Development and design of three-dimensional display system of visual design works based on virtual reality technology

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Abstract. Exhibition design involves many fields, including many disciplines, such as design psychology, visual communication, ergonomics, etc. Therefore, there are many factors to be considered in the design process, that is, to transform ideological intentions, display information and design views into images that can be received visually. Virtual reality technology is a computer simulation technology that can create and experience a virtual world. It uses computers to generate an interactive 3D dynamic scene, and the simulation system of its physical behavior can immerse users in the environment. In this paper, the 3D model is combined with the physical image, and the visual design works are displayed in a virtual way by using Cult3D technology and virtual reality, so that the visual design works and their scene environment to be displayed can be better presented to users in 3D form, and the realism and visual beauty in the process of product browsing experience can be enhanced through humanized interactive design and artistic interface design. In the development process of the three-dimensional display system of visual design works, the cost accounting and the actual operation effect of the system have been considered, which has met the actual needs of users and has certain theoretical and practical value.

Keywords: Virtual reality; Visual design; Three-dimensional display system; Virtual display of products

1. Introduction
In recent years, stereo vision has been developed in computer vision and other fields. The purpose of stereo vision is to reconstruct the three-dimensional geometric information of the scene, and through the visual representation of the scene, make users observe and understand the products from various angles, and realize the direct interaction between users and this environment [1]. The application of virtual display technology to the physical display of visual design works can spread to the eyes of users through convenient Internet systems. On the one hand, users can fully recognize visual design works, observe the overall effect and details of visual design works by dragging the mouse, and introduce the manpower, time and space cost of physical display of visual design works through computer and network technology [2-3].

Since the development of display design, there are not many specialized researches on visual process design. Therefore, we choose this topic to study, hoping to find out how to make the visual process design of display more formal aesthetic feeling, exert its own functions, attract audience,
spread display information, arouse audience's emotional resonance, impress display content and improve the influence of display design.

A good display design can powerfully spread display information, leave a deep impression on visitors, and achieve the purpose of display, whether it is to spread culture, mourn martyrs, carry forward tradition or attract consumption, and increase commercial benefits [4]. In this paper, a three-dimensional display system of visual design works based on virtual reality technology is constructed, which combines the spatial color optimization structure deployment and color feature decomposition of visual design works to carry out three-dimensional visual matching of visual design works, and adopts distributed three-dimensional visual reconstruction method to carry out three-dimensional design of visual design works. This cross-time display mode is a brand-new change mode, which has a good driving and demonstration effect on the informationization and technological development of other industries.

2. Virtual reality technology
Virtual realization technology is a special technology inherited from artificial intelligence, computer graphics, network technology and multimedia technology, which can be regarded as a user-oriented interface fundamentally. People can embody different contents in the virtual world through this technology, and the simulation of objects in the real world by computers provides people with realistic perception of the world.

Graphics processing is divided into static automatic system and dynamic interactive system. In the static automatic system, the system draws images according to some key data provided. In this way, some images may be drawn inaccurately. However, in the static automatic system, the drawn images cannot be modified, but can only be modified manually. Dynamic interactive system can dynamically process images, and editors can modify and adjust images in the editing window until the images are satisfactory. The current image processing system uses dynamic interactive image processing mode [5].

Virtual reality technology integrates computer graphics technology, computer simulation technology, sensor technology, display technology and other scientific technologies. It creates a virtual information environment in multidimensional information space, which can make users feel immersive and have perfect interaction ability with the environment, and help inspire ideas. Immersion, interaction and conception are the three basic characteristics of VR environment system, and the core of virtual technology is modeling and simulation.

3. Function of three-dimensional display system for visual design works
The visual design work design display system can realize interaction, expansion and visual data display, and can embody the contents related to visual design work design in a concentrated way. Through the import and analysis of product data, it can shape the change effect of products in all directions, and reasonably evaluate the feasibility and visual display effect of visual design work design [6]. The functional structure of the system is shown in Figure 1.

![Figure 1 System functional structure diagram](image)

(1) System management module
The system management module ensures the performance of data display nodes, controllable nodes
and network communication equipment of visual design works by determining the system equipment framework, and meets the needs of three-dimensional virtual display of visual design works; Distribution and management of product data server nodes for 3D virtual display, regulation and management of network resources and system equipment, etc. [7].

(2) Product three-dimensional rendering module

Visual design works rendering module can realize 3D dynamic rendering and real-time interaction of 3D virtual architecture model of products, dynamic rendering of super-resolution pictures, and support visualization and interactive operation of visual design works data. The editors involved mainly include product 3D structure simulation editor, visual effect editor and scene editor [8].

(3) Scene interaction and splicing presentation module

The scene interaction and mosaic presentation module of the virtual display system is mainly used to deal with the problems of unmatched interfaces or incompatible structures of different adapters and significant differences in event responses in the rendering stage of mosaic display units [6]. The interactive engine is mainly used to enhance the visual interaction of various module links. In order to adapt to more types of visual design works, virtual display is carried out in the 3D virtual display system, and different types of interfaces are developed to realize the data conversion of visual design works.

(4) Product information management module

The module includes the necessary functions such as user management, product intellectual property management, product inventory management and product quick query.

4. Implementation of key system technologies

4.1. System scene design

Visual design works display is a professional display with specific works as the information carrier and high-efficiency information transmission as the fundamental purpose. Facing the specific crowd in the specific site space, combined with the product function, technology, artistic image and cultural connotation, the two-way information release, transmission, reception and feedback are carried out by mobilizing visitors' visual, auditory and tactile recognition systems [9].

When the 3D animation simulation display module is oriented to production, it can display the effect diagram of socks design results in advance through 2D design software and 3D rendering software, and determine the pattern and coordinate information, which can achieve the purpose of shortening the "design-production" cycle of products.

In the design and application of three-dimensional animation simulation display, PS software, rhino three-dimensional surface modeling software and keyshot three-dimensional rendering software are selected; In application, firstly, a three-dimensional model of simulated visual design works is established, and the three-dimensional visual design works model is imported into keyshot three-dimensional rendering software for real-time rendering; Import the drawn design drawing into rhino imported into keyshot in advance, and adjust the UV coordinates of PS map to make the design drawing fit the 3D model completely. The process is shown in Figure 2. The animation can be output by adjusting the model action, and the animation can also be edited by premiere editing software and put into the display system.

The three-dimensional display system of visual design works is a system that realizes the collocation of concrete works and the virtual display of three-dimensional effects in different scenes. Through virtual display, customers can feel the three-dimensional layout effect of visual design works, so as to meet customers' personalized needs and stimulate shopping desire. This system divides the display system into different scenes according to the different types of visual design works in different space environments. In order to let users enter different scenes, they can not only feel the difference of different environments, but also clearly understand the environment decoration of visual design works, and have an immersive feeling. The following problems should be paid attention to when designing the display scenes in this system.
First of all, we need to pay attention to the placement of visual design works in different scenes, and how to match all kinds of visual design works together, so that they show the overall beautiful effect and have a sense of reality. At this time, it is necessary to carry out necessary operations, such as processing the image to a certain extent, and paying attention to the material map and lighting settings when building the model, so as to make it closer to the real object in the real scene.

Secondly, in order to make the visual design work show its own style and characteristics, it is necessary to control the appearance of each model except the visual design work model to set off the overall effect of the visual design work [10].

4.2. Visual optimization of distributed three-dimensional visual design

(1) Information fusion

On the grid model matching point, the information enhancement processing of distributed 3D visual work design image is carried out [11], and the associated scale information component of distributed 3D visual design work design image is expressed as:

\[
\left\{ \begin{array}{c}
\tau_{\mu}(\mu, \tilde{\mu})_{\phi_0} \\
\|\tau_{\mu}(\mu, \tilde{\mu})_{\phi_0}
\end{array} \right. = \left\{ \begin{array}{c}
\tau_{\mu}(\tilde{\mu})_{\phi_0} \\
\|\tau_{\mu}(\tilde{\mu})_{\phi_0}
\end{array} \right.
\]

Using regular pixel feature decomposition technology, the adaptive pixel fusion of visual images of distributed three-dimensional visual works design is carried out through template matching results [12], and the output is:

\[
\frac{\partial}{\partial d} \left( \tau_{\mu}(\mu, \tilde{\mu})_{\phi_0} \right) = \frac{\tau_{\mu}(\mu, \tilde{\mu})_{\phi_0}}{\|\tau_{\mu}(\mu, \tilde{\mu})_{\phi_0}\|}
\]

\[
\left( \left. \tau_{\mu}(\mu, \tilde{\mu})_{\phi_0} \right| \tau_{\mu}(\mu, \tilde{\mu})_{\phi_0} \right) = \left( \left. \tau_{\mu}(\mu, \tilde{\mu})_{\phi_0} \right| \tau_{\mu}(\mu, \tilde{\mu})_{\phi_0} \right)
\]

(2)
In the formula, \( \| r_d u \|_{\rho_g} \) represents merging texel sets, and adopts gradient operation method for feature decomposition, so as to realize the regional positioning and spatial distributed reconstruction processing of distributed 3D visual work design visual images [13].

(2) Optimal combination of color features

Using the edge pixel matching method, the texture segmentation area of the distributed 3D visual work design visual image between pixels is as follows:

\[
G = \sum_{r=1}^{t} \sum_{q=1}^{k} W_r^T x_r - W_r^T x_{rq}^2 \| B_{rq} = tr(W_r^T H_r W_r) \tag{3}
\]

In which,

\[
H_r = \sum_{r=1}^{t} \sum_{q=1}^{k} (x_{r} - x_{rq})(x_{r} - x_{rq})^T B_{rq} \tag{4}
\]

Representing the characteristic values of grid regions reconstructed in different 3D vision, combining pixel region segmentation and adaptive feature matching method, the color feature optimization combination and design optimization of distributed 3D vision works design are realized.

4.3. Design of data source for virtual display of visual design works

In this system, Access database is used as the system database. The way and content of adding 3D data of visual design works in the system are different from those of other materials. It is necessary to double set the data of 3D objects in Cult3D, and set the coordinates of 3D model and three basic data of length, width and height in the system.

Photoshop has a powerful image processing function, which can make various transformations such as zooming, rotating, tilting, mirroring, perspective, etc., copy, remove spots, modify image damage, etc., adjust and correct the color of the image conveniently and quickly, and switch different colors to meet the application of the image in different environments. Therefore, this paper chooses Photoshop for image processing.

In the system, it is necessary to create a separate template for each individual visual design work entity, and the entity modification of the visual design work is completed in the template. The visual design work template can be added in the Cult3D project, and the model can be modified separately when entering the template model. This modification method does not change the scene and other matching entity materials, but the scene is modified by a separate module, which is similar to the production of flash. Visual design template can be added to any scene and can be copied many times.

4.4. Loading technology

"Loading" is the preloading of animation, which is called preloading picture in Flash. This 3D display system applies a large number of materials with large files, such as AS sample pictures of wooden doors, background music of the display system, video materials, etc. In order to achieve smooth playing of animation, it is necessary to use "AS" sentence technology to complete the realization of "loading" technology.

Through film editing, make the animation progress bar effect of loading. Create a new movie clip "mc", name it "myloading", enter the editing area of movie clip "myloading", and draw a progress bar with rectangle tool. Insert a key frame at 100 frames, return to the first frame of the movie clip "myloading", use the deformation tool, change the center point of the progress bar, place it on the leftmost side, and change it into a dot. Create a shape gradient between frame 1 and frame 100. Create a new layer in the editing area of the movie clip "myloading" and make the outline of the progress bar.

Back to the main scene, open the library panel, drag and drop the movie clip "myloading" to the first frame of layer 1, and extend the second frame. Click the movie clip in the scene and fill in the instance name "myloading" in the property panel.

Create a new layer in the main scene and name it as. Insert a blank keyframe at frame 2 of the "as"
layer. Add the "as" statement in the first frame and the second frame of the "as" layer as follows:

Frame 1:
```javascript
a=getBytesLoaded();
b=getBytesTotal();
loaded=int(a/b*100);
myloading. gotoAndPlay( loaded );
```

Frame 2:
```javascript
if (a==b) {
gotoAndPlay("Scenario 1", 1);
} else {
gotoAndPlay(1);
}
```

Open the scene panel and rename the current "Scene 1" as "loading". And put the "loading" scene at the front of all scenes, and the application of the preloaded picture technology can ensure that the animation demonstration of the 3D display system is smoother.

5. Test and test analysis

The visual image sampling sample set of distributed 3D visual work design image is 1 500, the size of 3D visual block area is 266 × 266 × 234, and the matching coefficient of normative template features for indoor 3D design is 0.15. The virtual visual simulation program is used for distributed 3D interior design, and the design results are shown in Figure 3.

![Figure 3 3D interior design renderings](image3)

Combined with the 3D point cloud feature recombination method, the color space reconstruction of distributed 3D visual works design is realized, and the color feature optimization combination of distributed 3D visual works design is realized. The information fusion result is shown in Figure 4.

![Figure 4 Image color information fusion results](image4)

**Table 1** Performance comparison test

| Way                    | Normalized root mean square error | Time overhead /s | Information saturation |
|------------------------|----------------------------------|------------------|------------------------|
| This method            | 0.022                            | 20.281           | 0.833                  |
| Traditional manual design method | 0.228                            | 117.640          | 0.662                  |

According to the color information fusion results in Figure 4, the design optimization of distributed 3D visual works is realized, and the normalized root mean square error and time cost of the design are
tested. The comparison results are shown in Table 1. The analysis shows that this method has good visual effect and strong feature expression ability in distributed 3D visual works design.

6. Conclusion
With the development and progress of modern society, it brings infinite possibilities to the progress of design. Especially in the Internet age, more and more innovative products are integrated into our lives, which provides a certain degree of comfort and efficiency for our lives. In this paper, based on virtual reality technology, we analyze the relationships among the links of the three-dimensional display system, establish the structure, functions and specific development methods of the three-dimensional display system, and make a comprehensive overall design for the three-dimensional display system of visual design works. Through the arrangement of scene 3D modeling method, interface interactive realization technology and image processing technology, the 3D display system of visual design works is realized, and the original design idea is verified by testing. Compared with the traditional product display system, the display system designed in this paper has a faster refresh rate, which can effectively avoid the sense of delay. The system runs smoothly and has a better running effect.

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