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# *Design and Implementation of the Internet of Things Virtual Art Exhibition Hall for Intelligent Computing*

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***Abstract:*** Since the rapid development of high-tech in modern society, the concept of virtual art museum has aroused extensive discussion in society. Although its application scope is not very wide at present, most exhibitions are still more inclined to physical exhibitions. However, the technology of virtual exhibitions is very mature at present, and some countries are gradually replacing physical exhibitions with virtual exhibitions, hoping to spread culture, better protect artworks, and reduce the consumption of artworks. However, virtual exhibitions generally have high technical requirements for designers, because the virtual exhibition covers the entire physical exhibition hall, and the psychological needs of the audience must also be considered. Therefore, the design and implementation of virtual art museums has always been a subject that many scholars like to study. Scholars have studied the design and implementation of virtual exhibitions from different perspectives, and the research reports obtained are also very close to reality. However, the application of intelligent computing to study virtual art museums is relatively rare, so in order to better achieve the effect of the design and implementation of virtual art museums, this study takes the virtual art museum model as an example to deeply discuss the design and implementation process of virtual art museums. The new problems and coping strategies faced in the art gallery, the method of intelligent computing is adopted, the design and implementation problems of the art museum are analyzed, and the collision detection and simulation prediction experiments are carried out. The results show that the intelligent algorithm in this paper is better than the original the collision detection algorithm improves the efficiency by about 10%-15%, and the larger the scale of the scene, the higher the improvement efficiency of the algorithm. And the average prediction model accuracy is 1.30, 1.36 and 1.29 percentage points higher than other models. This greatly improves the efficiency of creating virtual exhibition halls. Therefore, in order to promote the better development of virtual exhibition halls, the application of intelligent computing should be studied more fully.

## 1. Introduction

The virtual exhibition hall has appeared since the beginning of virtual technology. Its appearance allows the audience to see the exhibition of artworks on the Internet without having to go offline, and the experience is very real. The launch of this idea is mainly to allow the audience to have better contact with the exhibits by means of online interaction, and to allow audiences from different places to roam and simulate interaction in the museum. And this method is very fast and effective, and can be exhibited all over the world. At present, there are relatively few studies in this area in China, because the application of this concept is not very extensive. However, there are also practical cases that show that virtual exhibitions can effectively enhance the browsing experience of the audience, thereby increasing consumers' attention to artworks and increasing the popularity of artworks. In addition, the effect of virtual exhibitions is good, and it can reduce the cost of venues, reduce the consumption of artworks, and expand the influence of publicity. And intelligent computing refers to a branch of artificial intelligence, which can assist humans to deal with various problems. Therefore, this paper attempts to use artificial intelligence to study the design and implementation of virtual art exhibition halls, which may be able to obtain good results [1-2].

## 2. Approaches to Design and Realize a Virtual Art Gallery

### 2.1. Virtual Pavilion

Since the construction, maintenance and dissemination of physical exhibition halls are all limited by time, space, human and material resources, the unique interactivity and immersion of virtual reality technology make the construction of network virtual exhibition halls, virtual museums, virtual school history museums, virtual art galleries, etc, technical support [3]. The virtual exhibition hall is used to present things in reality or virtual space on the Internet, which is convenient for people to visit and exhibit across time and space. The comparison of various indicators between online virtual exhibition halls and physical exhibition halls is shown in Table 1.

Table 1: Comparison table between virtual and physical pavilions

| | Online virtual exhibition hall | Physical exhibition hall |
|---|---|---|
| characteristic | Display, educate, archive, research digitally | Physical display, education, collection, research |
| autonomy | User passive | User active type |
| convenience | With the Internet, any place can be accessed at any time | Tickets must be purchased at the destination to enter the exhibition |
| interactive | Interaction, games, extended information, etc | Interactive window environment control |
| Environmental control | A single interaction | Unable to control or change the environment |

As shown in Table 1, the establishment of a virtual pavilion can increase the initiative of users, so that visitors are no longer passively visiting and browsing, but can visit independently. And this type of pavilion does not need to go to the designated destination to buy admission tickets, no matter where, as long as there is a network, you can enter and participate in the browsing. In this way, the artworks in the exhibition can be appreciated by more people, and the way of visiting is also very convenient. In terms of interactivity, this exhibition hall can achieve a wide variety of interactions. In terms of environmental control, virtual ones can interact with windows for environmental control, but physical exhibition halls cannot do this. Therefore, the establishment of

virtual exhibition halls has many advantages. It can also improve the means of protecting works of art, so that more people have the opportunity to appreciate the works of art. It can also promote the dissemination of culture and facilitate the publicity of works of art [4]. However, building such a pavilion requires a lot of development work, and involves a wide range of disciplines. It needs to combine a lot of tools and languages, and the technical requirements for developers are also very high. Therefore, in order to solve the development problem of the virtual exhibition hall in the process of design and implementation, this paper proposes a scheme of applying intelligent computing, hoping to effectively solve the problem of exhibition hall development [5].

The functions of the virtual exhibition hall generally have five functions, as shown in Figure 1.

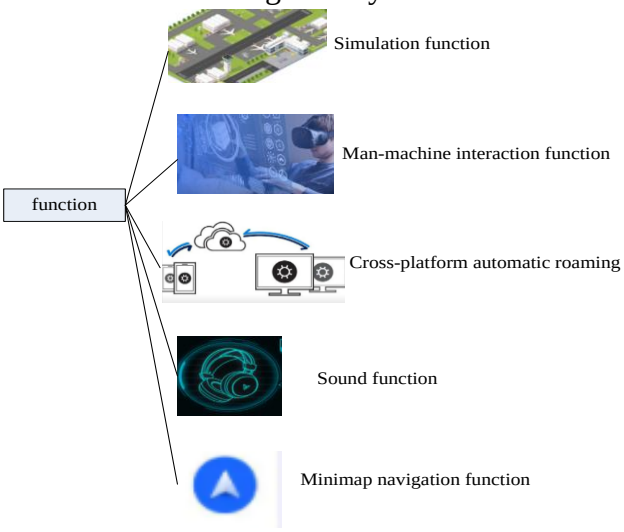


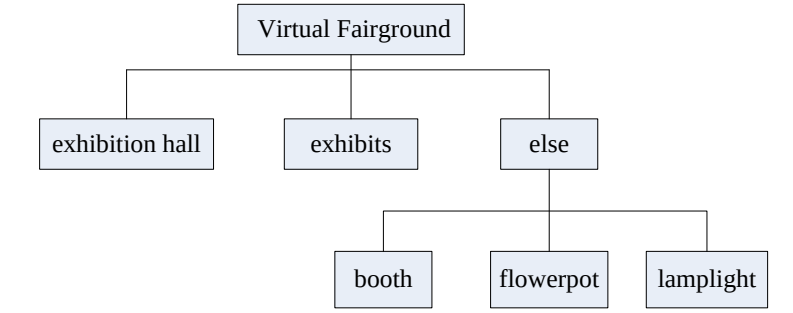

Figure 1: Features of the virtual exhibition hall

As shown in Figure 1, it has five functions. The first is the ability to simulate simulation. This feature is very important. This function can directly affect the success of the construction of the pavilion. Because it determines the sense of reality and immersion that the construction of the pavilion brings to the users. And the real simulation is carried out in some ways, so that users can have an immersive feeling when browsing. Therefore, users can truly integrate into the virtual exhibition hall and enjoy some artworks very relaxedly. The second feature is the cross-platform free roam feature. This feature is mainly that it enables users to enter browsing from different platforms. Moreover, users are not bound when browsing artworks in the museum, and can watch them more freely. The third function is the human-computer interaction function. This function describes the roaming operation that the user can use the keyboard and mouse. When viewing artworks, they can view it from different angles. They can get closer or farther away, and the viewing angle can be controlled. And when you click on the artwork, the relevant introduction instructions will appear. The fourth function is about the sound effect. This function mainly means that when the user performs a virtual scene, there will be corresponding background music, and the virtual character will generate corresponding sounds when walking or making explanatory actions. The fifth function is the map navigation function. It mainly says that the system will provide all users with a map navigation in the library. By viewing the map, the user can clearly know the overall layout of the pavilion and the location of the artwork. In this way, after users understand their location, they can easily find the location of the artwork they want to watch [6].

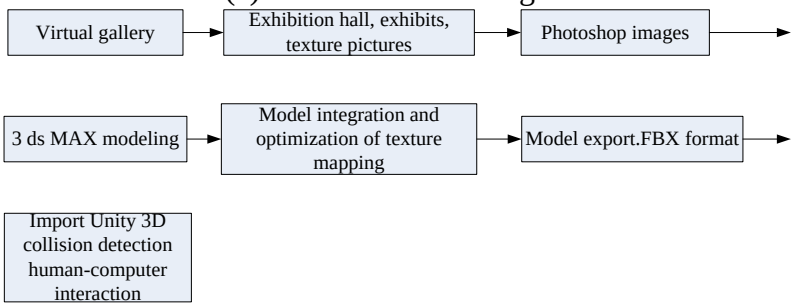
Generally speaking, all virtual exhibition hall layout models and the process of realizing virtual exhibitions are basically the same as shown in Figure 2.

As shown in Figure 2, it can be seen that the model of the pavilion layout is actually composed of three parts. The first part is the pavilion, that is, the 3D virtual modeling of the entire pavilion.

The second part is the exhibits, that is, works of art for people to appreciate. The third part is more complicated. It can be the lights in the museum, the style of the booth, or the flower pots in the museum. That is to say, the model of the pavilion is what the whole pavilion contains. The realization process of the virtual exhibition is to first take the texture pictures of the exhibits in the pavilion and the station, and then import the pictures into Photoshop to process these pictures, then model them, form the model integration and optimize the texture maps, and then export the model, and then you can carry out the human machine interacts. Instructions are also very important for the use of the software to create a virtual exhibit.




(a) Model structure diagram




(b) Implementation process

Figure 2: Exhibition hall layout model and the process of realizing virtual exhibition

## 2.2. 3ds Max Software

Through the survey, we also know what types of software are generally used to complete the construction of the pavilion. As shown in table 2.

Table 2: Development Platform and Running Software

| The serial number | Category name | The name of the software |
|---|---|---|
| 1 | Running operating system | PC:Win11 |
| | | The mobile terminal:Android 7.1.1 |
| 2 | Professional software required | Adobe Photoshop 15.0.1 |
| | | 3ds MAX 2020 |
| | | Unity 3D 4.3.4 |

As shown in Table 2, generally in the modeling process, the most commonly used software is 3ds Max software. Its functions are relatively powerful, it can do both three-dimensional and two-dimensional, and it is also very professional. It does not have very high operational requirements for users, and the interface is very simple. Its interface diagram on the client side is shown in Figure 3.

Figure 3 shows the interface of the latest version of this software, that is, the interface of the

2020 version. Compared with the previous version, it has done a lot of optimization, which is more convenient for designers to export models. The working process of this software is shown in Figure 4.

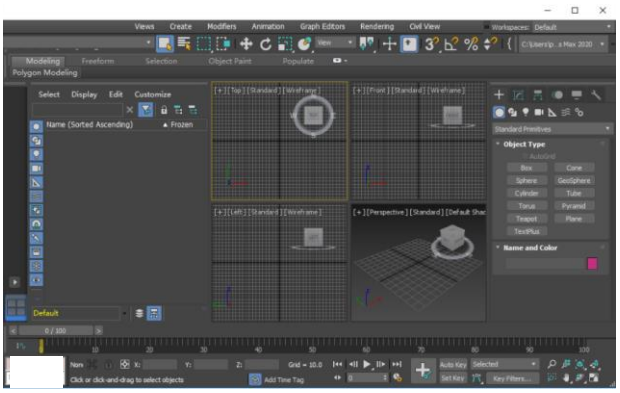


Figure 3: The main interface of the 3ds Max software

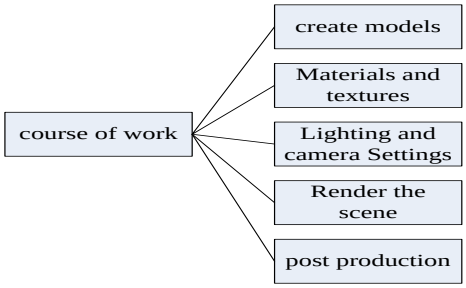



Figure 4: Software working process diagram

As shown in Figure 4, the working process of the software is mainly divided into five parts. The first step is to build the model first, you need to set the length of the model and then build the model. And there are many modeling methods in this software, and there are many commands in the main interface to implement modeling operations. Generally simple models can be implemented by applying some command buttons below the command panel. You can also draw your own drawings to create models. Complex models can be modified using this software, or other tools can be used to assist in the operation. The second part is materials and maps. It means that after the model is built, the appropriate texture can be used according to the type of model. Then use the material editor to design its material. The third part is the lighting and camera settings. Lighting is very important for virtual scenes, because when a beam of light hits the artwork, and the beam is right, the artwork will appear very real. Without the right light, the artwork might be displayed at a significant discount. This software can set a lot of lights, very practical. The camera represents the angle that the visitor is about to see, so the placement of the camera is also very important. The fourth part is about rendering the scene, that is, adding a little environmental effect to the virtual scene to make the scene more atmospheric. The fifth is post-production, which is the final refinement step. Because there may be some small problems in materials or lighting, it needs to be dealt with appropriately to solve these small problems.

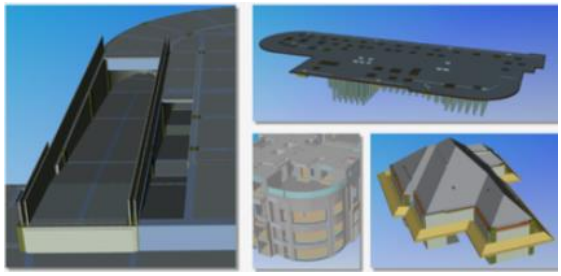
The application field of this software is also very extensive. As shown in Figure 5.

As shown in Figure 5, it can be found that the application fields of this software are very many. In the decoration design of the house, it can also achieve a very realistic one-to-one replica decoration effect, and can see the overall effect. In the production of film special effects, a lot of special effects can be achieved. These special effects make animation more appreciative and make animation no longer limited to two-dimensional effects. In engineering modeling, the visualization

of the model can also be achieved, which is more convenient for engineers' construction work. It can be seen that this software is very suitable for use as a construction tool for virtual exhibition halls.

(a) Modeling renderings

(b) Film special effects production



(c) Engineering model visualization

Figure 5: Application areas

## 2.3. Intelligent Computing

The concept of intelligent computing is relatively broad, but in general, it can be said to be a program with rich experience, computer thinking, and thinking. It is actually a part of artificial intelligence, and its main function is to help humans solve different kinds of problems, and these problems have the nature of independent thinking. Its characteristics are shown in Figure 6.

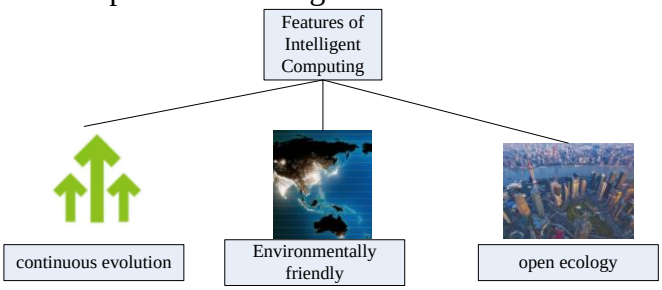



Figure 6: Characteristics of intelligent computing

As shown in Figure 6, the algorithm has three main features. The first feature is that of continuous evolution. It is to describe that this algorithm has a relatively intelligent self-management control function, and it has the ability to upgrade. That is to say, this algorithm is very adaptable, and can be continuously upgraded and updated with the progress of the times, dedicated to assisting human beings to solve problems. The second feature is that of being environmentally friendly. This feature mainly means that the algorithm can not be constrained by the location of the Geographical Environment Department, can be deployed anytime and anywhere, and can connect various work points very efficiently and conveniently. The third feature is an open ecosystem. Different from the literal meaning, this feature mainly refers to the fact that both upstream and downstream in the industry can participate in this algorithm. It has no personnel restrictions, is highly flexible, and is very inclusive. That is to say, this feature emphasizes the

relationship of mutual benefit and mutual benefit.

## 3. Experiments and Analysis of Designing and Realizing Virtual Art Exhibition Halls with Intelligent Computing

### 3.1. Design Development Strategy

The development strategy mainly refers to the development of the operating environment of the system, that is, the 3ds Max software mentioned above. There is also the construction of the model, which is the model structure diagram that appeared above. Finally, the rules that must be followed in the display of art works.

Below is the design of the display pavilion model and the exhibit model. As shown in Figure 7.

(a) Schematic diagram of the structure of the exhibition hall

(b) Schematic diagram of exhibits

Figure 7: Design of Pavilion Model and Exhibit Model

As shown in Figure 7, the design of the pavilion should refer to the physical art museum. According to the previously determined data, including the size of the room and the design of the space, etc., after the creation is completed, appropriate textures and posters are designed, and materials and textures are added. The exhibits need to use two-dimensional and three-dimensional production models, and finally verify whether there is a distinction between 3D and 2D models when generating panoramic roaming. For complex models, different levels of models need to be made, and the models are made with 3Dmax software. The texture of each model is to UV unfold and edit the model.

During the development and design process, the display of exhibits should also follow three principles, as shown in Figure 8.

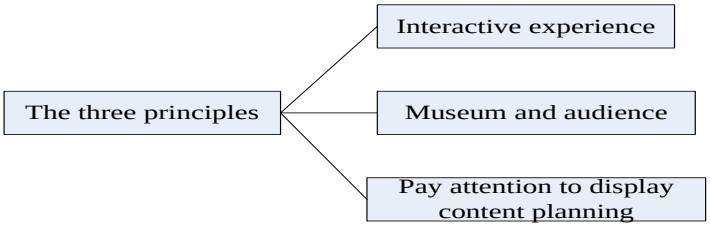



Figure 8: Principles for the display of exhibits

As shown in Figure 8, the principle of interactive experience should be followed when displaying artworks. That is to say, it is necessary to focus on the connotation of this art work. The location and orientation of the display will affect the connotative value of the artwork. Therefore, the work should be displayed according to the purpose, authenticity and scientificity that the work needs to be presented to the audience. Without exhibits, a pavilion cannot be called a pavilion to be browsed. Therefore, mining the connotative value of exhibits can effectively realize the design of virtual exhibition halls. And it should also be people-oriented. The display of the exhibition hall will also affect the attitude of the audience, and the audience can get information from the display. In fact, no matter in the virtual scene or the real pavilion, the audience has always feedback the existence of the whole pavilion. As a qualified exhibition hall, it should mobilize people's sense of participation, so that the audience can integrate into the exhibition hall. This display is not just a blind display of high-tech virtual technology, but also to spread meaningful information to the public. The audience is the main body of the exhibition, so we should study the audience in a more scientific way, serve the audience with a more humane attitude, and incorporate the audience's psychology into the design of the exhibition hall. We can divide audiences into three types. The first is the form of visit. Compared with the physical art museum, the virtual art museum saves the time of the audience. This also saves viewers' costs. The second is based on the psychological division of visitors, because the psychology of people who visit the exhibition is different, some may be for the study of art, and some are just for pure appreciation. These are the factors that lead to different psychology. Therefore, the psychological behavior of people is very worthy of attention for the design of the exhibition.

### 3.2. System Design Process

(1) Design virtual characters

In the design of virtual characters, two children with genders are considered as controllable characters. On the one hand, the cute image of the children is used to make people feel good. On the other hand, it can also attract young people to participate in the roaming of the virtual environment by substituting their identities, so that they can acquire relevant knowledge in interactive entertainment. The user can choose the gender of the character to be used. Since the scene loading analysis is required when entering, the prompt information and the display of the loading progress percentage are added in this link to inform the user of the waiting time.

(2) Help tips

When the user enters the 3D scene, a help prompt will automatically pop up to introduce the operation method of the 3D scene, so that the user can understand the operation method of the exhibition items and browse the exhibition items smoothly. After reading, the user can click the close button to close the help prompt box. The system provides two operation modes for the user to choose. The user can control the movement of the character in the virtual scene through "WASD", or double-click the ground with the mouse to control the user's movement. The default movement of the character is to walk slowly, and the user can switch the walking/running state of the character through the "R" key.

(3) Regional explanation and minimap guide

In the main blocks of the virtual scene, the regional guides (tour guides) are placed in appropriate positions. The guides will explain the different areas for the user according to the different areas, introduce the content of the art works, and display the subtitles synchronously. There will be a small map module in the lower right corner of the exhibition item, which is used to display the user's position in the virtual scene and the surrounding environment. With the "torch light" function to display the user's orientation, the user can clearly know where he is in the scene. Solve the trouble

of getting lost when you are not familiar with the virtual scene. In order to enable users to quickly reach the area they want to go, there is a quick jump button on the left side of the minimap, and the user can quickly jump to the specified area by clicking on the name of the area.

(4) Environment rendering

In order to increase the user's sense of integration when browsing the exhibition items, environmental sound effects are added for different areas. In addition, under the premise of not affecting the network performance, an image suitable for the style of artwork is added in an appropriate position to enrich the overall effect of the scene.

### 3.3. Design and Implementation Experiments Based on Intelligent Computing

For the intelligent algorithm in this paper, three objects A, B, C are tested for collision detection in two different scenes. There are two circular surfaces in scene 1, and each circular surface is composed of 3000 triangles. Scene 2 There are also two circular faces, one consisting of 3000 triangles and the other consisting of 15000 triangles. The experimental results are shown in Figure 9:

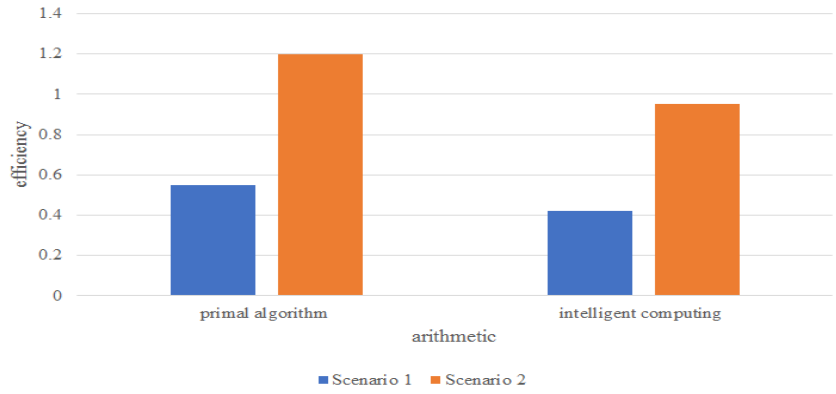



Figure 9: Objects A, B, C collide at the same time

It can be seen from the experimental results that the intelligent algorithm in this paper is about 10%-15% more efficient than the original collision detection algorithm, and the larger the scene scale, the higher the improvement efficiency of the algorithm.

In order to verify that the detection efficiency of the intelligent algorithm in this paper is higher than other algorithms, the cost of constructing art works of each algorithm is compared as shown in Table 3.

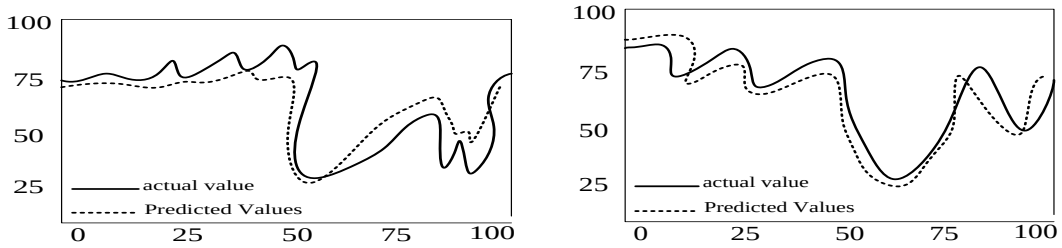
Table 3: Cost of constructing a work of art

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| intelligent computing | 0.005 | 0.203 | 9.005 |
| primal algorithm | 0.018 | 0.417 | 17.89 |
| Difference | 0.013 | 0.214 | 8.885 |

As can be seen from Table 3, the original algorithm has the shortest construction time, but the tightness is poor, especially for the detection objects with irregular structure, this method will leave a large gap in the corners, thus increasing the workload of collision detection. When the detected object is extremely complex, its detection time will also increase. The algorithm in this paper has the smallest overhead, the best compactness, and the shortest time for constructing art works. Combined with the cost function, it can be seen that the overall cost is the smallest. The intelligent algorithm proposed in this paper. Through experiments and verification results, it is proved that it can greatly improve the efficiency of collision detection, and when used in virtual scenes, it will

save time and space costs.

Then, in order to verify the effective predictive effect of intelligent computing in the design and implementation process, a model simulation experiment using the algorithm was carried out. To ensure the accuracy of the experiments, we conducted two experiments. The experimental results are shown in Figure 10.




(a) The first experiment (b) Second experiment

Figure 10: Simulation results

As shown in Figure 10, it can be found that the error of the predicted value based on intelligent calculation is smaller than that of the single model, and it has a better fit with the actual load curve. Experiments show that the prediction model based on intelligent computing has a relatively good prediction effect in the prediction of virtual exhibition halls. And the average accuracy of the prediction model is 1.30, 1.36 and 1.29 percentage points higher. It can be seen that the combined model is based on the maximum information utilization, and integrates the information contained in a variety of single models to improve the prediction results.

After completing the construction and development of the online pavilion, in order to check whether the system has design and functional defects based on intelligent computing, it is necessary to test the system. The test is mainly to check whether the website meets the needs of the customer and whether there will be program errors or other problems during the operation. The test results of the main page are shown in Table 4.

Table 4: Test results for the main page

| serial number | The name of the function | function declaration | test result |
|---|---|---|---|
| 1 | Home page | Click the gallery exhibition to enter the home page | Yes |
| 2 | Map button animation | Mouse over the map button to appear the corresponding options | Yes |
| 3 | Go to each page | Click on the map I Niuniu can enter the page | Yes |
| 4 | Tool Introduction Loading | Click on the tool to display it | Yes |
| 5 | Return to main page | Click on the home page | Yes |

As shown in Table 4, we mainly detect five main features. All functions of the system are running very smoothly. Different pages can be accessed through different buttons. This shows that the use of intelligent computing is very beneficial to the operation of the virtual exhibition hall system.

In order to detect whether the virtual scene function based on intelligent computing can meet the requirements of the exhibition items and meet the customer's requirements for the restoration of the museum, it is necessary to test the virtual scene. The test results are shown in Table 5.

As can be seen from Table 5, the functions of this system test are correctly implemented according to the customer's requirements. The coverage of the test function meets the functional requirements. The key functional tests of the project are all correctly implemented. Browser

compatibility testing is done correctly. From the effect shown in the table, this system can achieve a high degree of restoration, and the human-computer interaction has been very successful in this aspect, which can make the audience feel immersive, which is the ultimate purpose of designing the virtual exhibition. And through the blessing of intelligent computing, the operation of all aspects of the software and hardware of the system is within the controllable range. The work level is very stable. Therefore, it can be shown that the application of intelligent computing is very helpful for the design and implementation of virtual art museums, and improves the efficiency of design and implementation.

Table 5: Testing of Virtual Scenarios

| serial number | The name of the function | function declaration | test result |
|---|---|---|---|
| 1 | Virtual Scene home page | Click virtual Scene to enter the login information | Yes |
| 2 | User Login Information | Example Create user login information | Yes |
| 3 | Character creation | Select role | Yes |
| 4 | Distribution of load | Get into the scene quickly | Yes |
| 5 | To help illustrate | Help Instructions | Yes |

## 4. Conclusions

This paper studies and analyzes virtual art exhibition halls through intelligent computing, and concludes that the application of intelligent computing is very helpful to the design and development of virtual art museums, improving the efficiency of design and implementation of models, and also in prediction and detection models. Therefore, in the process of building a virtual art museum, intelligent computing can be used to assist designers in solving problems encountered in designing and implementing models make the final result better. However, due to the limited space of the article, there is no way to discuss more, nor can it cover all aspects. There are few cases used in the research process, which is also the limitation of this paper. In the future, the author looks forward to using more real data to conduct deeper research, so as to discover more methods that can help design and implement virtual art museums.

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