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Research on the Development and Application of Virtual Interactive Games Based on Manchu Paper-Cutting in Jilin Province

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ABSTRACT: This paper starts from the research background of developing virtual interactive games based on Manchu paper-cutting in Jilin Province, analyzes its current applications and existing problems, and conducts in-depth research from the perspective of virtual interactive game design, including cultural presentation, pattern design, color matching, process design, and interaction design. It aims to apply the cultural connotations of Jilin Manchu paper-cutting to the design of virtual interactive games, offering new directions, practices, and approaches to enhance the artistic quality of games, shape game brands and characteristics, and promote cultural integration and innovation.
KEYWORDS: Manchu paper-cutting in Jilin Province; virtual interactive games; gaming culture; game art; intangible cultural heritage.

I. RESEARCH BACKGROUND

The "Implementation Plan for Promoting Equipment Upgrades in the Cultural and Tourism Sector," issued on May 21, 2024, by the National Development and Reform Commission and other departments, mentions promoting the upgrade of gaming equipment, encouraging the use of high-tech, energy-efficient, and immersive devices to better meet consumers' cultural and entertainment needs. The implementation of this policy helps virtual interactive games shift toward immersive and experiential experiences, which aligns perfectly with the way Jilin Province showcases Manchu paper-cutting art. Integrating Jilin's Manchu paper-cutting deeply into virtual interactive games aligns with the trends of the times.

The "Special Action Plan for Boosting Consumption," issued on March 16, 2025, by the General Office of the CPC Central Committee and the General Office of the State Council, explicitly includes the gaming industry within the scope of policy support. In the "Consumption Quality Improvement Action" section, it mentions integrating China's outstanding traditional culture into product design, supporting the development of original intellectual property (IP) brands, and promoting consumption of animation, gaming, esports, and related derivative products, expanding the domestic and international markets for trendy Chinese products. The release of this document provides policy support for incorporating Jilin Province's Manchu paper-cutting culture into virtual interactive game design, enriching the channels for disseminating Manchu paper-cutting from Jilin Province and expanding the cultural connotations and design concepts of virtual interactive games.

II. THE CURRENT STATUS OF THE APPLICATION OF PAPER-CUTTING GAMES DOMESTICALLY AND ABROAD

2.1 A REVIEW OF RESEARCH ON PAPER-CUTTING GAMES

According to analyses of existing research papers on paper-cutting games, the design of paper-cutting games is often examined from multiple perspectives, including cultural and artistic perspectives, interaction design, technological applications, educational and psychological perspectives, dissemination and promotion, and game art design.

For example, "Innovative Application of Paper-Cutting Games in Elementary Mathematics Teaching" approaches from a teaching perspective, using paper-cutting games to enhance students' understanding of geometric patterns in mathematics, enriching classroom engagement while achieving the educational objective of teaching geometric patterns. The paper "On the Integration and Innovation of Paper-Cutting Art Elements and Game Animation Design" focuses on the unique two-dimensional style and clear contour lines of paper-cutting, applying them to game character design, background design, and interface design, resulting in a minimalist and modern aesthetic in the game. In "The Collision of Paper-Cutting Art and Game Digitization," through in-depth research on the unique characteristics of paper-cutting, such as folding, cutting, and engraving operations, these features are applied in game design so that players can use a toolbox on the interface to perform a series of operations like grabbing, drawing, and cutting paper, gaining a profound experience of the paper-cutting process.

The above papers provide theoretical support for the development of interactive virtual games based on Manchu paper-cutting in Jilin Province.

2.2CASE STUDY OF PAPER-CUTTING GAMES

At present, there are many cases in China where intangible cultural heritage elements are integrated into game design. This article focuses on analyzing interactive games such as "Honor of Kings," "Genshin Impact," "Fantasy Westward Journey," "Returning Dragon Tide," "Primitive Journey," and "Battle of Balls" (see Table 1 for details), and finds that these games incorporate cultural elements into character design, theme design, scene design, and derivative product design in virtual interactive games, providing design ideas for the virtual interactive game design of Manchu paper-cutting in Jilin Province.

SERIAL NUMBER	GAME NAME	DESIGN HIGHLIGHTS
1	Honor of Kings	Design a character skin 'Diao Chan—Encountering the Whirling Dance' featuring Dunhuang elements; the pattern design uses entwined pomegranate vine motifs as the core element; for the action design, the character's entrance animation dances gracefully atop the intangible cultural heritage war drum.
2	Genshin Impact	The 'Sea Lantern Festival' themed event combines intangible cultural heritage elements such as paper-cutting, shadow puppetry, and carp lantern dance.
3	Fantasy Westward Journey	The game features the auspicious item 'Truly Drunken Bird,' inspired by the 'Owl Wine Vessel' from the Shanxi Museum collection, and the ornate costume 'Yongle Immortal Cao,' inspired by the immortal attire in the 'Chao Yuan Tu' mural at Yongle Palace.
4	Returning Dragon Tide	In terms of character design, the game incorporates 45 different traditional cultural elements such as Shanghai-style qipao, auspicious cloud patterns, and lion dance, achieving a fusion of traditional elements with modern domestic trends; in terms of music and voice acting, the game combines traditional opera and instruments with modern electronic music, and character dialogues are voiced in regional dialects.
5	Primitive Journey	Invite Wang Tianwen, a representative inheritor of the national intangible cultural heritage of Shaanxi Huaxian shadow puppetry, to custom-make shadow puppets for the classic game character General White Horse. From selecting the leather, making the leather, drawing drafts, reviewing drafts, to carving, coloring, steaming and ironing, and assembling, the classic is recreated in the form of trendy Chinese cultural and creative products.
6	Battle of Balls	Introduce a unique blue-and-white series of game skins and porcelain gift boxes for players.

Table 1: Current Domestic Cases of Integrating Intangible Cultural Heritage into Game Design

In addition, although many domestic game designs incorporate cultural connotations, the design of games specifically focusing on the cultural connotations of paper-cutting is rather superficial. For example, the mini-program game "Jianmi" contains 12 levels, sequentially presenting players with paper-cut patterns such as ingots, pig-shaped pottery jars, engraved silver hooks and belts, copper vat lamps, jade elephants, gu vessels, pottery eagle cauldrons, jade deer, Jinsha copper standing birds, jade anthropomorphic divine beasts, jade bears, and bronze running horses (Figure 1). Players use virtual

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scissors to cut out the patterns in each level, ultimately generating patterns that can be downloaded and saved. This provides a design scheme for virtual interactive games featuring Manchu paper-cutting in Jilin Province.

Figure 1: Paper-cutting game 'Jianmi' (Image source: Screenshot of the 'Jianmi' game page)

2.3 ISSUES EXISTING IN PAPERCUT VIRTUAL INTERACTIVE GAMES

By analyzing existing paper-cutting games and related research both domestically and internationally, the following issues are identified in the design of paper-cutting games:Firstly, there is insufficient excavation and presentation of cultural connotations. Most paper-cutting games only use paper-cut patterns as interface decorations, character designs, or scene designs, without deeply exploring the cultural stories, historical origins, or folk meanings behind the paper-cutting art. The games also fail to organically integrate modern elements, preventing players from naturally experiencing the inheritance and development of culture during gameplay.Secondly, the integration of game art design with paper-cutting culture is inadequate. Although some games borrow the two-dimensional style and contour lines of paper-cutting, their overall visual effects are still limited and fail to fully leverage the rich color coordination and diverse patterns of paper-cutting. This results in game visuals that lack appeal and artistic impact, failing to convey the aesthetic value of paper-cutting art.Lastly, the interactive design experience is poor. The unique techniques of paper-cutting such as folding, cutting, and engraving are not fully utilized to create more engaging and innovative interactions. Most games merely allow players to perform simple operations like clicking and dragging to complete the paper-cut patterns, lacking deep simulation and experience of the paper-cutting process, and failing to let players fully appreciate the charm and fun of paper-cutting skills.

III. DEVELOPMENT STRATEGY OF VIRTUAL INTERACTIVE GAME FOR MANCHU PAPER-CUTTING IN JILIN PROVINCE

3.1 CULTURAL PRESENTATION STRATEGIES

Deeply explore cultural connotations. Organize cultural experts, folklorists, and inheritors of Manchu paper-cutting to systematically sort out and conduct in-depth research on the historical origins, folk meanings, and cultural stories of Manchu paper-cutting in Jilin Province, forming a detailed cultural database. In the game, these rich cultural connotations can be naturally integrated into the plot through narrative introductions, background stories, and character dialogues, allowing players to subtly understand and appreciate the profound heritage of Manchu paper-cutting culture during gameplay.

Construct cultural experience scenes. Create virtual settings featuring Manchu characteristics, such as traditional Manchu villages, sacrificial sites, and wedding venues, displaying Manchu paper-cuttings as important elements in the scenes, including window decorations, wall ornaments, and sacrificial items. This makes players feel as if they are immersed in an authentic Manchu cultural environment, enhancing the sense of cultural experience.

Combine cultural inheritance with innovation. While showcasing traditional culture, focus on organically integrating modern elements. For example, design scenes combining modern technology with Manchu paper-cutting, merging traditional paper-cutting patterns with contemporary fashion elements to demonstrate cultural transmission and development, allowing players to experience the vitality and innovative charm of Manchu paper-cutting in modern society.

3.2PATTERN DESIGN STRATEGIES

Digitization and optimization of traditional patterns. Conduct high-precision digital capture and processing of traditional patterns from Manchu paper-cutting in Jilin Province, preserving the original lines, textures, and detailed features. On this basis, optimize and innovate the patterns to make them more suitable for visual presentation in virtual interactive games. For example, the complexity of the patterns can be appropriately adjusted to ensure clearer and smoother display in the game; the colors of the patterns can be reassembled to match the atmospheres of different game scenes.

Dynamic and interactive design of patterns. Transform static paper-cutting patterns into dynamic effects, such as bringing paper-cut characters to life and making paper-cut animals vivid, increasing the fun and appeal of the game. At the same time, design interactive elements related to the patterns, such as allowing players to change the shape, color, or movement of the patterns through touch or clicks. This enables players to actively engage in the design and creation process of the patterns, enhancing the interactivity and participation of the game.

Diversity and layering design of patterns. According to different game levels and scenes, design a wide variety of paper-cutting patterns, including characters, animals, plants, geometric shapes, etc., forming a complete system of patterns. At the same time, pay attention to the design of layering in the patterns, using contrasts such as size, density, and solidity versus emptiness to create rich visual effects, making the game scenes more lively and interesting.

3.3COLOR MATCHING STRATEGIES

Follow traditional color conventions. Conduct an in-depth study of the traditional color matching rules of Manchu paper-cutting in Jilin Province, as well as some color combinations with special symbolic meanings, such as red representing good fortune and wishes, and yellow representing nobility and wealth. In game design, strictly adhere to these traditional color conventions to ensure that the game's visual style aligns with the Manchu paper-cutting culture, reflecting its unique artistic charm.

Coordination and harmony between colors and game elements. Ensure that color matching is coordinated and harmonious with other elements in the game, such as characters, scenes, and props. For example, the colors of a character's clothing should correspond with the background colors, and the colors of props should blend with the overall style of the game. Avoid conflicts and inconsistencies among colors to create a harmonious and cohesive visual environment in the game.

3.4PROCESS DESIGN STRATEGIES

Story-driven and task-oriented process design. Design an engaging main storyline that incorporates Manchu paper-cutting culture throughout the game, guiding players gradually deeper into the game through tasks. Each task can revolve around a specific paper-cutting theme or cultural element, such as creating a paper-cutting artwork with special symbolism, completing a traditional ceremony related to paper-cutting, etc., allowing players to learn about and experience Manchu paper-cutting culture while completing tasks, enhancing both the fun and educational value of the game.

Phased and layered process design. Divide the game process into different stages, each with its own goals and difficulty levels, creating a sense of layering. For example, the beginner stage can involve simple paper-cutting patterns and basic operation tutorials to help players familiarize themselves with game rules and controls; the intermediate stage can introduce more complex paper-cutting patterns and combined tasks to test players' skills and creativity; the advanced stage can include more challenging tasks, such as creating unique paper-cutting works based on specific cultural backgrounds or themes, or competing with other players in paper-cutting contests, stimulating players' curiosity and competitive spirit.

Feedback and incentive process design. Establish a comprehensive feedback and incentive mechanism to provide timely player feedback and rewards. For example, when players successfully complete a paper-cutting pattern or task, they receive corresponding points, reward items, or honorary badges; outstanding paper-cutting works created by players can be showcased and shared in the game community, allowing other players to like and comment, enhancing players' sense of achievement and satisfaction, thereby increasing their engagement and loyalty to the game.

3.5INTERACTION DESIGN STRATEGIES

Simulating real paper-cutting operations. Using advanced technologies such as virtual reality (VR) and augmented reality (AR), the process of real paper-cutting can be simulated, allowing players to create paper-cutting art in a virtual environment through gestures, movements, and other actions. For example, players can use gesture recognition devices to simulate actions like grabbing scissors, cutting, and folding, experiencing the texture and techniques of paper-cutting; or they can use AR technology to project virtual paper-cutting patterns onto real-world objects, enabling players to perform paper-cutting in the real environment, enhancing the realism and immersion of the game.Diversified interaction methods. Design a variety of interactive methods to meet the needs and preferences of different players. In addition to basic paper-cutting operations, other paper-cutting-related interactive elements can be added, such as allowing players to control the generation and alteration of paper-cutting patterns via voice commands; or collaborating or competing with other players to complete a large-scale paper-cutting work or tackle a complex paper-cutting task, increasing the game's interactivity and sociality.Intelligent assistance and personalized customization. Introduce intelligent assistance systems to provide guidance and suggestions for players' paper-cutting operations. For example, when players encounter difficulties during paper-cutting, the system can automatically suggest the correct methods and techniques; or based on players' operational habits and skill levels, it can automatically generate personalized paper-cutting patterns and tasks, allowing each player to have a unique experience and sense of achievement in the game.

IV. CONCLUSION

The development of a virtual interactive game based on Manchu paper-cutting in Jilin Province holds significant cultural value and practical significance. By deeply exploring cultural connotations, optimizing pattern designs, reasonably coordinating colors, and carefully designing processes and interaction methods, the game can showcase unique artistic charm and cultural value through both inheritance and innovation. It not only offers players an immersive cultural experience but also opens up new avenues for the inheritance and preservation of Manchu paper-cutting in Jilin Province. At the same time, it promotes the cultural integration and innovative development of virtual interactive games, possessing broad application prospects and far-reaching social impact.

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