

Creation of Augmented Reality and Virtual Reality Technology in VR Animation Design

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VR refers to virtual reality. In the animation industry, VR technology offers people a new type of animation experience. Nowadays, VR animation is being used in a wide range of industries, bringing huge economic benefits. However, there are several problems that cannot be ignored in the current design and production of VR animation, mainly due to the use of a single technology. Relying on a single virtual reality technology for design and production will lead to unsatisfactory results and poor quality VR animations. Therefore, this present study integrated augmented reality technology and virtual reality technology into VR animation design and creation, and developed a model based on the UNITY 3D platform. After simulating 50 samples, the experimental results showed that the application of the improved development mode could increase the production effect of VR animation design by 7.04%, which enables VR animation to benefit the social economy and cultural construction.

Keywords: VR animation design, augmented reality technology, virtual reality technology, UNITY 3D

1. INTRODUCTION

In the foreseeable future, there will no longer be a traditional one-way transmission and reception of information between animation products and audiences. The audience will be immersed in a virtual animation environment and can participate in the presentation. The remainder of this section reviews the works of several scholars who have conducted research on VR animation design and augmented and virtual reality technology.

Several scholars have examined VR animation design in particular. Kwon conducted an in-depth study on the characteristics of VR animation in cross-media content by applying the concept of implicit editing [1]. Research by Monteiro et al. pointed out that many VR animations are based on the first-person perspective, but there are advantages to using other perspectives, such as the third-

person perspective [2]. Zhao established an ontology describing the material properties of animations and, by exploring commonalities across aspects such as 3D technology applications, 3D space, and artistic and cultural factors, revealed the intrinsic connection between digital sculpture and 3D character animation [3]. The research of Wang et al. took the gastroscope simulation system as an example, and discussed the excellent performance of VR animation technology in surgical research, training and education [4]. Wei proposed a bidirectional system capable of animating the full-face avatars of two users using user-friendly head-mounted cameras; by establishing precise correspondences between images and avatars, the system learns an end-to-end real-time tracking model [5]. The research of Dadalan et al. scholars examined the impact of virtual reality on students' cognitive level from the controller and regulatory system units [6]. Ho explores the application of 6-DOF highly immersive virtual reality in spatial mapping to evaluate the impact of spatial perception ability on learning motivation for 3D software [7].

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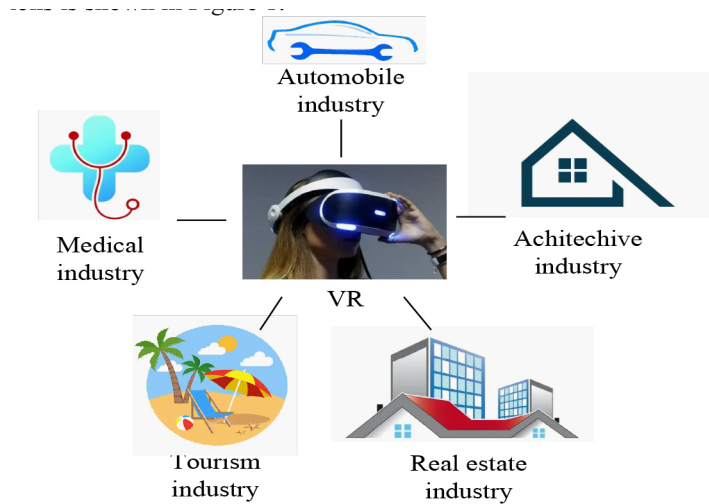


Figure 1 Overview of VR applications.

In addition, many scholars have conducted research on augmented and virtual reality technology. The research objective of Hutahae et al. was to develop an augmented reality media system that makes it easier for students to understand the process of installing a computer network, thus making the system an alternative to learning media [8]. Sappa's research focused on the importance of augmented reality technology applied to cultural products and studied this from the perspective of intellectual property [9]. Iskander's study investigated the current state of augmented and virtual reality technologies widely used in ophthalmology, and explained the technologies used [10]. Sun et al. proposed a method for visualizing the dynamic inspection of railway routes based on augmented reality technology. First, a dynamically moving train model was generated using the railway track spectrum and matched with a home-made calibration device. Then, a kinematic structure algorithm was used to reconstruct the environment and, finally, a distance function was used to calculate the distance to determine whether the train could pass a certain line. Experimental results showed that the method performs well, with low cost and high accuracy [11]. Wahidi et al. designed a safety simulation system based on virtual reality technology to provide an immersive experience for safety training and reduce the training cost [12]. Chen et al. proposed that the application of virtual reality technology to the classroom environment is a low-cost and highly efficient solution [13]. The research of Biener et al. focused on ways to help users identify target slides and create animations with the help of virtual reality technology [14]. Liu extracted four key words from the target literature by means of word frequency analysis and abstracted them into four social concepts: conceptual awareness, education, regulation and finance to explore the inner link between society and virtual reality [15].

Nowadays, there are many research studies and applications related to VR animation design and augmented and virtual reality technology, and the theoretical research results are of high quality. Therefore, starting with the existing research results, this paper applies augmented reality technology and virtual reality technology to VR animation design, so as to improve the effect of VR animation design and production.

2. VR ANIMATION DESIGN AND CREATION

(1) Scope of application of VR

VR has been applied in many industries, and has produced both cultural and economic benefits [16]. An overview of VR applications is shown in Figure 1:

Figure 1 shows the application of VR in various industries. Automotive industry: VR allows engineers and designers to easily experiment with vehicle appearance and construction before commissioning expensive prototypes. Healthcare industry: VR can have a major impact on healthcare. Healthcare professionals are now using virtual models to prepare for work on real bodies, and VR is even being used to relieve the pain of burns. Tourism industry: VR can make travel more accessible. Using VR to view properties around you from home, without the need for a real estate agent, allows people to explore home types online. Architecture: VR is gradually changing the way architects design and experiment with work. Homeowners can experience the building space and make real-time changes before the house is actually built, saving money and architects' time. Entertainment industry: VR is mainly evident in games and movies. Art design: VR can be used to create artworks such as animations, illustrations, dioramas, etc.

(2) Innovation of design and creation mode

VR animation and traditional 3D animation have similarities and differences [17]. They have this in common: VR animation, like traditional 3D animation, is based on a 3D model [18]. The difference is that VR animation can present images of any dimension, and the viewer needs only to control the VR device to complete all operations, which offers an incomparable sense of presence [19]. This current study applies augmented reality and virtual reality technology to the innovation of VR animation design and creation model, which can create higher quality VR animation. The innovation of the design and creation model is shown in Figure 2:

It can be seen from Figure 2 that in the VR animation design based on augmented reality and virtual reality technology, there is a standardized design process:

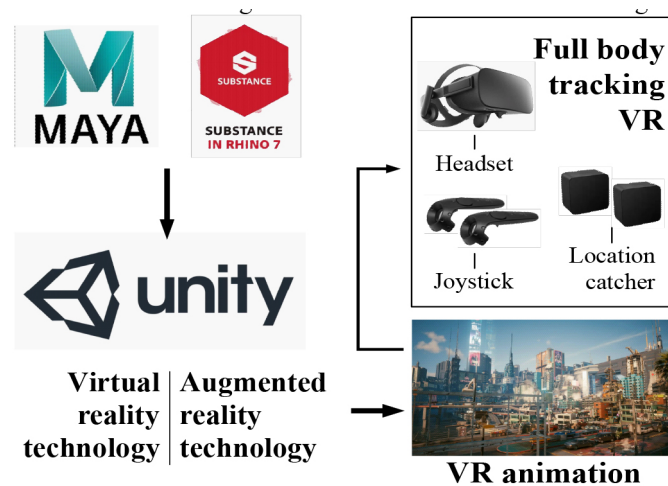


Figure 2 Innovation in design and creation models.

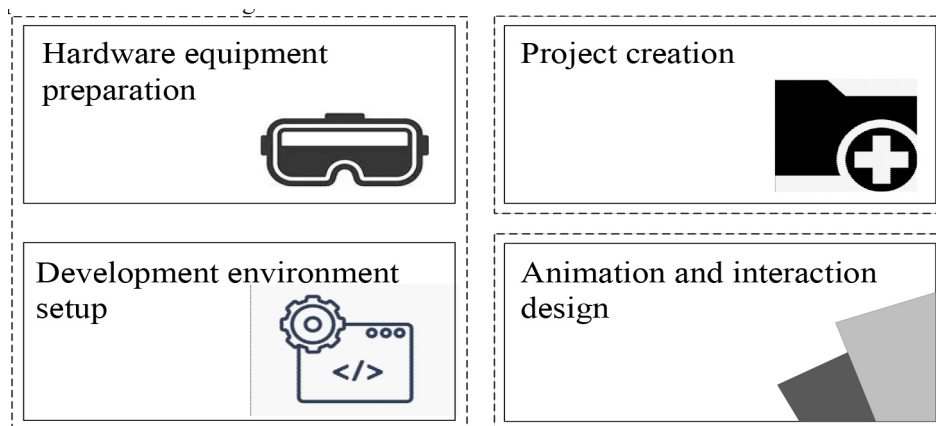


Figure 3 Development process.

1) Geometric modeling

Using MAYA for modeling, some models will involve bone binding [20]. The widely used modeling methods are as follows: using basic elements to make geometric models by splicing and combining them; generating a new geometric model by performing Boolean operations between two shapes; making objective object models through instant modeling tools; using 3D transformations to generate new shapes; performing linear or nonlinear transformations on 3D models to generate new shapes; using particles to simulate geometric modeling. A series of particles are used to define the life cycle process of each particle of an object, thereby generating object models of certain natural phenomena such as clouds, fog, snow, rain, fire, and waterfalls.

2) Texture map

In 3D design, the clever application of materials and textures will produce a good result in the created work [21]. A normal map is a special texture that can be applied to a 3D surface. It contains a lot of detailed surface information and can create many special stereoscopic effects on the shape of an ordinary object [22]. A good model can provide a good start for animation, and the right texture can greatly enhance this model. The two complement each other and cannot be separated from one other. The VR animation design and creation model studied in this paper mainly uses SUBSTANCE to create texture maps.

3. APPLICATION OF AUGMENTED REALITY AND VIRTUAL REALITY TECHNOLOGY

(1) Development platform

This model uses UNITY 3D as a development platform, which has the following advantages. UNITY 3D supports multiple publishing platforms, which is an important reason why UNITY 3D is widely used for VR projects. It can meet the needs of most projects and is suitable for multi-platform publishing. The instant preview of the screen is a favorite feature with many developers. The biggest feature of UNITY 3D is that it allows developers to observe the effect of the developed scene in real time, and it is very convenient to preview the scene. UNITY 3D's development function makes it easy to create objects with the ability to drive target objects. The development process is shown in Figure 3:

The development process is comprises four modules:

- 1) Hardware equipment selection: high-performance configuration computer; suitable VR equipment; suitable network access environment.
- 2) Development environment construction: downloading UNITYHUB; adding editor; adding system plug-ins.

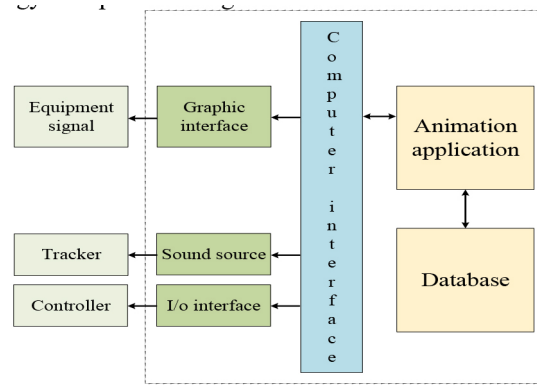


Figure 4 Concept of virtual reality technology.

- 3) Creation of project: selecting mode; selecting platform.
- 4) Animation and interaction design: creating or importing assets; animation production; program development.

(2) Realization of virtual reality technology

Animation is a form of artistic expression, which fully combines rich plots, well-defined characters and beautiful scenes, bringing audiences enjoyment in terms of audio-visual, spiritual and other experiences. Animation films occupy an important position in the film market. Animation is one of the mainstream entertainment methods for people today, and its derivative industries have brought many social benefits, so the animation market space is very large. Given the progress of society and people's greater entertainment demands, the animation industry must keep up with the trend and make changes if it wants to continue to maintain its position from the perspective of the audience. At present, virtual reality technology is gradually becoming mature and, organically combined with animation production, it will definitely give people greater enjoyment. The concept of virtual reality technology is depicted in Figure 4:

Figure 4 shows the concept of virtual reality technology. The combination of virtual reality technology and animation production not only stimulates the enthusiasm of animation producers; it also reduces the cost and threshold of animation production, and optimizes the animation production process, which can improve the quality of animation production, enabling more people to participate in animation production. The application of the improved model proposed in this paper is as follows:

1) Character model design

In pre-animation production, modeling and scenes are undoubtedly very important. In a good animation work, the sophistication and beauty of the character model affects the hearts of the audience. In the traditional animation production process, animators need to consider many factors and spend much time modeling, which is undoubtedly a major obstacle to animation production. Virtual reality technology can simplify the animation production process, make the character model design more appropriate, beautiful, fine and flexible, save manpower, material resources and time, and significantly improve the efficiency of character modeling.

2) Motion tracking capture

Virtual reality technology is closely related to motion capture technology. Virtual reality technology can cooperate with animation capture technology to greatly reduce animation production time and improve animation quality.

3) Scene design

In a good animation work, in addition to the characters, the most important thing is the scene. Whether the scene is realistic, beautiful, and whether it is seamlessly connected with the surrounding environment will affect the quality of the animation work. It is not enough for animation works to have good plots and beautiful, meticulously designed characters. The scenes provide the finishing touch, and can give animation works aura certain atmosphere. The application of virtual reality technology to the production of scenes is very convenient for animators, will help them solve many problems, and adds the finishing touch to animation works.

(3) Realization of augmented reality technology

Augmented reality technology is a complex technology that involves both hardware and software implementation. The steps used to achieve enhanced display technology are shown in Figure 5:

As shown in Figure 5, firstly, the real-world scene is obtained by the camera, and then the image of each frame in the video information is detected separately. When there is a matching image, the tracking registration is performed and, finally, the virtual object and the real-life scene are superimposed.

4. ALGORITHMIC PROCESSING IN THE TECHNIQUES USED

With augmented reality technology, the camera obtains information, and finally displays the object image in the real world on the pixel plane where the screen of the mobile phone is located through a series of coordinate transformations, forming a frame image visible on the handheld terminal. The imaging principle model and coordinate representation of the camera are given, as shown in Figure 6:

Converting from Figure 6 to the pixel coordinate system, the relationship can be obtained with Formula 1:

$$u = \frac{x}{d_x} + u_0 \quad (1)$$

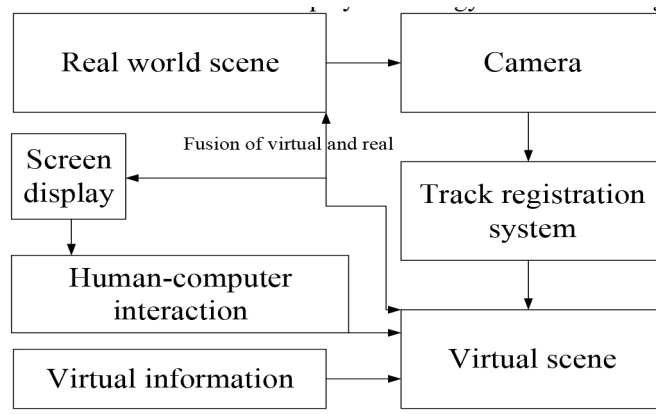


Figure 5 Achievement of augmented reality.

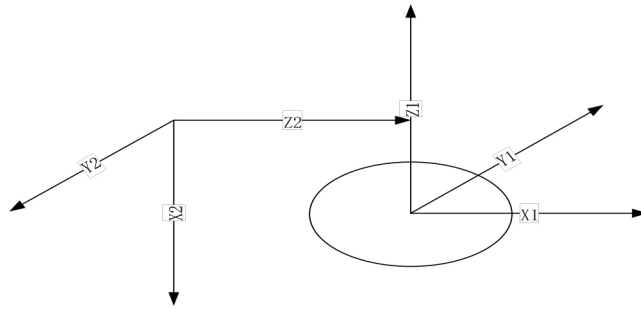


Figure 6 Coordinate representation.

Further, the relationship for another axis can be deduced with Formula 2:

$$v = \frac{y}{d_y} + v_0 \quad (2)$$

After converting to matrix form, the relation is obtained with Formula 3:

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{1}{d_x} & 0 & 0 & \frac{1}{d_y} \end{bmatrix} \quad (3)$$

In the relationship, x refers to the right side of the screen, and the y axis refers to the bottom of the plane.

According to the perspective projection formula, the change relationship can be obtained with Formula 4:

$$\begin{cases} x_0 = f \frac{x_c}{z_c} \\ y_0 = f \frac{y_c}{z_c} \end{cases} \quad (4)$$

It can be converted to Formula 5:

$$z_c = \begin{bmatrix} x_0 \\ y_0 \\ 1 \end{bmatrix} \quad (5)$$

The initial transformation of coordinates is carried out by using the translation transformation formula. The translation transformation formula is obtained with Formula 6:

$$(x, y, z, 1) = (x + t_x, y + t_y, z + t_z, 1) \quad (6)$$

where t_x, t_y, t_z is the translation vector.

The scaling transformation is as shown in Formula 7:

$$\begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix} = M \begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix} \quad (7)$$

After further transformation, Formula 8 can be obtained:

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = sH \begin{bmatrix} x_w \\ y_w \\ 1 \end{bmatrix} \quad (8)$$

Combining the above formulas, Formula 9 can be obtained:

$$H = [h_1 h_2 h_3] = sM_{int} [r_1 r_2 t] \quad (9)$$

where, S is a constant, and M_{int} is an internal parameter of the camera.

After further decomposition, Formula 10 can be obtained:

$$\begin{aligned} h_1 &= sM_{int}r_1 \\ h_2 &= sM_{int}r_2 \\ h_3 &= sM_{int}r_3 \end{aligned} \quad (10)$$

Because R is orthogonal, r_1, r_2 is also orthogonal, which leads to two implicit formulas: Formula 11 and Formula 12:

$$r_1^T r_2 = 0 \quad (11)$$

$$\|r_1\| = \|r_2\| = 0 \quad (12)$$

In Formulas 11 and 12, r_1, r_2 are the components of R on x axis and y axis.

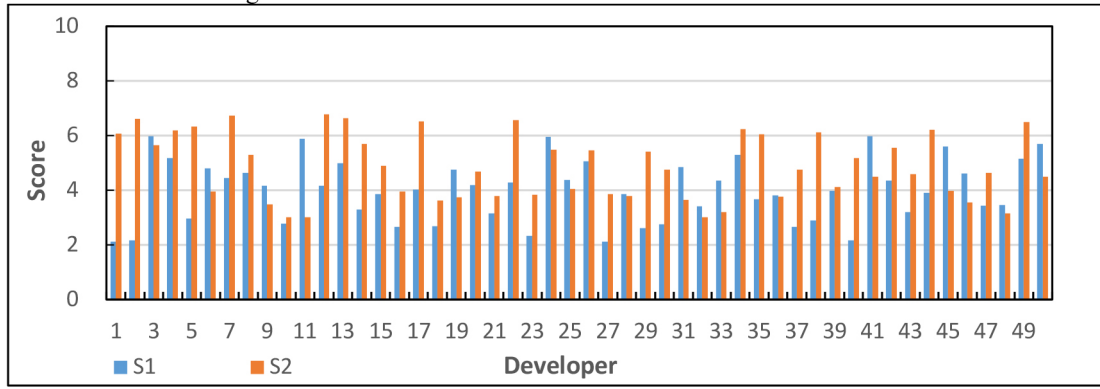


Figure 7 Comparison of animation presence results.

By replacing r_1, r_2 with the relevant knowledge of linear algebra, Formulas 13 and 14 are obtained:

$$h_1^T M_{int}^{-T} M_{int}^{-1} h_2 = 0 \quad (13)$$

$$h_1^T M_{int}^{-T} M_{int}^{-1} h_1 = h_2^T M_{int}^{-T} M_{int}^{-1} h_2 \quad (14)$$

After expansion, B can be obtained, as shown in Formula 15:

$$B = \begin{pmatrix} \frac{1}{fx^2} & 0 & \frac{-c_x}{fx^2} \\ 0 & \frac{1}{fy^2} & \frac{-c_y}{fy^2} \\ \frac{-c_x}{fx^2} & \frac{-c_y}{fy^2} & \frac{-c_x}{fx^2} + \frac{-c_y}{fy^2} + 1 \end{pmatrix} \quad (15)$$

In Formula 15, B is a symmetric matrix.

Through the image obtained by the camera during checkerboard correction, Formula 16 can be obtained:

$$vb = 0 \quad (16)$$

After solving the matrix, the internal parameters of the camera can be obtained, as shown in Formula 17:

$$fx = \sqrt{\lambda/B_{11}} \quad (17)$$

According to the obtained formula, the solution of the internal related data of the camera is completed, and the homography matrix obtained from the feature point pair information after optimization and matching is used. The external parameters of the camera are as Formula 18:

$$\begin{cases} r_1 = \lambda_1 M_{int}^{-1} h_1 \\ r_2 = \lambda_1 M_{int}^{-1} h_2 \\ r_3 = r_1 \times r_2 \\ t = \lambda_1 M_{int}^{-1} h_3 \end{cases} \quad (18)$$

t represents the image obtained by each camera when the checkerboard is corrected.

The second order difference is as Formula 19:

$$V_c([a, b] \times [c, d]) = \Delta_a^b \Delta_c^d C(u, v) \quad (19)$$

Then the function is determined as Formula 20:

$$C(u_1, \dots, u_n) = F(F_1^{-1}(u_1), \dots, F_n^{-1}(u_n)) \quad (20)$$

5. EXPERIMENT AND RESULT COMPARISON

Fifty practitioners were invited to test the effect of VR animation designed and produced by the improved VR animation development model. They used the proposed model and the unimproved design and development mode respectively for VR animation design and production. After the testing was completed, the practitioners were asked to respond to a survey questionnaire intended to determine the effects of VR animations produced using each of the two modes in terms of three attributes: animation presence, animation interactivity, and animation finesse. through design scoring, with 1-10 points for each item. Finally, the final animation effect was evaluated and compared through the scores of the questionnaire. The improved design and development model and the unimproved design and development model were set to S1 and S2 respectively.

(1) Comparison of animation presence score results

Through augmented reality and virtual reality technology, the audience can receive a more immediate experience from VR animation. Presence comprises two aspects of immersion: psychological and physiological. The core of psychological dimension immersion is the achievement of the audience's psychological distance, and the audience's psychological distance to VR animation changes according to the changes of the presence dimension created by the immersive medium. According to the immersion degree and narrative experience of immersive animation, the presence dimension can comprise bystanders, participants, immersers and witnesses. The presence of animation breaks through the aesthetic barriers between the experiencer and the medium, reduces the threshold and requirements of art appreciation for the experiencer as much as possible, and impresses the experiencer with its most direct and essential beauty. The comparison of the animation presence scoring results for the two modes is shown in Figure 7.

Figure 7 shows a comparison of the developer's scores for the presence of animations produced by each of the two modes. Developers rated the presence of VR animations made in the improved mode higher than VR animations made in the unimproved mode. To sum up, the improved design mode proposed in this paper outperformed the unimproved design mode in terms of animation presence.

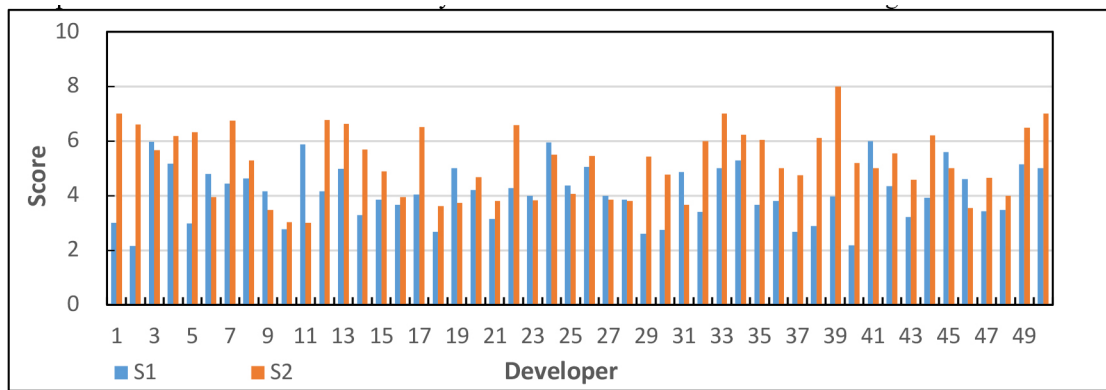


Figure 8 Comparison of scoring results for animation interactivity.

(2) Comparison of animation interactive scoring results

The interactive design basis of VR animation has the following three aspects:

1) Designing interaction points based on light and shadow

Proper fill light will enhance the effect of the film, and the same is true in virtual reality animation. For example, the use of spotlights allows users to select and focus on information in the virtual reality animation world. At the same time, it can also highlight the key points of the situation and improve the atmospheric result.

2) Designing interaction points based on sound

Sound is an important auxiliary tool for setting the atmosphere. No matter what movie or animation it is in, the assistance of sound can make the situation more exciting, allowing the audience to be more immersed in the film by combining the virtual display technology and the situation. The inclusion of sound allows the audience to enhance their sense of space, distance and direction.

3) Designing interaction based on audience and character eyes

The current virtual reality technology uses the user's handle and twists the head to perform corresponding action recognition, and the recognition of the user's eyes, consciousness, etc. has not yet been formed. Generally speaking, the tracking technology of user head data in virtual reality technology is relatively mature. By monitoring the degree of user head movement, the transmission and transformation of corresponding data can be achieved. When the user moves the head to a certain position and stops, it will trigger the timing effect of the system. When the user's head stays in this position for one second and then moves, the next decision will not be made. When the user's head stays at this position for more than one second and no corresponding motion data is generated, it means that the user wants to know more about this part of the scene. This judgment provides information assistance for the system's next decision. Once the system senses that the user has stayed in a certain position for too long, it will trigger the next scene and lead the user to a new scene.

The comparison of the animation interactivity results for the two modes is shown in Figure 8:

Figure 8 shows the developers' comparison of the interactive scores of animations produced in the two modes. Developers rated the interactivity of VR animations made

with the improved mode higher than those made with the unimproved mode. To sum up, the improved design in this paper outperforms the unimproved design in terms of animation interactivity.

(3) Comparison of animation precision score results

The role of VR animation finesse is as follows:

1) It is convenient for shaping the objective space.

Objective space refers to the space composed of visible objective substances for character performance, and is also often referred to as 'material space' or 'narrative space'. VR animation designers provide a good foundation for the movement of characters and the scheduling of shots by designing the composition, perspective, and scene of the shots. The requirement of animation precision is that animation should accurately express the time, place, cultural characteristics, historical features and other aspects of the event.

2) It can show the personality of the character.

In VR animation, characters and animation finesse are interrelated. High-precision animation can show the character's personality, hobbies, living habits, occupational characteristics, etc., so that the audience can understand the character's characteristics, and play a direct and strengthening role in portraying the character's personality traits.

3) It can demonstrate the psychological activities of the role.

The excellent VR animation precision can highlight the psychological changes and inner emotional world of the characters, which has lyrical and expressive functions.

4) It can create atmosphere, metaphor, and theme.

High-definition VR animation can build a space image with sufficient atmosphere.

The comparison of the animation finesse scores for the two modes is shown in Figure 9:

Figure 9 shows a comparison of the developer's scoring results for animation finesse produced using the two modes. Developers rated the finesse of VR animations made with the improved method higher than those made with the unimproved method. To sum up, the improved design proposed in this paper outperformed the unimproved design in terms of animation finesse.

(4) Comparison of final animation effect scoring results

The above experimental results were comprehensively calculated, and the final animation scoring results were compared, as shown in Figure 10.

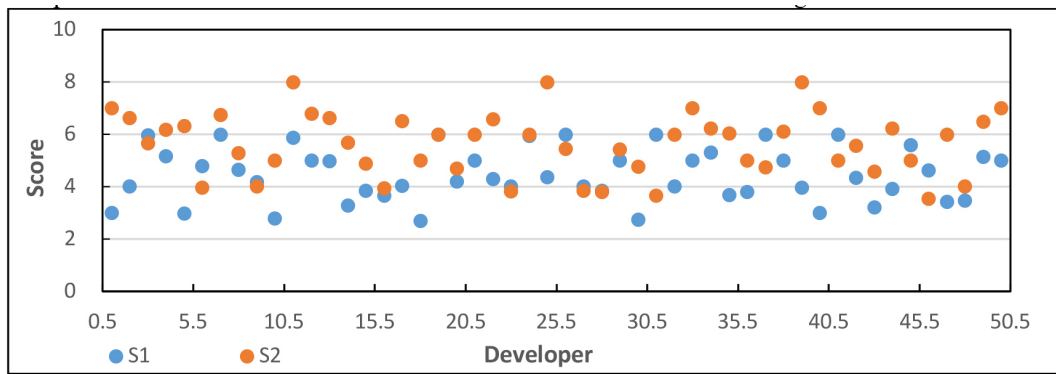


Figure 9 Comparison of scoring results for animation fineness.

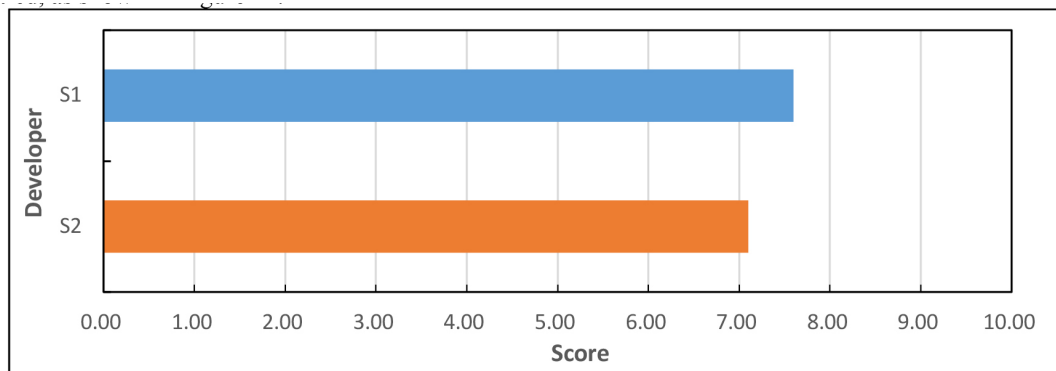


Figure 10 Comparison of the scores for the final animation effect.

Figure 10 enables a comparison of the final animation scores for the two VR animation production modes. The experimental results show that the application of the improved development mode can increase the production effect of VR animation design by 7.04%, which will assist designers to produce higher quality VR animations.

6. CONCLUSIONS

VR animation is a relatively recent form of expression. It combines the essence of computer science, graphics and film and television, benefitting the economic and cultural construction of society. Hence, the research on creative VR animation design is absolutely necessary. This paper applies augmented reality and virtual reality technology to the creative mode in VR animation design to solve the problem of the unsatisfactory effect of current VR animation. After simulating 50 samples, this paper obtained four experimental results, with scores for: animation presence, animation interactivity, animation fineness, and final score. The experimental results showed that the application of the improved VR animation design and creation mode improved the quality of VR animation by 7.04%, which enables VR animation to create more value for people and the animation industry.

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