Application of Intelligent Virtual Reality Technology in College Art Creation and Design Teaching

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Abstract

Virtual scene requires a more natural interaction paradigm to meet the needs of users. Graphical paradigm can be an effective supplement to natural paradigm. At present, there is little research on the application of graphical paradigm in virtual space. In application, there may be deep conflict between graphical paradigm and the subject in virtual scene. This paper proposes a new interactive intelligent virtual reality (VR) paradigm, and studies two ways to alleviate deep conflicts in virtual scenes by adding aperture blur and adjusting the distance between components and subjects by taking VR finding different and augmented reality (AR) Tetris scenes as examples. By analyzing the data of time and deviation required for subjects to perform interactive tasks such as viewing, grabbing and sliding in the virtual scene, this paper compares two deep conflict mitigation methods from six dimensions of ease of learning, accuracy, ease of use, authenticity and comfort. Aiming at the problem that traditional image-based rendering cannot meet the needs of artistic style virtual environment, and this paper introduces non photorealistic rendering technology into virtual scene construction, and proposes a virtual environment generation method based on non photorealistic rendering. Firstly, the local structure of the image is described by calculating the structure tensor, and then the smooth tensor field is obtained by using the adaptive filtering of the total alterable partial differential equation; then, the line integral convolution is used to guide the brush direction to generate the line wave motion art image; finally, it is integrated into the 3D scene to generate a feasibleartistic virtual environment. The experimental results show that the new algorithm can not only simulate the line wave motion art image, but also realize the construction of artistic style virtual environment.

Keywords: Artistic creation, Virtual reality, Interactive paradigm, Augmented reality, Instructional design

1 Introduction

Virtual reality (VR) is a new human-computer interaction technology that emerged at the end of the 20th century [1]. In order to maximize the fidelity of the final scene, a new rendering method, image-based rendering (IBR), has attracted extensive attention of researchers. The new image synthesis is realized by combining the original image now [2]. However, for the virtual environment with a specific artistic style, it is different from the photos directly obtained by IBR method [3]. As an effective supplement to natural interaction, graphical component interaction paradigm can improve user experience. In the actual use of the graphical paradigm in 3D space, there may be some depth conflicts such as inconsistent texture maps and front and back occlusion. Reference [4] proposed that the depth conflict can be alleviated by adjusting the user's visual focus when watching the specific interactive scene of virtual panoramic video. Reference [5] pointed out that the subtitles placed on the stereo video may cause depth conflict, and proposed a difference adjustment method to alleviate the depth conflict, but it did not extend it to the entire virtual scene. Some scholars have studied the impact of deep conflict on small interactive components, such as mouse cursor [6] or game crosshairs [7], and put forward the design scheme of small components.

For the application of using intelligent VR technology for the college art creation and design teaching, some researchers used the interactive study of multimedia and virtual technology to the art education in college, and the experimental results have shown that the interactive study strategy is very useful for the college education [8]. In addition, other researchers have done some experiments to validate the effects of a VR-based pottery making approach on junior high school students' creativity and learning engagement [9]. Fortunately, the experimental results have shown that the VR based pottery making approach have greatly effects on the junior high school students' creativity and learning engagement [10]. To compare the immersive VR to mobile applications in foreign language learning in higher education, a quasi-experiment has been done for the college art creation and design teaching [11], and the experimental results have shown that the immersive VR can be applied for

the foreign language learning in higher education, which achieves a significant effect for the teaching design. The development and application of VR course resources are also explored by researchers based on the embedded system in open education. The experimental results have shown that the VR course resources are useful for the college art creation and design teaching based on embedded system. Moreover, the augmented reality towards a simplified pedagogical scenario case of teacher training is also explored by using the experiments in regional centers for education and training in Morocco [12], and the experimental results have shown a perfect performance on the college art creation and design teaching.

However, many of the studies mentioned above do not involve the deep conflicts at the interaction paradigm level in virtual scenes. How to accurately locate and solve the conflict problems needs further research. In this paper, the non photorealistic rendering technology is introduced into the virtual scene, and a virtual environment generation method based on non photorealistic rendering is proposed to meet the needs of the specific artistic style in the virtual scene. This method is different from the traditional linear smoothing method based on tangent vector of image [13]. It first calculates the local structure of the image through the structure tensor, then uses the total variation partial differential equation to carry on the adaptive filtering smoothing to the image structure tensor field, and then uses the line integral convolution to guide the brush direction to simulate the artistic image with line wave motion [14]. Finally, the art image is integrated into the scene to generate the virtual environment of artistic sense, and the art scene is browsed by using the technology of "swim in the picture" (tip).

2 Application Advantages of Intelligent VR Technology in College Art Creation Teaching

Traditional digital media art creation means are relatively simple, and in addition to the knowledge base of creators have high requirements, they also have higher requirements for their imagination and perception. Therefore, to create a high-quality digital media art work, not only takes a lot of time, but also consumes a lot of energy and material resources [15]. Here we can see that the increasing popularity of VR technology and artificial intelligence has effectively led to the steady development of the times, but also given more forms and content to digital media art.

2.1 Artificial Intelligence of VR Technology Improve the Efficiency of Information Transmission

Every revolution in science and technology will bring about fundamental changes in our life, enterprise production and other fields. For example, the hot artificial intelligence technology, VR technology, big data technology, cloud technology and so on leading the way in many fields and become the object of introduction in many fields. Under the influence of information technology, we are surrounded by a variety of information resources, but these information resources are not all useful for digital media art creation, and even some information may have misleading effect [16]. It is often unrealistic to rely solely on human resources to screen and identify this information. The use of VR technology of artificial intelligence can effectively avoid this problem, and let it help us do some tedious things, so as to reduce the workload of digital media art creation.

2.2 VR Technology Can Create a Kind of Immersive Feeling

In the artificial intelligence application of VR technology, binocular stereo vision has a very powerful function, which can make the two eyes of the participants see different images, which are reflected in two different displays. If we don't use VR technology, even if the experience wears special glasses, they can't experience the real virtual scene, and the stereoscopic effect caused by parallax will be much worse. The artificial intelligence of VR technology can create a more real environment for people, and the three-dimensional sense of human vision is also stronger. Therefore, it often gives people the feeling of immersing themselves in the real scene, which makes people laugh.

2.3 VR Technology Can Create More Ideal Creation Conditions for Digital Media Art Creators

VR technology can change the cognitive behavior of digital media art creators to a certain extent, so that they can create more happily. In different times, people's cognitive means will have great changes [17]. Driven by information technology, VR technology and artificial intelligence technology, the thinking logic and space-time concept of digital media art creators have changed greatly. More and more people have jumped out of the scope of traditional learning mode and found new learning ways to understand things. In the current social background, the popularity of high-tech influence is growing, and its development has greatly changed the way people deal with information. For digital media art creators, many of them are used to using computer information processing system to complete the creation.

3 Algorithm of Non Photorealistic Rendering Art Design Based on Tensor Field

3.1 Calculation of Image Structure Tensor Field

The structure tensor of an image describes the local structure information of the image, which is widely used in fingerprint recognition, edge enhancement and so on [18]. If the tensor of image structure is S, then there is a processing as follow:

$$S = \begin{pmatrix} s_{1,1} & s_{1,2} \\ s_{2,1} & s_{2,2} \end{pmatrix} = g_{\sigma_1} * \begin{pmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{pmatrix} \qquad (1)$$

$$g_{\sigma_1} = \frac{1}{2\pi\sigma_1^2} e^{-\frac{x^2+y^2}{2\sigma_1^2}} \qquad (2)$$

where g_{σ_1} is the Gaussian convolution kernel with variance or; I_x and I_y are the derivatives of image I in row and column directions respectively. In addition, the operation used in equation (1) means the dot multiplication between two matrices of images for the corresponding pixels.

The structure tensor S of an image plays an important role in analyzing the local structure of an image: two eigen-values can be obtained by decomposing it, and the corresponding two eigenvectors describe the local structure of the image [19]. Among them, the feature vector with large eigen-value corresponds to the vertical direction of the curve at the pixel, while the eigenvector with small eigen-value corresponds to the curve direction of the pixel. Let the eigenvector corresponding to the smaller eigen-value of S is V_2 : for any pixel (i, j) , the corresponding eigenvector is $V_2 = (v_{1,2}, v_{2,2})^T$, then the local curve direction θ at point (i, j) is:

$$\theta = \arctan\left(v_{2,1} / v_{2,2}\right) \qquad (3)$$

Color images generally contain multiple channels, but it is not necessary to process all channels one by one, and only the tensor field of luminance component can be calculated. The luminance component K is generally obtained by weighted averaging the values of R, G, B three channels of each pixel in the source image J according to the following formula:

$$K = R \times 0.299 + G \times 0.587 + B \times 0.114 \qquad (4)$$

For any point (i, j) in the luminance component image, the structure tensor S of the point can be calculated by formula (1), and the local curve direction $\theta(i, j)$ of the point (i, j) can be obtained according to

the corresponding eigen-vector as $\theta(i, j) \in \left[-\dfrac{\pi}{2}, \dfrac{\pi}{2}\right]$.

Since the angle can be calculated by using the arctangent function from the positive and negative relationship between component values V_2, the local curve direction of the actual point of $\theta(i, j) \in [0, 2\pi]$.

3.2 Anisotropic Diffusion Smoothing

Because of the sharp and irregular jump in the curve angle field θ calculated by tensor field, if it is directly used to control the stroke direction to draw, the final rendering effect is not smooth enough, so it is necessary to smooth the angle field [20]. In traditional vector field smoothing, neighborhood linear weighting is usually used, but the local structure of vector field is not considered, so the smoothing operation may lead to the consistency of the whole vector field. Total variation model [21] is widely used in image denoising because of its local characteristics. In this paper, the idea is introduced into the angle field smoothing operation, and the following alterableequations are constructed:

$$\theta = \arg\min_S \int_\Omega |\nabla \theta| dx dy \qquad (5)$$

where $|\nabla \theta| = \sqrt{\left(\dfrac{\partial \theta}{\partial x}\right)^2 + \left(\dfrac{\partial \theta}{\partial y}\right)^2}$, and Ω is the angular field space.

The above formula describes the continuous model of angle field smoothing, and the corresponding discrete model should be established for the digital image studied in this paper [22]. The angle field of digital image θ can be regarded as a set of discrete signals defined in the space of non empty nodes Ω. For any point $p = (i, j)$ on θ , the diamond neighborhood space is defined as follows:

$$n_p = \left\{(i, j-1), (i, j+1), (i-1, j), (i+1, j)\right\} \qquad (6)$$

Then the variation and discretization at point p can be defined as:

$$|\nabla_p \theta| = \sqrt{\sum_{s \in n_p} \left(\theta_p - \theta_s\right)^2} \qquad (7)$$

Therefore, the discrete model corresponding to the image angle field smoothing in this paper is:

$$E(\theta) = \sum_{p \in \Omega} |\nabla_p \theta| \qquad (8)$$

According to the direct alterablemethod, the optimal energy functional should satisfy the Euler Lagrange equation:

$$div\left(\frac{\nabla\theta}{|\nabla\theta|}\right)=0 \qquad (9)$$

Using the half point difference scheme, the following discrete scheme can be established for any point $p=(i,j)$ on the angle field of θ:

$$\sum_{s\in n_p} w_{p,s}\left(\theta_p-\theta_s\right)=0 \qquad (10)$$

where n_p is the neighborhood of point p, if $w_{p,s}=\frac{1}{|\nabla_s\theta|}$, then there has been satisfied:

$$\theta_p=\frac{\sum_{s\in n_p}\left(w_{p,s}\theta_s\right)}{\sum_{s\in n_p} w_{p,s}} \qquad (11)$$

This method is different from the traditional smoothing operation, because it considers the gradient value of the direction angle of the smoothed pixel and that of the neighboring pixels, so the orientation angle of the smoothed pixel can be obtained by the adaptive weighting calculation of the orientation angle of the initial pixels around the point (as shown in formula (11)).

3.3 Adaptive LIC Integration

Line integral convolution was first used in the visualization of vector fields. It reflects the whole motion of the field through an intuitive graphical interface. The basic idea of the traditional LIC algorithm is to take the image vector field and the initial texture image as the input, and then convolute the input signal along the streamline direction to obtain the high-precision image reflecting the field motion direction [23]. Experiments show that the dynamic effect of fluid wave in the final image is not consistent with the trend and randomness of the brush shown in the actual art works due to the source image of line integral convolution strictly according to the direction of the curve angle field. Therefore, in order to better simulate the randomness of brushes in art works, this paper randomly perturbs the source image I by adding a certain proportion of Gaussian noise to obtain the texture image $\hat{I}$. At the same time, it can also have certain randomness. Finally, we can get the simulation art image with lively and jumping artistic effect.

Let x_0 be any point in the texture image, $f(r)$ is the streamline passing through point x_0 and the length is $2L+1$, then the output value of point x_0 is determined by the integral calculation of pixel value of texture image point determined by streamline and convolution kernel function, that is

$$F(x_0)=\frac{\int_{r_0-L}^{r_0+L} k(r)\hat{I}(f(r))dr}{\int_{r_0-L}^{r_0+L} k(r)dr} \qquad (12)$$

$$x_0=f(r_0)$$

where $k(r)$ is the one-dimensional convolution kernel function, and $\hat{I}(f(r))$ is the pixel value of texture image corresponding to the point passed by streamline $f(r)$. To solve the adaptive LIC integration problem, we cannot solve the integral problem directly. The main method to solve such problem is to transfer the problem to the discrete form, which can be obtained as follow:

$$F(x_0)=\frac{\sum_{i=-L}^{L} k(x_i)\hat{I}(x_i)}{\sum_{i=-L}^{L} k(x_i)} \qquad (13)$$

$$x_i=f(x_0+i)$$

Note that the smaller the distance between point x_i and point x_0, the larger the corresponding weight $k(x_i)$. Therefore, one-dimensional Gaussian kernel can be used as the weight function:

$$k(x_i)=\frac{1}{\sqrt{2\pi}\sigma}e^{-\frac{(x_i-x_0)^2}{2\sigma^2}} \qquad (14)$$

Using LIC algorithm to generate fluid art map, the integral step number L is the most important factor affecting the efficiency and accuracy of the algorithm: the value of L depends on the curve angle field θ, if l is too large, the final output image tends to be smooth; if L is too small, the final image is lack of artistic line motion. Therefore, this paper uses the distribution of local details of the image to control the number of integration steps: if the details in the neighborhood of the current point are richer, the integration steps are smaller; if the neighborhood is smoother, the integration steps are larger. Because the standard deviation $\sigma(x_0)$ can better describe the richness of image block details, the brightness component image can be divided into several independent $n\times n$ image blocks, and $L_{\max}$ and $L_{\min}$ are respectively the maximum and minimum steps of global line integration. In this paper, the following formula is used to determine the required integration steps of current point x_0:

$$L(x_0)=L_{\max}-(L_{\max}-L_{\min})\frac{(\sigma(x_0)-\sigma_{\min})}{(\sigma_{\max}-\sigma_{\min})} \qquad (15)$$

where $\sigma_{\max}$ and $\sigma_{\min}$ are the maximum and minimum standard deviations of all image blocks corresponding to $\sigma(x_0)$ is the standard deviation of image blocks

centered on point x_0. $L(x_0)$ is a function that decreases monotonically with the standard deviation of image blocks. If the standard deviation is larger, the details of the corresponding image block are more abundant, the number of integration steps is smaller; if the standard deviation is smaller, the corresponding image block is smoother, and the integration steps are larger. This is in line with the following characteristics of artistic painting style [24]:

(1) In smooth areas such as the sky, a large brush is used to draw roughly;

(2) In the area with rich details, the small brush is used for fine rendering.

If the current drawing point is x_0, and its corresponding integral steps are $L(x_0)$, then the corresponding line integral convolution requires $2L(x_0)+1$ samples. According to the curve angle field data, the line integral convolution of $2L(x_0)+1$ point by formula (12) (as shown in Figure 1) can be used to simulate the artistic image.
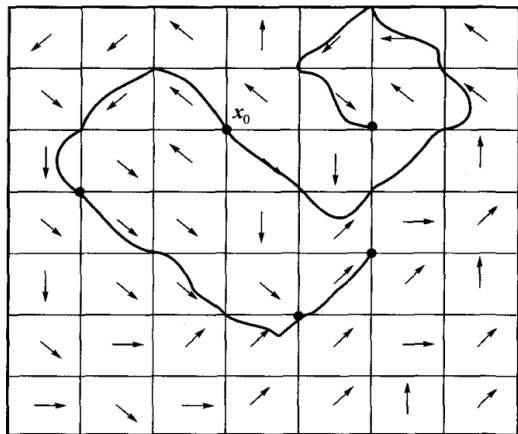

Figure 1. One dimensional line integral convolution based on tensor field (L = 1)

3.4 VR Scene Roaming Art Creation Based on Tip

After the wave motion art image is generated, an ordinary 3D virtual scene is constructed, and the generated art image is mapped to the scene in texture mode to get a virtual art scene similar to a museum.

Because the art image does not contain any 3D geometric information, the whole scene can be regarded as a normal 2D image and browsed through the middle of the picture technology. Tip technology is an image browsing technology [25] first proposed by Horry in 1997. Compared with other image-based rendering techniques, tip technology is based on perspective principle. Given an image and without camera parameters, tip technology can easily generate 3D roaming views of the image with multiple angles and distances. The basic principle is: by specifying a visual vanishing point and four radiation lines, the scene is modeled as a box shaped 3D model including five parts: left wall, right wall, back wall, ground and top surface, and then the perspective relationship of each part of the scene is determined. After the modeling is completed, the camera is positioned in the 3D scene of tip model, and the virtual art scene image can be browsed with different distances and angles. Figure 2 shows the specific process of scene roaming using tip technology.

4 Intelligent VR Teaching Experiment of Art Creation in Colleges and Universities

4.1 VR Test System

The hardware includes a notebook computer with Intel i7-9700K core processor running Microsoft Windows 10 operating system, a notebook computer running MacOS Catalina operating system, an HTC-VIVE head mounted display and two hand control handle, and an apple mobile phone. All two notebooks contained 16GB memories to meet the requirements of VR technology. Users can select, grab, click and slide through the handle. The gesture operation is more natural, which conforms to the user's real scene operation habits. The system helps the research by obtaining the time of user operation and the distance from the target object. Using NVIDIA GTX 1080Ti graphics card for scene rendering, the HMD helmet virtual scene can be viewed in real time through the screen display. The virtual scene consists of two parts, as shown in Figure 3.
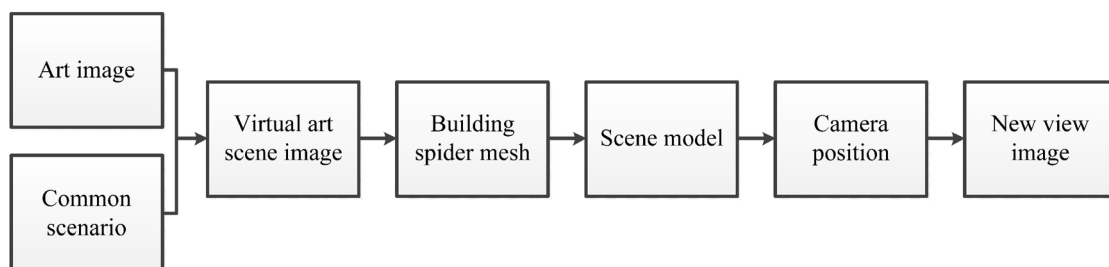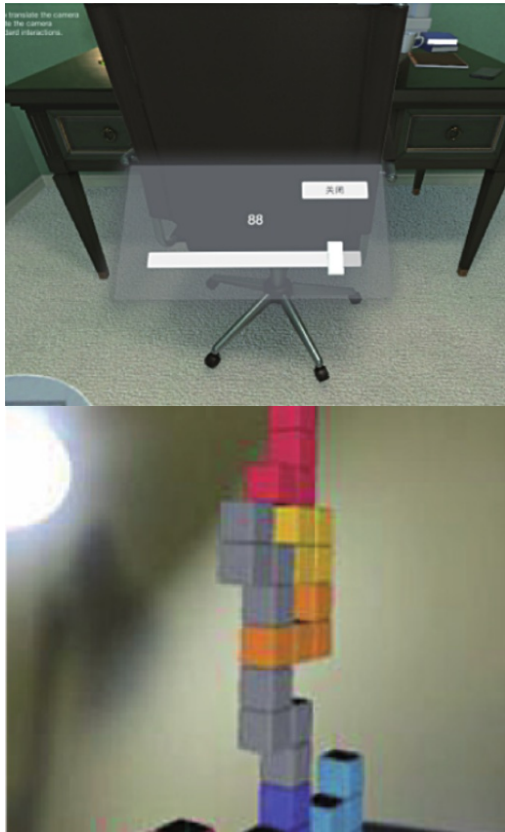

**Figure 2**. Art creation process of VR scene roaming based on tip

Figure 3. VR looking for different scenes and AR Tetris scenes

The first part is to find different scenes for VR, "different" objects are randomly placed in any position in the scene. Users first observe the initial scene, and then enter the scene with "different" objects through the "switch" button. The main task of users is to find two "different" objects in different scenes. Taking the baseline distance 3M [26] officially given by HTC as the scene design standard (the visual angle and distance between the graphical interaction components and the subjects can be adjusted in the experiment), the scene is built through unity3d platform. The second part is the augmented reality (AR) Tetris scene. Seven shapes of squares appear randomly in the center of the scene. The rules of the game are the same as those of the traditional two-dimensional Tetris. Users slide up, down, left and right on their mobile phones. The metaphor of interaction is consistent with the real world, which conforms to the user's habits [27]. The scene is built by Arkit [28].

4.2 Teaching Tasks of Art Creation in Universities

As shown in Figure 4, the comparison results of depth conflict and aperture blur link mainly include two parts. The first part is to guide the subjects to complete the task of content viewing (including viewing and searching tasks), moving the slider bar and game operation (input) in different VR scenes. When the subjects finished the task, they were asked to move the objects according to the prompts. Then find

the most comfortable section by adjusting the slider. In the scene, you can click the prompt button and move the slider to select "different" objects. When the slider slides to a specific value (88), the system will display the position of "different" objects. VR has designed 2 levels for different games. By intentionally adding the parallax between left and right eyes on the slide bar interaction component, the feedback data of the subjects were collected, and the effects of the two mitigation methods were finally evaluated.
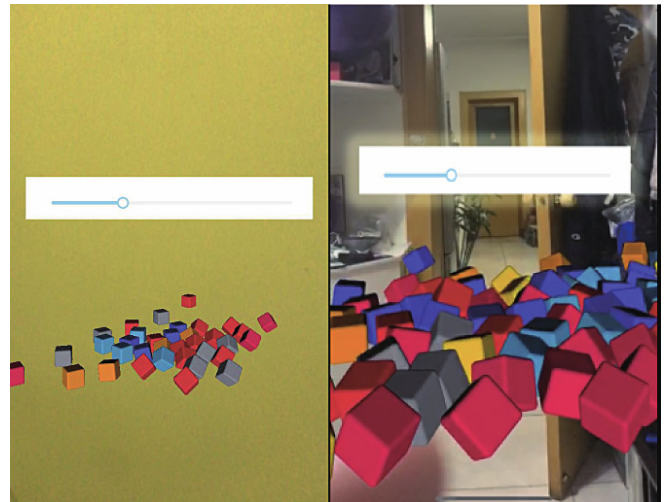
Figure 4. Comparison of deep conflict and aperture blur after mitigation

The second part is to guide the subjects to complete the game task and slide bar interaction task in the AR Tetris scene by left and right clicking the moving box, sliding up the rotating square, sliding down the fast falling box, and describing the content of the experimental scene. In this scene, the situation of blocking the game components is designed, and the participants can close the components through the button. At the end of the game, the slider option appears, and the participants can restart the game by sliding the slider to a specific position. By intentionally adding the parallax between left and right eyes on the slide bar interaction component, the feedback data of the subjects were collected, and the effects of the two mitigation methods were finally evaluated.

4.3 Assumption of Teaching Design of Art Creation in Universities

In this experiment, user interaction tasks are divided into three categories: view scene information, input and input according to the obtained content (adjust the slider). Among them, the interactive task of viewing scene information includes information search task. The depth conflict between the graphic component and the scene is alleviated by adding aperture blur and adjusting the distance between the component and the subject. The method of adding aperture blur is to add 2% - 5% of the aperture blur value at the edge of the graphical interaction component; the way of adjusting

the distance between the component and the subject is to adjust the position of the camera representing the subject's perspective to 2.0-3 5 m. Firstly, the hypothesis is put forward: both of the two mitigation methods are effective, adding iris blur in the user experience dimension is the better way; narrowing the distance between components and subjects will cause discomfort; adding dynamic adjustment will lead to system stuck, and it cannot guarantee that each component is applicable. In this experiment, we do not consider the combination of multiple mitigation methods, and just only consider a single type of mitigation.

Suppose that in the experimental scenario, adding two deep conflict mitigation methods, the user experience (ease of learning, accuracy, ease of use, authenticity, comfort, satisfaction) is significantly improved (H0). In addition, based on the characteristics of the two deep conflict mitigation methods, a further hypothesis is put forward: both of the two deep conflict mitigation methods can bring different user experiences (H1); in the dimension of ease of learning, they are interactive, so there is no significant difference (H1.1); because adding the mode of halo blur can display the central content more obviously, so it is accurate, easy to use and comfortable In the dimension of adaptability and satisfaction, distance adjustment is better than distance adjustment (H1.2, H1.3, H1.4, H1.5); in the dimension of authenticity, the distance adjustment method is considered to be better (H1.6) due to the increase of unreal feeling due to the addition of iris blur. Among the three interactive tasks of searching, inputting and moving the slider, the effect of adding aperture blur is better (H2.1, H2.2, H2.3). The subjects were divided into three groups, and the hypothesis was verified by comparing the data between two experimental groups (two types of deep remission) and one control group (deep conflict).

4.4 Artistic Creation Tasks of Colleges and Universities Under Intelligent VR

In this experiment, 19 subjects, including 11 males and 8 females, were selected. The subjects were aged from 17 to 22 years, with an average age of 20 years. Among the 19 students, 10 had VR and AR experience. The subjects were divided into group A, group B, and group C. There were 7 people in group A (1 left hander), 6 people in group B, and 6 people in group C. about 50% of each group had no VR and AR experience. Before the experiment, we didn't disclose the specific experimental tasks. Three groups all experienced two scenes of VR and AR Tetris.

4.5 Experimental Process of Art Creation and Design Teaching in Universities

First of all, simply collect user information, and inform the experimental process, equipment operation and other related matters. The experiment was carried out according to the following four steps [29]:

Step 1: The subjects entered VR to find different scenes, accepted the task prompts, viewed the scene, and took off the helmet to retell the objects contained in the scene. A. Group B participated in the two experimental scenes of aperture blur and distance adjustment, and group C participated in the scene with deep conflict.

Step 2: The participants started the game after finishing the viewing task. After observing the scene, they switched to the scene with "different" objects through the button, searched for "different" object targets by rotating the head mounted display, and grasped the "different" object targets in the scene through the handle. At this time, the operation time, grasping times and success probability of the subjects will be recorded. After the task, the subjects were interviewed and asked to describe their overall perception of the scene and fill in the questionnaire.

Step 3: The subjects enter the AR Tetris scene, accept the task prompts, view the scene, exit the scene and retell the objects contained in the scene. Group B participated in the two experimental scenes of aperture blur and distance adjustment, and group C participated in the scene with deep conflict.

Step 4: After completing the task of viewing the scene, the participants enter the scene again to perform the game task. After completing the five layers of squares, the participants continue to perform the next interactive task. The system will record the number of operations and the operation position. Move the slider to 88 to restart the game. In the second level, the slide bar was designed to be translucent, which had a deep conflict with the background content and required the subjects to continue to complete the task. After the task, a brief interview was conducted and the questionnaire was completed.

4.6 Data Collection and User Interview

During the experiment, the VR system recorded the position of the trigger button and the corresponding target object position, the number of trigger grabs and the time spent on completing the task. In VR finding different scenes, the difference between the position of the trigger button and the corresponding target position can help to judge the accuracy of the test operation, and the smaller the difference, the higher the accuracy; VR finding the trigger times of the handle in different scenes and the number of screen clicks in the AR Tetris scene can help determine the ease of use of the interaction, and the more times, the lower the ease of use; in the two experimental scenarios, the interaction task is executed The service time can be used as auxiliary data for verification. The most comfortable way of conflict relief was obtained through comparative experiment. Because the four dimensions

of learnable, facticity, convenient and satisfaction are subjective emotions, they can be scored by use scale. The relationship between the subjects' experience indicators and the collected data is shown in Table 1.

In addition, the efficiency of conflict mitigation was judged by the time-consuming data of participants in completing interactive tasks.

Table 1. The relationship between the participants' experience indicators and the collected data

Indexes	Objective Data					Subjective Data
	VR find Different			AR Tetris		AR Tetris /VR find different
	Distance Error	Grab trigger times	Time consumption	Click trigger times	Time consumption	USE Scale
Accuracy	√	—	√	√	—	—
Usability	—	√	√	—	√	—
Learnable	—	—	—	—	—	√
Facticity	—	—	—	—	—	√
Convenient	—	—	—	—	—	√
Satisfaction	—	—	—	—	—	√

5 Experimental Results and Analysis

Figure 5 shows the subjective scores of all subjects in six situations of no remission, adding iris blur mitigation and adjusting distance remission in two kinds of scenarios. In VR scene, the average score is only 4.06 when there is deep conflict and no mitigation, while the average score after adding aperture blur is 5.89, and the average score after adjusting distance is 5.00; in AR scene, the average score is only 4.53 when there is deep conflict and no mitigation, the average score after adding aperture blur is 6.58, and the average score after adjusting distance is 5.74. In the two kinds of virtual scenes, the depth conflict can be effectively alleviated by adding aperture blur and adjusting the distance between components and subjects.
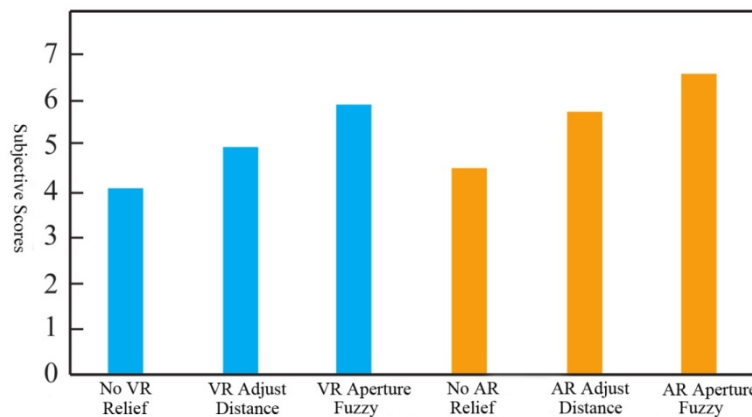
Figure 5. The scores of subjects in art creation and design scenes of two types of universities

Figure 6 shows the data of two kinds of deep conflict mitigation methods when the subjects are performing VR tasks in different scenes. Figure 6 (a) shows the distance error between the trigger handle button and the real three-dimensional object position. The average error is 158.12mm when the aperture is blurred. The average error of adjusting distance mode was 182.81mm, which was 24.69mm (13.57%) higher than that of aperture blur mode, but there was no significant difference between the two methods (at the significance level $\alpha = 0.05$, after variance test, $p = 0.06 > 0.05$.

Figure 6 (b) shows the time taken by subjects to complete the task. The average time spent in the mode of adding aperture blur is 588.81s and that of adjusting distance is 608.45s. In the dimension of ease of use,

adding aperture blur saves 19.64s (3.23%), but the difference is not significant (significance level $\alpha = 0.05$, after variance test, $p = 0.06 > 0.05$), which is consistent with the conclusion of distance error index. Figure 6 (c) shows the number of grabbing triggers. The average number of grabbing triggers under the mode of adding aperture blur is 86, and that of adjusting distance is 95. In terms of usability, adding aperture blur mode reduces 9 times (9.45%). The difference was significant (at the significance level $\alpha = 0.05$, $p = 0.04 < 0.05$). It is also proved that the operation can be carried out more easily and accurately with the addition of aperture blur mode, which is consistent with the conclusion of time-consuming index. Figure 6 (d) shows the subjective score. The two methods have no effect on authenticity and satisfaction.

Adding iris blur is better than adjusting distance in the dimension of easy learning, but the difference between the two methods is not significant (at the significance level $\alpha = 0.05$, through the test of variance, $p = 0.07 > 0.05$). The average comfort score of the subjects under the mode of adding iris blur was 6.24, which was higher than that of the mode of adjusting distance (5.37), indicating that the comfort of adding iris blur was better.
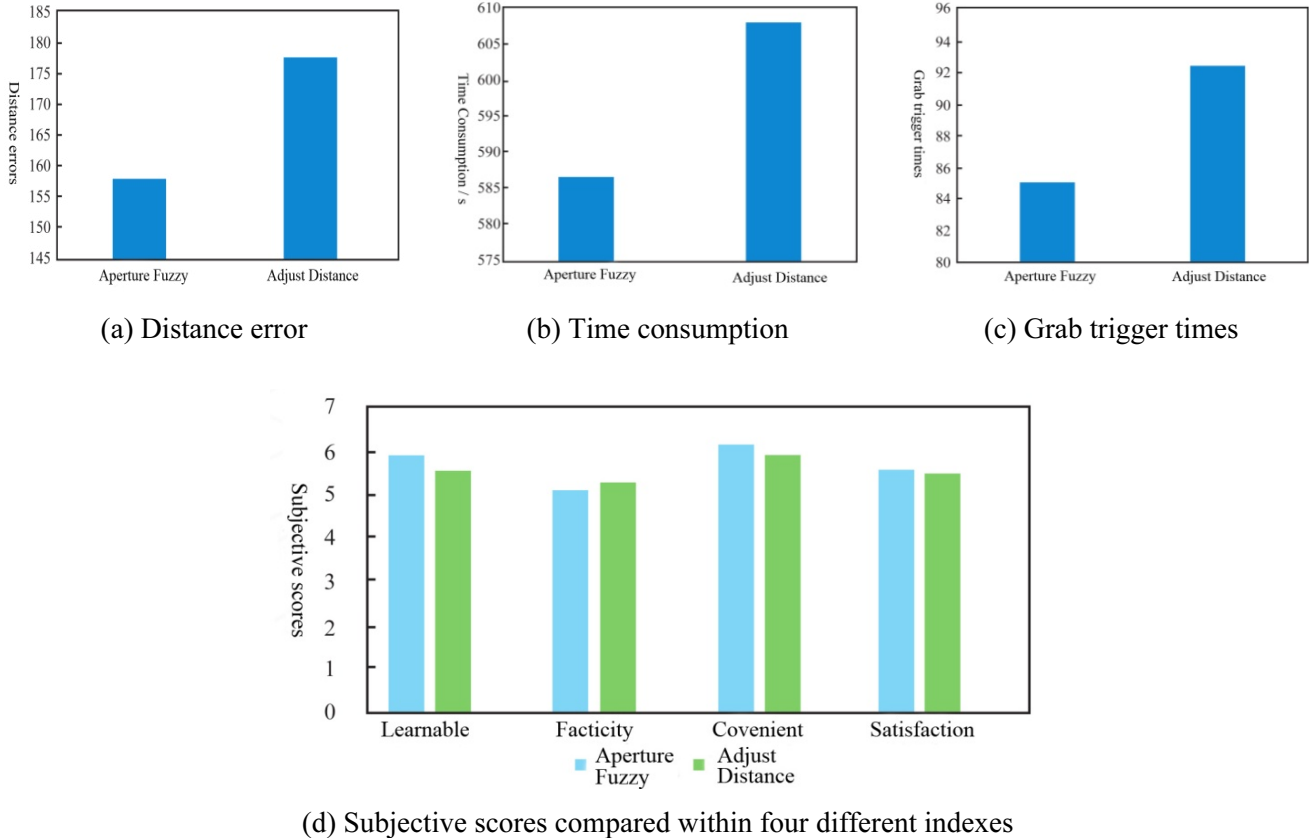

(a) Distance error   (b) Time consumption   (c) Grab trigger times

(d) Subjective scores compared within four different indexes

Figure 6. VR finding subjective and objective data in different scenes

Figure 7 shows the data of two deep conflict mitigation methods when the subjects perform tasks in the AR Tetris scene. Among them, Figure 7 (a) shows the hit trigger times of the pilot, the average click trigger times under the mode of adding aperture blur is 342, and the average click trigger times under the mode of adjusting distance is 398. In the dimension of accuracy, adding aperture blur mode reduces the operation by 56 times (14.07%). It can be seen that adding aperture blur mode can be more leisurely and more accurate. Figure 7 (b) shows the time taken by subjects to complete the task. The average time spent in the mode of adding aperture blur is 315.44s, and that of adjusting distance mode is 324.43s. On the dimension of ease of use, the method of adding aperture blurs saves8.99s (2.77%). There is a significant difference between the two methods (at the significance level $\alpha = 0.05$, through the test of variance, $p = 0.04 < 0.05$), indicating that the method of adding aperture blur is easy to use It's better sexually. Figure 7 (c) shows the subjective score. Adding aperture blur can play a certain role in the dimension of easy learning, but it is not significant (group excludes left handedness data, at the significance level of $\alpha = 0.05$, through the test of variance, $p = 0.06 > 0.05$). In addition, there was no significant decrease in the authenticity dimension (at the significance level of $\alpha = 0.05$, after variance test, $p = 0.08 > 0.05$).

There was no significant difference in comfort and satisfaction. This experiment further analyzed the experience elements of participants in the interaction tasks of viewing scene, inputting and moving the slider bar under the two mitigation modes. The results showed that the average time spent in the two kinds of mitigation was similar (5.0 s and 5.6 s, respectively) in the moving slider task. In the view / search and input tasks, adding aperture blur is more efficient. In the interview, 12 participants mentioned that aperture blur can help users focus on the scene content. The average time consumption of adding aperture blur mode is shorter than that of adjusting distance mode, which can prove that adding aperture blur is a friendly way to alleviate deep conflict in virtual scene, as shown in Table 2. In the experiment, it is found that 2.6m is an effective reference value under the mode of adjusting distance. At this time, users' perception of deep conflict is weak and the experience is better.
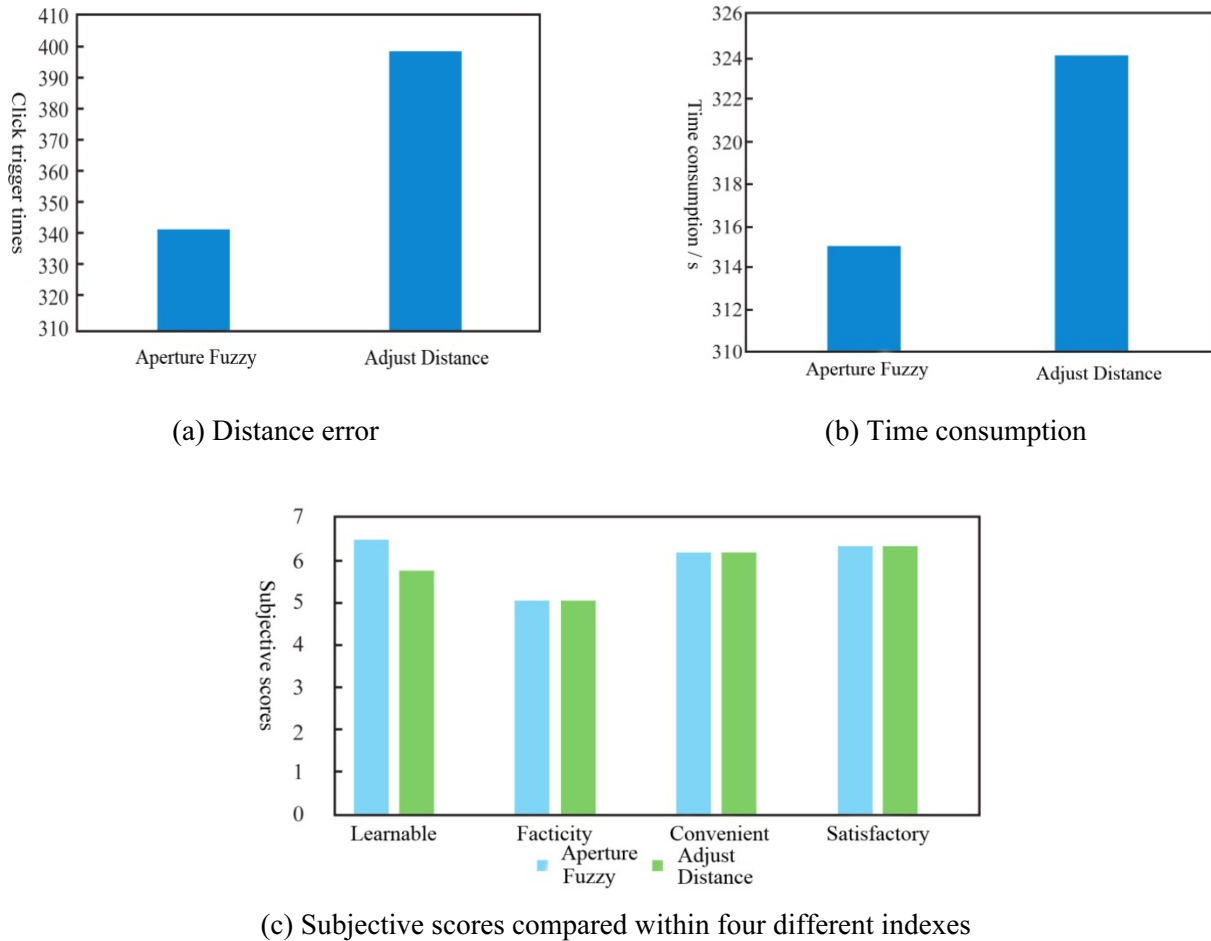
(a) Distance error

(b) Time consumption

(c) Subjective scores compared within four different indexes

Figure 7. Subjective and objective data of AR Tetris scene

Table 2. Comparison results of time spent on completing three types of interactive tasks (Time: Seconds)

Compared indexes	Aperture Fuzzy	Adjust Distance
Input	32.2938	34.3894
View / search	11.2833	12.3941
Slide bar	8.3736	7.9387

6 Conclusion

In this paper, non photorealistic rendering is introduced into the construction of virtual scene, and LIC algorithm based on tensor field is used to simulate artistic image to generate artistic virtual environment. In the simulation, firstly, the curve angle field describing the local structure of the image is obtained by calculating the structure tensor of the brightness component of the source image; secondly, the total variation partial differential equation is used to smooth it to control the direction of the brush in the line integral convolution; secondly, the texture reference image is generated by randomly disturbing the source image, making the final drawing image full of lively motion; Finally, the art image is integrated into 3D scene, and tip technology is used to get a feasible virtual environment with artistic feeling. This kind of non photorealistic rendering has opened up a new space for the teaching of art creation and design of traditional VR technology in colleges and universities. Although this paper uses the VR technology gives a novel method to build art creation and design teaching, the experimental results have shown that the proposed algorithm has an excellent effect on the field of college art creation and teaching design. How to collect more related data for the VR technology and apply such technology to the college art creation and teaching design is our future works.

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