Research on Real Scene Robot 3D Visualization of Historical Architectural Heritage Based on Big Data Objects

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Keywords: big data, historical building, heritage protection, 3D analysis, reality historic building heritage robot

Recieved: February 27, 2024

In the era of the rapid development of big data technology, 3D robot technology has been widely used in various aspects such as real scene demonstration and maintenance of historical buildings, and has far-reaching significance in the recording, maintenance, and restoration of historical buildings. The development of big data technology makes robot simulation of human beings a safe, reliable, flexible, and convenient design means, which plays a pivotal role in the overall design and development of robots. In this paper, virtual reality technology is used to realize the construction of a visual 3D system. Taking a serial robot with six degrees of freedom as an example, the 3D entity modeling is constructed by using the big data object measurement method. This paper constructs a robot model in big data object estimation and then introduces it into OpenGL through the form transformation of data. On this basis, it integrates with VC++ to construct a robot motion simulation system based on big data VC++. In the experiment of the 3D robot with visualization, because of the low quality of the captured image, the two-dimensional maximum threshold image based on the maximum two times threshold is used to analyze. The experiment proves that based on the big data object, the real robot can make full use of the spatial information of the image, reduce the computing speed, and achieve a good visualization effect in the recording, maintenance, and repair of historical architectural heritage, and has certain practical significance.

Povzetek: Študija raziskuje uporabo 3D robotov za vizualizacijo zgodovinske arhitekturne dediščine z uporabo tehnologije velikih podatkov. Uporaba navidezne resničnosti in 3D modeliranja omogoča natančno beleženje, vzdrževanje in obnovo zgodovinskih stavb. Eksperiment dokazuje, da robot z uporabo prostorskih informacij slike izboljša hitrost izračunov in doseže učinkovit vidni učinek.

1 Introduction

As the greatest scientific and technological achievement of the 20th century, big data technology covers a large number of technologies and disciplines, including mechanical engineering, control engineering, historic building heritage robotics, artificial intelligence, microelectronics, sensing, material science, and bioengineering. Historic building heritage robots not only allow humans to make rapid responses and analysis and discrimination of various situations around, but also can continue to work for a long time, have high accuracy and can resist poor working conditions, so they have been well applied in military, industrial, medical, family, entertainment, historical building maintenance, and other social life. This paper takes VC++ as the development platform, combines Pro/E and OpenGL, and develops a historic building heritage robot 3D kinematics simulation software with high fidelity.

1.1 Historical architectural heritage has a high demand for realistic historic building heritage robots

Aiming at the 3D visualization analysis of the real scene of the building, the multi-joint upright multi-arm manipulator can be used. It includes six rotatable hinges, and a special electromagnetic hand clamp is equipped at the end of the joints. The main body of the manipulator must be connected to the mounting base, which in turn is connected to the concrete floor by bolts to ensure its stable operation at high speeds. The AC visual motor is used to drive the six transmission mechanisms of the manipulator, and the precise resonance reducer is used [1-4].

Building real three-dimensional visualized by 6 sets of AC motors, control box for embedded network line of motion controller and the species composition, among them, the control box front has power light (for the historic building heritage robot control box has been opened 220 V input power), the power indicator on the historic building heritage robot visual (show that hinge historic building heritage robot control electric motor, in sports, or movement). Emergency stop button (in case of emergency, press the emergency stop button to disconnect the power supply of the hinge control motor to prevent danger). The historic building heritage robot console is also equipped with a suitcase, which can power and emergency stop at a long distance, and the suitcase must be placed in front of the operator's body, to better operate, when the historic building heritage robot changes, it can respond quickly. In the manual operation box on a historic building heritage robot visual electric instructions (the same as the function of the historic building heritage robot controller ark), historic building heritage robot visual electric button (when the historic building heritage robot controller and carrying a box on the emergency stop button has been canceled when the power supply is opened, the control box can visualization on the power button to open the power of the hinge type machine), emergency stop button [5-8].

The concept of OpenGL is a graphics software development interface independent of hardware and OS. It can be used in Unix, Windows 2000, NT/T, and other mainstream operating systems. In OpneGL, different programming languages such as c, C++, VisualC+ t, Java, etc. Now there are many popular 3D engineering graphics applications, such as 3 dsmax, Pro/E, UG, and so on. OpenGL has been recognized as the industry benchmark of high-performance image and interactive visual processing technology, and it is also the development direction of high-end 3D workstations. Because various transformations, colorings, lighting, texture properties, and interactive actions and dynamics can be easily performed in OpenGL, it has received much attention in the design of 3D games.

Because openGL is easy to invoke, especially has a close interaction interface with VisualC++, and has a good 3D realistic effect, we can apply it to the 3D model of the real scene of the building. OpenGL only provides based geometry elements of points, lines, polygons, etc, so establishing a precise and detailed historic building heritage robot in the process of the 3 d models, takes a lot of time and energy, in this paper, by adopting large data objects of professional 3 d drawing tool modeling, to ensure the accuracy of the established 3 d model of the historic building heritage robot and speed, to some extent, it enhances the reality of the historic building heritage robot and extends the application of the historic building heritage robot simulation system in 3D software.

1.2 Historic building heritage robot 3D modeling applied to historical building protection

The Pro/E software developed by PTC Technology company has been widely used in the world.CAD is a set of design and manufacturing in one of the mechanical manufacturing systems, its application range includes electronics, machinery, mold, industrial design, automotive, aerospace, military, textile, home appliances, toys and other fields, CAD parametric modeling technology can easily create a variety of complex objects with practical application value. Based on Pro/E4.0, the 3D solid of the building realistic 3D historic building heritage robot is constructed, and its components include: base, rotating base, lower arm, elbow joint, upper arm, and the end of the historic building heritage robot, etc. Because each component has specific parameter constraints, the pressure of Pro is better than 3 dsmax in practical applications. The model of the historic building heritage robot was completed in Pro/ compression, and the format of the historic building heritage robot was converted. Finally, it was imported into OpenGL.This method can not only quickly establish and improve the speed of simulation, but also effectively control and transform the real 3D building historic building heritage robot. First, a model of a part is built for each cell.In the process of graph generation, "part" and "entity" are selected first, and then the corresponding name is assigned to each part and the corresponding storage route is set [9-10].

2 Related works

Table 1 summarizes the literature reviews on real scene robot 3D visualization of historical architectural heritage based on big data objects.

Table 1: Summary of related works

Reference	Proposed method	Outcome	Advantage	Limitation
[11]	Integration of critical and creative approaches with augmented reality for digital cultural heritage preservation.	Increased interaction and engagement with locations of cultural heritage using realistic AR experiences.	Integrates modern technological developments with cultural heritage to enable a deeper understanding and enjoyment of it.	Depends mostly on technology infrastructure and the availability of appropriate devices, possibly eliminating some groups of people.
[12]	Integration of 3D sensor-fusion technology for documenting rural heritage buildings	improved performance correctness and comprehensiveness	Improved accuracy and efficiency of data collecting	Cost and technical know-how needed for installation and functioning
[13]	Comparative analysis of gaze patterns in 2D and 3D representation of architectural and heritage objects	Finding patterns in visual perception helps to improve comprehension of historical buildings.	insights about the interests and behavior of viewers	A narrow focus could leave out a variety of heritage situations.
[14]	Evaluation of AR in enhancing historical context experiences of 3D restored court paintings	AR improves comprehension and immersion for viewers.	Improved education and interaction with historical artwork	Reliance on augmented reality gadgets and technologies could limit accessibility
[15]	Integration of videogrammetry and V-SLAM technology for 3D heritage modeling.	improved realism and accuracy in 3D heritage modeling, which makes preservation and analysis easier.	A comprehensive approach that combines two cutting-edge technologies to accurately reflect heritage.	Scalability and accessibility may be constrained by a reliance on sophisticated machinery and processing.
[16]	Utilization of low-cost 3D scanning systems for cultural heritage documentation	Methods that are affordable for conserving and recording historical artifacts	affordability of heritage preservation instruments	Possible restrictions on the accuracy and resolution of scanning, particularly for fine details
[17]	Utilization of interactive 3D models for documenting and presenting restoration and use of heritage objects	Historical artifacts can be presented and preserved more easily with the use of immersive digital representations	Improved reach and interaction for public audiences as well as specialists	There may be high technical requirements for developing and maintaining interactive models.

The research gap identified in the summarized papers is the need for comprehensive investigations on the interoperability and standardization of digital technologies in historic documentation and presentation. While separate studies highlight many creative strategies, there is a lack of coherent research concentrating on the integration of multiple approaches to enable broader applicability and efficacy in protecting and displaying cultural property. The above concepts driving force of this study. This study aims to create a uniform structure that incorporates various digital technologies for the documentation and display of cultural assets, to improve accessibility and saving efficiency.

3 Research methods

Because the global deformation matrix of the historic building heritage robot is composed of the coupling relationship between the multiple variables of the hinge, it is usually difficult to use the global transformation matrix method to determine the value of each node. Figure 1 depicts the design drawing for the camera hole of the building real scene robot:

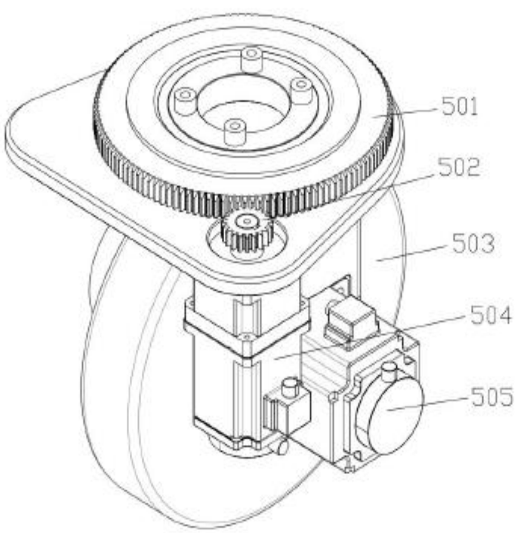

Figure 1: A design drawing of the camera hole on the building real scene robot.

The algorithm uses the reverse multiplication of the left side of the transformation matrix and the transformation matrix to exclude the coupling equation in the composite equation, and the numerical value of the nodes is found one by one for the corresponding cells (in Table 2).

Table 2: D-H parameters for the 3D historic building heritage robot

The joints	theta	d	a	alpha	The initial configuration theta Angle
1	θ_1	0	0	90	And the direction of the Angle,x90°
2	θ_2	0	a_2	0	The Angle between L2 and horizontal direction,90°
3	θ_3	0	a_3	90	The Angle between L3 and L2,0°
4	θ_4	d4	0	−90	x4 And the plumb line,0°
5	θ_5	0	0	90	And L4,0°
6	θ_6	0	0	0	x6 And the plumb line,0°

Since the Reinovo historic building heritage robot is a historic building heritage robot with six rotation axes, the angles of the six rotation joints are used as the joint variables of the historic building heritage robot: and the others are the joint length parameters.$\theta_1, \theta_2, \theta_3, \theta_4, \theta_3, \theta_6 a_2, a_3, d_4$Where, is.$d_4 179\text{mm}, a_2 = 260\text{mm}, a_3 = 235\text{mm}$. According to the principle of the D-H representation method, the change matrix from the brown coordinate system to the coordinate system can be obtained as, similarly, the change matrix of the adjacent coordinate system can be calculated as.$X_0 - Z_0 X_1 - Z_1 A_1 A_2, A_3 A_4 A_5$,A_6The expressions for these six-coordinate change matrices are as follows:

$$A_1 = \begin{bmatrix} C\theta_1 & 0 & S\theta_1 & 0 \\ S\theta_1 & 0 & -C\theta_1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

$$A_2 = \begin{bmatrix} C\theta_2 & -S\theta_2 & 0 & a_2 C\theta_2 \\ S\theta_2 & C\theta_2 & 0 & a_2 S\theta_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

$$A_3 = \begin{bmatrix} C\theta_3 & 0 & S\theta_3 & a_3 C\theta_3 \\ S\theta_3 & 0 & -C\theta_3 & a_3 S\theta_3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (3)$$

$$A_4 = \begin{bmatrix} C\theta_4 & 0 & -S\theta_4 & 0 \\ S\theta_4 & 0 & C\theta_4 & 0 \\ 0 & -1 & 0 & d_4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

$$A_5 = \begin{bmatrix} C\theta_5 & 0 & S\theta_5 & 0 \\ S\theta_5 & 0 & -C\theta_5 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (5)$$

$$A_6 = \begin{bmatrix} C\theta_6 & -S\theta_6 & 0 & 0 \\ S\theta_6 & C\theta_6 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (6)$$

The forward solution of historic building heritage robot kinematics is to find the position and attitude (represented by the total coordinate change matrix) of the historic building heritage robot (REN) under the premise of knowing the rotation angles of the six driving joints

Let the square sum of the above two equations, the following equation is obtained:

$$\left(c1p_x + s1p_y\right)^2 + {p_z}^2 + {a_2}^2 - 2c2\left(c1p_x + s1p_y\right)a_2 - 2s2p_z a_2 = {a_3}^2 + {d_4}^2 \quad (6)$$

Here, because the above has been concluded.

$$c1 = \pm \frac{p_x}{\sqrt{p_x^2 + {p_y}^2}}, s1 = \pm \frac{p_y}{\sqrt{p_x^2 + p_y^2}} \quad (7)$$

Reason. $\left(c1p_x + s1p_y\right)^2 = {p_x}^2 + {p_y}^2$ (8)

To:

$$c2\left(c1p_x + s1p_y\right) + s2p_z = \frac{{p_x}^2 + {p_y}^2 + {p_z}^2 + {a_2}^2 - {a_3}^2 - {d_4}^2}{2a_2} = k \quad (9)$$

It is concluded that

$$(2\text{-}10)\theta_2 = \tan^{-1}\left(\pm \frac{k}{\sqrt{{p_x}^2 + {p_y}^2 + {p_z}^2 - k^2}}\right) - \tan^{-1}\left(\frac{c1p_x + s1p_z}{p_z}\right) \quad (10)$$

Then let the and elements of the two matrices obtained by the formula be equal respectively, and c23 can be solved simultaneously:(1,4)(2,4)$s23$

$$\begin{cases} d_4 s23 + a_3 c23 + a_2 c2 = c1p_x + s1p_y \\ d_4 c23 + a_3 s23 + a_2 s2 = p_z \end{cases} \quad (11)$$

To:$s23 = \frac{a_3(p_z - a_2 s2) + d_4(a_2 c2 - p_x c1 - p_y s1)}{{a_3}^2 - {d_4}^2}$ (12)

$$c23 = \frac{a_3(p_x c1 + p_x s1 - a_2 c2) + d_4(a_2 s2 - p_z)}{{a_3}^2 - {d_4}^2} \quad (13)$$

The left =

$$\{\{n_x C_1 + n_y S_1, o_x C_1 + o_y S_1, a_x C_1 + a_y S_1, p_x C_1 + p_y S_1\}, \{n_z, o_z, a_z, p_z\}, \{-n_y C_1 + n_x S_1, -o_y C_1 + o_x S_1, -a_y C_1 + a_x S_1, -pyC_1 + p_x S_1\}, \{0,0,0,1\}\} \quad (14)$$

One of the key technologies of 3D architecture is to introduce vision technology based on traditional motion control technology to the historic building heritage robot. To explore the motion simulation of historic building heritage robots with visualization, this paper introduces it into virtual reality. The goal of three-dimensional architecture is to obtain the three-dimensional and spatial information of the target object by identifying and computing the image of the object before grasping the motion [18-21]. However, the acquired features of the object and the relationship with the corresponding position in the image, depend on the geometric modeling of the camera. There is a close relationship between the geometry of a photographic image and its parameters. Using experiments and calculation methods, we can obtain the performance of the camera carried by the 3D building real scene historic building heritage robot, that is, the camera calibration. Using the camera calibration technique, it is possible to measure the internal, external, and external parameters of the camera, which provides an experimental platform for the 3D positioning of captured objects. The grasp images of the left and right cameras obtained from the trials are processed to calculate the correct pose. This lays the foundation for the motion simulation of the manipulator in a virtual environment.

3.1 Principles of historic building heritage robot visualization

Machine vision is to use a variety of image means to replace the human eyes, the computer as the human brain to process and interpret. The ultimate goal of machine vision is to make computers have the same visual perception and self-adaptability as humans. Currently, it is widely concerned that visual perception ability and perception ability can achieve some specific functions at a certain level of intelligence.

The system mainly uses the camera to image the target, and then the image information is collected by the camera and then converted into digital images by the image acquisition board, and then analyzed by the computer. In the computer, the digital image will be processed and judged, and the computer will be right.

An image processing center is used to process digital signals. The system realizes the functions of image enhancement, noise suppression, and edge sharpening on the whole image, and the image is segmented, and the various aspects such as region and side length are extracted, and predefined (such as size, Angle, offset, etc.), to realize the automatic separation of the image.

Its essence is a 3D model-based acquisition model. The visual area of the 3D object is projected to the visualization device, and the computer makes stereo understanding according to the 2D image generated by the computer. The so-called "stereo cognition" is to transform the shape, size, distance, texture, and motion characteristics (direction and speed) of the observed object. The camera, drum, and so on are the input devices of mechanical vision, and the three-dimensional image is the input source of these visual input devices. If the stereoscopic image is converted to the planar stereoscopic image, which is regarded as the forward conversion, the two-dimensional image is converted to the stereoscopic objective stereoscopic image based on machine vision. Using this transformation method, the characteristics of the target object are extracted, and the corresponding actuator action can be driven by them. At the same time, the visual way can be used to guide.

Firstly, the external and external parameters of the left and right cameras were tested, and a test platform for collecting stereoscopic positioning data of images was built. This part is mainly to use the capture images of the left and right cameras collected in the test to process and calculate the correct pose of the capture object (grasp).

3.2 Chaos particle swarm optimization method is utilized to find the 2D maximum direct line of historic building heritage robot image

In the historic building heritage robot vision system, there are usually some specific parts involved, and to go from these specific and specific areas with special properties, it is necessary to classify them. In the process from image processing to image analysis, the optimal sub-threshold segmentation method is usually used to obtain more information as the starting point. The 2D maximum sub-threshold method is based on a binary column composed of the gray distribution of each pixel in the image and the average gray distribution in the region. Generally, it can achieve better segmentation results. In this part, the original experimental equipment is improved by using the binarization technology, and the hybrid optimization technology based on fuzzy clustering and threshold method is used to realize the internal uniformity of the region and the accurate division of the boundary shape. Figure 2 displays a robot foundation created using 3D modeling techniques and influenced by the concept of large data objects. This design visualizes how data might be represented in physical form in the context of robotics:

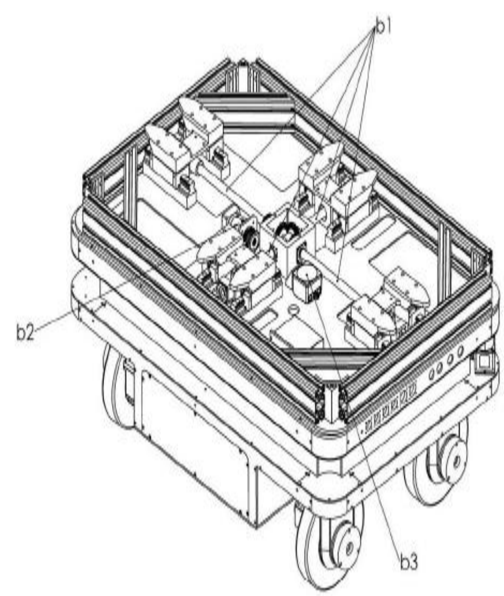

Figure 2: Robot base designed with 3D big data object modeling.

The simulation system uses a kinematics simulation module to simulate the forward and inverse kinematics of the historic building heritage robot. By giving the rotation Angle coordinates of the three hinges, the position relationship between the manipulator and the reference coordinates can be easily observed, so that the whole process of the manipulator moving from the standby position to the specified position, that is, the forward kinematics simulation of the manipulator is completed.

First of all, the rotation Angle information of the three hinges is entered, which is concerned with the moving distance of the historic building heritage robot and the position of the three hinges. When the mouse is clicked, a dialog box will appear, showing the Angle of the hinges, thus ensuring the accuracy of the input and the realism of the simulation. After completing the Angle data, click the forward motion simulation key, and the historic building heritage robot will display the Angle of the three hinges and the position of the grip in real-time according to the rotation direction of the three joints and the data of the rotation direction of the three joints. The simulation program is shown in the following chart:

The 2-D hybrid particle swarm optimization process is carried out in the following stages:

(1) Initialization: generate the initial population of variables according to the size of particle swarm M

$$X_{0;}(x_{01}, x_{0i2}), i = 1,2, \cdots, M \quad (15)$$

Inertia weight: acceleration coefficient as well as the most iterations that are permitted Gen: the starting position and speed of every particle, etc.

(2) in the range of gray level within 0-255 to a maximum of Di namely types the fitness function, namely to optimization, and to make the type can achievemaximum: st

(3) Compare the present fitness value (gen) of every particle with its unique historical, best fitness value (best), like fruitfp

$$f(gen) > p \quad (16)$$

Then pBest (gen), optimal position: Compare the current fitness value of all particles in the swarm with the global historical Best fitness value Best,

$$\text{if} tps = genf(gen)gf(gen) > g \quad (17)$$

The gBest= $f(gen), ps = gen$:

(4) Calculate the new velocity and position of each particle according to the following equation.

$$v = \omega v + c_1 r_1 (p\text{Best} \quad \text{Best} - x) + c_2 r_2 (g - x) x = x + v \quad (18)$$

Where and are random numbers between 0 and 1, respectively:$r_1 r_2$

To guarantee that the particles remain in the search space during the evolution phase, go back to (3) to do further particle swarm optimization calculations if a random number rand is defined as a value between 0 and 1: otherwise, enter the step to conduct chaos optimization search on the particles (indicating the first chaos search)

4 Result analysis

Table 3 displays the experimental setup component. In historic building heritage robotics, the simulation of historic building heritage robots is an increasingly important topic, in which the simulation of historic building heritage robot's three-dimensional motion is one of the key technologies. Currently, the simulation methods for historic building heritage robots are:

Table 3: Components for experimental setup

Experimental Setup Component	Description
Type of Data Used	Data regarding geometric and kinematic qualities, such as computer-aided design (CAD) models or digital depictions of historic buildings.
Robot's Movements	Kinematic properties that describe degrees of freedom, joint configurations, and operating limitations.
	Particular activities or situations, including manipulating objects or navigating through architectural structures, are replicated.
Data Analysis	entering kinematic and geometric data into simulation programs (AutoCAD, PRO/E, 3DSMAX, etc.).
	robot motion computation using preset algorithms (e.g., inverse or forward kinematics).
	gathering of simulation-related performance metrics (e.g., job completion time, collision avoidance, and path correctness).

4.1 Visualization of historic building heritage robot-aided design developed based on AutoCAD

Although it is capable of kinematic simulation, its interaction capability is weak, and its kinematic inversion capability is weak. It is not good for the expansion of the simulation system. Historic building heritage robot simulation based on AutoCAD and Matlab: Using the graphics processing technology of AutoCAD, a historic building heritage robot simulation system with high operation efficiency and good graphics display effect is implemented. However, because it is based on MATLAB, adding new features to the simulation is not easy to implement. Animation simulation of 3 DSMAX: Apply 3 DSMAX to dynamic simulation of historic building heritage robot.

The 3D MAx model of historical architectural heritage lacks some accurate positioning capabilities, which makes the real-time interaction ability and real-time performance of simulation need to be further improved. Dynamic Simulation Platform Based on Visua1C+ t and OpenGL [Rl: VC+ perfect base class library and the software can easily access OpenGL, and can well complete the interface of OpenGL, DXF, SLP and other image files. To compare the above two algorithms, this paper uses VC++ and OpenGL to develop a visual simulation platform for historic building heritage robot control simulation systems based on VC++ [22].

4.2 3D visualization of historic building heritage robots based on big data objects

(1) Using the modeling ability of OpenGL, but the 3D model is not real and not suitable for practical use. OpenGL is based on basic geometric elements and still has some shortcomings in building realistic and realistic historic building heritage robots.

(2) The current historic building heritage robot simulation system based on OpenGL can only introduce some simple CAD graphics, and it needs further exploration to support other standard models.

Therefore, the system is modeled in 3D using PRO/E simulation software. To solve the above problems, this paper designs a format conversion program of 3D solid modeling based on PRO/E and introduces the model into OpenGL which has strong rendering ability.

In this system, the historic building heritage robot body in PRO/E is divided into four modules, that is, the base, the lower arm, the upper arm, and the hands, and the four modules are reconstructed according to their coordinates (referring to D-H), which lays a certain theoretical basis for the future simulation work. (2) Kinematic simulation of the manipulator: in the movement, the hinge Angle information of the historic building heritage robot can be displayed in real-time, and after the terminal positioning of the historic building heritage robot is given, the simulation calculation is carried out, and finally the required position is reached.

(3) Implement the role of grasping block positioning and grasping: Using the image analysis in the previous chapter, the data of grasping block is entered into the historic building heritage robot simulation system and displayed on the simulation interface. Once the final positioning of the manipulator is determined, the fixed point can be grasped and reached. (4) Preliminary construction of simulation system: in the process of building the modeling of the historic building heritage robot, the environment simulation is discussed, so that it can dynamically observe from multiple perspectives.

To complete the above work, this paper uses VC+ technology as the development platform, the software is divided into two parts: key selection and dynamic demonstration.

The specific implementation process of the system is as follows: (1) Create a single file application using AppWizrd in MC. (2) In CMyView.cpp programming, use the Create function to generate the corresponding keys and text input/output space, to facilitate the selection and output of the simulation scheme.

In this chapter, this paper compares and analyzes the current common historic building heritage robot simulation technology, and on this basis, integrates the advantages of various software and hardware, and finally develops a whole simulation system. On this basis, the structure design and main functions of the system are mainly described. The core of the simulation system is the 3D building scene. Through processing the graphics of the virtual object, the geometric feature information of the object is input into the virtual instrument, to realize the simulation of grasping the object.

5 Discussion

The proposed simulation system greatly improves the accuracy and realism of historic building heritage robotics visualization, especially in tasks like grabbing and positioning, by integrating OpenGL with PRO/E simulation software. This development solves existing simulation approach constraints while also enhancing the viability and efficacy of historical architectural heritage protection initiatives. Although some kinematic modeling is possible with existing methods, realistic representations of historical structures are difficult to achieve and robust interaction features are frequently lacking. However, the proposed simulation system intends to overcome these obstacles by utilizing a combination of hardware and software innovations. It aims to improve the accuracy and usefulness of 3D visualization in the preservation of historical architectural heritage by the integration of diverse tools and approaches, providing academics and stakeholders with better accuracy and immersive experiences.

6 Conclusion

In summary, from the perspective of the maintenance and development of historic buildings, this paper has been widely used in robot kinematics, dynamics analysis and synthesis, trajectory planning, and off-line programming. In this paper, VC++ as the development platform, combined with Pro/E, OpenGL, and other technologies, developed a 3D virtual reality environment with high fidelity of the historical building real scene model. In this paper, the basic construction characteristics of 3D robots are studied, and the basic coordinates are determined on this basis. The 3D simulation program Pro/E based on the building real scene 3D, based on the construction characteristics of the building real scene 3D itself, built the building real scene 3D agent model. Using VC++ as the development platform, the dynamic simulation of the 3D visibility of the real scene of the building is carried out, including forward and inverse kinematics and experiments of robot grasping objects. The simulation system makes full use of the relevant theories of robot kinematics, verifies the accuracy of the analytical method of forward and inverse kinematics, and can get intuitive motion simulation, which lays a foundation for future robot education and scientific research work. These technologies have the potential to transform maintenance and development practices in historic building preservation by providing intuitive motion simulations and analytical insights.

Data Availability The data used to support the findings of this study are included in the article.

Conflicts of Interest The authors declare no conflicts of interest

Funding Statement

1: Co-construction Project of Guangzhou Philosophy and Social Science Planning Project "Research on the Influence of Ancestral Temple Culture in Guangdong Overseas Chinese Residence on the Path to Building an ASEAN Community of Common Destiny under Cultural Identity" (2022GZGJ313).

2: Characteristic Innovation Project of Guangdong Provincial Department of Education (2023ZDZX402) Study on Lingnan Cultural Heritage protection and rural development Path.

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