

Digital Translation of Multi-Ethnic Floral Patterns Based on Auspicious Culture: Six Motifs in a Caisson Ceiling

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Abstract

At present, the study of digitalization of ethnic patterns mostly focuses on the protection and dissemination of single ethnic or regional cultural resources, while the coordination and integration of cross-ethnic pattern resources and their sharing mechanism are still relatively insufficient. This paper takes crabapple, peach blossom, osmanthus, peony, lotus, pomegranate, six kinds of flowers that appear frequently in multi-ethnic embroidery as objects, introduces the four-layer nested structure of caisson, and constructs six caisson units carrying auspicious meanings such as "full of wealth", "continuous birth of noble children", "full of gold and jade", "spring flowers and autumn fruits", "a hundred years of good union" and "auspicious ruyi". At the same time, with the help of TouchDesigner and MediaPipe platforms, a dynamic interactive system based on gesture recognition is realized, which supports pattern selection, rotation, hierarchical disassembly and reset. The research refines the method chain of "flower screening-caisson combination-digital translation", which provides a new path with both theoretical innovation and practical operability for the cross-cultural integration of multi-ethnic patterns and the regenerative design of digital heritage.

Keywords: Patterns; Auspicious Culture; Digital Translation; Coffered Ceiling; TouchDesigner

1 Introduction

Digital technology has been deeply involved in the protection and inheritance of intangible cultural heritage, and a standardized path characterized by "collection-extraction-visualization" has basically taken shape. In the field of digitalization of ethnic patterns, the existing research has accumulated rich results. For example, Wang Jianhua and Cui Xinlong built a digital framework for Yi nationality clothing patterns based on AIGC technology, covering three major links: data collection, adaptive generation model and human-machine collaborative design [1]; Li Siyu carried out systematic digital protection research on Manchu patterns, and proposed a specific operation process from document collection to physical scanning [2]. However, most of these studies focus on the preservation of patterns of a single nation or a specific region. There is a lack of effective dialogue and integration between cultural resources of different nations, and the independent situation has not yet been broken [3].

At the same time, as a spatial structure, the square value of caisson's "reorganization container" is far from being fully tapped. Existing practices mostly regard caisson as the object of borrowing pattern resources-for example, Yu Lan applied Dunhuang caisson pattern to clothing design [4], or Zheng Menghuan and Liao Shuting used the structural characteristics of caisson and the principle of kaleidoscope imaging to make interactive space devices [5]. None of them touched the deep binding relationship between the caisson structure itself and the semantics of the pattern. The hierarchical order, centripetality and sacred sense of space contained in caisson could have become a "grammatical container" for cross-ethnic pattern reorganization, but it is relatively lacking in existing research.

What is more noteworthy is that auspicious culture, a semantic clue that runs through multiple nationalities, has not been fully tapped in digital translation. Auspicious patterns cross the boundaries of regions and nations, forming a common value coding system [3]. However, the existing research pays more attention to the shape recognition and generation of patterns, while ignoring the cultural motives behind the shape of "why embroider" and "for whom to pray". Although the research direction in the past five years has expanded to cultural gene extraction [6] and interactive experience immersion [7-8], there is a serious lack of cross-ethnic integration methods, and the binding between caisson structure and auspicious semantics has not been deeply studied. An important emotional clue has not been effectively used.

Relying merely on single-nation pattern collections or 2D pattern scanning yields disjointed materials without semantic links, unable to support cross-ethnic pattern integration and in-depth auspicious cultural interpretation. Directly adopting caisson patterns for decoration also wastes their four-layer nested semantic carrier structure. To fill these gaps, this study proposes a multi-ethnic floral pattern digital translation method anchored in auspicious culture and framed by caisson layouts. It picks six common embroidery flowers across ethnic groups for composite design matching the caisson's four-tier spaces, then builds a gesture interactive system via TouchDesigner and MediaPipe to turn static motifs into sensory, manipulable, shareable digital experiences.

2 Significance of the Study

The significance of this study is mainly reflected in two aspects. On the one hand, from a theoretical point of view, it is the first time to systematically integrate flower patterns scattered in multi-ethnic groups, and establish a set of cross-ethnic comparison and reorganization square framework. The six kinds of flowers selected in this study, Begonia, Peach Blossom, Osmanthus, Peony, Lotus, and Pomegranate, all appear repeatedly in the embroidery pedigree of different ethnic groups, and each carries "Yutang", "Chunhua", "Fame", "Wealth", "Harmony" "Duozi" and other complementary auspicious semantics provide a natural cultural basis for the integration of cross-ethnic pattern resources. At the same time, the four-layer structure of the caisson is introduced as the "grammatical container" of pattern organization, so that the four levels of center, secondary, transition, and edge undertake the functions of flower positioning and semantic reading order, and the caisson is thus transformed from a passive pattern carrier to an active structural tool. This translation method expands the scope of caisson research and provides a reference for digital regeneration of other spatial forms.

On the other hand, from a practical point of view, the gesture interaction system based on TouchDesigner and MediaPipe realizes operations such as pattern selection, rotation, four-layer disassembly, and reset. This design transforms the research method of "dismantling-analysis-reorganization" into intuitive body operation. While users control patterns with gestures, they also naturally experience "multi-angle examination-hierarchical dismantling-structural analysis-overall restoration" "complete cognitive chain, thereby enhancing cultural immersion and cognitive participation. The system adopts parametric modeling method, which can be extended to the digital regeneration of other intangible cultural heritage items. It can be said that this study responds to the digitization of multi-ethnic patterns that "emphasize shape, neglect semantics" and "have resources, but no integration", and provides a new paradigm for digital heritage interaction design that integrates cultural semantics and body operations.

3 Flower Selection and Altar-style Design

The method chain of this paper is divided into two links: flower screening and caisson combination.

Begonia, peach blossom, osmanthus, peony, lotus, pomegranate six kinds of multi-ethnic embroidery recurrent flowers. Begonia is a homonym for "Yutang", implying a prominent family; Peach blossoms symbolize spring and auspiciousness; Osmanthus symbolizes fame; Peony represents wealth; Lotus is homophonic to "Hehe", implying; The pomegranate symbolizes the reproduction of descendants because of its many seeds. The pattern characteristics of these flowers are respectively extracted from the embroidery of the Complacent, Dong, Bai, Mongolian, Er, Xibe, Qiang, Zhuang and other ethnic groups, including the stylized four-petal heart shape of the Manchu crabapple, the Qingyaping embroidery of the Bai lotus, and the rich color of the Er peony, the plump shape of the Xibe pomegranate, etc. (Fig.1-2).



Fig. 1 Six Examples of Flower Patterns



Fig. 2 Six Examples of Flower Patterns

The four-layer space of caisson is divided into center, sub-inner, transition and edge, and the four-layer structure is suitable for hierarchical visual narrative. Therefore, this paper reconstructs six kinds of flowers into six caisson units, each unit is distributed in four floors with four kinds of flowers, and endows it with four auspicious names: Fuguimantang (crabapple, peach blossom, osmanthus, peony), Liansheng Guizi (lotus, pomegranate, osmanthus, peach blossom), Jinyu Mantang (osmanthus, crabapple, lotus, peony), Chunhua Qiushi (peach blossom, pomegranate, crabapple), Hundred Years of Haohe (lotus, crabapple, peony, pomegranate), auspicious Ruyi (peony, peach blossom, pomegranate, osmanthus) (Fig.3) Caisson has thus changed from a passive carrier to an active structured tool, which determines the hierarchical position of flowers and the reading order of auspicious semantics.

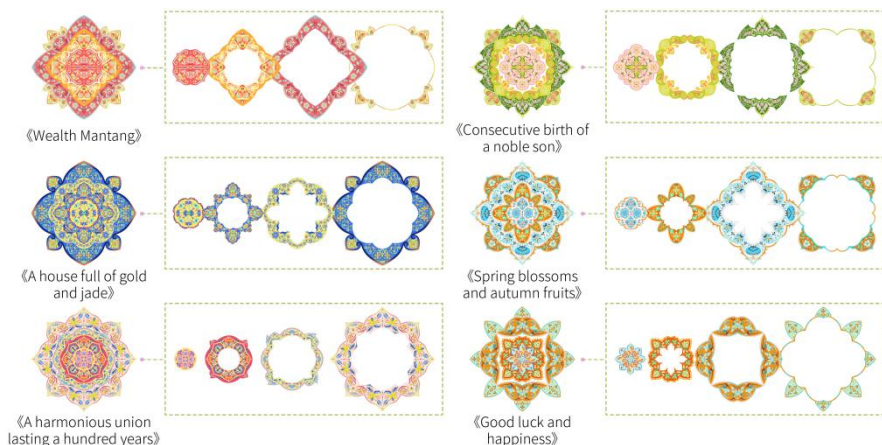


Fig. 3 Schematic Diagram of Six Caisson Units

4 Digital Translation and Interactive Implementation

In the digital translation link, this paper builds a gesture recognition interactive system based on TouchDesigner and MediaPipe [8]. The system captures the key points of the participants' hands in real time and maps them into circular cursors, forming a direct mapping of "hand-cursor-pattern", The operating threshold is set (Fig.4).

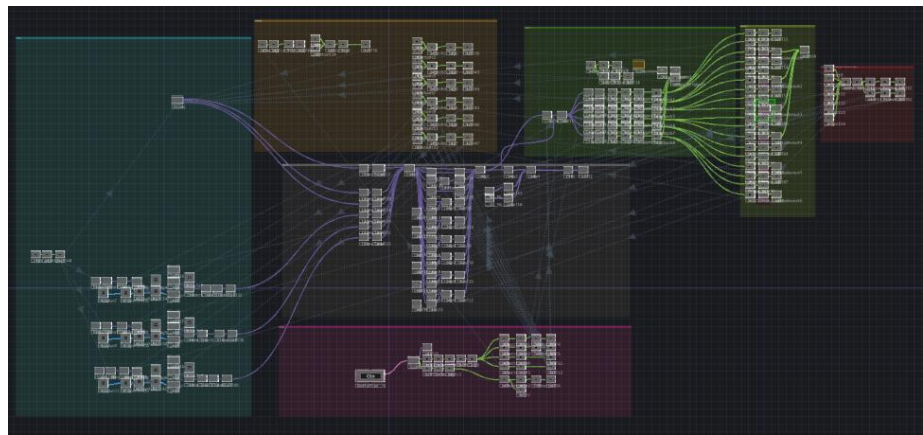


Fig. 4 Touchdesigner Data Structure Diagram

There are two levels of interaction. The first layer is a pattern selection interface, with six caisson units arranged in a ring, each with a thumbnail and a four-character name. When the cursor falls into the sensing area and performs the fist-making action, the system judges and selects it, and enters the second layer-pattern overview interface. The left side of the interface displays the name and auspicious meaning of the caisson, and the right side is the enlarged pattern (Fig.5).



Fig. 5 The First Layer of MediaPipe Gesture Interactive Interface

After entering the detailed view interface, the patterns rotate synchronously when the hands move left and right, simulating the experience of flipping the embroidery object; After clenching the fist for one second, the pattern is split into four independent levels in the vertical direction, which strictly corresponds to the four-level space of the caisson, so that the center, secondary interior, transition, and edge structures are clearly separated; Make a fist for another second, and the four-layer pattern will be re-established. This "dismantling-restoring" sequence guides participants to pay attention to hierarchical order and combination rules, and strengthens the overall restoration perception. In addition, the five-second system resets and returns to the selection panel. The five-second threshold not only avoids false touches but also provides a clear exit signal (Fig.6).



Fig. 6 The Second Layer of MediaPipe Gesture Interactive Interface

The interactive system aims to establish an interesting and solemn dialogue between the static display and dynamic operation of multi-ethnic patterns. Gesture recognition eliminates physical intermediaries, making body movements directly act on patterns; Operations such as rotation, dismantling, restoration, and resetting metaphor the cognitive chain of "multi-angle examination-hierarchical dismantling-structural analysis-overall restoration".

Participants are no longer bystanders, but gradually uncover the auspicious cultural semantics carried by the six caisines at their own rhythm. Through digital translation, multi-ethnic embroidery patterns are liberated from the material form fixed by needles and threads, and the possibility of being rotated, dismantled and repeatedly explored in the digital space.

5 Conclusion

This paper puts forward a multi-ethnic pattern integration design method of "flower selection-caisson combination-digital translation". Its contribution is mainly reflected in three aspects: theoretically establishing a complete translation chain from auspicious culture to interactive realization, providing cross-ethnic patterns Research provides a reusable paradigm; In practice, the transformation from static pattern to dynamic gesture interaction is realized through TouchDesigner, which verifies the operability of the method; In the cultural sense, it reveals the phenomenon that although the shapes of the six flower patterns are different in different nations, their auspicious meanings are highly consistent, indicating that cross-ethnic integration is not a blunt combination of heterogeneous elements, but a natural convergence of cultural semantics with the same root and origin.

There are still certain limitations in this study. For example, the interactive system currently only includes the basic parametric models of six kinds of flowers, has not yet included more ethnic pattern variants, and has not conducted system user testing. Future research will expand the sample size and introduce machine learning, and strive to achieve a paradigm upgrade from "preset auspiciousness" to "generate auspiciousness". In general, the method proposed in this paper provides a solution with promotion value for breaking through the "independence" in the digital research of multi-ethnic patterns, and also injects the warm and spiritual core of auspicious culture into the regenerative design of digital heritage.

DECLARATIONS

Dataset to be available

All data generated or analyzed during this study are included in this published article.

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