experience. Through the questionnaire survey and summarizing experience of teachers and participating students, the opinions and suggestions on improving the innovative ability training in the teaching of "Mathematical Modeling and MATLAB" are put forward, and the innovative practice path of "course-training-competition-summary" is further optimized. strategy [17].

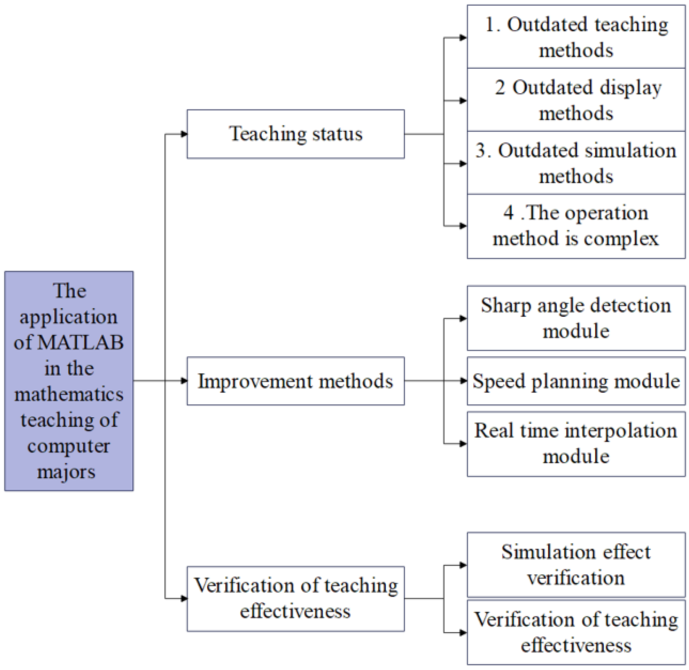

Fig. 1.1: Organizational structure of this article

Computer and mathematics are closely related. In computer science, the importance of mathematics is particularly prominent. The methods and technologies in various fields of computer science are based on one or more mathematical theories [18]. Advanced mathematics, linear algebra, probability theory and mathematical statistics, discrete mathematics and other mathematics courses are the basic courses for computer majors, which play a very important role in the training of computer professionals [19], and are important tools for students to learn subsequent professional courses. . It is also an important part of the postgraduate entrance examination.

Integrating MATLAB into high school mathematics teaching in the context of the technological era is a trend that conforms to teaching innovation. As a teacher of the new era, mastering the skills of using MATLAB software is not only a requirement of the technological era, but also meets the learning needs of students. Applying new teaching techniques to teaching practice will benefit students the most. It is reasonable to predict that MATLAB will be widely used by teachers as a teaching tool in the field of high school mathematics education in the future, and then students will initially master and apply it to mathematics learning.

The existing MATLAB application in mathematics teaching in computer science cannot meet the actual needs of computer science. Due to the influence of professionalism, new technologies need to be combined with MATLAB to meet the needs of computer science students.

The organizational structure of this article is shown in Figure 1.1.This paper analyzes the application of MATLAB in the mathematics teaching of computer majors in colleges and universities under the background of new engineering, and improves the mathematics teaching effect of computer majors in colleges and universities through intelligent models.

2. MATLAB image simulation. The real-time forward-looking MATLAB interpolation algorithm mainly includes three modules: sharp angle detection module, speed planning module and real-time interpolation module. The main process of the whole algorithm is shown in Figure 2.1:

The file reading module: it is used to read NC program files, and it converts NC characters into corresponding control vertex $d_i\ (i = 0, 1, ..., n)$, weight or weight factor $\omega_i\ (i = 0, 1, ..., n)$, node vector $U = [u_0, u_1, ..., u_{n+k+1}]$.

The sharp corner detection module: it mainly determines the sharp corners on the MATLAB curve. The so-called sharp angle refers to the sensitive point on the curve where the feed rate must be reduced in order

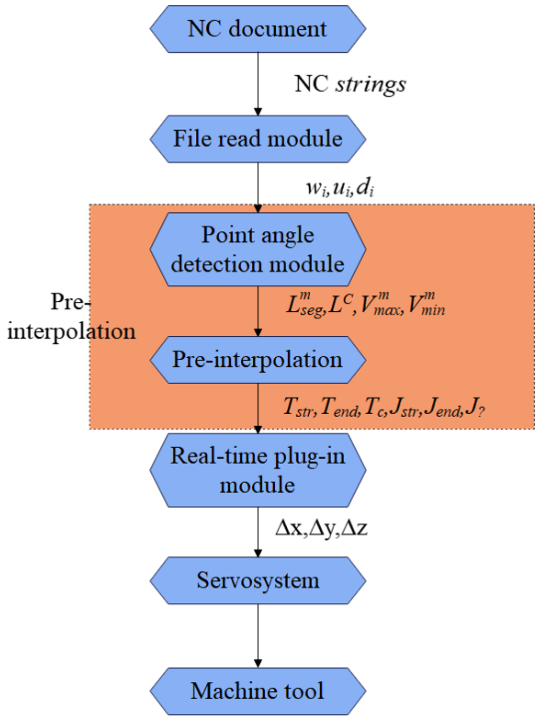

Fig. 2.1: Real-time MATLAB interpolation algorithm with look-ahead

to ensure the machining contour accuracy requirements due to the large local curvature. It divides the curve into small sub-segments using the determined sharp angles, and calculates the length L^m_{seg} of each sub-segment, as well as the maximum speed $V_{\max}$, starting speed V_{str} and ending speed V_{end} in each sub-segment.

The speed planning module: based on the limitations of the maximum bow height error, feed rate, acceleration/deceleration and jerk, etc., according to the length L^m_{seg} of each subsection, and the maximum speed $V_{\max}$, start speed V_{str} and end speed V_{end} in each subsection, the feed type of each subsection is planned, and the parameter values of acceleration and deceleration are calculated accordingly, such as T_{str}, T_c, T_{end}, J_{str}, J_{end}, etc.

MATLAB real-time interpolation: according to the parameter values of acceleration and deceleration calculated by the speed planning module, the next interpolation point, namely u_{i+1}, is calculated from the current u_i, speed $V(u_i)$, and acceleration $A(u_i)$. Then, the coordinate values $x(u_{i+1})$, $y(u_{i+1})$, and $z(u_{i+1})$ of the next interpolation point are calculated. The operation is performed by the servo system to drive and control the machine tool.

The so-called sharp angle refers to the sensitive point on the MATLAB curve where the feed rate must be reduced in order to ensure the machining contour accuracy requirements due to the large local curvature of the curve. In the vicinity of such sharp corners, the curvature is larger. If the feed rate is not reduced, the feed step length in each interpolation cycle will be too large, resulting in an increase in the bow height error, even exceeding the allowable value of the maximum bow height error. Therefore, the feed rate must be reduced at sharp corners.

In general, sharp corners occur at the extreme points of curvature in local sections of the curve. Therefore, the first criterion for determining sharp corners is at sharp corners. The derivative of its curvature is 0. The

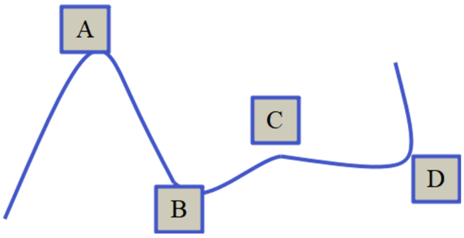

Fig. 2.2: Schematic diagram of extreme point

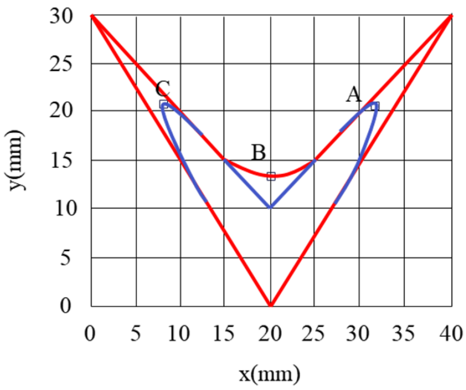

Fig. 2.3: Schematic diagram of the extreme point of the V-shaped curve

formula is as follows:

$$\frac{dk\left(u\right)}{dt}|u=u_k=0 \tag{2.1}$$

Among them, k(u) is the curvature of the curve, and u_k is the node vector value that may become a sharp corner point. The curvature calculation formula is:

$$k\left(u\right)=\frac{\left|P'\left(u\right)P''\left(u\right)\right|}{\left|P'\left(u\right)\right|^3} \tag{2.2}$$

In this paper, a fast algorithm for $P'\left(u\right)$, $P''\left(u\right)$ is given. It is not repeated in this section. On these possible points that satisfy the first criterion for identifying sharp corners, the curvature at this point must be an extreme point in the local small segment, that is, a maximum or minimum value. However, from the perspective of larger sections, the curvature values of extreme points in some local areas may be larger than those at extreme points in other areas. This problem is evident from Figure 2.2 below.

The curve in the above figure has four extreme points A, B, C, and D, of which the curvature of point C is significantly smaller than that of other points. Taking a V-shaped curve as an example, the same problem exists. As shown in Figure 2.3, the curvature of point B on the V-shaped curve is significantly smaller than the other two points A and C.

Since it is determined to be a sharp corner, the feed rate at the sharp corner must be reduced. It can be imagined that if in the NC program, when the given feed rate F is high, the three points A, B, and C are all defined as sharp corners, and the feed rate at these points must be reduced to ensure the contour accuracy of machining. However, when the given feed rate F is not high, if point B is still determined as a sharp corner point, the tool will pass point B at a slow speed because the feed rate is too low. However, the curvature of

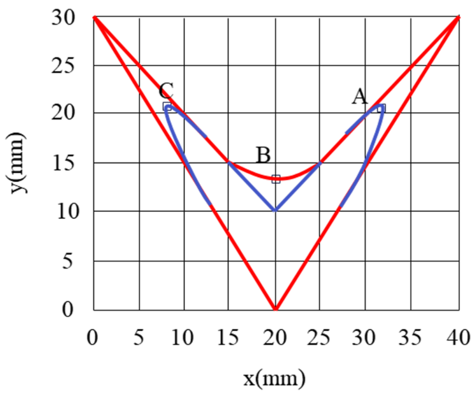

Fig. 2.4: Sharp corners at F=150mms

point B is not very large, so the feed rate at point B does not need to be reduced so much, and the contour error at point B can be controlled within the required accuracy range. At this point, point B should not be determined as a sharp corner point.

It can be seen from the above analysis that the first sharp corner identification criterion cannot fully and accurately identify sharp corner points. Therefore, the second sharp corner identification criterion is that the curvature at the sharp corner exceeds the limit value k_{th}. The formula for calculating the curvature limit k_{th} is as follows:

$$k_{th} = \frac{A_{\max}}{F^2} \tag{2.3}$$

Among them, $A_{\max}$ is the maximum allowable value of acceleration limited by the acceleration and deceleration performance of the machine tool, and F is the maximum value of the feed rate set in the NC program.

The second sharp corner identification criterion is to determine the sharp corner point by judging whether the centripetal acceleration at the above-mentioned local extreme point exceeds the maximum acceleration allowed by the machine tool. That is, if $k(u_i) > k_{th}$, then the speed must be reduced at that point. Otherwise, the tool will not be able to pass this point normally due to the limitation of acceleration. Therefore, only points that satisfy both of the above criteria will be determined as sharp corner points.

It should be noted that according to the calculation formula of the curvature limit value k_{th}, it can be found that in the same MATLAB curve, different numbers of sharp corner points may be obtained under different feed rates F. It can be seen from Figure 5 that there are 3 sharp corners when the set feed speed is F=150mm/s. It can be seen from Figure 2.5 that there are only 2 sharp corners when F=120mm/s. Therefore, the lower the given feed rate F, the less the number of sharp corners that may be determined. Conversely, the higher the feed rate F, the greater the number of sharp corners that may be determined.

After the sharp corners are determined, the curve is divided into several small subsections by the sharp corners. We assume that there are n-1 sharp corners, then the curve is divided into n segments. The curve length $L_{seg}^m (m = 1, 2, ..., n)$ of each subsection is calculated, and the length value of each subsection will be applied in subsequent modules. The formula for calculating the length of the tower is as follows:

$$L_{seg} = \int_{u_{str}}^{u_{end}} P'(u)\, du = \int_{u_{str}}^{u_{end}} \sqrt{[x'(u_i)]^2 + [y'(u_i)]^2 + [z'(u_i)]^2} du \tag{2.4}$$

u_{str}, u_{end} are the starting point u_ix value and the ending point u_i value of the subsection curve respectively Then, there is $f(u) = L_{seg} = \sqrt{[x'(u_i)]^2 + [y'(u_i)]^2 + [z'(u_i)]^2}$.

Using the composite Simpson formula to solve the length L_{seg}^m of each segment, the composite Simpson

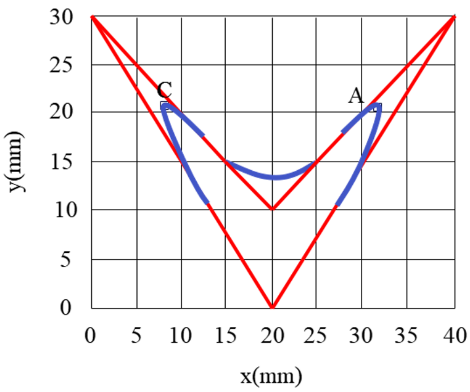

Fig. 2.5: Sharp corners when F=120mmts

formula is expressed as:

$$\int_a^b f(x)\,du \approx S_n = \frac{h}{6}\left\{f(a) - f(b) + 2\sum_{k=1}^{n}\left[2f\left(x_{k-\frac{1}{2}}\right) + f(x_k)\right]\right\} \tag{2.5}$$

Among them, $h = \frac{b-a}{n}$ is the step size.

After the integral interval [a, b] is divided into n equal parts, the S value is calculated according to the above formula, which is the approximate value of the integral. The larger the subdivision is, the more precise the approximation of the integral will be, and the closer it will be to the true value. In practical computing applications, the approximation error is estimated using the post-hoc estimation method of the error.

The algorithm divides the integral interval [a, b] into half successively, uses the same composite Simpson formula to calculate the approximate value of the integral every time, and uses the difference between the two calculation results before and after to judge the size of the error. If $|S_{2n} - S_n| < \varepsilon = 15\varepsilon'$ (ε' is the allowable error of the calculation result), the algorithm stops the calculation and takes ε' as the approximate value of the integral. Otherwise, the algorithm divides the interval into half again, calculates a new value, and then uses the difference between the two calculation results before and after to judge the error. If $|S_{4n} - S_{2n}| < \varepsilon = 15\varepsilon'$, the algorithm stops computing. Otherwise, the algorithm continues to subdivide until a result that meets the accuracy requirements is obtained.

We set the size of ε', that is, the size of the allowable error value of the calculation result, which directly determines the accuracy of the calculation result and the length of the operation time.

The algorithm accumulates the segment length L^C (C=1,2,...-,m), and increments the segments one by one. Each time a subsegment is added, the data is saved once.

$$L^C = \sum_{j=1}^{c} L_{seg}^{j}\,(C = 1, 2, ..., m) \tag{2.6}$$

After the length L_{seg}^{m} of each segment is obtained, the calculation of the cumulative segment length L^C (C=1,2,...-,m) is still very easy. Fourth, the algorithm calculates the maximum feed rate $V_{\max}$ and the minimum feed rate $V_{\min}$ on each segment.

According to the segmentation of the sharp corners, the algorithm calculates the maximum feed rate $V_{\max}$ and the minimum feed rate $V_{\min}$ on each segment. The maximum feed rate $V_{\max}$ and the minimum feed rate $V_{\min}$ generally appear at the extreme points of each curvature within the segment and at both ends of the segment.

The calculation of the maximum speed $V_{\max}$ and the minimum speed $V_{\min}$ should consider the influence of two aspects. The first is to limit the bow height error $\delta_{\max}$ to ensure that the bow height error does not exceed the limit, and the second is the change of the curvature ρ.

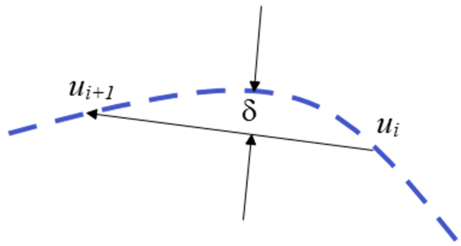

Fig. 2.6: Schematic diagram of interpolation operation

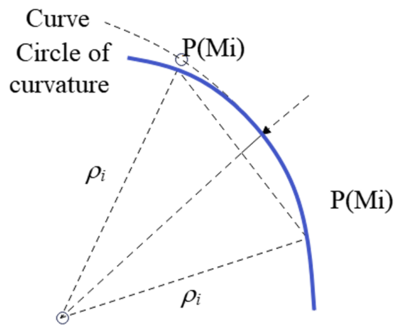

Fig. 2.7: Bow height error analysis diagram

2.0.1. Adaptive feed rate interpolation algorithm based on limited bow height error. The size of the feed rate specifically represents the length of the feed step per interpolation cycle. In order to ensure maximum processing efficiency, under the premise of ensuring that the speed limit is not exceeded, it is hoped that the longer the feed step of each interpolation cycle, the better. Figure 7 is an enlarged view of a part when interpolation is performed from u_i to u_{i+1} point in curve interpolation.

In MATLAB curve interpolation, each interpolation cycle is a process in which a straight line replaces a curved arc. Since each interpolation point is still on the MATLAB curve, the trajectory accumulation error is not introduced, but the bow height error δ is introduced, as shown in Figure 2.7. The size of the bow height error δ is related to the feed step $\triangle$L and the curvature radius ρ.

If the curved arc is replaced by a circular arc segment, under normal circumstances, $\rho >> \delta$, the bow height error relationship of MATLAB curve interpolation can be obtained:

$$\Delta L = 2\sqrt{\rho_i^2 - (\rho_i - \delta)^2} = 2\sqrt{2\rho_i\delta - \delta^2} \tag{2.7}$$

From $V_{af}T = \Delta L$, the relationship t between the speed V_{af} and δ can be known as follows:

$$V_{af} = \frac{2}{T}\sqrt{2\rho_i\delta - \delta^2} \tag{2.8}$$

In practical engineering applications, the bow height error 6 of the entire MATLAB curve interpolation trajectory is limited within the specified allowable error range. If the maximum allowable bow height error $\delta_{\max}$ is given, in order to ensure that the bow height error does not exceed the limit value, the adaptive feed rate based on the limited bow height error is:

$$V_{af}\left(u_i\right) = \frac{2}{T}\sqrt{2\rho_i\delta - \delta^2} \tag{2.9}$$

If the calculated $V_{af}(u_i)$ is greater than the feed rate F set in the NC program, $V_{af}(u_i) = F$ is set. If it is calculated that $V_{af}(u_i)$ is not greater than the feed rate F, then $V_{af}(u_i) = \frac{2}{T}\sqrt{2\rho_i\delta_{\max} - \delta_{\max}{}^2}$.

Therefore, there are:

$$V_{af}(u_i) = \begin{cases} \frac{2}{T}\sqrt{2\rho_i\delta - \delta^2}, if\ \frac{2}{T}\sqrt{2\rho_i\delta_{\max} - \delta_{\max}{}^2} \le F \\ F \qquad\qquad\qquad if\ \frac{2}{T}\sqrt{2\rho_i\delta_{\max} - \delta_{\max}{}^2} > F \end{cases} \tag{2.10}$$

In the formula, $\rho_i = \frac{1}{k}$, and ρ_i can be known by obtaining the curvature. The calculation of k can refer to Formula 2.

2.0.2. Curvature-based Feed Rate Interpolation Algorithm. The curvature-based feed rate $V_{cbf}(u_i)$ is calculated in formula 12, as follows:

$$V_{cbf}(u_i) = \frac{k_{cbc}}{k(u_i) + k_{cbc}} F \tag{2.11}$$

Among them, $k_{cbc} = 1.001mm^{-1}$, and k_{cbc} is the set curvature value used to maintain the continuity of the derivative of V_{cbf}. That is, when the curvature k(ui) is 0, V_{cbf}=F is made.

$k(u_i)$ is the curvature value of the MATLAB curve at point u_i, and F is the feed rate set in the NC program.

In the above two algorithms, the adaptive feed rate interpolation algorithm is used to obtain V_{af}, and this algorithm considers the bow height error to ensure that the bow height error does not exceed the maximum allowable bow height error $\delta_{\max}$. The curvature-based feed rate interpolation algorithm obtains V_{cbf}, which adjusts the feed rate based on the curvature of the curve. Therefore, the feed rate at a certain point on the curve is:

$$V(u_i) = \max\{\min(V_{af}(u_i), V_{cbf}(u_i), F_{\max}), F_{\min}\} \tag{2.12}$$

In the formula, $F_{\max}$ is the given maximum allowable feed rate, and $F_{\min}$ is the given minimum feed rate.

The maximum feed rate $V_{\max}$ and the minimum feed rate $V_{\min}$ generally appear at the extreme points of each curvature within the segment and at both ends of the segment. According to formula (2.12), the two ends of each subsection and the extreme point of curvature are calculated to determine the maximum feed rate $V_{\max}$ and the minimum feed rate $V_{\min}$ in each subsection.

For each sub-segment, according to its parameters such as L_{seg}^m, V_{str}, V_{end}, $V_{\max}$, as well as the values of $A_{\max}$ and $J_{\max}$, it can be determined which of the above 7 types the segment is. Then, for different types, the corresponding scheme is used to plan the motion trajectory of the segment.

The specific determination method and process are as follows:

1. Calculate the L_{r1}, L_{r2}, L_{r3}, L_{r4} length values

$$L_{r1} = 2V_{str}T \tag{2.13}$$

$$L_{r2} = (V_{str} + V_{end})\sqrt{\frac{|V_{end} - V_{str}|}{J_{\max}}} \tag{2.14}$$

$$L_{r3} = (V_{str} + V_{end})\sqrt{\frac{|V_{\max} - V_{str}|}{J_{\max}}} + (V_{end} + V_{\max})\sqrt{\frac{V_{\max} - V_{end}}{J_{\max}}} \tag{2.15}$$

$$L_{r4} = (V_{str} + V_{\max})\sqrt{\frac{|V_{\max} - V_{str}|}{J_{\max}}} \tag{2.16}$$

Among them, L_{r1} is the minimum length that can be planned into type II and III, L_{r2} is the minimum length that can be planned into type VI, and L_{r3} is the minimum length that can be planned into type VII. When $(V_{str} = V_{\max})$or $(V_{end} = V_{\max})$, L_{r4} is the minimum length that can be programmed into type IV or V.

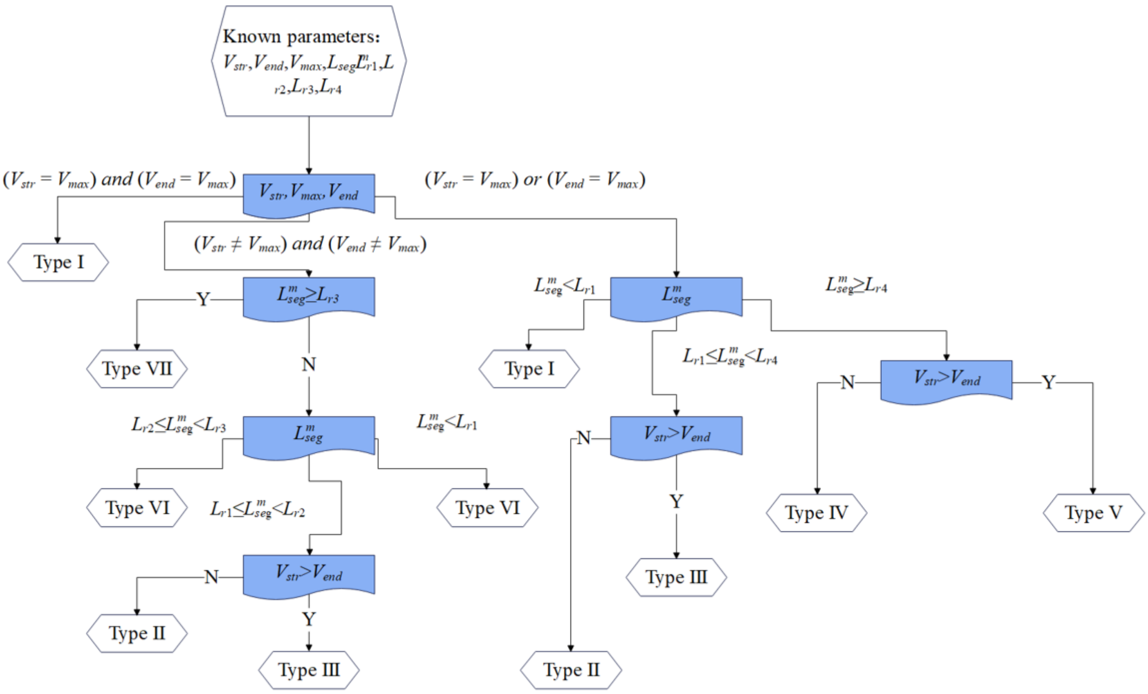

Fig. 2.8: Type judgment flow chart

2. Determine the segment type. According to its L^m_{seg}, V_{str}, V_{end}, $V_{\max}$ and other parameters, the segment type is determined according to the flow chart 9 given below.

3. Calculates the parameters of S-shaped acceleration and deceleration:T_{str}, T_c, T_{end}, J_{str}, J_{end}. Taking type V as an example, when $V_{str} \neq V_{\max}$ &$V_{end} \neq V_{\max}$ and $L_{r2} \leq L^m_{seg} \leq L_{r3}$ of a segment, it is considered that this sub-segment can be planned as a type.

From the figure 2.7, we can see that:

$$V_{\max} = V_{str} + J_{\max} T_{str}^2 = V_{end} + J_{\max} T_{end}^2 \tag{2.17}$$

$$T_{end} = \sqrt{T_{str}^2 + \frac{V_{str} - V_{end}}{J_{\max}}} \tag{2.18}$$

$$L^m_{seg} = (V_{\max} + V_{str}) T_{str} + (V_{\max} + V_{end}) T_{end} \tag{2.19}$$

Substituting formula (3.4) and formula (3.5) into formula (3.6), we get:

$$L^m_{seg} = \left(2V_{str} + J_{\max} T_{str}^2\right) T_{str} + \left(V_{str} + V_{end} + J_{\max} T_{end}^2\right) T_{end} \sqrt{T_{str}^2 + \frac{V_{str} - V_{end}}{J_{\max}}} \tag{2.20}$$

The formula is as follows:

$$\begin{aligned} f\left(T_{str}\right) = J_{\max}\left(V_{str} - V_{end}\right) T_{str}^4 + 2J_{\max} L^m_{seg} T_{str}^3 - \left(V_{str} - V_{end}\right) T_{str}^2 \\ +4V_{str} L^m_{seg} T_{str} + \tfrac{(V_{str}+V_{end})^2 (V_{str}-V_{end})}{J_{\max}} - \left(L^m_{seg}\right)^2 = 0 \end{aligned} \tag{2.21}$$

The solution T_{str} of this nonlinear equation $f\left(T_{str}\right)$ is calculated using the Newton-Lei Fusheng method. When using the Newton-Lei Fusheng method to calculate the solution T_{str}, the initial value is set as T_j, as

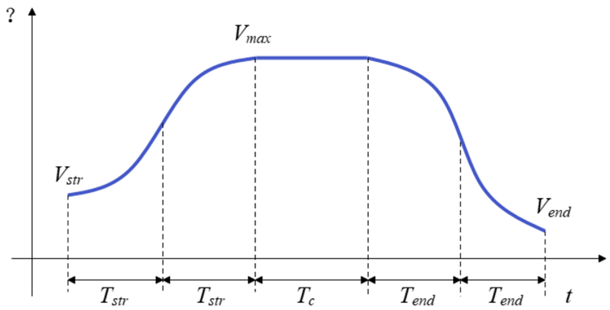

Fig. 2.9: Acc-cv-DEC acceleration and deceleration diagram

follows:

$$T_j = \frac{A_{\max}}{J_{\max}} \tag{2.22}$$

The solution of the equation T_{str} is close to the value of T_j, and the value of T_j is used as the initial value, which is conducive to the rapid convergence of the Newton-Lei Fusheng method, and will not produce unreasonable numerical solutions. After obtaining T_{str}, the value of T_{end} can be calculated by the formula.

According to the type of each segment, the T_{str}, T_c, T_{end}, J_{str}, J_{end} parameters are obtained after preliminary calculation. Among them, T_{str}, T_{end}, and T_c are the time values of each stage of the speed change, respectively, and the value obtained after the calculation in Table 1 is not an integer multiple of the interpolation period T. For example, T_{str}=0.16578, and the interpolation period is T=0.001. It can be seen that 0.00078 seconds in T_{str} is less than one interpolation period, and the time that is less than one interpolation period can neither be discarded nor simply rounded to 1 interpolation period. Its direct truncation or rounding will make the speed value inconsistent with the subsequent calculation value. In order to ensure the equal interval interpolation period of the data sampling interpolation method to ensure the accuracy and precision of the processing, the T_{str}, T_c, T_{end}, J_{str}, J_{end} parameters are further corrected.

The revised principles are as follows:

1. T_{str}, T_{end}, T_c must be corrected to an integer multiple of the interpolation period.
2. The total arc length L_{seg}^m remains unchanged in each segment.
3. The maximum processing speed of each segment is guaranteed not to exceed $V_{\max}$.
4. The jerk value of each segment is guaranteed not to exceed the allowable value $J_{\max}$.

Under the conditions of the above four principles, the parameters of each segment are corrected segment by segment according to the segment type. Now, taking the correction of Type V as an example, Figure 2.9 shows the acceleration and deceleration diagram of Acc-cv-DEC type.

The algorithm rounds T_{str} according to the number of interpolation cycles, and takes the smallest number greater than T_{str} and an integer multiple of T as the new T_{str}, which is denoted as T'_{str}.

$$T'_{str} = ceil\left(\frac{T_{str}}{T}\right) * T \tag{2.23}$$

J'_{str} is calculated while keeping $V_{\max}$ constant and the value T'_{str} as follows:

$$J'_{str} = \frac{V_{\max} - V_{str}}{{T'_{str}}^2} \tag{2.24}$$

T_c at value T_c is calculated as follows:

$$T_c = \frac{L_{seg}^m - (V_{\max} + V_{str})\, T'_{str} - (V_{\max} + V_{end})\, T_{end}}{V_{\max}} \tag{2.25}$$

The algorithm rounds T_c according to the number of interpolation cycles, and takes the largest number less than T_c and an integer multiple of T as the new T_c, which is denoted as $T_c^{'}$.

$$T_c^{'} = fix\left(\frac{T_c}{T}\right) * T \tag{2.26}$$

The remaining length of this curve is calculated, that is, the deceleration interval curve length L_3, as follows:

$$L_3 = L_{seg}^m - (V_{\max} + V_{str})\,T_{str}^{'} - V_{\max}T_c^{'} \tag{2.27}$$

T_{end} is calculated as follows:

$$T_{end} = \frac{L_3}{V_{\max} + V_{end}} \tag{2.28}$$

The algorithm rounds T_{end} according to the number of interpolation cycles, and takes the smallest number greater than T_{end} and an integer multiple of T as the new T_{end}, which is denoted as $T_{end}^{'}$.

$$T_{end}^{'} = cell\left(\frac{T_{end}}{T}\right) * T \tag{2.29}$$

The algorithm calculates $V_{end}^{'}$ at the value $T_{end}^{'}$ when the length L_3 of the deceleration section and the initial speed of the deceleration section are still unchanged at $V_{\max}$, as follows:

$$V_{end}^{'} = \frac{L_3}{T_{end}^{'}} - V_{\max} \tag{2.30}$$

In $2T_{end}^{'}$ time, the deceleration of $V_{end}^{'}$ from $V_{\max}$ to the required $J_{end}^{'}$ is calculated as follows:

$$J_{end}^{'} = \frac{V_{\max} - V_{end}^{'}}{{T_{end}^{'}}^2} \tag{2.31}$$

So far, the revised parameters T'_{str}, T'_c, T'_{end}, J'_{str}, J'_{end}, V'_{end} are all calculated.

It should be noted that the revised parameters will affect the next segment. For example: the value of $V'_{end}(i)$ in the i-th segment should be used as the starting speed $V_{str}(i+1)$ of the next segment, that is, the first segment.

3. Research method.

3.1. MATLAB curve end deceleration planning. Because the feed rate at the end of the MATLAB curve is zero, that is, $V_{end} = 0$ for the last subsection. If the L_{seg}^m length of the last subsection is too short, or the initial speed V_{str} is too large, or both, it may result in a Type lII (DEC) velocity plan from the start of the last sub-segment starting at V_{str} toward the end of that sub-segment (i.e., the end of the curve). When it reaches the end point, V_{end} falls below zero. To make the end speed V_{end}=0, you need to use a jerk greater than $J_{\max}$ to plan this last curve. Obviously, this violates the jerk limitation principle and exceeds the allowable value of the machine tool. Therefore, if the length L_{seg}^m of the last subsection is too short, or the initial speed V_{str} is too large, it is necessary to re-plan the feed rate scheme of the last several subsections.

In order to judge whether the length L_{seg}^m of the last subsection is sufficient, the maximum deceleration distance L_{dec} and the remaining section length R are introduced.

The maximum deceleration distance L_{dec} refers to the deceleration distance required to reduce the feed rate from the feed rate F given by the NC program to ? under the limit of the jerk $J_{\max}$. The calculation formula t is as follows:

$$L_{dec} = FT_{end} = F\sqrt{\frac{F}{J_{\max}}} \tag{3.1}$$

The remaining segment length R refers to the length from the current segment to the last segment. The calculation formula is as follows:

$$R^r = \sum_{j=r+1}^{c} L_{seg}^{j} \tag{3.2}$$

Among them, r is the segment number currently performing interpolation, and c is the total number of segments in the curve.

When the program file is long, the method of pre-reading a certain number of steps is adopted, so the deceleration planning at the end of the MATLAB curve must be carried out after all the steps are pre-read. When the condition satisfies $R^{r+1} \leq L_{dec} \leq R^r$, all the remaining segments $L_{seg}^{r+1}, L_{seg}^{r+2}, ..., L_{seg}^{c}$ can be merged into one segment to become a new segment L_{seg}^{r+1}. The feed rate planning is carried out, and the parameters T_{str}, T_c, T_{end}, J_{str}, J_{end} of the new acceleration and deceleration mode are calculated.

Finally, the algorithm transmits the parameters T_{str}, T_c, T_{end}, J_{str}, and J_{end} of the acceleration and deceleration mode to the real-time interpolation module, and the real-time interpolation module generates instructions, drives the servo system, and controls the machine tool movement.

After calculating the parameters T_{str}, T_c, T_{end}, J_{str}, and J_{end} of the acceleration and deceleration mode, the real-time interpolation module can use these parameters to calculate J_{end} by using the second-order Taylor series expansion method, namely:

$$u_{i+1} = u_i + \frac{V(u_i)\,T}{|P'(u_i)|} + \frac{T^2}{2}\left\{\frac{A(u_i)}{|P'(u_i)|} - \frac{V^2(u_i)\,[P'(u_i)\,P''(u_i)]}{|P'(u_i)|^4}\right\} \tag{3.3}$$

Among them, the specific process of the fast calculation method of $P'(u_i)$ and $P''(u_i)$ values is detailed in Section 3.3.

The $V(u_{i+1})$ and $A(u_{i+1})$ corresponding to the next point u_{i+1} are:

$$V(u_{i+1}) = V(u_i) + A(u_i)\,T \tag{3.4}$$

$$A(u_{i+1}) = A(u_i) + JT \tag{3.5}$$

3.2. Trajectory calculation. The algorithm brings the new parameter u calculated by formula (3.3) into the MATLAB curve equation (2.2) to obtain the position coordinates of the next interpolation point and the incremental value of each coordinate:

$$P_{i+1} = P(u_{i+1})$$

It is equivalent to:

$$\begin{cases} x_{i+1} = x(u_{i+1}) \\ y_{i+1} = y(u_{i+1}) \\ z_{i+1} = z(u_{i+1}) \end{cases} \tag{3.6}$$

$$\begin{cases} \Delta x = x_{i+1} - x_i \\ \Delta y = y_{i+1} - y_i \\ \Delta z = z_{i+1} - z_i \end{cases} \tag{3.7}$$

After obtaining the parameters T_{str}, T_c, T_{end}, J_{str}, J_{end} of the acceleration and deceleration mode, the real-time interpolation module obtains the interpolation position of the next point by real-time interpolation within the same interpolation period T. It sends out each axis feed command to the servo system, drives the machine tool to perform the movement, and completes the interpolation task of this cycle. Moreover, the real-time interpolation continuously repeats the above two real-time interpolation steps, parameter densification, trajectory calculation, until $u_{i+1} \geq 1$ and $V_{end} = 0$, reaching the end point of the curve, the entire MATLAB curve interpolation trajectory can be completed.

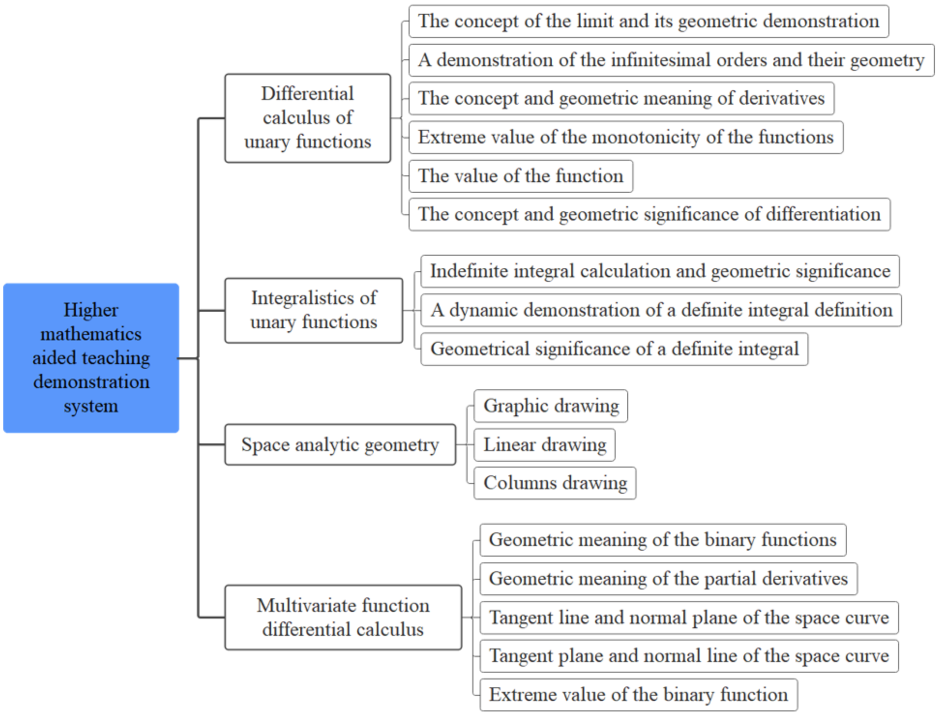

Fig. 3.1: Structure diagram of the teaching demonstration module of the system

3.3. Result. This article uses the Matlab platform for teaching mathematics in computer majors, which not only effectively improves teaching efficiency, but also helps students with poor mathematical foundations to strengthen their understanding and reduce the difficulty of mathematical understanding through intuitive displayThere are many teaching contents in advanced mathematics courses. This system focuses on four teaching contents, namely differential calculus of unary functions, integral calculus of unary functions, spatial analytic geometry and differential calculus of multiple functions. In these four teaching contents, each part contains many important mathematical concepts, such as derivatives, differentials, space surfaces and partial derivatives, etc. There are 17 teaching demonstration modules in the whole demonstration system, as shown in Figure 3.1.

The evaluation of the simulation effect of computer major teaching in this experiment is mainly carried out through the intelligent method proposed in this article to display the simulation of teaching content. After constructing the teaching system through Matlab, the real-time display of teaching content is simulated, and quantitative evaluation is carried out through manual evaluation.

The evaluation of the teaching effectiveness of computer science in this experiment is mainly carried out through the intelligent method proposed in this article to display and simulate the teaching content. The teaching effectiveness of this article is quantitatively evaluated through the experimental teaching mode, and data processing is carried out using mathematical and statistical methods

The mathematics teaching system for computer majors based on MATLAB proposed in this paper is evaluated, and the simulation effect of mathematics teaching images is evaluated, as shown in Table 3.1.

After verifying that the mathematics teaching system for computer majors based on MATLAB has a good simulation effect, the teaching effect of the mathematics teaching system for computer majors based on MATLAB is verified, as shown in Table 3.2.

Comparing the model presented in this article with the teaching model presented in reference [10], it is agreed to conduct mathematical teaching for computer major students. The teaching effectiveness is verified through teaching evaluation methods, and the teaching evaluation results are shown in Table 3.3.

Table 3.1: Simulation effect of the mathematics teaching system for computer majors based on MATLAB

Num	Simulation effect	Num	Simulation effect	Num	Simulation effect
1	96.36	14	95.21	27	95.23
2	95.49	15	97.70	28	97.22
3	96.82	16	96.42	29	95.28
4	95.85	17	95.24	30	95.80
5	97.55	18	97.70	31	95.88
6	95.12	19	94.83	32	97.47
7	96.83	20	96.05	33	97.87
8	96.08	21	97.86	34	96.75
9	95.77	22	96.40	35	96.78
10	95.02	23	97.84	36	95.08
11	97.98	24	94.87	37	96.54
12	96.67	25	94.83	38	94.77
13	97.42	26	96.30	39	94.51

Table 3.2: The teaching effect of the mathematics teaching system for computer majors based on MATLAB

Num	Teaching effect	Num	Teaching effect	Num	Teaching effect
1	80.12	14	83.56	27	84.43
2	81.99	15	83.72	28	79.62
3	82.11	16	82.39	29	84.47
4	79.90	17	82.78	30	82.26
5	81.92	18	82.29	31	85.58
6	81.73	19	81.96	32	81.22
7	85.91	20	82.83	33	83.72
8	81.82	21	84.63	34	81.32
9	82.13	22	83.62	35	79.12
10	85.15	23	85.11	36	84.38
11	81.86	24	84.45	37	85.71
12	80.29	25	79.89	38	80.91
13	80.13	26	81.81	39	80.94

3.4. Analysis and Discussion. Mathematics is an important foundational course in computer science, which plays an extremely important role in cultivating students' logical thinking ability and problem-solving ability, as well as in the study of professional courses and subsequent courses. However, some computer science students have basic mathematical knowledge, and most of them find mathematics difficult to understand. They believe that mathematics is just boring calculations and lack interest in it. To solve these problems, we can timely and appropriately apply MATLAB software in mathematics teaching for computer majors. This can not only help students understand abstract concepts and theorems in mathematics more intuitively, stimulate their interest in learning, but also help them free themselves from tedious calculations. MATLAB, as a powerful mathematical software, has efficient numerical calculation functions and complete graphic processing functions. At the same time, due to its proximity to the natural language of mathematical expressions, it is also easy for students to learn and master. Therefore, in teaching practice, we can use MATLAB as a teaching aid, so that students no longer need to perform complex mathematical operations, and classroom teaching is more vivid and vivid. At the same time, we can strengthen the use of MATLAB in mathematical modeling activities, so that students can better use software to solve practical problems.

Therefore, in mathematical modeling activities, it can be said that students must master certain MATLAB skills. Mathematical modeling problems come from real life and are all aimed at solving practical problems, which are complex and often require the use of computational software. In our school's mathematical modeling

Table 3.3: Comparative Evaluation of Teaching Effectiveness

Serial Number	The model of this article	The model of reference [10]	Serial Number	The model of this article	The model of reference [10]
1	85.49	78.30	9	81.70	81.24
2	84.94	79.03	10	83.88	76.32
3	84.97	73.43	11	79.36	74.87
4	84.16	80.78	12	81.89	81.09
5	87.24	73.17	13	87.91	76.32
6	87.56	81.72	14	85.86	80.67
7	87.28	73.70	15	82.76	77.22
8	79.05	77.14			

activities, we have developed an active programming training plan centered on solving specific problems. Students first find the steps to solve the problem, and then implement them step by step in MATLAB. Through problem-solving, they strengthen their understanding of the training knowledge and experience the joy and sense of achievement of learning after solving the problem.

In recent years, the use of MATLAB software platform has gradually increased some practical teaching content in the process of university mathematics teaching, which can make certain abstract mathematical concepts, formulas or theorems visual and vivid, effectively helping students grasp the essence of mathematical problems. This effectively resolves many teaching difficulties in university mathematics, promotes the coordinated development of abstract thinking and visual thinking among students, Cultivate students' learning enthusiasm and innovation. MATILAB is a powerful mathematical software. The graphical user interface GUI technology of MATILAB provides an interactive environment for the teaching of university mathematics. The introduction of MATILAB's graphical user interface GUI technology in university mathematics teaching provides an interactive environment for teaching. Further development of graphical user interfaces for courses such as numerical analysis, probability statistics, and operations research is carried out on the MATILAB platform, Changing the traditional mathematics teaching mode, integrating theoretical teaching and experimental demonstration, is conducive to enhancing the intuitiveness and interactivity of university mathematics teaching, enriching teaching methods, improving teaching effectiveness, and more conducive to mobilizing students' learning enthusiasm.

As shown in Tables 3.1 and 3.2,From the above research results, it can be seen that the simulation effect evaluation of computer mathematics teaching systems based on Matlab is distributed between [94,98], and the teaching effect evaluation of computer mathematics teaching systems based on Matlab is distributed between [79,86].

From the results of the teaching control experiment, it can be seen that the teaching model proposed in this article can better leverage the advantages of intelligent teaching in mathematics teaching for computer majors compared to traditional teaching models

Through the evaluation and analysis, it can be seen that the mathematics teaching system for computer majors based on MATLAB can effectively improve the intuitive effect of advanced mathematics teaching and help improve the teaching quality of advanced mathematics.

In addition, the model proposed in this article can not only be used for mathematics teaching in computer majors, but also for abstract teaching in other majors. Through more specific methods, it helps students understand abstract knowledge that is difficult to understand. Therefore, the model proposed in this article can not only play a role in mathematics teaching in computer majors, but also in teaching other professional disciplines

In actual teaching, the following teaching methods can be used to carry out teaching:

The Fourier series has a relatively wide range of applications in engineering and technical practice, and is an important tool in signal processing. In practice, the Fourier series is mainly formed by the superposition of sine curves. During the learning process, students have great difficulties in understanding the curves with sharp points that are superimposed. If it is difficult to achieve Fourier series by manual demonstration, MATLAB can be used to draw specific images and conduct comparative analysis to guide students to learn concepts more intuitively and improve understanding.

In the drawing of univariate function graphs, MATLAB software can be used to better guide students to learn and understand the meanings of extreme points, inflection points, etc., thereby more efficiently mastering relevant concepts and knowledge points. MATLAB can quickly create univariate function graphs, store data on the x-axis and y-axis in two vectors of the same dimension, and use commands to draw function graphs. You can also use MATLAB to create animations. Multivariate function integration is an important part of basic mathematics teaching. In learning, it is necessary to draw graphs of multivariate functions. For some relatively complex function graphs, it is difficult to complete them without the help of software, which can affect the teaching effect. The graphics drawn based on textbooks and blackboard writing are flat and stationary, and errors are prone to occur during drawing, making it difficult for students to understand spatial graphics. In teaching, MATLAB software can be used to create three-dimensional spatial function graphics, and the formation process can be demonstrated in the form of animation to help students better understand relevant knowledge points.

In basic mathematics teaching, it is very difficult for teachers to manually draw spatial geometry, and the operation is not convenient. For example, rotating a quadratic surface can only be statically displayed, and students need to rely on imagination and abstract thinking to facilitate understanding and mastery. MATLAB software can dynamically demonstrate complex graphics, rotating quadratic surfaces, etc., such as displaying the dynamic formation process of elliptical paraboloids in the form of animation through program settings, making mathematics classes more vivid and enhancing students' enthusiasm for learning mathematics.

In the teaching of qualitative theory of equations, most general solutions cannot be expressed using elementary function integrals, and there is no need to solve equation solutions in practical applications such as biology, physics, and chemistry. Specific equation solution images can be simulated using MATLAB systems to help students better understand and reduce the difficulty of learning ordinary differential equations

4. Conclusion. Algorithms, graphics and images, programming and artificial intelligence courses in computer science are closely related to mathematics. Computer major is one of the important disciplines in the development of new engineering. According to the requirements of new engineering education, students majoring in computer should have good logical reasoning ability and practical innovation ability, as well as good mathematical foundation and application ability of mathematical knowledge. In order to cultivate computer professionals who, meet the needs of society, the main research is on the application of the mathematical software MATLAB in the mathematics teaching of computer majors, so as to further improve the students' innovation and practice ability. Through the evaluation and analysis, it can be seen that the mathematics teaching system for computer majors based on MATLAB can effectively improve the intuitive effect of advanced mathematics teaching and help improve the teaching quality of advanced mathematics.

This article uses the Matlab platform for teaching mathematics in computer majors, which not only effectively improves teaching efficiency, but also helps students with poor mathematical foundations to strengthen their understanding and reduce the difficulty of mathematical understanding through intuitive display

The computer mathematics teaching system based on MATLAB can change the traditional teaching mode of computer mathematics. In the future, this method and intelligent machine learning methods can be combined to further improve the teaching methods and enhance the effectiveness of computer mathematics teaching.

In terms of technological improvement, a PC based CNC system based on a new high-performance processor can be adopted. Through efficient algorithms and simplified software design that directly manipulates the CPU core, the comprehensive advantages of the best combination of software and hardware can be fully utilized, effectively ensuring the implementation of high-speed and high-precision interpolation technology.

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