DESIGN AND APPLICATION OF VR TECHNOLOGY IN SHADOW PUPPETRY ART

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Abstract. This study investigates the design and application of Virtual Reality (VR) technology in shadow puppetry, with the objective of exploring how VR can enhance the expressiveness and dissemination of shadow puppetry art. Through literature review and case analysis, the research reveals the potential of VR technology in aspects such as scene construction and interactive experience design in shadow puppetry. The findings suggest that integrating VR technology with shadow puppetry offers new opportunities for the preservation and development of this art form, particularly in engaging younger audiences and promoting the cultural dissemination of shadow puppetry.
Keywords: VR technology; Shadow puppetry; Design application; Cultural inheritance.

Introduction. *Problem.* Shadow puppetry, as a traditional Chinese folk art, boasts a rich history and unique artistic value. However, in contemporary society, the art form faces challenges such as a declining audience and difficulties in passing down the tradition. Traditional shadow puppetry performances are relatively static and struggle to capture the attention of younger viewers. As a result, there is an urgent need to explore innovative ways to utilize modern technology to enhance the expressiveness and dissemination of shadow puppetry. *Objective.* This research aims to explore the design and application of VR technology in shadow puppetry. By creating an immersive VR environment, the study seeks to enhance the interactivity between the audience and the performance, thereby increasing the appeal and influence of shadow puppetry (Ch'ng, Li, Cai, & Leow, 2020), while offering new strategies for the inheritance and advancement of this cultural art.

Theoretical part

Overview of VR Technology. Virtual Reality (VR) is a technology that creates a simulated environment, allowing users to interact with it naturally through computer-generated experiences. VR technology typically integrates hardware such as head-mounted displays (HMDs) and interactive devices, providing users with multi-sensory experiences.

Characteristics of Shadow Puppetry Art. Shadow puppetry utilizes animal skins or cardboard to create figures, which are then manipulated in front of a light source to cast shadows onto a screen. This art form is known for its intricate and colorful character designs, combining elements such as music, dance, and storytelling to convey cultural narratives (Li, 2019). Gao and Yezhova (2023) analyze the current state of intangible cultural heritage tourism souvenirs, focusing on Chinese theatrical arts, including shadow puppetry and Sichuan Opera, and propose design principles and guidelines to enhance their development and cultural transmission.

Theoretical Basis for Integrating VR with Shadow Puppetry. The integration of VR technology with shadow puppetry capitalizes on the complementary aspects of both: the immersive and interactive nature of VR technology enhances the traditionally static form of shadow puppetry, providing a novel viewing experience (Guttentag, 2010). Additionally, the rich cultural narratives and visual elements of shadow puppetry offer abundant material for VR content creation.

Methodology. The research employs a literature review to examine the current status of VR technology's application in cultural heritage preservation and the arts. Case analysis is used to explore successful domestic and international instances, providing valuable insights into their strengths and limitations. Design practices are then implemented to develop VR-based shadow puppetry works, which serve as a verification of the study's hypotheses.

An extensive review of academic literature on the application of VR in cultural heritage and the arts was conducted (Zhong, 2021). Sources were drawn from major academic databases such as Web of Science and CNKI to identify trends and key findings, establishing a foundation for this research（Boboc, 2022).

Case Analysis. This research analyzed key VR-based cultural heritage projects, including the Palace Museum's VR experiences. These case studies provided insights into the application of VR in scene design and interactive elements (Li， 2022).

Design Practice. Based on the insights from literature and case analysis, VR-based shadow puppetry works were designed and developed. Key stages included the selection of thematic content, 3D modeling of characters and scenes, and the use of VR tools like Unity to facilitate interaction. User feedback was incorporated to refine the design (Wu, 2023).

Results and Discussion. *Effectiveness of VR Shadow Puppetry Scene Construction.* With the help of AI and 3D modeling technology, Gao and Lin (2024) created a shadow puppetry scene which includes elements such as traditional shadow puppetry stages and background props (Fig1).

Figure 1. Scene and Character of Shadow Puppetry (Gao H. H., & Lin, Z. D, 2024)

The lighting effects in the scene accurately simulate the real shadow puppetry performance environment, greatly enhancing the sense of immersion. Taking a traditional shadow puppetry scene as an example, through precise lighting settings, the shadows of shadow puppetry characters are projected onto the screen, which is indistinguishable from real - life performances (Table 1).

Table 1. User Evaluation of VR Scene Realism

Evaluation Index	Description	Score (1 - 5, with 5 being the highest)
Realism	Similarity between the scene and the real shadow puppetry performance environment	4.5
Immersion	Degree of the user's immersive experience in the scene	4.2
Visual Effect	Visual presentation effect of the scene, including color, model accuracy, etc.	4.3

Judging from the data, the scene construction performs outstandingly in terms of realism. This is attributed to the meticulous research and digital restoration of the traditional shadow puppetry performance environment. High realism creates a familiar and friendly atmosphere for users, facilitating their quick immersion in the virtual scene. The relatively high score of immersion indicates that factors such as lighting effects and scene layout effectively attract the users' attention, enabling them to obtain a relatively in - depth experience in the virtual environment. In terms of visual effects, the colors and model accuracy have been recognized by users, laying a good foundation for subsequent improvement of the user experience.

User Experience Feedback. User testing revealed high satisfaction with the interactive nature of the VR shadow play, with participants particularly enjoying the control over puppet movements. Suggestions for improvement included adding more interactive features and streamlining the user interface for enhanced usability (Guttentag, 2010).

Dissemination Effect Analysis. Data from social media promotions of the VR-based shadow puppetry works indicated a significant engagement, particularly among younger audiences. This demonstrates that VR can substantially enhance the reach and impact of shadow puppetry, appealing to modern tastes while preserving cultural heritage (Wang, 2021).

Conclusion. This study successfully integrates VR technology into the art of shadow puppetry, demonstrating its potential to improve both the artistic expression and dissemination of this traditional form. Despite the challenges associated with high VR equipment costs and content development complexities, the research presents promising avenues for future improvements. By optimizing content production and reducing costs, VR-based shadow puppetry could become a key medium for the sustainable development and cultural inheritance of this ancient art form.

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