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The application of interactive technology in interior design and its promotion of art and design innovation

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Abstract This paper starts from the reality of the interior design industry, combines the characteristics and system of VR technology to elaborate in detail, starts from the interior design process, takes several projects interior design as an example, compares the traditional interior scheme design method with the interior scheme design method under VR technology, and summarizes the innovation of the VR technology in the interior scheme to the art design. Compared with the typical scheduling algorithms FCFS and SJF, the A* algorithm proposed in this paper has better execution efficiency, with the average response time and waiting time in the interval of 0~0.3 and 0~0.6, respectively. The user interaction related indexes have high scores, all of them are not less than 6 points. Comparing with two traditional interior design methods, the interior program design method under VR technology improves the overall visual effect of the interior space, with the overall visual effect exceeding 80% in both cases. It can also change the thinking and approach of traditional design to create a different emotional design of interior space.

Index Terms VR technology, A* algorithm, interior design, visual effect, spatial emotionalization

I. Introduction

Scientific and technological progress has brought us into an era of full informationization, and computer networks are widely used in various fields of production and life. Modern interior design, as an emerging popular industry, is constantly trying to update itself in terms of design means, information exchange and expression presentation, and a large number of scientific and technological elements have been introduced to attract the consumer groups, which is the most prominent and intense innovation in the way of presentation of residential design [1]-[4]. The traditional residential interior design process is complicated and the presentation method is single. For designers, there are barriers to professional communication with customers, and for non-professional customers, they can not intuitively feel the essence of the design, and ultimately it is difficult to achieve the desired results [5], [6]. With the development of network technology and the improvement of computer graphics processing capabilities, prompting the combination of graphics and network technology, virtual reality technology is an important product of this combination. Based on virtual reality technology to build open interactive interior design application system, using gesture recognition, voice recognition combined with modular 3d engine, can realize the combination of art design and science and technology, so that customers can feel the interior and housing environment immersive, through the virtual environment interactively transfer design information [7]-[10].

Virtual reality technology mainly refers to the use of computer processing technology, interactive device technology, digital imaging technology and digital audio technology and other technical methods, the role of the audience's visual, auditory, tactile and other perceptual functions, so that the audience is immersed in a digital virtual environment to produce a corresponding real environment feeling of an art form [11], [12]. The application of virtual reality technology in interior art design can effectively display the content of the design to be embodied vividly, creating an easy-to-conceptualize design space for the designer, thus making the design work to transform the static art into a dynamic art that can be explored, so that it comes to release itself in the virtual space [13]-[15].

The use of virtual reality technology in interior design can focus on bringing the immersive and interactive features of virtual reality technology into full play. It enriches the form of expression of interior design, and the relationship between interior design and virtual reality technology is mutual influence and mutual promotion.Doktah, M. N. A et al. pooled and analyzed the Scopus database of studies related to virtual reality technology empowering interior design, affirmed the potential of the existence of virtual reality technology in interior design, and concluded that virtual reality technology tools will become the interior designers' left arm in the future [16]. Wang, M et al. conceived a VR 3D modeling strategy with fuzzy c-mean clustering (FCM) as the underlying architecture, which can assist the realization of interior design solutions based on VR distributed technology, and the proposed algorithm for VR 3D modeling strategy has good overall convergence performance and global search capability [17]. Sokienah, Y. Y et

al. based on block Chain technology in interior architecture application report analysis, pointed out that blockchain technology effectively enhances the level of collaboration and environmental sustainability in the process of transforming interior design and architectural practices, and finally looked forward to the integration and practice of cutting-edge technology with the built environment industry [18]. Strand, I examined how VR technology can play a role in the fields of architecture, interior design, and engineering design, and focused on analyzing the advantages and challenges brought by VR technology, such as assisting the complexity of complex 3D modeling, and the need to improve the performance of VR technology [19]. Kazeem, K. O et al. illustrated the case study and research analysis of the practice of VR technology and digital twin technology in the construction industry, and concluded that the digital technology led by VR technology and digital twin technology effectively improves the construction process of the site and ensures the safety of the site practitioners [20].

With the rapid development of modernization, interior art designers design interior art through design elements such as color and texture to make it more expressive. Yang, Y et al. introduced the concept of environmental art design, which originated from the design and decoration of interiors, and summarized the research and analysis about environmental art design related to the design of interior art and concluded that in the field of China's environmental design, the design culture has a uniqueness and locality [21]. Peters, O. R et al. systematically summarized the practice of combining art and architecture and the correlation between the two, pointed out that art design plays an active role in architectural design, and advocated that architectural designers should enhance their artistic cultivation [22]. Ko, H. K et al. combined the method of interview research and the method of literature review, revealing that the large-scale text-to-graphic generation model (ltgm) helps visual artists to expand their thinking and helps to automate the creative process [23]. Bertelsen, L et al. reviewed the performance of AI technology empowering the art field and provided a comprehensive and in-depth analysis of three types of AI art, which involves the concept of AI art methodology, AI art design capabilities, etc [24].

This paper points out that the core of VR technology used in interior decoration is the model building and interaction design, using 3D to build 3D models, and building virtual scenes in Unity3D to complete the interaction design and visualization expression. Sort out the design and operation steps in the process of project production, and organize the operation methods of modeling method and interaction. Summarize the design process of interior scheme based on VR technology. Using VR technology in interior scheme design, take a building interior design as an example, through the scheme design as an example, to carry out the preliminary realization of VR technology in interior design of user interaction mode of innovation. And the elements of interior decoration materials, interior furniture, interior decorations, interior colors, interior lighting design and interior plants and greenery are discussed in detail. The applicability of interactive VR technology to the emotional design of interior space is illustrated from the user's perspective.

II. VR technology in interior design process construction

In the virtual scene, roaming technology can be divided into two kinds, interactive roaming technology, this way through the mouse, keyboard or other input devices to realize. Users can change the direction of the line of sight or the position of the point of view in the virtual scene according to their own ideas to observe and tour the virtual scene. Interior design is the unification of functional design and aesthetic design. It combines engineering technology, lifestyle, visual art, etc. It is a mutual combination of technology and art, practicality and aesthetics. Interior design is human-centered and starts from human needs. Therefore, the design is customized for the client. In order to achieve the customer's needs, the designer and the customer need to communicate constantly, resulting in the design program needs to be revised many times.

II. A.Interior Decoration Business Processes

Design preparation stage: including accepting the owner's commission, clarifying the content and requirements of the design, understanding the function of the use, design scale, design style, total cost of the project, etc. Determine the time and progress of the design, site survey data, and so on. Program design stage: according to the preliminary communication, combined with the relevant design materials, complete the preliminary sketch design. A and B discuss the preliminary design, and then through in-depth design, program comparison, to complete the final program design. Construction Drawing Design Stage: Drawing of construction drawings, including indoor layout, ceiling layout, indoor elevation, node structure, detail drawings, equipment piping diagrams, preparation of construction budgets and other content. Design implementation stage: also called the construction stage, through effective communication between designers and technicians, according to the requirements of the drawings, using a variety of materials, technology, equipment for the construction of the project. After the construction is completed, the quality of the construction is accepted before it is finally delivered to the owner.

II. B.Interior Programming Process

The program design stage is the fundamental of the whole design. The interior decoration scheme includes CAD drawing design scheme, computer three-dimensional model design, effect drawing out, and finally the design scheme shown to the customer. Interior program production process includes four aspects of hard furnishing design, soft furnishing design, visualization design, aesthetic design, interior program production process shown in Figure 1. Hard furnishing design needs to be the actual survey in the early stage, record all the dimensions of the space. Sketch program design part includes hand-drawn sketches, sketches, the entire design program for preliminary planning. Space planning such as personnel use analysis, space zoning, functional needs analysis, this part is done through CAD drawing. The modeling part is mainly done in 3dsMax. Water and electricity design belongs to the hidden works, which should be fully considered in the program design. Soft furnishings, including furniture, curtains, decorative components, etc., for the material texture mapping is particularly important, mainly play a role in beautifying the space. Visualization design from the overall layout, such as from the choice of furniture, materials, home decoration items with the design of lighting and so on. Beautification design is from 3dsMax out of the map, and finally use Photoshop processing to get.

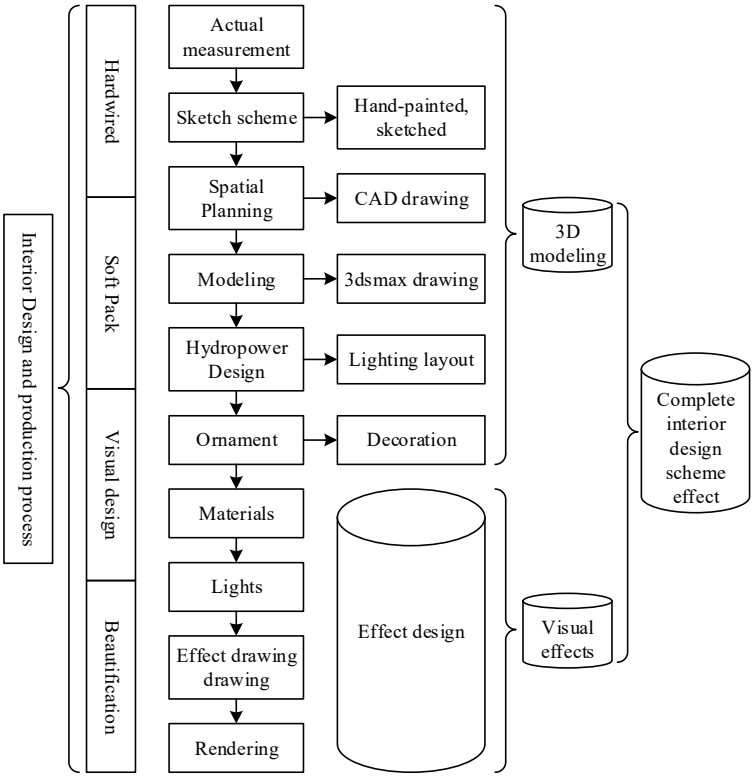

Figure 1: Interior plan process

II. C.Implementation of 3D modeling for VR interactive interior decoration display system

The realization of 3D modeling of VR interactive interior decoration display system 3D scene modeling is an important part of the VR interactive interior decoration display system, is the key to the production of the project, watching the 3D scene is the ultimate goal of the user experience to feel the VR interior decoration display. In this design, the development of VR interior display scene is mainly divided into three steps: the first step is to build a framework for the CAD drawings of the sample room; the second step is to model all the objects in the sample room that need to be displayed and interacted with individually. The third step is to centralize all the built models into the VR model room. The implementation process of 3D modeling for interior decoration is shown in Figure 2.

In this study, the frame model of the model room is created by using the joint modeling method of 3DsMax and AutoCAD, firstly, AutoCAD is used to draw the planning diagram of the model room, then the planning diagram is imported into 3DsMax, and the model is constructed according to the planning diagram.

Furniture model is an important modeling object of the virtual model room, including lamps, sofas, tables and chairs and other models need to be focused on production and careful design. The fineness and aesthetics of these models are directly related to the final display effect, which is also a key part of whether it can create a sense of

realism for users, and one of the key points related to the success or failure of the project. In the production process, some general-purpose furniture can be found in a variety of models on the Internet to find a more beautiful high model, there are some more special furniture need to access the Internet to collect a large number of photographs of reference drawings for 3DsMax modeling.

After all the models were exported, Unity3D was used to integrate the models and scenes, and all the models were placed according to the CAD planning of the design drawings, and individual furniture needed to be adjusted individually in terms of position and angle to make the visual effect harmonious.

The beautification of the scene occupies an irreplaceable position in the whole project, which is related to the final effect of the scene. If the beautification work is not in place, the pre-production of the model and then fine, mapping and then beautiful is also unable to show, this link involves more difficult points, need to be carefully studied. ColorSpace (also known as color space) plays a decisive role in the color performance of Unity's finished product.Unity's ColorSpace module uses several alternative algorithms to mix colors for material loading and lighting, different choices will directly affect the visual experience of the final picture. When choosing colors, it is important to be aware of the color space limitations of some low-end hardware.

The production of materials is a major challenge in art optimization, involving the use of maps and the writing of shaders, of which the writing of shaders is particularly important.

Unity's lighting is relatively simple, divided into three types: point light source. From a position to send light in all directions, like a lamp. Point light sources emit light from all directions at a certain point. They are the most commonly used lights in computer games - often used for explosions, light bulbs, etc. Directional light sources (parallel light). Parallel lights are one of the most common types of lights used in Unity art scenes, and are mostly used for celestial lighting (sun or moon). The impact of parallel light can reach infinity without any attenuation. Spotlight. Spotlights are used relatively infrequently and are mainly used for simulation of indoor spotlights, which have a cone shape similar to that of a spotlight and have a well-defined orientation. They are the most resource intensive on the graphics processor.

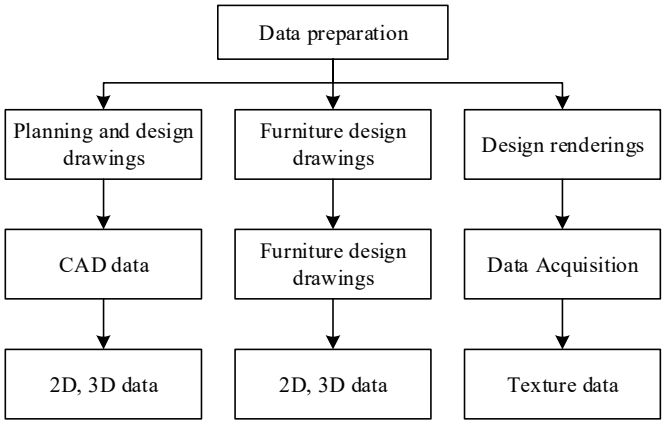

Figure 2: Interior decoration 3D modeling implementation process

III. Computational algorithms related to virtual interaction

III. A. Real-time Graphics Drawing

After establishing the virtual environment and model, the efficiency of real-time graph drawing should be studied. The following describes the real-time graphics drawing process and the algorithm to improve the drawing efficiency.

BSP can be combined with wraparound box for scene management. The data based on the bounding box can be placed in any hierarchical structure of the BSP, which can be called the hierarchical bounding box structure based on the BSP data scene. This approach allows for fast implementation of intersection and field of view cropping algorithms.

Equation (1) represents the process of changing the plane K in the world coordinate system to the view cropping space, which can be used to detect the intersection between K and the view plane cross-section body:

$$K' = \left[(PM)^{-1} \right]^{T} K \tag{1}$$

where P is the projection matrix and M is the change matrix from the world coordinate space to the viewing space. The range of values of the vertex coordinates of the visually flat truncated body in the cropping space is ± 1. The maximum dot product $d_{\max}$ and the minimum dot product $d_{\min}$ are as formulated in Eq. (2) and Eq. (3):

$$d_{\max} = \left|K'_x\right| + \left|K'_y\right| + \left|K'_z\right| + \left|K'_w\right| \tag{2}$$

$$d_{\min} = -\left|K'_x\right| - \left|K'_y\right| - \left|K'_z\right| + \left|K'_w\right| \tag{3}$$

If $d_{\min} \le 0$ then the apparent parietal exists in the negative half-space of K, indicating that no object in the positive half-space of K can be seen. If $d_{\min} \ge 0$ then the optic parallelepiped exists in the positive half-space of plane K, indicating that no objects in the negative half-space of K can be seen.

In order to save time in terms of reducing the excessive number of invisible regions when making visibility judgments, the gate system technique can be used. The algorithmic idea of the gate system is to achieve the purpose of dividing the whole scene into a number of unrelated sub-scenes which can be connected by gates.

In the process of performing cross-gate reduction, there is a situation where the vertices $V1, V2, \ldots, Vn$ of the gates are arranged in a convex polygon, if the conditions satisfy Eq. (4) and Eq. (5):

$$L \cdot V_i > 0 \tag{4}$$

$$L \cdot V_{i+1} < -\varepsilon \tag{5}$$

W for additional nodes:

$$W = V_t + t\left(V_{i+1} - V_i\right) \tag{6}$$

$$t = \frac{lL \bullet V_i}{L \bullet \left(V_{i+1} - V_t\right)} \tag{7}$$

A new shear plane is generated through the origin with V_i and $Vi+1$:

$$L_i = \left\langle \frac{V_{i+1} \times V_i}{\left\| V_{t+1} \times V_i \right\|}, 0 \right\rangle \tag{8}$$

A large number of occlusion detection processes can be implemented on current mainstream graphics cards to reduce the amount of occlusion computation. The BSPs covered in the previous section can come in handy in the next design. The BSPs can also be implemented to transfer data in a certain order.

III. B. Definition and principles of the A algorithm*

In this paper, we propose a task-tree based optimal path algorithm for human-computer interaction in order to improve the operational efficiency of the VR virtual roaming system and thus improve the user experience. Using A* algorithm to deal with the roaming process is effective it is a good way to find the optimal path that exists in the system.

The A* algorithm formula is expressed as:

$$f(n) = g(n) + h(n) \tag{9}$$

where $f(n)$ is the valuation function of node n from the initial point to the goal point, $g(n)$ is the actual cost that has been paid from the initial node u_0 to the current node n in the state space, and $h(n)$ is the estimated cost of the best path from the current node n to the goal node v. Assuming that $h'(n)$ is the actual minimum cost from the current point to the goal point, $h'(n) \le h(n)$ must be guaranteed.

Guarantee to find the shortest path (the optimal solution) conditions, the key lies in the selection of the valuation function $h(n)$: the valuation value is less than the actual value of the distance from n to the target node, in this case, the number of points to search for, the search range is large, low efficiency, but can get the optimal solution. If the estimated value is greater than the actual value, the number of search points is less, the search range is smaller, the efficiency is high, but the optimal solution is not guaranteed. The closer the valuation value is to the actual value, the better the valuation function is.

The A* algorithm is also a best-first algorithm, only with some constraints. It is used in some problem solving to be able to solve the shortest path of the state space search, i.e. to solve the problem in the fastest way.

III. C. Hierarchical Wraparound Box Method

Collision detection is significant in virtual roaming environment. It usually needs to solve two problems one is how to detect the collision. The second is how to detect the location of the collision. The basic idea of hierarchical enclosing box method is to use a simpler and larger enclosing box than the complex object to contain the object, and before detection, we should see whether there is any intersection between each enclosing box, and if there is no intersection, then we should see whether there is any sound collision between the objects specifically.

Enclosure box is usually a regular simple geometry as the basic elements, because the degree of regular geometry directly affects the complexity of the enclosure box algorithm and the amount of computation, so the shape of the enclosure box is best to choose the sphere, rectangle, K-dop convex polyhedron. Different boxes have different properties.

It is easiest to test the intersectivity by comparing whether the distance between the centers of two spheres is greater than the sum of the radius lengths of the two spheres. If it is greater, the two spheres do not intersect. If it is less than that, then the two spheres have intersecting parts.

The rectangular bounding box is also a common form, each axis is oriented in the same direction as the coordinate axes, so it is also called the axial bounding box AABB. It is easy to construct the AABB bounding box, and it does not require much computation, the only thing that you need to pay attention to is the degree of approximation.

K-dop is a convex polyhedron, which is the most computationally intensive when solving for intersections, but has the highest degree of envelopment. Its outer plane is defined by multiple outer normal vectors.

Based on Eq. (10) we can determine a depletion function that can be used to measure the enveloping box detection algorithm to determine the range of enveloping box applications:

$$T = Nv \times Cv + Np \times Cp + Nu \times Cu \tag{10}$$

where, T is the total consumption of collision detection. Nv is the number of pairs of enclosing boxes involved in the overlap test, Cv is the cost of doing the overlap test for a pair of enclosing boxes. Np is the number of pairs of geometric elements involved in the intersection test, Cp is the cost of doing the overlap test for a pair of geometric elements; Nu is the number of nodes in the hierarchy of its enclosing boxes that need to be modified after the object's motion, and Cu is the cost of modifying a node.

According to this dissipation function, a perfect enclosing box is: a box that is tightly packed with its subparts in each direction to minimize Nv, Np. Pairs of enclosing boxes can be detected iteratively and quickly to minimize Cv. The information about nodes in the structure of the enclosing box can be changed quickly after the object has moved to minimize Cu.

IV. Application of VR technology in interior design and its innovation in art and design

IV. A. Analysis of Interactive Algorithms for Scheduling Evaluation in Interior Design

In order to verify the feasibility of the proposed A* optimal path algorithm for human-computer interaction, four kinds of virtual interaction devices such as PC mouse, touch screen, VR glasses and Kinect somatosensory are used to conduct human-computer interaction experiments. The main parameters of the relevant hardware of the interaction devices are Inteli76700k CPU, 8GB RAM, GTX1060 - 6GB GPU. 15 inches, resolution of 1920 × 1080. 200mm × 110mm × 100mm, 102° viewing angle, 90Hz. range of rotation: ± 27 °, and range of sensing depth: 1.2 ~ 3.5m.

Under the same experimental conditions, FCFS scheduling algorithm, SJF scheduling algorithm and the A* optimal path algorithm of this paper are compared, and the comparison results of the average response time and average waiting time of the three algorithms are shown in Fig. 3. It can be seen that with the increase of the number of interaction tasks, the average response time and average waiting time of the three algorithms are getting larger, but the average response time and average waiting time of the FCFS scheduling algorithm grow faster, and the slope of its numerical curve is larger. Compared with the FCFS scheduling algorithm, the slope of the curve of the SJF scheduling algorithm decreases, i.e., the growth of the average response time and average waiting time slows down. However, under the condition of the same number of task requests, the A* optimal path algorithm in this paper has the smallest average response time and average waiting time results, and the average response time and average waiting time do not exceed 0.3 and 0.6. And the slope of the curve is the smallest, which is due to its effective utilization of GPU computational resources, thus increasing the speed of task execution.

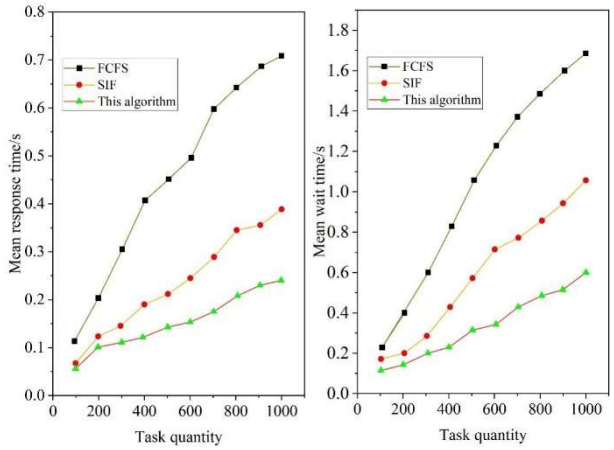

Figure 3: Results of average response time and average waiting time

IV. B. Artistic innovation in the field of interior design by VR technology

IV. B. 1) Innovations in user interaction models

The purpose of the test, virtual reality technology is applied in the indoor scene design of a building, test the constructed scene, choose the reading area in the indoor scene of a building to test, and complete the color change of the objects in the small scene, which requires the operator to complete the indoor scene interaction and analyze whether the scene is effective. Test content. First of all, we open Unity a building indoor project, the reading area object change color test experiment, click on the background wall in the scene, there are three color selection buttons, click on one of the pink button, the background wall color change, complete the object color change, the stage of the small test is complete. Test conditions, in the virtual scene of a building indoor scene test, choose Kincet somatosensory equipment with Unity engine to complete the test task. Because the virtual scene testing needs equipment is intact, in order to ensure that the test state is good, the equipment can not appear to lag and dead, high requirements for equipment. An indoor virtual scene of a building was tested and received commands and was able to complete the commands while it was in progress.

In order to ensure the authenticity of the test results of the virtual scene, ten participants were invited to test the scene, and the test results and analysis are shown in Table 1. It is found that when virtual reality technology is applied to the indoor scene design of a building, the scores of its user interaction-related indicators are all above 6 points, with high ratings.The VR devices have a fixed area range in receiving the induction rays, and once this area range is exceeded, the data transmission will be terminated, or even errors will occur. The main reason for this failure was that the user was out of range of the rays and the participant's interaction with the scene was interrupted. The test must be carried out indoors, the scene is built on the computer virtual construction technology, wireless signal transmission is also very easy to be affected by environmental interference, the test process, due to the distance between the test instrument and the virtual reality equipment is too close to the lack of the necessary safety shielding measures, but also lead to errors in the virtual scene display process, this phenomenon needs special attention in the actual operation.

Table 1: Statistical chart of test objects

Serial number	Content	Average score (Total score 10)
1	Handle operation	9
2	Virtual scene	7
3	Interactive participation	7
4	Operational experience	8
5	Scene generation	8
6	The process is easy to understand	7
7	There is a sense of vertigo in operation	6

IV. B. 2) Visual realism

With the development of PC hardware technology, high configuration of the PC hardware costs continue to reduce, will inevitably lead to high configuration and low price of the PC will be in people's lives to get a wider range of popularity, which undoubtedly from the perspective of the hardware to solve the VR roaming technology applied to

people's lives required by the large amount of data computing problems, more complex design solutions, three-dimensional models, richer and truer colors, more realistic virtual environment. None of them are obstacles to VR roaming development.

The visual effect under VR technology is recorded as Experiment A group, and the visual effect of the two mentioned traditional design methods is recorded as Experiment B and Experiment C. Comparison experiments are conducted to compare the visual effect of the 3 groups of experiments on the rationality of the interior space.

The indoor scene of the building inside the first floor is selected as the experimental object, and the size of the evaluation area of the indoor space is changed, and the evaluation area is controlled at 30~90m2, and the visual effect on the indoor space as a whole is recorded. The comparison results are shown in Table 2.

On the basis of the 1st group of experiments, a fixed area of 90m2 was selected for visual rationality assessment. Changing the number of iterations of the 3 groups of experiments, i.e., changing the complexity coefficient of the rationality assessment, and comparing the overall visual effects of the 3 groups of experiments under indoor spaces of different complexity, the visual effects of Experiment Group A were all higher than those of Experiment Group B and Experiment Group C, which were 98.4%, 88.1%, 94.3%, and 87.4%, respectively.

Statistics of the scene visual effects under the experimental conditions of this group, although the spatial visual complexity increases, the scene visual effect of group A decreases, but it is still higher than that of groups B and C, and the more complex the spatial visualization, the greater the evaluation advantage of experimental group A is. The accuracy is also higher than that of experimental groups B and C. And the larger the number of experimental iterations, the visual effect of group A decreases more slowly compared to experimental groups B and C. In summary, Experimental Group A utilized virtual reality technology to identify indoor spatial details more accurately and improve the visual effect of visual rationality. The advantages of virtual reality technology make the assessment of spatial visual rationality more accurate.

Table 2: Experimental comparison

Scene	Experimental A group	Experimental B group	Experimental C group
First group: the assessment area is 30~ 90 m2			
Wall	98.4%	95.4%	93.2%
Ceiling	88.1%	84.6%	82.0%
Door	94.3%	75.9%	70.4%
Ornamental	87.4%	67.1%	58.4%
Second group: the assessment area is 90m2, different iterations			
Wall	87.8%	81.9%	60.5%
Ceiling	81.6%	76.4%	20.8%
Door	84.0%	76.5%	41.2%
Ornamental	80.5%	57.6%	38.6%

IV. B. 3) Emotionalization of residential interior spaces

(1) Experiments on Interior Decorations

This section takes the design model of a building's indoor living space as an example, and uses the immersive VR display system, combined with the physiological data collected by the wearable EDA detector, to analyze and judge the affective design in the space. In the selected model of residential interior space, except for the element of interior color, all other elements of emotional design evaluation are reflected in the model design. However, according to the changes in the EDA values in the experimental data and the comparison of the experimental video images, the data feedback from multiple subjects for the three elements of emotionalized design evaluation, namely, interior decorations, interior furniture, and lighting design, is more obvious, and therefore the experiments on these three elements are mainly described in detail here.

Many decorations were placed in the experimental room, and here the potted plant on the dining table, the fruit basket on the kitchen bar, the crystal vase in the living room, and the laptop computer in the bedroom were selected as examples to be analyzed for 10 subjects.

The EDA values are shown in Table 3.The EDA values were tested for 1 minute before entering the immersive VR living space model, and the initial EDA averages of the 10 subjects were 9.72, 11.184, 17.75, 3.928, 3.12, 8.64, 6.36, 23.807, 27.864, and 7.29.When focusing on the potted plants, the No. 1, No. 2, No. 5 No. 1, No. 6, and No. 7 subjects had EDA averages of 8.54, 11.79, 3.4, 9.58, and 6.7. When focusing on the laptop, No. 1, No. 2, No. 3, No.

4, No. 6, No. 8, and No. 10 subjects had EDA averages of 11.1, 11.24, 17.89, 4.1, 8.3, 23.8, and 8.0. When focusing on the fruit basket, the mean EDA values for subjects #1 and #9 were: 10.65, 24. When focusing on the crystal vase, the mean EDA value for subject #4 was: 4.4.

Table 3: The indoor decoration EDA list

Numbering	Mean value	Potted plant	Fruit basket	Crystal bottle	Notebook computer
1	9.72	8.54	10.65 (grab)		11.1
2	11.184	11.79			11.24 (caress)
3	17.75				17.89
4	3.928			4.4	4.1 (caress)
5	3.12	3.4			
6	8.64	9.58			8.3
7	6.36	6.7			
8	23.807				23.8 (caress)
9	27.864		24		
10	7.29				8.0

(2) Indoor natural light and lighted experiment

Since the experiment was to allow the subjects to conduct the tour independently, and there was no restriction on the specific route and the time of each tour, the subjects conducted the tour exactly according to their own preferences. The red area represents the living room where the sun shines, and the green area represents the kitchen where the light shines. Our recorded EDA changes from the 10 subjects for these 5 minutes are shown in Figure 4, where subjects #1, #3, #5, #6, #8, #9, and #10 stayed more in the living room, #4 stayed only in the living room and only looked far away from the direction of the kitchen, while #2 stayed relatively more in the kitchen, and #7 stayed in the living room with little difference from the kitchen.

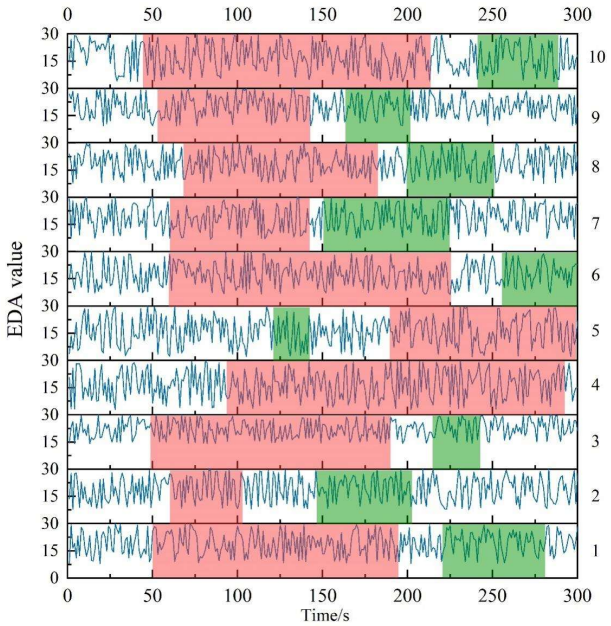

Figure 4: Eda chart

(3) Experiments on interior materials, furniture and colors

Although the selection of interior decorative materials, furniture and interior color design determines and expresses the style of the emotional design of the interior space and realizes the use function of the interior space. However, from the experimental recording screen, decorative materials, furniture and color are the basis of interior design with a wide range, and the subjects did not produce obvious changes in EDA when observing these three elements after entering the interior.

(4) Indoor green plant experiment

The left area was designed with a running water vignette and a row of green plants. Similarly, firstly, analyzing from the frequency of attention, 6 out of 10 subjects saw the green plants, which were #1, #3, #4, #8, #9, and #10, of which subjects #1, #3, #4, and #9 approached the green plants.6 saw the running water vignette, which were #1, #2, #4, #6, #8, and #9, of which subjects #1, #2, #6, #8, and #9 approached the running water vignette Secondly, from the EDA values of the subjects as shown in Table 4, the mean EDA values of subjects No. 1, No. 3, No. 4, No. 8, No. 9, and No. 10 at the sight of the greenery were 6.07, 11.05, 10.34, 24.78, 7.28, and 3.48, respectively, where subjects No. 1, No. 3, No. 4, and No. 9 had the following EDA means when they were approaching the greenery: 7.24, 13.35, 12.74, 8.96. In seeing the running vignette is, the EDA mean values for subjects #1, #2, #4, #6, #8, and #9 were: 5.82, 6.02, 9.8, 5.24, 24.743, and 6.86, respectively, where the EDA means for subjects #1, #2, #6, #8, and #9 when approaching the running vignette was: 6.04, 6.34, respectively, 5.21, 24.48, 7.35.

Table 4: The EDA list was shown

	Mean value	See the green plant	Close to green	When you see the little water	Near the water
1	5.84	6.07	7.24	5.82	6.04
2	8.61			6.02	6.34
3	10.84	11.05	13.35		
4	9.37	10.34	12.74	9.8	
5	21.22				
6	4.74			5.24	5.21
7	11.48				
8	24.58	24.78		24.743	24.48
9	6.74	7.28	8.96	6.86	7.35
10	3.32	3.48			

V. Conclusion

This paper intends to objectively show, through actual case study research, comparative analysis and other methods, that combining virtual 3D modeling and interaction with actual cases to complete an indoor solution that can be immersively roamed and freely interacted with, and its innovation of indoor art design, is of some significance.

The results show that the proposed A* optimal path algorithm for human-computer interaction exhibits better performance in terms of average response time and average waiting time compared to the first-come-first-served (FCFS) scheduling algorithm and short-job-first (SJF) scheduling algorithm. The accuracy of interactive VR interior design evaluation is higher than the two traditional systems, enabling more precise evaluation of spatial visual rationality. The use of interactive VR technology allows 10 users to feel and experience the interior space from a new perspective and immerse themselves in the emotional design of the interior space.

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References

[1] Horvat, N., Kunnen, S., Štorga, M., Nagarajah, A., & Škec, S. (2022). Immersive virtual reality applications for design reviews: Systematic literature review and classification scheme for functionalities. Advanced Engineering Informatics, 54, 101760.

[2] Jamei, E., Mortimer, M., Seyedmahmoudian, M., Horan, B., & Stojcevski, A. (2017). Investigating the role of virtual reality in planning for sustainable smart cities. Sustainability, 9(11), 2006.

[3] Tastan, H., & Tong, T. (2023). Immersive virtual reality in AECO/FM to enhance education: Systematic literature review and future directions. Computer Applications in Engineering Education, 31(5), 1465-1491.

[4] Finseth, T. T., Smith, B., Van Steenis, A. L., Glahn, D. C., Johnson, M., Ruttle, P., ... & Shirtcliff, E. A. (2024). When virtual reality becomes psychoneuroendocrine reality: A stress (or) review. Psychoneuroendocrinology, 107061.

[5] Scorpio, M., Laffi, R., Masullo, M., Ciampi, G., Rosato, A., Maffei, L., & Sibilio, S. (2020). Virtual reality for smart urban lighting design: Review, applications and opportunities. Energies, 13(15), 3809.

[6] Pidel, C., & Ackermann, P. (2020). Collaboration in virtual and augmented reality: a systematic overview. In Augmented Reality, Virtual Reality, and Computer Graphics: 7th International Conference, AVR 2020, Lecce, Italy, September 7–10, 2020, Proceedings, Part I 7 (pp. 141-156). Springer International Publishing.

[7] Lee, K. T., Im, J. B., Park, S. J., & Kim, J. H. (2022). Conceptual framework to support personalized indoor space design decision-making: A systematic literature review. Buildings, 12(6), 716.

[8] Rui, L., & Aziz, M. F. B. A. (2023). A systematic review of chinese culture and heritage in interior design practices. Multidisciplinary Reviews, 6(4), 2023038-2023038.
[9] Liao, T., & She, J. (2023). How does Virtual Reality (VR) facilitate design? A review of VR usage in early-stage engineering design. Proceedings of the Design Society, 3, 2115-2124.
[10] Korkut, E. H., & Surer, E. (2023). Visualization in virtual reality: a systematic review. Virtual Reality, 27(2), 1447-1480.
[11] Kang, Z., Yang, J., Yang, Z., & Cheng, S. (2020). A review of techniques for 3d reconstruction of indoor environments. ISPRS International Journal of Geo-Information, 9(5), 330.
[12] Whiting, P., Cullen, V., Adkins, H., & Chatteur, F. (2023). A new retail interior design education paradigm for a circular economy. Sustainability, 15(2), 1487.
[13] Zhang, L., & Shen, T. (2024). Integrating Sustainability into Contemporary Art and Design: An Interdisciplinary Approach. Sustainability, 16(15), 6539.
[14] Mozan, B. M., & Razzaq, H. A. A. (2021). Decorative interiors between craft and digital design (CNC) in interior spaces. AL-ADAB JOURNAL, (137 Supplement 2).
[15] Amin, A., Soliman, T., Hasanein, A., & Abdelhafeez, A. (2023). Interior design applications based on IoT as detection and es-timation methods. International Journal of Telecommunications, 3(02), 1-13.
[16] Doktah, M. N. A., Ismail, I., Hamzah, W. M. A. F. W., Amin, M. M., Karim, F., & Zulkifli, A. P. M. (2024). Systematic Literature Review of Interior Design in Virtual Reality Environment. Journal of Advanced Research in Applied Sciences and Engineering Technology, 34(1), 337-349.
[17] Wang, M., & Huang, P. (2023, September). Distributed 3D Interior Design System Based on Fuzzy Clustering Algorithm. In 2023 International Conference on Telecommunications, Electronics and Informatics (ICTEI) (pp. 439-443). IEEE.
[18] Sokienah, Y. Y. (2024). Blockchain as a New Frontier in Interior Design: A Systematic Review of Opportunities, Challenges, and Future Directions. IEEE Access.
[19] Strand, I. (2020). Virtual Reality in Design Processes:-a literature review of benefits, challenges, and potentials. FormAkademisk, 13(6).
[20] Kazeem, K. O., Olawumi, T., & Fernando, N. (2023). Global Application of Digital Twins and Virtual Reality in the Construction Industry: A Systematic Literature Review. Innovations, Disruptions and Future Trends in the Global Construction Industry, 19-34.
[21] Yang, Y., & Dan, Z. (2020). Environmental design vs. Environmental art design: a Chinese perspective. TARIH KÜLTÜR VE SANAT ARAŞTıRMALARı DERGISI, 9(4), 122-133.
[22] Peters, O. R., & Olabode, O. (2018). Comparative Analysis between Art and Architecture. Online Journal of Art & Design, 6(2).
[23] Ko, H. K., Park, G., Jeon, H., Jo, J., Kim, J., & Seo, J. (2023, March). Large-scale text-to-image generation models for visual artists' creative works. In Proceedings of the 28th international conference on intelligent user interfaces (pp. 919-933).
[24] Bertelsen, L., & Short, A. R. (2023, August). State of the Art: A Review of AI Art Generation Methods for Rigorous Design. In International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (Vol. 87318, p. V03BT03A066). American Society of Mechanical Engineers.