Hindawi
Mobile Information Systems
Volume 2022, Article ID 6253292, 12 pages
https://doi.org/10.1155/2022/6253292

*Research Article*

# Promotion of Intelligent Digital Computer-Aided Design to the Improvement of Rural Public Environment Design

**Chang Yan**

*Changsha Normal University, Changsha 410000, China*

Correspondence should be addressed to Chang Yan; yanchang3333@csnu.edu.cn

Received 15 April 2022; Accepted 11 May 2022; Published 27 May 2022

Academic Editor: Chia-Huei Wu



In order to optimize the rural public environment, protect and build the characteristics and integrity of the rural public environment. This paper introduces the development and research of a digital design platform based on digital computer, taking parallel robot (cross IV) as the object. The basic functional requirement of the digital integrated design platform is parallel robot. In the design stage, it mainly needs six functional modules, including conceptual design module, detailed design module, simulation design module, electromechanical coupling design module, optimization design module, and database module. Based on the analysis and summary of the digital integrated design process of parallel robot, combined with the actual functional requirements, the key technologies and solutions of the digital design platform are determined, the overall framework of the digital design platform is drawn up, and the implementation process of the platform is planned in detail. The Design personnel involved in the design process and their corresponding responsible contents, and the user authority is managed reasonably. Set the parameters of the driving arm and the driven arm. The outer diameter of the driving arm is 58 mm and the thickness is 2 mm. The outer diameter of the driven arm is 14 mm, and the thickness is 2 mm. Their length can be calculated directly according to the parameters provided in the conceptual design. According to the rules set by the software, the automatic assembly operation is carried out to obtain the whole machine model. After entering the SolidWorks motion module, the dynamic interference inspection is carried out first, and then the simulation analysis is carried out. The results show that the selection is correct when the actual model is consistent with the theoretical model. The correct selection and wide application of CAD technology in the production and construction of building decoration engineering will inevitably bring great changes in construction management and concept and become a new trend and trend for construction enterprises to enhance their competitiveness. The aforementioned computer-aided design is a broad application category. It provides a strong foundation for the design of rural public environment.

## 1. Introduction

The existence of rural public buildings is closely related to the villagers' life. While building the countryside, we better plan a certain space area to build public activity places, and give them a public space that can enrich their amateur life and communication on the premise of improving the villagers' quality of life [1]. The rural public building is a carrier that can best reflect the rural spiritual civilization and material civilization. It can better reflect the rural spiritual outlook and show the vitality of rural development. In the planning of rural public construction, rural public buildings, as an important carrier, should also receive better attention [2]. The decoration of the facade of public buildings is the most direct expression of the building, and this expression effect can be better reflected through the rational use of materials in the design. Therefore, based on the study of rural public construction, this paper analyzes the principles and ideas of the use of materials in the design, so as to improve the artistry and aesthetics of the facade, so that it can be better integrated with the overall planning and design of the countryside, so as to better attract users and make full use of this public facility. This research is of great significance in rural construction. The formation of rural public space originates from China's unique rural environment. In the long-term production and life process of Chinese farmers, affected by social and economic factors, it has formed a rural environment with Chinese characteristics.

The role of traditional rural public environment is relatively single, which is affected by the environment at that time, and the rural environment is less affected by the outside world. With the progress of the times, in addition to being full of life atmosphere, the rural public space environment has gradually evolved into a public environmental place with various functions to show the rural local culture, and has become a comprehensive environmental place with great life atmosphere, entertainment atmosphere, and custom culture [3]. According to the strategy of rejuvenating China's beautiful countryside in the new era, we should pay more attention to the construction of such comprehensive public places, so as to provide better life experience for rural residents. However, there are still many problems in the current situation of China's rural construction, with serious polarization. Some rural construction failed to absorb modern planning and design concepts, and the function of public places is relatively single. Some rural governments excessively put the rural construction close to the urban direction and directly integrate the urban landscape into the rural design. Therefore, we must plan a positive and effective way for China's rural public environment construction [4]. In order to promote the sustainable development of environment, environmental engineering management plays a vital role. It is necessary for the development of the whole environment to do a good job in environmental engineering management, analyze and detect each kind of information data, find out relevant laws, and ensure the irreplaceable, accuracy, and completeness of information [5].

AutoCAD, 3dmax, and Photoshop: Figure 1 shows the construction of computer-aided design (CAD) knowledge map [6]. Parallel robot is a typical modern electromechanical system equipment. Its design process is a relatively complex system engineering, mainly including kinematic modeling analysis, dynamic analysis, electromechanical coupling analysis, and optimization design. Although there are abundant research results related to the design of parallel robots at home and abroad, these research results are relatively scattered, and the combination between design theory and design process is not close, so they cannot be effectively applied to the R&D and design of parallel robots [7]. The main manifestation of these achievements on parallel robots is still academic papers, but there is no operable software, which is difficult to integrate into the actual design process. The majority of robot design engineers are difficult to apply quickly. Engineering designers still design robots mainly based on their personal engineering experience [8]. At present, it is still a challenge for many disciplines to integrate the software of parallel mechanism design into the software of commercial mechanism design [9].

## 2. Literature Review

Aiming at this research problem, Zhao et al. developed the virtual design platform VPE-PKMAD for parallel equipment and applied the platform to the development of multiple parallel equipment in the manufacture project [10]. Alghamdi et al. proposed that rural construction should follow the principles of economy, practicality, beauty and comfort, pay attention to the elegance and softness of material color in facade design, and the application of materials should be coordinated with the surrounding environment [11]. Liu and Cheng pointed out that with the development of rural economy, the regional characteristics of traditional villages gradually disappear, and there are more and more phenomena of thousands of cities and one side in rural construction. In the transformation of the building facade of local rural streets, the awareness of protecting traditional folk houses is emphasized, and the overall design style is clearly defined as the traditional architectural style of Jiangnan [12]. Cai et al. pointed out that in the design of building facade, new materials are applied to the design of old buildings. Through the original color combination relationship of these materials and the material of the original building, they form a visual contrast, so as to show the artistic expressive effect of facade wall and make it more modern [13]. Chang et al. suggested rational use of natural resources, advocate integration with the environment in the idea of architectural design, and use the concept of technical design to better make the building meet its specific needs [14]. Presley and others proposed that the design of facade is not only attached to the skin of the building, but also can be better integrated into the composition of the building itself without boastful treatment and rendering in the design, so as to promote the principle of Architectural Rationality [15]. Chen et al. have done a lot of research and mentioned that the rural architectural style of Zhejiang is very ancient and retains a large number of ancient wood and stone techniques. The local traditional villages also use this unique wood and stone techniques as the processing and utilization of materials in the application of building facade materials [16]. Harisudin et al. pointed out that with the opening and development of Zhuang villages, most villagers lack professional guidance and use a large number of new building materials in the design of building facades. Although the color of local building facades presents a rich and diverse state, it has a serious impact on the landscape of Zhuang villages and gradually deviated from the original architectural style of Zhuang family [17]. Tao et al. mentioned that on the basis of adhering to the traditional architectural features, most of the rural architectural features of Japan still maintain the original form, and the application of building materials is rarely affected by western architectural standards, which is highly humanistic. This feature is also inseparable from the attitude of Japanese rural residents in actively participating in the construction of new villages and controlling the architectural features and forms [18]. On the basis of existing research, this paper proposes to develop and research a digital design platform based on digital computer model, and take parallel robot (Cross IV) as the object. Focusing on the demand of forward design software of parallel robot, based on advanced CAD/CAE software, a digital design platform for integrated and rapid development of parallel robot is studied using a variety of software development technologies. The marching cubes algorithm that may be used in CAD is explained. This paper analyzes and summarizes the digital integrated design process and characteristics of parallel robot, puts forward the

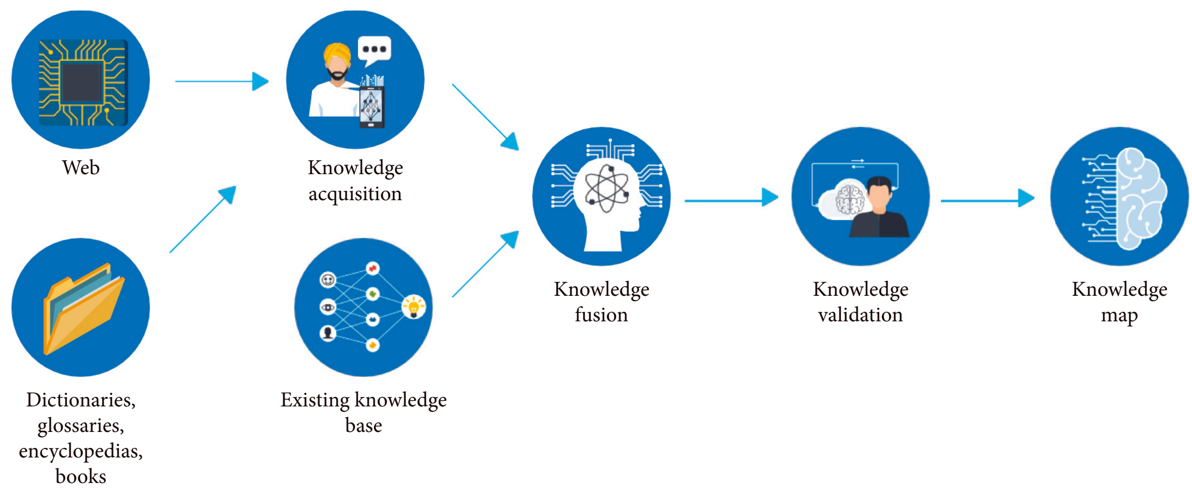


Figure 1: Construction of CAD knowledge map.

functional requirements of parallel robot digital platform, formulates the overall framework of digital design platform, and plans the implementation process of digital design platform in detail. The software system development and overall operation of parallel robot digital design platform are described in detail, and the platform authority management and structure design module are introduced in detail. Finally, combined with the development example of cross IV parallel robot, the feasibility and stability of various functions of the digital design platform of parallel robot are verified, which further promotes the design of rural public environment.

## 3. Method

*3.1. Basic Concepts of Rural Public Buildings.* Rural public buildings play an important role in publicity and serving the masses. They are an important place for rural residents to carry out public activities [19]. The project and scale of rural public buildings are generally planned according to the population status and village distribution of local villages, so that they can not only serve the villagers but also play the role of organizing and improving scientific and cultural literacy to the greatest extent. Therefore, the construction level of rural public buildings also reflects the modernization of local rural construction to a certain extent. There are great differences between rural public buildings and urban public buildings. Rural public buildings are generally small in scale. The functional requirements for rural public building construction projects will be relatively high. Houses with similar properties or close connections will usually be organized together or located in the same building, and individual houses should also have the possibility of multipurpose or flexible separation [20]. For example, the centralized construction of facilities, such as cultural publicity, education, and sports activities, can not only save expenses but also improve the utilization rate and flexibility of public buildings. Therefore, in rural public construction, we should examine the current environment and develop according to local conditions, rather than blindly copying the ideas of urban public buildings and foreign buildings [21].

The facade design is to show the functionality and practicability of the facade using the aesthetic concepts such as the collocation of materials in the design through materials, colors, and size proportion. External walls, doors, windows, and roofs are important components of the facade. The doors and windows in the building facade mainly play the functions of providing building space access, ventilation, daylighting, and so on. In the modeling of doors and windows, there are more ways of expression through the use of different materials. Therefore, different decorative languages are also expressed in the design of doors and windows in different ways. As an important part of covering the whole building, the building roof not only plays a role in shielding the wind and rain but also plays an important role in the overall image of the building.

*3.2. Application of CAD Technology in Architectural Decoration Construction.* The construction of building decoration engineering is mainly based on the drawing, that is, through the construction treatment of decoration structure, material installation, and process technology, so as to realize the scheme and intention of decoration design. The designer reflects the mature design idea on the drawings, and the construction personnel transform the construction drawings into engineering practice. However, in the actual Decoration Engineering, it is often not so simple because the production and construction of architectural decoration engineering is a process of recreation, a process of quality inspection and further deepening and improvement of decoration design. As the design drawings are produced before the project construction, they still lack the sense of reality for the final decoration effect, and each process of decoration construction is testing and improving the scientificity, rationality, and practicality of the design. It can be seen that the decoration engineering is not completely passive to accept the design. The decoration construction technicians should be talents who understand architecture, are familiar with drawings, have high-level operation skills and have good artistic quality. Every successful architectural decoration project should be the crystallization of the common wisdom and labor of designers and constructors. The characteristics of building decoration engineering construction can be summarized into five points:

(1) The technicality of building decoration engineering construction.
(2) Standardization of building decoration engineering construction.
(3) Professional construction of architectural decoration engineering.
(4) The complexity of construction management of architectural decoration engineering.
(5) Technical economy of building decoration engineering construction.

CAD technology is widely used in the production and construction of Building Decoration Engineering, which will inevitably bring great changes in construction management and concept and become a new trend and trend for construction enterprises to enhance their competitiveness. The aforementioned CAD is a broad application category. It has played an important role in the field of architectural decoration construction in recent years, and it will play an increasingly important role in construction management.

Several key elements in decoration construction management include construction progress control, material control, construction quality control, and coordination between personnel and disciplines. The content of the program is extracted from the experience of several large-scale interior decoration projects, which has a certain reference value. If the engineering technical management personnel can complete and use the contents of the program in time in the construction of building decoration, the project can be completed efficiently and with high quality. In the decoration project, the drawings of decoration, HVAC, electrical and other disciplines are closely related, and the system diagrams of electrical system and plumbing system are schematic drawing, and the blueprint only gives the approximate location of on-site installation components. However, in the construction stage, the actual conditions will change, and many variable factors will appear, so the installation and layout of these systems will be different from the design, which requires the use of CAD for secondary design according to the construction site. In the construction process, the secondary design can be carried out according to the combination of functional requirements and aesthetic ideals, so as to coordinate the contradictions between various disciplines, make the layout reasonable, the primary and secondary order, interspersed properly, and the implicit arrangement is followed, so as to achieve both convenient use and beautiful harmony. The design of modern buildings is becoming more and more intelligent. The decoration of a set of rooms often requires many types of work, such as water, electricity, heating, wood, mud, masonry, glass, paint, metal, and so on. It is often dozens of processes, coupled with the cross and rotation of system projects such as fire fighting, sound, communication, cable TV, and security. The more the specialty is divided, the more detailed the specialty is. It is inevitable that there will be contradictions among various specialties in the construction process. For example, when a professional facility has been installed in place and another professional facility cannot be constructed due to limited reserved space, the only way to solve the problem is for one or both parties to change the size of the equipment. Change the direction of the pipeline to meet the realization of functional objectives, which not only affects the construction period, but also damages the economic benefits. How to make each specialty work efficiently and orderly to ensure the realization of the overall progress of the process? Using CAD to draw the accurate coordinate positioning of professional facilities in advance can avoid the aforementioned contradiction to the greatest extent. This needs to focus on the requirements of forward design software of parallel robot, based on advanced CAD/CAE software, and use a variety of software development technologies to study the digital design platform for the integrated and rapid development of parallel robot.

*3.3. Computer-Aided Design (CAD).* Buildings need to be conceived and designed repeatedly, but users are often still dissatisfied. Designers can use virtual buildings in front of the building to allow users to observe the shape and internal room parts by themselves. It is also convenient for designers to modify the design. The application of a computer three-dimensional (3D) model in architectural decoration design and performance design is a creative process from fuzziness to clarity. The initial plan may be just an idea, not necessarily a specific building. What the designer does is to create and deliberate the pictures in his mind directly, and show them intuitively. As there is always a distance between the performance of the building and the design itself, the design and performance cannot develop synchronously, which undoubtedly brings a lot of inconvenience to our design. The powerful 3D modeling and display function of computer is to build a bridge between design and performance, connect the two, make the design and performance develop synchronously, and realize the integration of design and performance. The marching cubes algorithm for processing 3D orthogonal data fields is explained later in this paper.

The dice-running algorithm is a classic algorithm for generating equidistant lines in a 3D data field. This is a representative technique for extracting isosurfaces in a voxel cube. It generally handles 3D orthogonal data fields, namely,

$$\begin{aligned} F_{i,j,K} &= F\left(x_i, y_j, z_k\right), \\ &\quad \left(i = 1, \ldots, N_X,\ J = 1, \ldots, N_Y,\ k = 1, \ldots, N_Z\right). \end{aligned} \tag{1}$$

*Definition 1.* Let $f(x, y, z)$ be a 3D continuous image, occupying a limited bandwidth in the frequency domain, covering area V in space:

$$S(x, y, z) = \sum_{i=-\infty}^{\infty} \sum_{i=-\infty}^{\infty} \sum_{i=-\infty}^{\infty} \delta(x - i\Delta X, y - J\Delta y, Z - k\Delta z), \tag{2}$$

where

$$\delta(x, y, Z) = \begin{cases} 0, x, Y, z = 0, \\ 1, \end{cases} \tag{3}$$

Get image

$$\begin{aligned} f_D(i, j, k) &= f(x, y, z)\delta, \\ &(x - i\Delta x, y - j\Delta y, z - k\Delta z). \end{aligned} \tag{4}$$

Represented as 3D volume data.

*Definition 2*

$$p \mid f(p) = C \tag{5}$$

It is called equivalent point,

$$p \mid f(p) \geq C, \tag{6}$$

is a positive point,

$$p \mid f(p) < C, \tag{7}$$

is a negative point.

*Definition 3.* The cube in MC algorithm is defined as follows:

$$\begin{aligned} &Cube(i, J, K) = p = (x_0, y_o, z_0), \\ &X + i\Delta x \leq X_o \leq x + (I + 1)\Delta x, \\ &y + j\Delta Y \leq Y_0 \leq Y + (J + 1)\Delta y, \\ &z + k\Delta z \leq Z_0 \leq Z + (k + 1)\Delta z, \\ &v1(i, j, K), \\ &v2(i + 1, J, k). \end{aligned} \tag{8}$$

Then the intersection is: as follows

$$\begin{aligned} &v(x, J, k), \\ &x = i + \frac{c - f(V1)}{f(v2) - f(V1)}. \end{aligned} \tag{9}$$

When the intersection is on the axial edge, let the vertex of the edge be as follows:

$$y = j + \frac{c - f(v1)}{f(v2) - f(v1)}. \tag{10}$$

If the normal vector of the isosurface is obtained directly, its workload is large and time-consuming. The central difference method can be used to calculate the gradient of the vertex and then the linear interpolation can be used to calculate the gradient of the intersection, that is, the normal vector of the vertex of the triangle.

*3.4. Introduction to Parallel Robot (Cross IV).* This paper takes the parallel robot (Cross IV) as the object to develop the digital design platform. Cross IV is a new type of high-speed handling robot developed by the Institute of Manufacturing Equipment and Systems of Tianjin University. The relative sliding along the guide column between the main platform and the auxiliary platform can convert the lead screw nut transmission into the rotation of the actuator at the end of the platform around the $Z$ axis. Each branch chain is driven by the servo motor through the reducer to rotate the driving arm, and the driving arm drives the driven arm to move, so as to realize the spatial three translations and one rotation of the end actuator. Among them, translation is used to realize the spatial movement of the end effector, and rotation is used to adjust the placement attitude of the target. The robot is suitable for high-speed light load handling operation on industrial production line.

*3.5. Analysis of Digital Design Process of Parallel Robot.* According to the actual design experience, the digital design process of parallel robot (cross IV) is summarized as follows:

(1) User requirements.

Analyze the needs of users; set the basic performance requirements of the robot, such as workspace size, motion law requirements, load capacity, dynamic performance, accuracy requirements, and flexibility; and take these performance parameters as known conditions to complete the subsequent design.

(2) In the conceptual design stage, the theoretical modeling, trajectory planning and motion law setting of the parallel mechanism are mainly carried out. According to the needs of users, the preliminary scale parameter planning is carried out. Finally, the inverse kinematics and inverse dynamics of the parallel mechanism are solved, the driving parameters of the robot are obtained, and the motor selection and reducer selection are preliminarily carried out.

(3) 3D component design and assembly.

First, according to the requirements of high-speed motion for component lightweight and reliability, the detailed structures of static platform, driving arm, driven arm, preloadable ball hinge, moving platform and other components are designed. Then, these components are assembled into a complete machine for interference inspection. Finally, in order to facilitate the subsequent establishment of finite-element model, the whole machine model is simplified.

(4) Kinematics/rigid body dynamics design.

The 3D model is imported into the SolidWorks motion module. Combined with the trajectory planning and motion law in the conceptual design, the kinematics and rigid body dynamics simulation are carried out.

(5) Elastodynamic design.

The simplified CAD model is imported into SAMCEF, the finite-element model is established, and the global static stiffness, global mode and transient dynamic simulation analysis are carried out respectively to predict the static and dynamic characteristics of the robot, so as to provide support for the subsequent optimization design.

(6) Optimization design.

In the optimization design, two aspects are mainly considered: the optimization of scale parameters and the optimization of structural parameters of key parts. The optimization of scale parameters is mainly aimed at the length and eccentricity of driving rod and driven rod. Taking the volume ratio of workspace/mechanism and the force transfer characteristics within and between chains as constraints, and taking the minimum driving torque required for the maximum unit speed and acceleration at the end of the whole region as the optimization objective, the influence law of scale parameters on subobjectives and kinematic constraints is revealed, and the multiobjective optimization algorithm is used to determine the optimal scale parameters. The optimization of structural parameters is mainly aimed at the optimization of the wall thickness of the driving rod and the driven rod. Taking the maximum dominant modal frequency/mechanism mass ratio or the minimum mechanism mass under the constraint of dominant modal frequency as the optimization objective, the influence laws of different objective functions and constraints on the design results are revealed. By iterating with the dynamic design cycle, the satisfactory solutions of scale and structural parameters that can ensure the performance of kinematics, rigid body, and elastic dynamics at the same time are determined.

*3.6. Functional Requirements Analysis of Parallel Robot Digital Design Platform.* The basic functional requirements of the digital integrated design platform of parallel robot: In the design stage, it mainly needs six functional modules, including conceptual design module, detailed design module, simulation design module, electromechanical coupling design module, optimization design module, and database module.

(1) Conceptual design module: Based on the basic theory of mechanism, the mathematical theoretical model is established to support the functions of topology selection, performance index setting, inverse kinematics solution, inverse rigid body dynamics solution, precision design and so on.

(2) Detailed design module: It supports 3D modeling of parts, selection of common parts and standard parts, automatic assembly, trajectory planning and motion law setting, kinematics simulation and interference inspection, rigid body dynamics simulation, and other functions.

(3) CAE simulation module: Support the automatic generation of finite-element model.

(4) Electromechanical coupling design module: Support graphical modeling of control system, multirigid body control coupling system simulation, multiflexible body control coupling system simulation, controller/driver parameter design, and other functions.

(5) Optimization design module: Support multiobjective method, experimental design method, and response surface method to optimize the scale parameters and structural parameters of the robot.

(6) Database module: The reusable design knowledge is classified and the database is established, such as topology configuration database, standard parts database, common parts database, parts library, motion law database, joint surface feature database, and control model database.

*3.7. Overall Framework of Digital Design Platform.* Facing the requirements of automation and visual design of parallel mechanism, the architecture of digital integrated design platform is established. Based on the existing commercial CAX software, CAD/CAE, multidisciplinary collaborative design software and its secondary development tools are developed to develop an integrated design software platform. It mainly includes interaction layer, support layer, management layer, database layer, application layer, and data layer. The specific technical route is as follows:

(1) Interaction layer: The interaction layer provides users with a personalized interactive interface, realizes the navigation operation of the design process, prompts and controls the user's input, ensures the correctness of the data, reduces the difficulty of user designing the robot, and improves the design efficiency.

(2) Support layer: The support layer mainly refers to the external software system required in the platform development process, including numerical calculation system (MATLAB), CAD system (SolidWorks), CAE system (SAMCEF), control system (LabVIEW), optimization system (iSIGHT), and windows operating system. The numerical calculation system provides support for the theoretical design and calculation of parallel robot. CAD system provides support for 3D modeling, kinematics simulation, and rigid body dynamics simulation of parallel robot. The CAE system provides support for the finite-element simulation analysis of the parallel robot, the control system provides support for the control system design and electromechanical coupling simulation analysis of the parallel robot, and the optimization system provides support for the optimization design and process management of the parallel robot.

(3) Management: The management is mainly responsible for user authority management, database management, CAD/CAE data management, project process management, and so on. User authority management includes function authority and data authority. Database management includes maintenance operations, such as adding, deleting, querying, and modifying database information. CAD/CAE data management includes model data management, result data management, and version management. Project process management includes personnel organization management and design process management.

(4) Database layer: Using the existing database technology, the database required by the platform is developed, including topology configuration library, standard parts library, common parts library, parts library, motion law library, joint surface feature library, and control model library. The topological configuration library is to centralize the topological configurations of commonly used parallel mechanisms in the database for users to choose; The standard parts library is to put the standard parts often used in the parallel robot into the database for users to call directly, including motor, reducer, bearing, bolt, nut, lead screw, and guide rail; Common parts library is a database composed of gears and springs commonly used in parallel robot; Part library refers to the database composed of the parametric design model set of key parts and components; Motion law database refers to a database composed of multiple trajectory planning modes; The joint surface feature database refers to the database formed by the characteristic parameters between various joint surfaces, such as the parameters of joint surfaces such as hinges, bearing supports, and bolt preloading. The control model base refers to the database composed of various control modes and parameters of the robot.

(5) Application layer: The application layer refers to the functional module area of the platform, mainly including conceptual design module, structural design module, model verification module, and simulation analysis module. Based on the secondary development function of commercial CAD/CAE software, these functional modules are designed and developed.

(6) Data layer: The data layer mainly includes data definition, data interface, and data storage. Data definition refers to the guidance and control of user input data; Data interface refers to the data transmission between software systems and modules; Data storage refers to the storage of data generated in the design process, including public data, process data, and result data.

## 4. Results and Analysis

*4.1. Platform Permission Management.* *D* personnel involved in the design process and their corresponding responsible contents, the user authority is managed reasonably. Both the confidentiality of technical data and the parallelism of design process shall be achieved to facilitate the communication of relevant designers. Only by clarifying the responsibilities and corresponding authorities of relevant staff, can the whole software system and the actual design process be carried out in an orderly manner. The authority of the platform can be divided into five levels:

(1) The person with the highest authority, who has complete management authority over the whole platform, is responsible for the maintenance of the whole platform, adds and modifies the relevant information of the platform according to the needs, designates the general person in charge of the project, and opens all the use authority of the platform.

(2) Authority of the general person in charge of the project has complete access to the whole platform, manages the development progress and technical data of the whole project, approves the work of each project team, manages the person in charge of each working team, and arranges corresponding authority.

(3) Authority of the person in charge of the project team: including theoretical design team, engineering design team, simulation design team, control design team, they have the management and use authority of corresponding modules, are mainly responsible for the management and technical audit within the corresponding scope of work, and arrange the authority of corresponding designers.

(4) Designer authority be responsible for the design of corresponding modules and have the authority to modify corresponding documents.

The structural design module mainly completes the design of robot mechanical system through component selection and parametric design. The module needs to select the motor and reducer according to the result data obtained from the conceptual design, select the type of moving platform according to the actual demand, and finally carry out the parametric design of key parts. After the selection and design of parts, automatic assembly and interference inspection shall be carried out.

*4.2. Example Introduction.* Now a parallel robot is designed using the developed digital design platform of parallel robot. The main parameters of the robot are shown in Table 1.

Input the relevant parameters in Table 1 into the conceptual design interface and calculate the inverse solution to obtain the driving parameters of the mechanism, as shown in Figures 2–4.

*4.3. 3D Structure Design*

(1) According to the results obtained in the conceptual design, the motor and reducer are selected. The

Table 1: Main parameters of parallel robot.

| Name | Numerical value |
|---|---|
| Length of driving arm | $l_1 = 375$ mm |
| Boom length | $l_2 = 950$ mm |
| Workspace location | $H = 763$ mm |
| Workspace diameter | $D = 1000$ mm |
| Workspace height | $h = 250$ mm |
| Motion acceleration of terminal platform | $a = 150$ m/s$^2$ |
| Outer diameter of driving arm | $d_1 = 58$ mm |
| Driving arm wall thickness | $b_1 = 2$ mm |
| Outer diameter of driven arm | $d_2 = 14$ mm |
| Wall thickness of driven arm | $b_2 = 2$ mm |
| Radius difference of static and dynamic platform | $e = 125$ mm |
| Angle between gate track and $X$ axis | $\psi = 45$ |

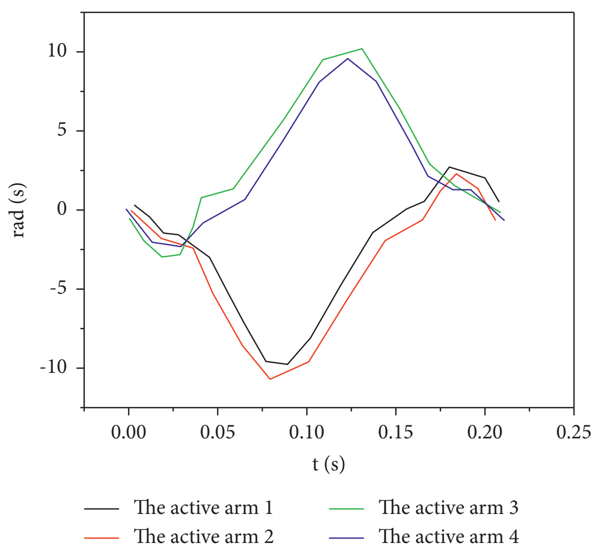


Figure 2: Driving parameters of parallel robot 1.

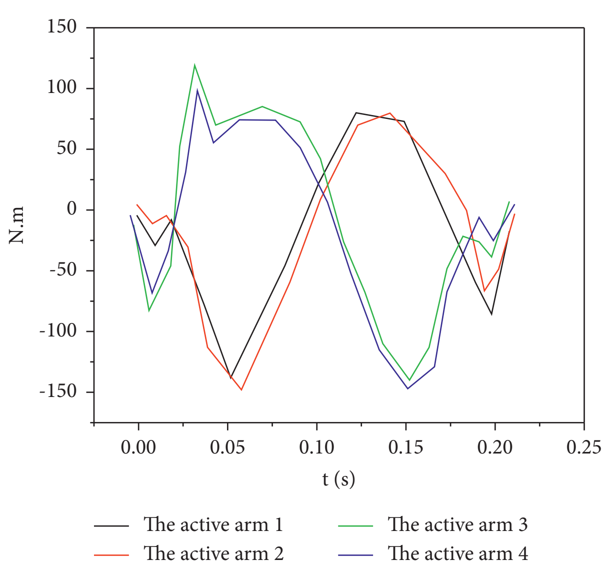


Figure 3: Driving parameters of parallel robot 2.

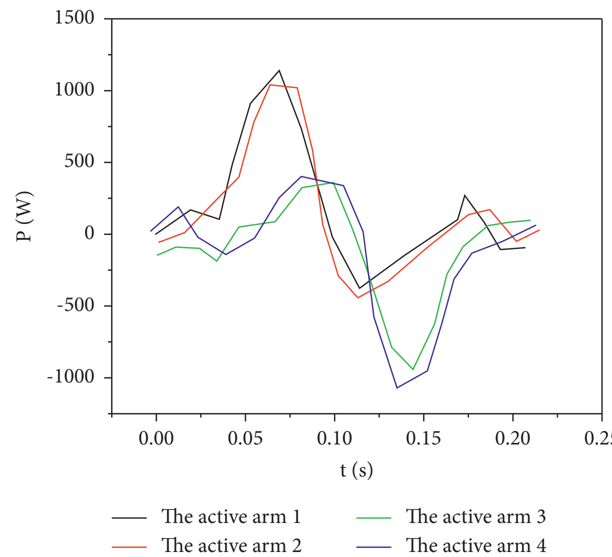


Figure 4: Driving parameters of parallel robot 3.

models of motor and reducer are msma202p1 and abr090-20 respectively, and the upper and lower translation moving platform is selected. At the same time, according to the actual needs, you can choose to insert standard parts and common parts at any time.

(2) Set the parameters of the driving arm and the driven arm. The outer diameter of the driving arm is 58 mm and the thickness is 2 mm. The outer diameter of the driven arm is 14 mm and the thickness is 2 mm. Their length can be calculated directly according to the parameters provided in the conceptual design.

(3) According to the rules set by the software, the automatic assembly operation is carried out to obtain the whole machine model.

(4) Conduct static interference inspection, and the model has no interference.

*4.4. Model Verification.* Enter the SolidWorks motion module, first conduct dynamic interference inspection, and then conduct simulation analysis. The analysis results check whether they meet the requirements. Figures 5 to 7 reflect the trajectory and motion law of the end. Figures 8 to 11 reflect the angular velocity of the driving joint. Figures 12 to 15 reflect the angular acceleration of the driving joint. Figures 16 to 19 reflect the driving motor torque. By comparing these results with the results of the conceptual design module and the selection parameters, it is verified that the actual model is consistent with the theoretical model, and the selection is correct.

The correct selection and wide application of CAD technology in the production and construction of building decoration engineering will inevitably bring great changes in construction management and concept and become a new trend and trend for construction enterprises to enhance their

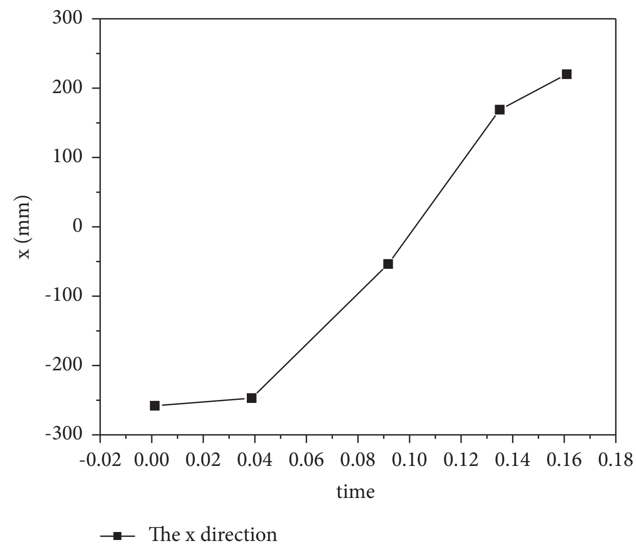


Figure 5: Movement law in $x$ direction.

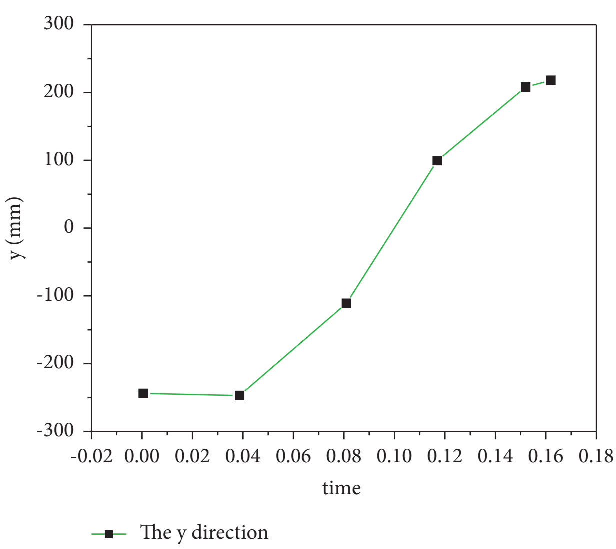


Figure 6: Movement law in $y$ direction.

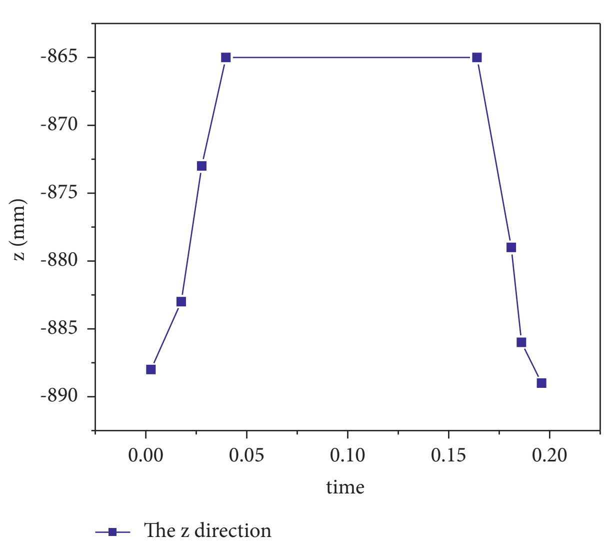


Figure 7: Movement law in $z$ direction.

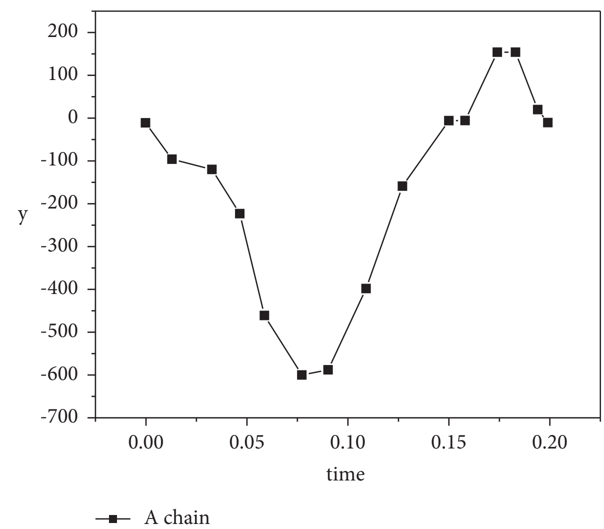


Figure 8: Angular velocity of driving joint a branch chain.

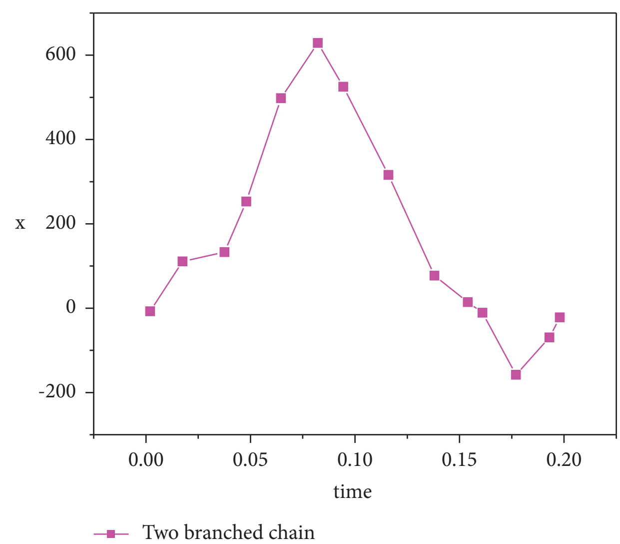


Figure 9: Angular velocity two branch chain of driving joint.

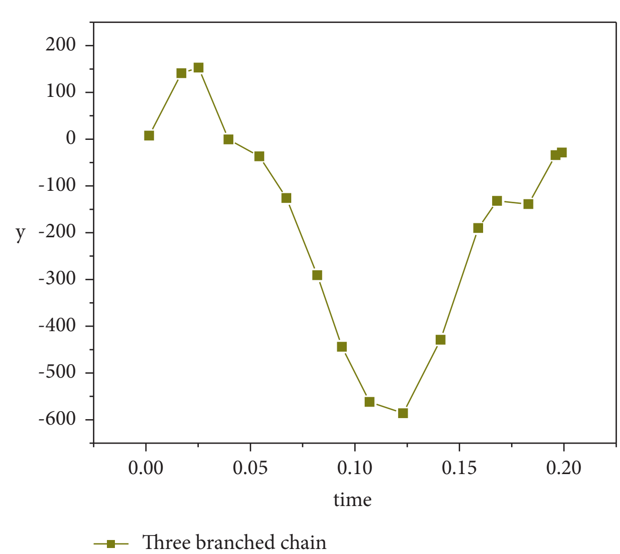


Figure 10: Angular velocity three branch chain of driving joint.

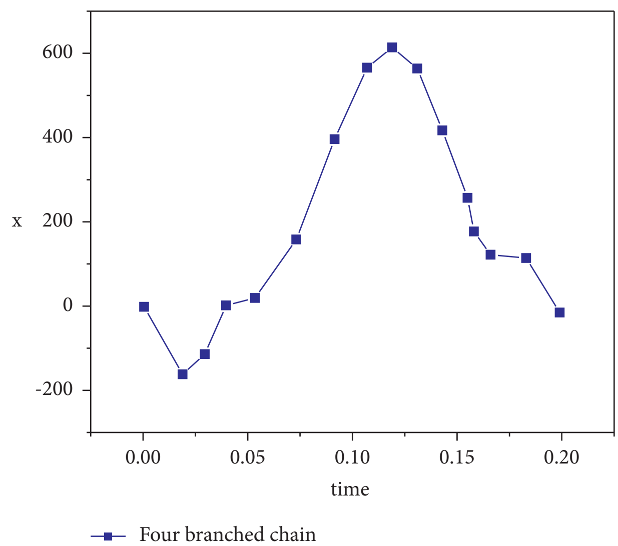


Figure 11: Angular velocity four branch chain of driving joint.

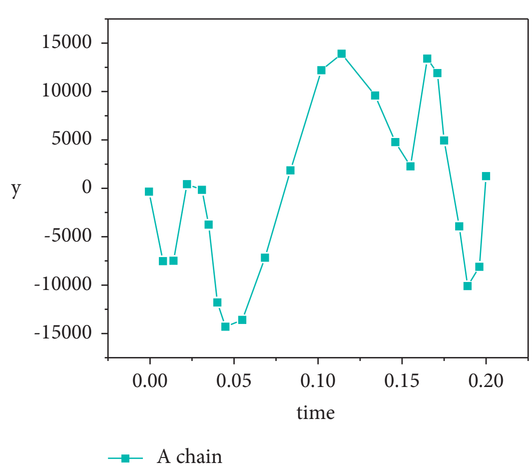


Figure 12: Angular acceleration of driving joint a branch chain.

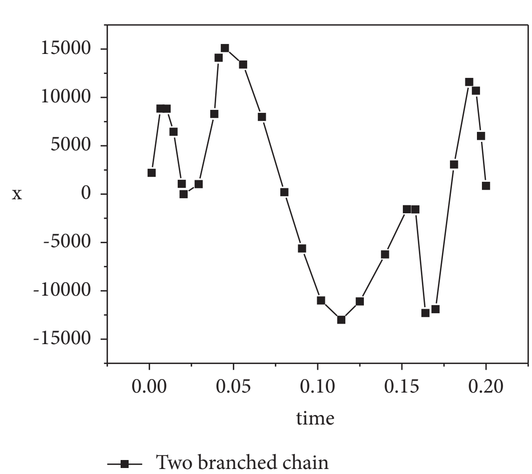


Figure 13: Driving joint angular acceleration two branch chain.

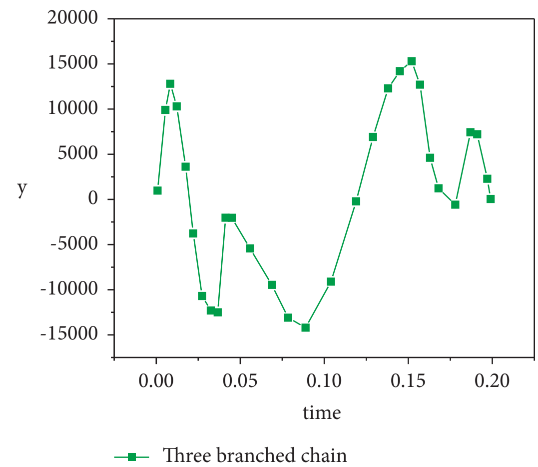


Figure 14: Angular acceleration three branch chain of driving joint.

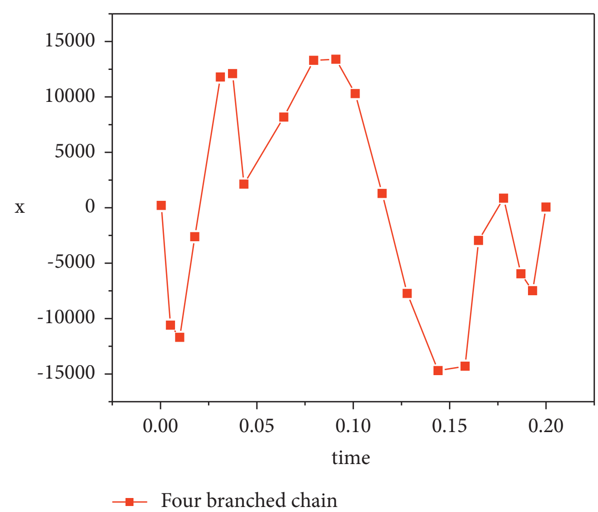


Figure 15: Four branch chains of angular acceleration of driving joint.

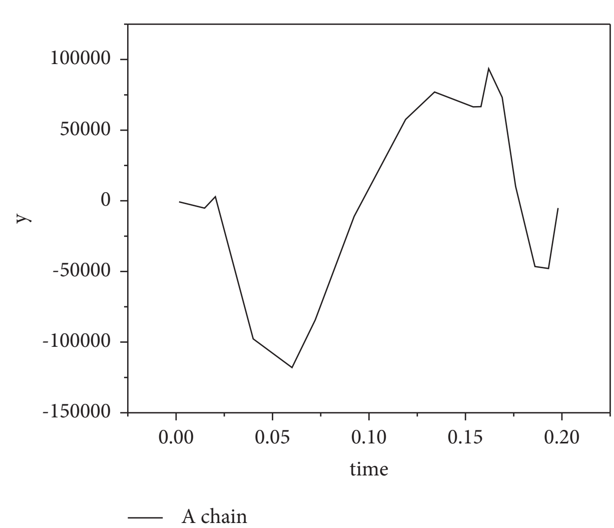


Figure 16: Torque chain of driving motor.

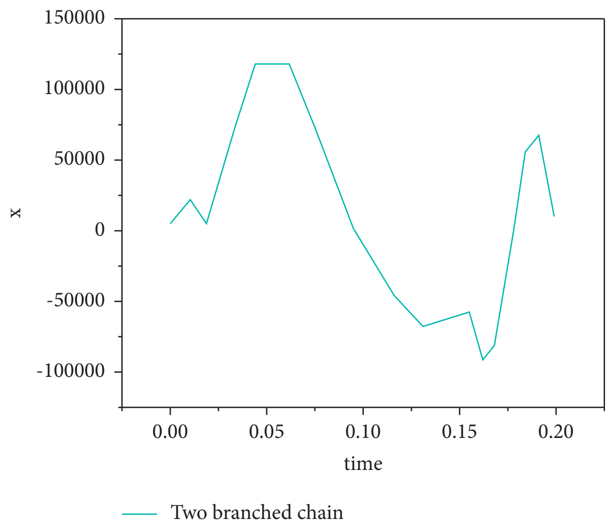


Figure 17: Torque secondary chain of drive motor.

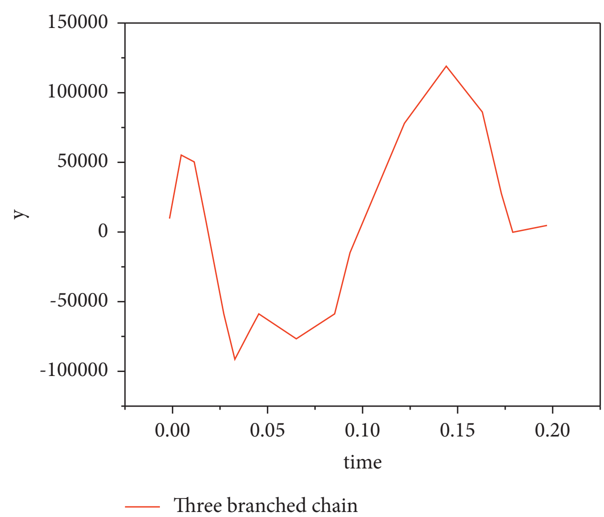


Figure 18: Torque three branch chain of driving motor.

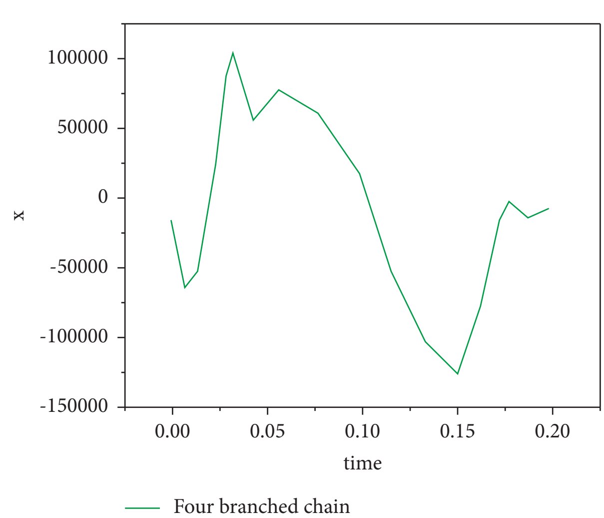


Figure 19: Four branch chains of driving motor torque.

competitiveness. The aforementioned CAD is a broad application category.

## 5. Conclusion

The improvement of rural public environment design needs to improve the architecture with the help of CAD software technology. How to make each specialty work efficiently and orderly and ensure the realization of the overall progress of the process? Using CAD to draw the accurate coordinate positioning of professional facilities in advance can avoid the aforementioned contradiction to the greatest extent. This needs to focus on the requirements of forward design software of parallel robot, based on advanced CAD/CAE software, and use a variety of software development technologies to study the digital design platform for the integrated and rapid development of parallel robot. This paper explains the marching cubes algorithm that may be used in CAD. This paper analyzes and summarizes the digital integrated design process and characteristics of parallel robot, puts forward the functional requirements of parallel robot digital platform, formulates the overall framework of digital design platform, and plans the implementation process of digital design platform in detail. The software system development and overall operation of parallel robot digital design platform are described in detail, and the platform authority management and structure design module are introduced in detail. Finally, combined with the development example of parallel robot Cross IV, the feasibility and stability of various functions of parallel robot digital design platform are verified. It has further promoted the design of rural public environment. In the follow-up work, iSIGHT and MATLAB software can be used to develop the optimization design module to form a closed-loop design mode of parametric model, simulation, and optimization of the whole process.

## Data Availability

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

## Conflicts of Interest

The author declares no conflicts of interest.

## Acknowledgments

This study was supported by Changsha Normal University.

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