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Article

Animated Interactive Communication of the Chinese Zodiac through Virtual Reality Technology

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Abstract: This study aims to explore the impact of a combination of virtual reality (VR) technology and Chinese zodiac animation for the dissemination of Chinese zodiac culture. A questionnaire survey was conducted for 100 university teachers and students for their experience in the VR Chinese zodiac animation. We used Flash, 3DMax, and UNITY to design a virtual showroom animation. Participants were highly satisfied with the VR Chinese zodiac animation with Cronbach's alpha coefficients of 0.862 and 0.941, confirming the internal consistency and reliability of the results. This animation provides an interactive experience, immersive viewing, and a space for imagination. The experts' understanding of VR technology and Chinese zodiac animation was higher than that of the students. The combination of VR technology and Chinese zodiac animation enhances communication and the user experience of Chinese zodiac culture. The results of this study are important for the design and improvement of VR for Chinese zodiac animations.

Keywords: Chinese zodiac culture, Chinese zodiac animation, Virtual reality technology, Transmission and dissemination

1. Introduction

Chinese zodiac culture, a key part of traditional culture, represents the year and personal phases according to the 12 signs of Rat, Ox, Tiger, Rabbit, Dragon, Snake, Horse, Goat, Monkey, Rooster, Dog, and Pig. Each zodiac sign presents a unique personality and traits, and symbolism with meanings. Zodiac culture reflects the Chinese people's observation and reflection of nature and serves as time division and cultural inheritance. Its study and dissemination deepen the understanding of the diversity of traditional Chinese culture. Chinese zodiac culture integrates global culture to create works of art with new cultural vitality.

The value of cultural inheritance lies in the preservation of traditions for future generations. In this study, the Chinese zodiac is regarded as the focus of traditional Chinese culture, carrying rich cultural information and profound symbolism. Therefore, it is important to develop effective preservation and dissemination methods. Along with the advancement of technology, particularly the rise of virtual reality (VR) technology, it is important to explore new applications of the technology in cultural dissemination. Using VR technology, short animations of Chinese zodiac culture can be presented in a more innovative, interactive, and immersive manner, meeting the standards of modern society by understanding and appreciating Chinese culture. Simultaneously, the combination of VR and animation effectively disseminates Chinese zodiac culture globally. This study was carried out to present cultural heritage, technological innovation, user experience enhancement, communication effect enhancement, and social practice evaluation in Chinese zodiac culture.

Inheriting and developing Chinese zodiac culture is the key to preserving traditional Chinese culture and an important path to building cultural confidence. To make the Chinese zodiac culture go global, traditional media restrictions must be lifted to expand communication channels for the culture. Existing traditional media such as newspapers, radio, and television, are often superficial in the presentation of Chinese zodiac culture and fail to explore its history and stories in depth. By explaining the history and development of Chinese zodiac culture, a short video animation was created in this study in line with the trend of the times. The story of the Chinese zodiac was integrated into the short animation. Using VR technology, immersive displays and interactive experiences were provided for the visual experience to transform traditional animation into new media for the dissemination of Chinese zodiac culture. As a cultural symbol, Chinese zodiac animation has the potential for cross-cultural and international communication which promotes intercultural understanding and exchange. Through the understanding of China and Chinese zodiac culture, cross-cultural friendships and cooperation can bee enhanced. Therefore, in this study, we enhanced audience participation using VR technology and displaying Chinese zodiac animation. The viewers could interact with the animation and had an immersive

experience, which helped thm understand the animation story and its cultural connotations. The animation enhanced the effects of education and learning. The VR interactive mode provided rich and vivid educational scenes for Chinese zodiac animation, stimulated the audience's interest in learning, and enhanced the educational effect. As a result, cultural experience and dissemination effects were increased. Through VR interaction, the audience understood the Chinese zodiac culture, which enhances the memory and resonance of the culture and promotes cultural dissemination.

After applying VR technology to Chinese zodiac animation, we explored its advantages in two main aspects: (1) whether VR Chinese zodiac animation gains higher recognition than traditional animation and (2) whether VR-enhanced Chinese zodiac culture can achieve wider dissemination. Through these studies, we demonstrated the effectiveness and advantages of VR technology in promoting the dissemination of Chinese zodiac culture.

2. Literature Review

2.1. Research on Chinese Zodiac

Zhao emphasized the importance of Chinese zodiac culture in Chinese paper-cutting art in her book "Presentation and External Communication of Chinese Zodiac Culture in Paper-Cutting Art" (Zhao, 2017). She pointed out that the art of paper-cutting demonstrated the diversity of Chinese zodiac culture and promoted its inheritance and wide dissemination. Teng analyzed the design characteristics of zodiac stamps in "Research on the Design of Zodiac Culture Stamps," showing its position in folk culture and folk art (Teng, 2020). In "Exploration of Cultural and Creative Design Based on Traditional Chinese Zodiac Images," Ye took the design practice of " Chinese Zodiac Rooster" as an example to explore the application of Chinese zodiac culture in contemporary cultural and creative fields (Ye, 2017). Chen and Liu applied diffractive paper art in cultural and creative industries and discussed how Chinese zodiac culture was fused with diffractive paper art and its impact on the industry (Chen & Liu, 2022). Chen discussed the application of Chinese zodiac culture in the jewelry market and its commercial value (Chen, 2021). Xu on the other hand, highlighted the role of Chinese zodiac culture in the fusion of Chinese and Western cultures by analyzing the Chinese zodiac elements in the animation "The Adventures of Jackie Chan" (Xu, 2020). At present, the main communication carriers of Chinese zodiac culture focus on the integration and application of mediums, such as paper cutting, stamps, jewelry, and cultural creation. Compared with these traditional cultural communication media, animation which is a more comprehensive and artistic expression and a carrier for the communication of Chinese zodiac culture appears to be advantageous in transmitting traditional folk culture to the world and in line with internationalization. Therefore, it is important to research the application of animation as a communication media carrier in the inheritance and dissemination of the Chinese zodiac culture.

As the carrier of Chinese zodiac culture, traditional communication media have one-way information dissemination, which limits audience feedback. Content production is mainly done by professionals, which reduces audience participation, and technological limitations lead to a lack of personalized experience. In contrast, zodiac animation as a comprehensive art can provide a rich audio-visual experience, emphasize the openness and participation of creation, and prompt the audience to deeply understand art and realize spiritual upliftment. Its plurality crosses artistic boundaries, encourages tolerance and openness, respects diverse perspectives, and provides a better posture.

In recent years, scholars have studied various presentations and innovations of the Chinese zodiac culture in animation. Fu, explored the combination of traditional and contemporary aesthetic needs and provided new creative ideas on "Zodiac Secret" in a humorous way (Fu, 2020). By analyzing "The Legend of the Chinese Zodiac", Chen and Li discussed the role of 3D and paper-cut animation in passing on Chinese culture and how the integration of Western musical elements added color to the story of the Chinese Zodiac (Chen & Li, 2018). Wang focused on the application of traditional elements in the Zodiac of the Dragon (Wang, 2014). In reflecting the characteristics of Chinese zodiac culture, he pointed out the excessive imitation of Western animation styles. Yuan and Zen on the other hand, analyzed Chinese Zodiac animation works from a critical point of view, pointing out that works such as "The Legend of the Chinese Zodiac's Twelve Chinese Zodiacs in General" were deficient in artistry and ethnicity, and even suspected plagiarism (Yuan & Zen, 2011). Liu showed that, although the newest Chinese zodiac animation works showed cultural vitality, they lacked image innovation and cultural connotations (Liu, 2022). On the other hand, Wang pointed out that although "Where is the Dragon" made efforts in the design of Chinese zodiac images, problems in other aspects impaired the overall quality of the work (Wang, 2017). Liu argued that character modeling design is the core of animation creation, reflecting the importance of folk art elements (Liu, 2017).

Although research on Chinese zodiac animation continues to expand into innovative areas, there is still an area to be developed on how to incorporate emerging technologies, such as VR to enhance the recognition and cultural conveyance of Chinese zodiac animation.

2.2. VR Development

VR technology has unique applications in various fields. Wang and Ma noted that VR plays an important role in psychology by simulating situations that are difficult to reproduce in the laboratory, such as agoraphobia treatment, while providing a safe training environment for athletes (Wang & Ma, 2023). This technology profoundly affects cognition, behavior, emotions, and attitudes through the creation of virtual characters and environmental adjustments. Li explored the digital communication of the Beijing Opera, an intangible cultural heritage (Li, 2021). He pointed out that with the integration of digital technology and traditional culture, digital communication of intangible cultural heritage has become a new research field. By applying the theory of spatial production and VR technology, he analyzed the situation of the dissemination of the Peking Opera culture in the digital era, its dilemmas, and its reasons, and proposes a new dissemination strategy based on VR. Zhong on the other hand, discussed the application of VR in the digital preservation of cultural heritage, emphasizing its advantages in improving the accuracy and efficiency of digital preservation (Zhong et al., 2021). He stated that VR technology demonstrated its importance in cultural heritage preservation by creating realistic virtual environments and simulated scenarios. Noah investigated the use of virtual 3D methods in cultural heritage research, particularly in interactive museum displays (Steuri et al., 2023). In particular, he emphasized the potential for using free game engine software and low-cost VR hardware to demonstrate image-based 3D reconstruction methods.

In summary, VR technology is increasingly used in psychology, cultural heritage, and heritage preservation. These research cases demonstrate the importance of VR technology in exploring the connotations of historical and cultural heritage and ways of transmission. In this study, the potential application of VR technology was explored in depth concerning the cultural background and animation of the Chinese zodiac.

3. Methodology

3.1. Research Process

We designed Chinese zodiac animation. We used VR technology to create a VR showroom. The research flow is illustrated in Fig. 1. We conducted a literature review to systematically collect, organize, analyze, and obtain the research status, trends, problems, and gaps in the research of Chinese zodiac culture and VR technology. A case study was carried out to examine the applications of VR technology. Using VR technology, a flash module was used to build Chinese zodiac elements to complete the Chinese zodiac animation short film. Additionally, 3DMAX was used to build a VR showroom, and Unity was employed to display the animation. A questionnaire survey was performed to verify the effectiveness and user recognition of this method.

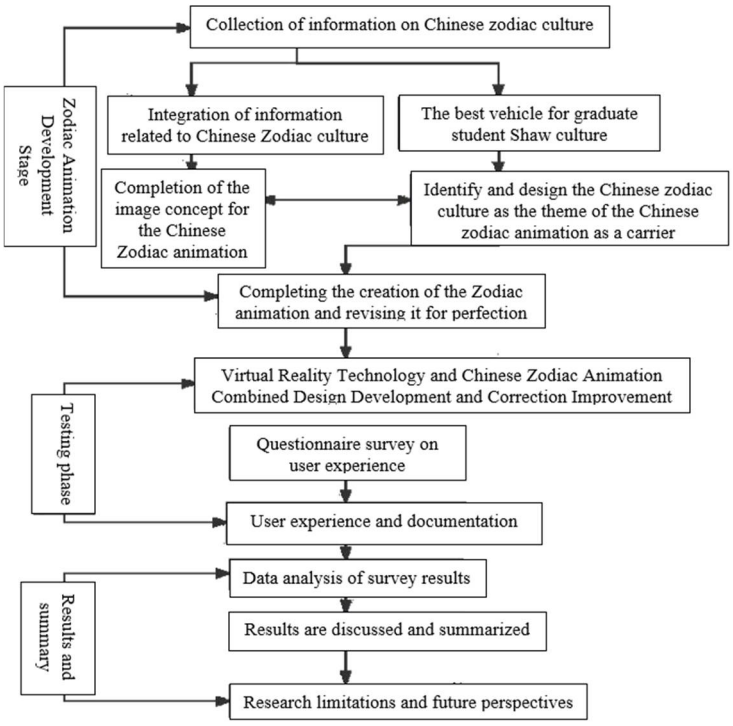

Fig. 1. Flow of this study.

3.2. VR Technology

VR technology is rooted in an interdisciplinary foundation to create an immersive user experience. The core purpose is to simulate real or imagined environments that meet the sensory and cognitive needs of the user. VR relies on advances in computer graphics to build realistic environments using 3D modeling, lighting, and texture mapping techniques. Interaction design ensures that users interact naturally and intuitively, including head tracking, gesture recognition, and voice control. User experience design emphasizes ease of use and intuitive interfaces to allow for hassle-free navigation and manipulation of virtual environments. Immersion and presence are the key concepts in VR experience. Immersion describes the user's disregard for the physical world and engagement with the virtual world to make the user feel "really there" in the virtual environment. These sensations rely on advanced software and hardware such as high-performance graphics processors, specialized VR headsets, and precise motion-tracking technology. In multi-user virtual environments, networking and social theories are essential for enabling effective real-time interaction and social connectivity. Psychological and cognitive science help developers understand user behavior, cognitive processes, and emotional responses in virtual environments which are critical to designing VR experiences that meet user needs. VR technology has three core functional characteristics: " interactivity ", " immersion, and " imagination ". Interactivity ensures effective interaction with the virtual environment; immersion provides a deep and comprehensive sensory experience; and imagination extends the boundaries of the user experience for the exploration and creation of scenarios beyond the real world. These three characteristics define the unique value and promise of VR technology.

In 1994, Burdea and Coiffet proposed (Li, 2022), three basic features of VR: 3I (Imagination, Interactivity, Immersion) based on the theory of 2I + B (two "interactivity" and one "boundary"). Burdea proposed adding immersion (I) to 2I to characterize VR systems more accurately. Thus, 3I succinctly summarizes the VR characteristics and represents a further refinement of VR technology and theory.

1 Interactivity refers to the ability of a user to interact with a VR environment. Interactivity requires a low-latency, highly responsive system design. For example, when a user turns his/her head, the virtual environment should be adjusted in real time to match the new perspective. This interactivity renders the experience more realistic and engaging.
2. Immersion refers to VR systems that create virtual environments in which the user feels "really there." Real-world perception was simulated using head-mounted displays, stereo sounds, and sensory inputs. Immersion is not limited to sight and sound but also includes touch, smell, and taste.
3. Imagination refers to the infinite possibilities of virtual scenarios and experiences offered by VR technology, which allows users to explore worlds that are impossible in reality or to perform activities that are impossible in the real world. It provides a broad platform for VR content creators to draw inspiration from various cultural, historical, and fictional backgrounds. Imaginability enables VR to provide rich application experiences in areas such as education, entertainment, art, and therapy.

3I characteristics are the cornerstones of the success of VR technology to deliver a unique, deep, and memorable experience to the user. As technology continues to evolve, 3I is used to achieve even greater enhancements and refinements and improve the overall quality of the VR experience and greatly advance the breadth and depth of VR technology applications.

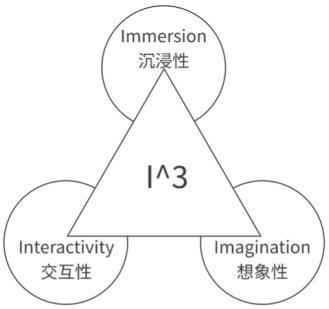

Fig. 2. Theoretical model of VR 3I.

As shown in Fig. 2, VR technology has evolved significantly covering hardware to software, content creation, and a wide range of applications. Hardware devices such as VR headsets, high-resolution screens, and various cutting-edge devices, provide realistic and comfortable experiences. Software and content continue to be innovated to meet the needs of various industries. Investor

participation in the global market has advanced VR technology to find applications in gaming, healthcare, military, education, architecture, and tourism, bringing innovative solutions to a wide range of industries.

3.3. Animation and VR

We explored how to effectively disseminate Chinese zodiac culture through an analysis using the ancient Chinese bronze culture as a dissemination carrier. Specifically, we compared the use of bronze elements in the animated short film "Wu Yue's Crossing" and the bronze culture in the VR game "Moss" to evaluate their advantages and disadvantages. Table 1 presents a comparative analysis to assess the effectiveness of VR technology in disseminating the add-on culture more intuitively.

Table 1. Analysis of animation and virtual games.

Bronze Cultural Products	Advantage	Drawbacks
2D animated short film "The Crossing of Wu and Yue	1. Cultural heritage 2. Artistic innovation 3. Engaging the audience 4. Nature of education	1. Historical accuracy 2. Artistic balance 3. Production costs 4. Audience limitations
VR games "Moss	1. Immersive experience 2. Interactivity 3. No geographical restrictions 4. Protection and preservation 5. Multimedia elements	1. High costs 2. Technical requirements

Figure 3 shows the animated short film "The Crossing of Wu and Yue" and its elements of the bronze culture of the Chu region to propagate and promote the cultural heritage of an important period in Chinese history. Through animation, innovative methods of artistic expression were explored to integrate bronze culture into storylines and character design, presenting a unique visual experience to the audience. Incorporating elements of bronze culture, particularly those related to history, attracts viewers of different ages and interests, thereby expanding the audience for cultural communication. Such animations can be used for educational purposes to understand the bronze culture of the Chu region and learn and understand history and culture. However, ensuring historical accuracy when incorporating bronze culture into animations is crucial to prevent audience misconceptions. The incorporation of bronze elements may pose the problem of balancing art and history. Artistic designs must remain visually appealing while respecting and conveying cultural elements.

Huge resources and funding may be required to produce animations that incorporate complex cultural elements, which may become a constraint. Although there is potential to appeal to a diverse audience, not everyone is interested in history and culture, so there may be some audience limitations. On the other hand, as shown in Fig. 3(b), the VR game "Moss," the presentation of bronze-based cultural elements, the VR game is more representative and typical. It provides an immersive experience for users to understand bronze culture. Users can experience ancient culture and history first-hand, increasing the attractiveness and depth of cultural communication. VR technology allows users to interact with bronze culture by touching, rotating, and zooming in, which enables them to actively participate in learning and improves the learning effect. It can be disseminated via the Internet, thus eliminating geographical restrictions. Irrespective of users' locations, virtual bronze culture exhibitions, and learning resources are accessible. Digital backups can also be created to prevent wear, tear, and damage to the artifacts and preserve cultural heritage. Furthermore, the integration of multimedia elements (e.g., audio, video, and text) into cultural communication provides more information and audio-visual effects that appeal to different audiences. However, the VR technology, including hardware, software, content production, and staff training, is expensive to develop and maintain. This limits their widespread applications.

The VR technology-enhanced game has advantages over animated short films. It provides an immersive experience, increases interactivity, eliminates geographic constraints, contributes to the protection and preservation of cultural artifacts, and allows for the integration of multimedia elements. However, it is also accompanied by large development and maintenance costs and the need for specialized equipment.

(a) **(b)**

Fig. 3. (a) Animated short film "The Crossing of Wu and Yue", **(b)** VR game "Moss".

4. Design and Practice

4.1. Flash Animation of Chinese Zodiac

Conceptual planning is the key to design before the production of Flash software to animate the Chinese zodiac. The design team needs to finely characterize each Chinese zodiac and assign specific movements and expressions to ensure that each character has its uniqueness and vitality. All the characters are integrated into a well-prepared storyline, where each zodiac character plays a unique role in the story. In using Adobe Flash software to create animations of animals in the Chinese zodiac, such as rats, oxen, tigers, rabbits, dragons, and snakes, it is necessary to carry out in-depth characterization and character analysis.

Figure 4(a)-(h) shows the creation process of zodiac animals. Figure 4(b) illustrates the morphology change of a rat, which is usually depicted as resourceful and flexible. In animation, a rat's image may be designed to be more compact and flexible. For fast and agile movements, its morphology changes with the flow of the animation. Designers begin with the paper-cut rat image (Fig. 4(a)). Transitioning to the abstract hieroglyphics to present the visual image of the rat, the traditional elements are conveyed by hieroglyphic and simplified characters as shown in Fig. 4(c). This transformation process shows that people's understanding of the Chinese zodiac rat has changed from figurative to abstract with the understanding of the initial figurative image. The last step is to change the image into a bronze statue (Fig. 4(d)). This transformation forms a closed loop from figurative-abstract-figurative allowing for the creation of another concrete rat.

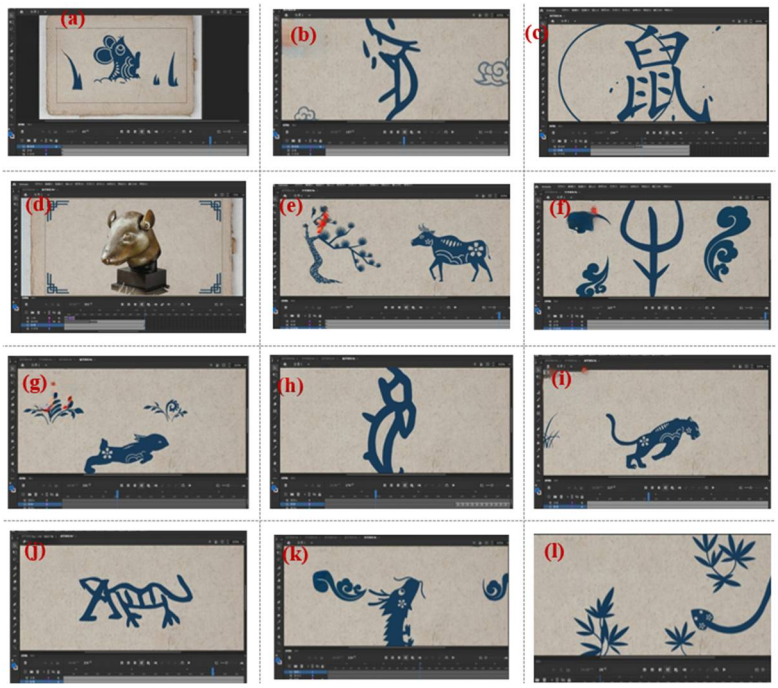

Fig. 4. Flash animation creation. (**a**) creation of rat (**b**) changing animated form of Rat - hieroglyphic character (**c**) simplified character Rat (**d**) bronze statue (**e**) ox model (**f**) hieroglyphic character of ox (**g**) creation of tiger (**h**) hieroglyphic character of tiger (**i**) rabbit model (**j**) hieroglyphic character of rabbit (**k**) dragon model (**l**) snake model.

In such a presentation of a visual image, abstract Chinese elements are incorporated into the characteristics and history of the Chinese zodiac. Similarly, the subsequent production of other zodiac animals is shown in Fig. 4. Each zodiac animals need to be adjusted according to its specific form. As a symbol of courage and strength, the tiger's animated image is designed to be powerful with strong and quick movements (Fig. 4(g)). A rabbit symbolizes wit and caution, and its animation image may be light, fast, and with a certain degree of alertness (Fig. 4(i)). Figure 4(j) shows the animation of the rabbit. The dragon is important in Chinese culture, symbolizing honor and power, so its animation image is grandiose with solemn and elegant movements (Fig. 4(k)). The snake is usually associated with flexibility and mystery, and its animated image may be designed with smooth and graceful movements (Fig. 4(l)).

When creating the animation in Flash, background padding is chosen as the base color of kraft paper with large Chinese characteristics, and the elements of paper cutting are integrated into the animation. The characteristics of these characters are reflected in their detailed lines, color choices, and animation effects. For example, the mouse's movements are designed as sudden jumps and quick movements, whereas the ox with slow but powerful strides. The movements of the tiger and rabbit are designed to be vivid and swift, whereas the dragon and snake's movements are smooth and full of variations. In addition to action design, sound effects are also important, such as the subtle sound of the rat and the low roar of the ox, all of which must match the characteristics of the character. To create these Chinese Zodiac animations in Flash, it is needed to focus on the visual presentation of each character and animation fluency, sound matching, and emotional expression to ensure that the image of each animal in the Chinese Zodiac is real and imaginative. In this creative process, each Chinese zodiac animal attracts the audience visually showing unique cultural connotations in its behavior and characteristics.

As the design team implements the visual narrative in Flash, they initiate the process by hand-drawing or importing predesigned characters and animating them using the timeline function and frame rate control provided by the software to ensure smooth and accurate movements. The design team also plans a sequence of movements for each zodiac character to render dynamically in the animation. In addition, the storytelling and viewing experiences are enhanced by the addition of background music and animated transition effects, resulting in a final product that excels in visual coherence and narrative appeal. Figure 5 shows the animated presentation of the tiger in the Chinese zodiac. The main point of action is depicted and portrayed in the running process of the tiger as follows.

1. Crouch: This is a preparatory movement before the tiger starts running; the body crouches and is ready to explode (Fig. 5(a)).
2. Sprinting: The tiger uses its powerful hind legs to make a quick sprint and start running (Fig. 5(b).
3. Speeding: Once accelerated, the tiger shows its speed on the ground (Fig. 5(c)).
4. Deceleration: Finally, the tiger gradually slows until it smoothly stops (Fig. 5(d)).

Next, the flow of movement to portray the tumbling of the Tiger in the Chinese Zodiac involves the following.

1. Preparatory movements: The tiger first lowers its body posture and crouches or prepares to accumulate strength for jumping. Its muscles are tense, showing signs of preparation for the event (Fig. 5(d)).
2. Initiation: The tiger uses its strong hind legs to initiate a roll. This movement is usually swift and powerful, demonstrating the excellent body coordination and strength of the tiger (Fig. 5(f)).
3. Aerial maneuvers: In tumbling, a tiger performs a series of coordinated maneuvers to ensure that its body is turned over. This phase requires excellent body control, as the tiger adjusts its legs and body to maintain balance and prepare for landing (Figs. 5(g) and (h)).
4. Landing: Tigers usually land by touching the ground with their front legs and quickly stabilizing their bodies. The landing is soft and precise to minimize impact and prepare the body for the next movement (Fig. 5(d)).
5. Return to posture: After tumbling, the tiger quickly returns to a standing or walking posture and is ready to perform the next maneuver or continue its activity.

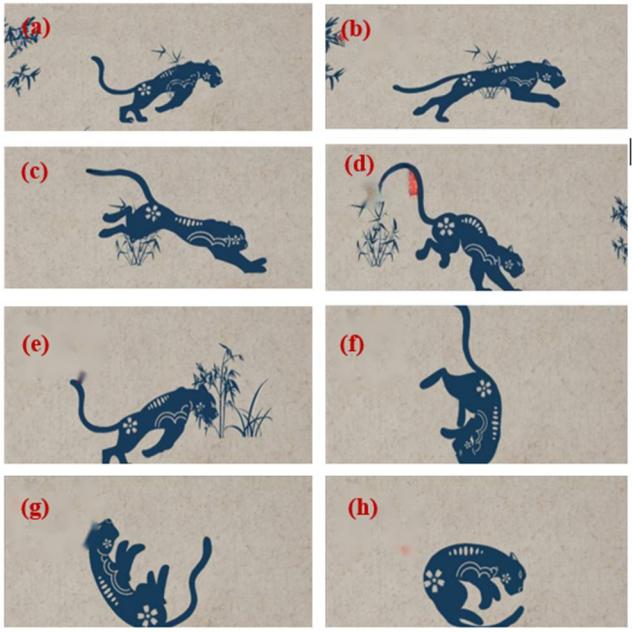

Fig. 5. Eight animation effects of tiger in Chinese Zodiac. (**a**) running and storing energy (**b**) jumping (**c**) running (**d**) landing (**e**), (**f**), (**g**), and (**h**) tumbling forms.

The entire tumble demonstrates the agility, strength, and grace of a tiger's body' Such movements are common for wild animals for self-entertainment, playing, or training hunting skills. In designing an animation project using a tiger as the Chinese Zodiac image, the key starting point is to present this creature in Chinese cultural symbolism and an animated form. The tiger symbolizes courage and strength, which are the central elements of animated design. Through careful observation of the tiger, the project focused on the fluidity of its movements and the expression of its power. Various tiger movements, including stalking, running, and jumping, are studied in depth and transformed into a series of fluid animation sequences. The tiger's image in the animation needs to reflect its real animal characteristics and integrate traditional Chinese cultural elements.

Therefore, artistic paper-cutting is adopted to express the outline and texture of the tiger so that the animation shows a unique visual effect. The lines and shapes of the paper-cutting are carefully designed to preserve the basic characteristics of the tiger and incorporate symbolic patterns, such as cloud patterns, wavy shapes, and traditional geometric shapes. These patterns change dynamically with each tiger's movement, creating a visual experience that is both classical and modern. In the animation process, special attention is paid to changes in the tiger movements. Using delicate frame animation techniques, every detail of the tiger's movement is accurately captured, making the action appear natural and powerful. Light and shadow effects in the animation are carefully adjusted to enhance the three-dimensionality and depth of the paper-cutting art style. Background and environment design also incorporates traditional Chinese elements, such as landscape painting style landscapes and symbolic color applications, further enhancing the overall cultural atmosphere. Finally, in terms of sound design, the timbre of traditional musical instruments is chosen and combined with the roar of the tiger and the sounds produced by its movements so that the animation provides a profound cultural experience both visually and aurally. Through this approach, the animation project demonstrates the potential and power of the tiger in the Chinese zodiac and successfully blends traditional Chinese art and modern animation techniques to create a unique and engaging visual work.

4.2. 3DMAX Virtual Showroom

The 3DMax software was used to create a virtual exhibition hall with many design elements such as site layouts and landscape facilities to significantly increase its complexity. Figure 6 illustrates the 3D showroom. When determining the scale and layout of a showroom, the design team considered the rationality of space utilization as it was demanded to meet the themes and functions of the showroom. The showroom booth and the background curtain were designed to ensure a high degree of comfort in the subsequent browsing experience (Fig. 6(a)). The scale was adjusted to choose the refined cell play. Consequently, the design team condensed the elements of the Chinese zodiac theme as shown in Fig. 6(b). Subsequently, the design team constructed a three-dimensional model of the showroom through 3D modeling technology and carefully added texture and color to enhance the realism of the model (Fig. 7). Light sources and camera settings were adjusted to create a realistic visual showroom environment. Lighting and material

are essential to achieve brightness. After these steps, the design team utilized 3DMax's advanced rendering capabilities to render the design into a high-quality visual image.

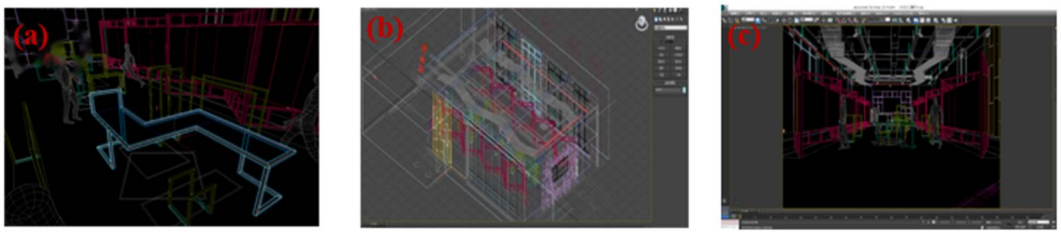

Fig. 6. (**a**) 3DMAX showroom model construction, **(b)** 3D showroom camera view, **(c)** 3D showroom front view.

Fig. 7. Virtual exhibition hall.

4.3. Virtual Showroom Playback Models

An UNITY was used to integrate animation into virtual showroom displays. The design team imported the virtual showroom model created in 3DMax into UNITY and organized and set up the scene to ensure that the model and resources were correctly configured. As shown in Fig. 8, UNITY imported the showroom model. UNITY imported the animation model, and selected and inserted the animation model from the animation on Type (Fig. 8(b)). Several steps were involved when using UNITY to realize the interaction. The following is a brief description of the general basic steps.

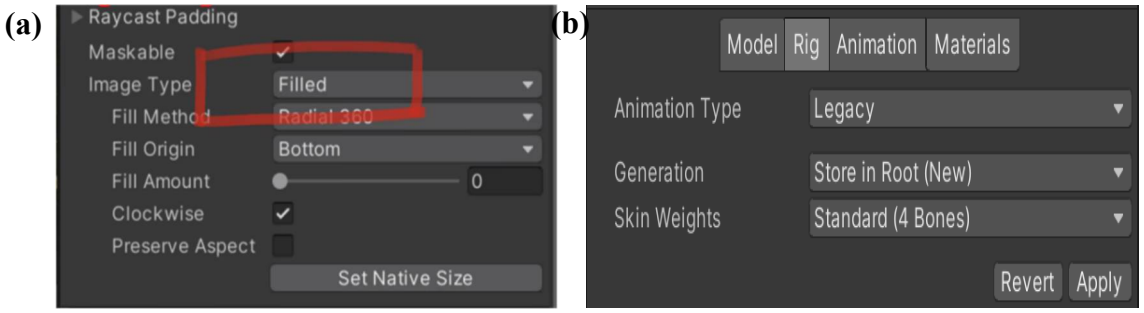

Fig. 8. File import process for animation generation. **(a)** UNITY importing a showroom model, **(b)** UNITY importing an animated model (Options: 1. Do not import: Do not import animation, 2. Option 2–4: Disabled, do not use, 3. Store in root (new): Import animation and store it in the root node of the model).

1. Import models and resources: Before starting, all 3D models, including objects and scenes, are imported into the UNITY project. UNITY supports many file formats, such as. obj and .fbx. The file format of the 3DMax showroom for this design is .obj. Fig. 9 shows the interfaces combined in the UNITY model.

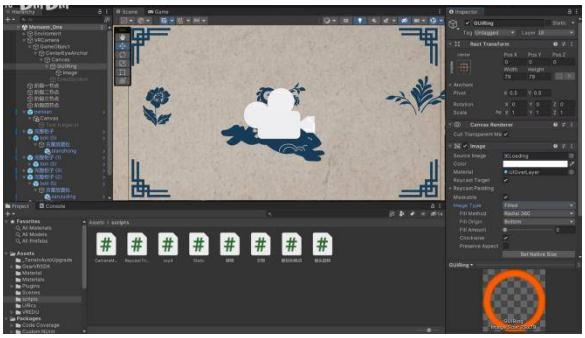

Fig. 9. UNITY model combining interface.

2. Scene setup and resource configuration: After importing models and resources, the scene at UNITY's interface is organized and laid out to set the position, rotation, and scaling of objects.

3. UI creation: User interfaces are created, including buttons, sliders, and text, which can be designed and configured on UNITY's "Canvas" (Fig. 10).

```
78              }
79              else if (hit.transform.tag == "gudong")
80              {
81                  储物 柜子 = hit.transform.GetComponent<储物>();
82                  if (GUiRing.fillAmount < 1f && Static.正在交互的物体 != 柜子.古董)
83                  {
84                      GUiRing.fillAmount += Time.deltaTime * ringSpeed;
85                  }
86                  else
87                  {
88                      GUiRing.fillAmount = 0f;
89                      //柜子.古董;
90                      Static.正在交互的物体 = 柜子.古董;
91                      ssyd 随身移动 = 柜子.古董.GetComponent<ssyd>();
92
93                      if (!随身移动.enabled) 随身移动.enabled = true;
94
95                      随身移动.mainCamera = mainCamera;
96                      随身移动.观赏中 = true;
97                  }
98              }
99              else if (hit.transform.name == "guohua")
```

Fig. 10. Interfacr script for UNITY.

4. Create and write scripts: Using a UNITY-supported programming language (C# or JavaScript), the code is written to implement the desired interactions. For example, by clicking a button, the user triggers an action or event through scripts. If the implementation of the action of playing Chinese zodiac animation in a virtual showroom is required, a new code can be created to achieve this interaction as shown in Fig. 10.

5. Setting event triggers: By binding the written scripts to the corresponding game objects or UI components and then setting the corresponding trigger conditions such as clicks, collisions, and key inputs, the expected interactive effects are realized.

6. Debugging and testing: After designing an interaction, testing is performed repeatedly to ensure that everything works as planned. In UNITY, interactions can be run and tested in real time by adjusting and modifying the problem areas.

7. Optimization and Release: After tests and debugging, the project can be further optimized to improve performance and user experience. Once satisfied, a project can be packaged and released on various platforms.

The above steps vary from project to project depending on the needs and scale of the project. The design team needs to develop interactive scripts to enable users to interact with the virtual showroom and utilize UNITY's animation control system to play the Chinese zodiac animation in Flash to enhance an immersive experience through the careful adjustment of lighting and sound effects. After extensive device testing and adjustments based on feedback, the design team builds and releases a virtual showroom for users to view and experience.

Fig. 11. Virtual exhibition hall animation playback.

Using a combination of Flash, 3DMax, and UNITY, the design of the Chinese zodiac animation in the VR showroom was completed as shown in Fig. 11. The smooth and precise images and animations of the Chinese Zodiac were created using Flash software. The story setting and characters were designed to enrich the visual coherence and narrative appeal. Second, considering multiple design elements such as site layout and landscape facilities, a three-dimensional model of the virtual exhibition hall was constructed with an advanced rendering function to present high-quality visual images using 3DMax. Finally, an engaging animation experience was created by integrating animation and a virtual showroom using the UNITY software. The equipment testing and adjustments with feedback were conducted to ensure the quality. Throughout the process, the features of the three software programs were integrated to form a multidimensional creative process and achieve successful design practices.

4.4. Questionnaire Survey

The questionnaire survey was performed for experts and students.

4.4.1. Survey for Expert

A questionnaire for experts was created by clarifying the objective and the target of the assessment. The objective included technical quality, user experience, or cultural accuracy or to collect suggestions for future improvements. The experts had an understanding of VR technology, basic theories of Chinese zodiac animation, and basic software and provided constructive and professional feedback. In this study, we designed structured interviews. Responses were scored on a Likert scale (5-very knowledgeable; 4-knowledgeable; 3-fair, 2-not very knowledgeable; 1-do not know). There were 15 questions in a single-choice format. In the questionnaire, professional terms and obvious expressions were used to avoid ambiguity. Anonymity and confidentiality were ensured for the data collection and analysis. Statistical methods were used for quantitative data analysis. Based on the collected feedback, the animation was modified and improved. If possible, further discussions or interviews with experts can be conducted to gain more perspectives. The result of the survey for experts helped improve the quality and attractiveness of the VR zodiac animation design.

4.4.2. Feedback Questionnaire

We evaluated the feedback of students (users) on their experience with the VR Chinese zodiac animation using a questionnaire survey. The same Likert scale for the expert survey was used. 15 questions in a single-choice format were included in the questionnaire. The participants comprised 100 college students who were randomly selected to experience the VR Chinese zodiac animation. After experiencing the virtual animation, participants filled out the questionnaire provided by this study. After completing the questionnaire, the responses to the questionnaire were classified. Those who demonstrated a good understanding of the basics of the design were categorized as experts, while the rest possessing relatively relevant knowledge were categorized as students. In the survey, responses lacking experience with the design were discarded. Identical responses were also excluded.

5. Results and Discussion

5.1. Survey Result

We collected 100 responses for the questionnaire survey. 40 valid responses were used for the analysis.

Table 2. Paired samples t-test analysis on student and expert questionnaires.

Number	Item	Students (n = 15) Cronbach Alpha = 0.941		Experts (n = 15) Cronbach Alpha = 0.862		t-test	*p*
		Average	Standard deviation (SD)	Average	Standard deviation		
1	Do you know anything about virtual reality technology?	3.35	0.813	4.35	0.81273	-4.156	0.001
2	How familiar are you with Zodiac Animation?	3.15	0.813	4.30	0.65695	-4.945	0.000
3	Have you ever created or learned about an application related to virtual reality technology?	2.95	0.826	4.35	0.81273	-4.626	0.000
4	Do you know anything about Flash, 3DMAX, or Unity?	3.30	0.865	4.60	0.59824	-5.940	0.000
5	Do you think the virtual reality Zodiac animation is an interactive experience?	4.00	1.124	4.70	0.47016	-2.896	0.009
6	Do you think that virtual reality Zodiac animations are immersive to watch?	4.20	1.056	4.85	0.36635	-2.459	0.024
7	Do you feel that virtual reality Zodiac animated scenes offer room for imagination?	3.95	1.146	4.65	0.48936	-2.570	0.019
8	Has virtual reality technology enhanced your understanding and recognition of the Chinese zodiac culture?	4.10	1.071	4.55	0.75915	-1.630	0.119
9	Do you think virtual reality Chinese zodiac animation is helpful in spreading and promoting Chinese zodiac culture?	4.10	1.071	4.70	0.73270	-1.983	0.062
10	Has the virtual reality Chinese Zodiac animation sparked your interest in Chinese Zodiac culture?	4.20	1.056	4.60	0.75394	-1.192	0.248
11	Has the use of virtual reality in Chinese Zodiac animation prompted you to become more interested in Chinese Zodiac culture?	4.00	1.257	4.60	0.75394	-1.641	0.117
12	Does the application of virtual reality technology in Chinese zodiac animation help the international community to better understand and recognize the Chinese zodiac culture?	4.25	1.020	4.75	0.71635	-1.810	0.086
13	Have you recently experienced an interactive virtual showroom and its animated Chinese Zodiac screening?	1.00	0.000	1.00	0.00000	0.00	0.00
14	Do you feel right about the whole virtual reality Zodiac animation design?	4.00	1.076	4.65	0.58714	-2.371	0.028
15	What is your overall satisfaction rating for this Virtual Reality Zodiac Animation?	3.85	1.089	4.45	1.09904	-1.431	0.169

$p < 0.01$, t = ± 5.940; $p < 0.05$,t = ± 2.371; $p < 0.1$,t = ± 1.810

The effectiveness of the animation and student satisfaction and recognition were evaluated. The scores of items 1–5 showed a significance level of $p < 0.01$, suggesting that the results were inconsistent. The t values of the scores of items 1–4 were 4.156, 4.945, 4.626, and 5.940. These showed that the experts and students exhibited a different understanding of VR technology and Chinese zodiac animation. Items 6, 7, and 14 showed ($p < 0.05$, t = 2.459), ($p < 0.05$, t = 2.570), and ($p < 0.05$, t = 2.371), which implied statistical significance. This also showed that the experts had professional insights and experience in VR experience with basic knowledge, compared to students who had less understanding and experience of interactivity, imagination, and immersion in VR (Table 2). Both groups highly scored for the zodiac animation in VR technology. The mean values of the questionnaires for the experts and students were 3.85 and 4.45, indicating a high level of satisfaction. The deviation in the score of each item was small, indicating that the participants were satisfied with the Chinese zodiac animations using VR technology. The average scores of the students and experts ranged between “strongly agree” and “agree” suggesting that the students and experts showed a high level of approval of VR animation. The participants agreed that VR technology can provide interactive experience, immersive viewing, and imaginative space. This corresponds to the 3I's of VR. With these three characteristics, the participants were interested in Chinese zodiac animation and, therefore, understood the Chinese zodiac culture. The survey result suggested that VR technology enhanced the user experience and recognition of Chinese zodiac animation. VR Chinese zodiac animation can solve the problem of insufficient traditional carriers of Chinese zodiac culture and provide traditional artistic expression to the audience. This was supported by higher average scores of items 9 and 10 than that of item 4.

The results of the survey were validated by the Cronbach alpha of 0.862 and 0.941, respectively, indicating good internal consistency. The experts and students responded positively to this design practice and were satisfied with the design practice and the combination of VR technology and Chinese zodiac animation, which proved its feasibility.

6. Conclusions

The result of this study showed that Chinese zodiac animation can disseminate Chinese zodiac culture effectively. VR technology with animation significantly enhances user experience and fosters innovation. Thus, it is crucial to emphasize the VR Chinese zodiac animation design practice.

The questionnaire survey results for 40 valid responses showed a high degree of satisfaction and recognition which are important in the dissemination of the Chinese zodiac culture and the application of VR technology. The Cronbach's alpha coefficients of 0.862 and 0.941 confirmed the internal consistency and reliability of the survey. The experts and students were highly satisfied with the VR Chinese zodiac animation. This suggests that VR technology provides a rich interactive and immersive experience to effectively promote Chinese zodiac culture. The participants believed that VR technology provides an interactive experience, immersive viewing, and imaginative space. The addition of The three characteristics deepened their interest in Chinese zodiac animation and their recognition of Chinese zodiac culture. The participants "strongly agreed" and "agreed" to the animation. VR Chinese zodiac animation was proven to overcome the limitations of traditional carriers and present Chinese zodiac culture aligning with the needs of modern society.

The rapid development of VR technology has created unprecedented interactive communication opportunities for the Chinese zodiac animation. By simulating the sensory experience of the real world, this technology greatly enhances the audience's participation and immersion, enabling them to gain a deeper understanding of the zodiac culture. Through advanced technologies, such as gesture recognition and head tracking, viewers can interact with virtual Chinese Zodiac animation characters, which increases emotional connection and the effectiveness of cultural communication. VR technology provides a new immersive experience for viewers to freely explore and interact in a virtual environment. Then, their knowledge of Chinese zodiac culture as well as emotional resonance can be deepened. The application of VR technology in education has significant potential. In interactive learning, viewers can participate more actively in storylines, which enhances their learning and creativity. Most importantly, the application of VR technology disseminates Chinese zodiac animations not restricted in time. This method of dissemination not only increases the number of viewers but also expands the influence of zodiac culture, which is of great significance to the inheritance and development of culture. The result of this study confirmed the advantages of VR technology for Chinese zodiac animation. By providing an interactive and immersive experience, this combination enhances user experience and disseminates an understanding of Chinese zodiac culture. The application of VR technology provides new opportunities for the inheritance and development of Chinese Zodiac culture as an innovative and effective method for cultural dissemination and user experience.

In this study, there are significant limitations such as a lack of sample representativeness. A small number of participants may affect the applicability of the findings. A quantitative method was mainly used such as interviews or case studies, which may limit the understanding of user experience. The potential value of other technologies in the Chinese zodiac culture was not considered in this study. A long-term impact and external validity were not explored, too particularly for the applicability of technology in non-academic settings. Therefore, future studies are demanded to enhance validity and diversity. Combining qualitative and quantitative research methods is needed to assess the role of VR technology in cultural communication more comprehensively. In addition, by exploring different technological tools such as augmented reality and mobile applications, diverse ways of disseminating Chinese zodiac culture can be explored. Long-term tracking and cross-cultural studies are necessary in different cultural contexts. By implementing these strategies, the potential of VR technologies in cultural communications and education can be studied in more detail than this study.

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