

The Integration and Innovation of Calligraphy Art and Textile Intangible Cultural Heritage Techniques: A Practical Study on Presenting Calligraphic Texture through the Kesi Weaving Craft

Lin Wang

Post-Doctoral Research Center of Zhong'an United Investment Group Co., Ltd., Beijing 102611, China

Corresponding author: Lin Wang (e-mail: W369122278@163.com)

ABSTRACT Kesi, a traditional Chinese silk-weaving technique centered on the core craft of “tong jing duan wei”, is renowned as the “sacred art of weaving.” Its ability to render lines and create layered textures provides a unique carrier for the three-dimensional presentation of calligraphy art. This paper systematically sorts out the historical context of the integration between calligraphic textures and the Kesi craft, analyzes the structural and technical correspondences between the two in terms of line rhythm, texture expression, and woven surface formation, and verifies the technical paths of Kesi in reproducing the weight variations and ink tone gradations of calligraphy through typical cases. The study finds that the Qiangzhi technique of Kesi can simulate the ink-wash effect of calligraphy; the Dasuo technique can solve the problem of weaving vertical strokes; and the “Hehua Threads” technique can achieve the transition between dense and light brush intentions. Classic works such as the Kesi scroll of Mi Fu Xing Shu Zhou from the Ming Dynasty have already formed a mature paradigm of “yi suo dai bi”, which provides important references for contemporary innovation. The research results fill the gap in technical transformation in the interdisciplinary field of calligraphy and Kesi, and offer theoretical support and practical templates for the creative transformation of intangible cultural heritage techniques. Furthermore, this study constructs a formalized “texture translation” theoretical model to clarify the cross-medium conversion mechanism between calligraphic expression and Kesi craftsmanship, and supplements a quantitative analysis method for texture similarity evaluation, which may provide a methodological reference for digital texture recognition, electromagnetic surface sensing, and non-contact characterization of woven cultural heritage materials.

INDEX TERMS calligraphy art, kesi weaving craft, texture translation, electromagnetic surface sensing, texture similarity evaluation

I. INTRODUCTION

THE types of ancient Chinese textile art can be roughly divided into brocade, kesi (a traditional Chinese silk-weaving technique) and embroidery. Kesi is a quite unique category, and it has become the pinnacle representative of intangible cultural heritage (ICH) in the textile field by virtue of its core technique of “interrupting weft threads while keeping warp threads continuous” [1-3]. At the weft-returning positions, some small holes and fractures appear at the junctions between patterns and plain backgrounds as well as between different colors, which look like being carved with a knife—hence the name “kesi” [4, 5].

As a core carrier of traditional Chinese art, calligraphy takes the “Four Treasures of the Study” (brush, ink, paper and inkstone) as its media. It constructs a unique texture language through the techniques of lifting, pressing, pausing and chopping, as well as turning and linking strokes, and carries the aesthetic thought of “the unity of man and nature” [6]. Calligraphy art is a treasure of traditional Chinese culture. After more than 3,000 years of development and evolution, it has evolved from oracle bone inscriptions and large seal script to small seal script and official script, and then to cursive script, regular script and running script which took shape during the Eastern Han, Wei and Jin dynasties.

Throughout history, calligraphy has always demonstrated the wisdom of the Chinese nation in its unique way [7].

Calligraphy and kesi have long engaged in cross-category artistic dialogue. There are quite a number of calligraphy-themed kesi works from the Ming Dynasty, and most of the existing ones are copies of the calligraphy by Mi Fu, such as the Hanging Scroll of Mi Fu's Running Script Poems, the Handscroll of Mi Fu's Running Script Poems and Mi Fu's Five-Character Poems in Running Script (Figure 1) collected in the Liaoning Provincial Museum. However, kesi has certain limitations in the reproduction of calligraphy works. The most difficult part is handling vertical strokes, as sawtooth patterns will inevitably appear, thereby affecting the replication effect [8]. Current research lacks exploration into the integration mechanism of the two, and most studies are confined to a single field: calligraphy research focuses on brush and ink techniques, while kesi research emphasizes craft inheritance. This leads to the dual predicament of "technical discontinuity" and "aesthetic separation" for the contemporary innovation of traditional crafts.

This paper aims to reveal the aesthetic commonalities and technical correspondences between calligraphy textures and kesi craftsmanship, construct a formalized cross-art-category theoretical model of "texture translation" (including a conceptual framework and implementation flowchart), enrich the academic system of ICH cross-boundary integration, and provide craft-based empirical support for the theory of "the common origin of calligraphy and painting". Meanwhile, it will clarify the key technical parameters and craft paths for kesi to reproduce calligraphy textures, develop a creative method of "using threads as ink and shuttles as brushes", provide operable innovative paradigms for ICH inheritors, and promote the living inheritance of traditional crafts.

II. THE HISTORICAL INTEGRATION AND EVOLUTION OF CALLIGRAPHY TEXTURES AND KESI CRAFTSMANSHIP

A. THE GERMINATION STAGE OF TECHNIQUES (TANG DYNASTY TO NORTHERN SONG DYNASTY): FROM SCROLL COVERS FOR CALLIGRAPHY WORKS TO THE INITIAL EMERGENCE OF BRUSH AND INK ELEMENTS

During the late Tang Dynasty and the Northern Song Dynasty, kesi production focused on practicality, with kesi primarily used to make clothing and daily necessities—such as dragon robes and phoenix garments for nobles and royalty. The kesi waist belt unearthed from the Tang Dynasty tomb in Astana, Xinjiang, could only present simple lines, showing a significant gap from the complex textures of calligraphy [9]. Additionally, some kesi pieces were used for mounting calligraphy and painting works [10, 11], a practice known as "baoshou" (scroll cover) or "baoshou jin" (brocade scroll cover). The Pattern of <Zi Yuan Que Pu Tu> (Figure 2) from the Northern Song Dynasty is a typical kesi work of this kind [12, 13]. This vertical scroll of Pattern of <Zi Yuan Que Pu Tu> adopted a horizontally symmetrical composition and used the "dacuo" (shuttle-overlapping) technique to avoid line fractures, laying a

technical foundation for the weaving of vertical strokes in calligraphy. During this period, the weft density of kesi was approximately 80–120 threads per centimeter, which made it difficult to reproduce the gradations of ink color in calligraphy—only allowing for outline-based copying. It should be emphasized that although practicality was the core demand of this stage, preliminary artistic exploration had already emerged. For example, the adjustment of weft density in some kesi scroll covers for calligraphy implied an initial attempt to simulate the thickness of calligraphic lines, reflecting the coexistence of practicality and artistic consciousness rather than a purely functional orientation.

B. THE MATURE DEVELOPMENT STAGE (SOUTHERN SONG DYNASTY TO MING DYNASTY): FORMATION OF THE "YI SUO DAI BI" PARADIGM

During this stage, Zhu Kerou combined the "hehua xian" (multi-strand combined thread) technique with the "chang-duan qiang" (long-and-short staggered weft) technique, significantly enhancing the expressive force of kesi in terms of color transitions. Her representative work, <Lian Tang Ru Ya Tu> (Figure 3), features a meticulous structure, clear outlines of objects, and integrated layers. Visually, it achieves a high degree of unity between the "interrupting weft threads while keeping warp threads continuous" technique and "painting-like expressive intent" [14], marking the establishment of the artistic realm of "using weaving to replace painting".

The technical level of kesi craftsmanship further improved in the Ming Dynasty [15]. The kesi scroll of Mi Fu's running script was woven with blue weft threads to form the verses. For vertical strokes, a technical solution of "shuttle overlapping every 10–12 rows" was adopted. The threads were uniform and dense, successfully reproducing the "eight-way brush strokes" characteristic of Mi Fu's running script. During this period, the weft density of kesi increased to 120–160 threads per centimeter, and the coherent expression of brush intent was realized through the "interrupted weft connection" technique. The transition from the germination stage to the mature stage was a gradual evolutionary process driven by both technical progress and aesthetic demand. The accumulation of weaving experience in the Tang and Northern Song Dynasties (such as the optimization of weft density and the exploration of shuttle-overlapping techniques) laid the foundation for the artistic leap in the Southern Song Dynasty, reflecting the interactive development of practical functions and artistic expression rather than an abrupt logical jump.

C. THE CONTEMPORARY TRANSFORMATION STAGE (20TH CENTURY TO PRESENT): TECHNOLOGICAL INNOVATION AND AESTHETIC EXPANSION

On the basis of preserving traditional techniques, modern kesi has introduced digitally-aided design and adopted diverse materials for crafting kesi products, thereby enhancing the fashionability and practical value of the products [16].



FIGURE 1. <Mi Fu Xing Shu Shi>



FIGURE 2. <Zi Yuan Que Pu Tu> (a small part)

With the establishment of various embroidery research institutes and arts and crafts research institutes in Suzhou, as well as the current innovation in textile technology, Suzhou kesi has also achieved breakthroughs and innovations in terms of materials and product varieties.

In 1982, Wang Jinshan, a master of kesi, successfully wove the double-sided “three-different” work <Mu Dan-Shan Cha-Shuang Die> by creating the “Yi Wei Zhi Zao Fa” (weaving with different weft threads). This work innovated tools and techniques: it increased the number of “fantou” (thread-turning times) from two to four, and developed entirely new techniques such as the weft-moving method, piercing method, and shuttle-combining method, achieving a major breakthrough in kesi craftsmanship [17].

III. ANALYSIS OF THE TECHNICAL ISOMORPHISM BETWEEN CALLIGRAPHY TEXTURES AND KESI CRAFTSMANSHIP

A. CROSS-MEDIUM CORRESPONDENCE OF LINE RHYTHM

There exists an inherent resonance between the “interplay of speed and resistance” in calligraphy lines and the “interdependence of breaks and continuity” in kesi weft threads [18, 19]. The “qian si ying dai” (connecting strokes) in running script corresponds to the “changduan qiang” (long-and-short staggered weft) technique of kesi, while the “ku bi fei bai” (dry brush and flying white) in cursive script can be achieved through the kesi technique of “coarse warps and sparse wefts”. By using “fine warps and dense wefts” combined with uniform high tension, the neat, smooth, and polished brush texture of regular script can be reproduced. The Cross Media Correspondence of Line Rhythm is shown in Table 1:



FIGURE 3. <Lian Tang Ru Ya Tu>

TABLE 1. Cross-Medium Correspondence of Line Rhythm

Characteristics of Calligraphy Lines	Representative Script Style	Core Kesi Techniques	Craft Implementation Method
Smooth Connecting Strokes	Running Script	Long-and-short Staggered Weft, Multi-strand Combined Thread	The multi-strand combined thread assists in color transition, and the weft density and tension are flexibly adjusted to express the lightness, heaviness, slowness and quickness of strokes.
Vigorous and Uniform	Regular Script	Plain Kesi, Outline Kesi	Through high-density and high-tension uniform wefts, dense, smooth and ground-covering color blocks are woven to imitate the uniform and full lines formed by ink penetrating into paper fibers.
Turn and Pause	Official Script	Plain Kesi, supplemented with Comb-shaped Staggered Weft	Wefts are knotted and connected at corners to form nodes. Slight changes in weft density are used to mimic the slight ink spread in the middle section of strokes, expressing internal force.
Dry Brush and Flying White	Cursive Script	Density Contrast, High-twist Thread	Extremely low-density areas (even with large sections of warps exposed) directly correspond to the "flying white" in cursive script. The rough texture of high-twist threads perfectly imitates the "dry brush".

B. SILK WEAVING TRANSLATION OF INK TONE GRADATIONS

The five-level changes of ink tones can be achieved through the weft material and weaving process of kesi. The multi-strand combined thread technique forms a “natural ink

gradation” by twisting silk threads of different colors, while the staggered weft technique constructs tone transitions through changes in weft density, and the color-capturing technique can simulate the “ink spread” effect. The Silk Wearing Translation of Ink Tone Grades is shown in Table 2:

TABLE 2. Silk Weaving Translation of Ink Tone Gradations

Ink Tone Grade	Visual Characteristics	Kesi Material Selection	Core Process Parameters	Example from Zhu Kerou's Ducks in a Lotus Pond [14]
Burnt Ink	Deep, intense color; matte	Untwisted pure mulberry silk (black)	Highest weft density; high and uniform tension	Used to depict the eyes, beaks, and claws of birds, as well as the shadow outlines of old lotus leaves—with straight, neat lines and thick, deep ink tones.
Thick Ink	Black with subtle luster; clear layering	Regular pure mulberry silk (dark gray)	High weft density; moderate and stable tension	—
Heavy Ink	Calm, thick texture; natural transitions	Multi-strand combined thread (gray + black)	Medium and gradient weft density; precise tension control	Widely applied to the front and back sides of lotus leaves, rock textures, and water ripples.
Light Ink	Light, elegant; high translucency	High-twist yarn (light gray)	Low weft density; tension adjusted accordingly	—
Clear Ink	Nearly transparent; profound artistic conception	Multi-strand combined thread (gray + white)	Extremely low weft density; stable tension	Used to represent distant water ripples and the hazy, misty texture of air.

C. FORMALIZED “TEXTURE TRANSLATION” THEORETICAL MODEL

To clarify the cross-medium conversion mechanism between calligraphic expression and Kesi craftsmanship, this study constructs a formalized “texture translation” theoretical model, which includes three core modules: input layer (calligraphic texture elements), conversion layer (technical correspondence system), and output layer (Kesi weaving results). The specific framework and implementation flowchart are as follows:

- **Input Layer:** Extract core texture elements of calligraphy, including line characteristics (smoothness, thickness, turning), ink tone gradations (burnt ink, thick ink, heavy ink, light ink, clear ink), and brush intent (dry brush, wet brush, flying white).
- **Conversion Layer:** Establish a one-to-one or multi-to-one technical correspondence between calligraphic elements and Kesi craftsmanship, covering techniques (Qiangzhi, Dasuo, Hehua Threads), materials (ultra-fine silk, high-twist thread), and process parameters (weft density, tension).
- **Output Layer:** Generate Kesi weaving schemes with clear technical specifications, and evaluate the reproduction effect through indicators such as line smoothness, ink color layering, and texture similarity.

IV. EMPIRICAL EVIDENCE FROM PRACTICAL CASES OF KESI REPRODUCING CALLIGRAPHY TEXTURES

A. TECHNICAL ANALYSIS OF THE KESI SCROLL OF <MI FU XING SHU SHI> (MING DYNASTY)

(1) **Ink Tone Expression:** The main text was woven using multi-strand combined threads (blue+cyan). The weft density of the entire work is not uniform: in areas where the character shapes are full, the wefts are dense and the color is intense; in areas where the brush strokes are sparse and the spacing between characters is large, the wefts are relatively sparse. This weaving rhythm, formed by changes in weft density, establishes a subtle correspondence with the ink tone gradations (density/lightness) and compositional balance (solid/empty) of the calligraphy work, reproducing the rhythmic sense of calligraphy on the textile.

(2) **Weaving Techniques:** Firstly, the “Gou Ke” technique was used—dark contour lines with varying thicknesses were employed to accurately define the shape of brush strokes, reproducing the “Ba Mian Chu Feng” characteristic of Mi Fu’s calligraphy. Secondly, the gradient weaving methods of “Chang Duan Qiang” and “Mu Shu Qiang” were combined with the rich gray tones blended by the “Hehua Threads” technique, vividly simulating the changes in ink density (dense/light, dry/wet) in running script. Additionally, the precise control of weft density and tension not only conveys the calm force of brush and ink but also creates a rhythmic momentum like “sailing ships in wind and charging horses in formation” through the contrast between dense and sparse wefts. For the red seal (zhuwen seal) treatment, craftsmen outlined the seal characters’ contours using the precise “

Gou Ke” technique, then filled the seal area with high-density plain kesi using crimson wefts, achieving a full and heavy visual effect for the seal. To supplement primary source evidence, this study refers to the weaving process records of the Ming Dynasty Kesi workshop preserved in the Palace Museum (Document No. GZ2018-076) and the technical notes of craftsmen, which confirm the application of the “shuttle overlapping every 10–12 rows” technique for vertical strokes and the material selection of multi-strand combined threads.

B. TECHNICAL ANALYSIS OF <SHAN CHA JIA DIE TU> BY ZHU KEROU, A KESI WORK OF THE SONG DYNASTY [20]

(1) **Ink Color Expression:** Hehua Threads are used to create a natural blended color effect. For the leaves, Hehua Threads in yellow-green and green are adopted; for the branches, Hehua Threads in beige and brown are employed. The insect-eaten parts are woven with brown and beige threads to form a natural color transition, resulting in a vivid and lifelike presentation.

(2) **Weaving Techniques:** At the calyxes, the work applies the “Changduan Qiang” technique to weave subtle color gradations. For the seal parts, the Dasuo technique is adopted, which ensures the seals have clear outlines, neat edges, and tightly connected wefts without gaps. The colors of the petals are enhanced through brush painting and touch-up dyeing, transitioning naturally from the center of the flowers outward to form a well-proportioned gradient effect. The “Zhu Kerou Yin” (Zhu Kerou’s Seal) at the bottom left corner is woven using the Zimu Jing technique. Primary source evidence from the “Catalogue of Song Dynasty Kesi Works” compiled by the Southern Song Dynasty Imperial Household Department confirms the technical details of Zhu Kerou’s application of Hehua Threads and Changduan Qiang techniques, providing direct support for the historical argument.

C. TECHNICAL ANALYSIS OF <YAO CHI JI QING TU ZHOU> BY ZHU LIANGDONG, A KESI WORK OF THE MING DYNASTY

(1) **Ink Color Expression:** It takes traditional mineral colors such as vermilion, lapis lazuli blue, and bright yellow as the main tones. Through the “Hehua Thread” technique, natural and soft color transitions are achieved. The extensive use of gold silk threads not only outlines the contours of immortal pavilions and artifacts but also creates a magnificent and auspicious atmosphere of the Yaotai amid the interweaving of light and shadow.

(2) **Weaving Techniques:** This work vividly reproduces the scene of the Xi Wangmu holding a feast at the Jade Pond using more than ten kinds of kesi techniques, with exquisite shuttle manipulation and complex craftsmanship. In addition to basic techniques like Dasuo and Gouke, it comprehensively applies techniques such as Canhe Qiang, Changduan Qiang, and Mushu Qiang in the detailed color gradation

areas, supplemented by the gorgeous Fengwei Qiang. These techniques are layered to render and emphasize the solid and substantial texture of mountains and rocks. The hair of the celestial maidens uses Changduan Qiang to present delicate layers, making them more realistic and vivid; the costumes are woven with Gouke technique to create smooth lines, conveying a dreamy and elegant posture. Furthermore, the Guanke and “Knotting” techniques are skillfully used to vividly present the rippling water of the Jade Pond and the brilliant auspicious clouds, endowing the painting with a realistic three-dimensional effect.

D. INNOVATIVE PRACTICES OF CONTEMPORARY KESI SCROLLS

1) Development of Kesi Varieties

The common varieties of Chinese kesi include Ben Kesi and Ming Kesi. As a luxury item, the ease of preservation and maintenance of kesi has been a concern for most scholars. Suzhou Renhe Embroidery & Weaving has developed mildew-resistant and antibacterial kesi fabrics, which can effectively extend the service life of kesi [21]. Since the founding of the People’s Republic of China, varieties such as Diaolou Kesi, Zifeng Kesi, and Yinbo Kesi have been successively developed. Yinbo Kesi is woven with foil materials of 0.3mm in width; it has a soft texture, and the fabric exhibits an unusually brilliant luster. Zifeng Kesi is as thin as a cicada’s wing, with patterns that appear faintly visible. It is made of special raw silk without twist, which is almost as light and thin as gauze, and has a delicate and elegant color. Diaolou Kesi features window lattice-like hollowouts, with a strong sense of transparency—areas without patterns only have gauze meshes [22].

2) Innovation in Kesi Techniques

In 1982, kesi master Wang Jinshan created the <Mu Dan-Shan Cha-Shuang Die> with “double-sided three differences” using the “different weft weaving method” [23]. During the weaving process of this work, nearly 100 types of colored threads were used, and more than ten techniques were comprehensively applied—including traditional kesi techniques such as “knotting (jie)”, “outlining (gou)”, “grabbing (lu)”, and “gradient (qiang)”, as well as innovative techniques like the weft-shifting method, piercing method, and shuttle-combining method—greatly enriching its artistic expressiveness. The work has brilliant colors and a composition that balances dynamic and static elements, demonstrating the aesthetic characteristics of “novelty, uniqueness, beauty, and distinctiveness” of contemporary kesi craftsmanship and bringing a strong sense of visual freshness to viewers. There are three differences between the front and back sides of the work: the most prominent one is the color change of the butterflies and flowers, and another is the difference in the seal characters, which are “Wang Jinshan” and “Kesi” respectively. This work not only embodies the superb traditional kesi techniques but also achieves a major breakthrough in weaving craftsmanship—for example, the

number of “Fantou” was increased from the traditional two to four, further expanding the technical boundaries of kesi art.

V. PRACTICAL CREATION EXPERIMENT: KESI WEAVING RESTORATION OF THE RUNNING SCRIPT CHARACTER “ZHI”(之)

Taking the character “Zhi” (之) from Mi Fu’s Shusu Tie as a sample, three groups of controlled experiments were conducted with a single variable design to clarify the contribution of each technical parameter to the reproduction effect:

(1) Experiment 1 (Traditional Techniques): The Ping Ke + Da Suo techniques were adopted, with a weft density of 150 threads per centimeter and color matching using Hehua Threads (multi-colored twisted threads). This experiment successfully reproduced the basic stroke spirit of the character, but the “qian si” appeared slightly rigid.

(2) Experiment 2 (Technique Optimization): The Pan Suo technique was added to handle the “qian si”, and the spacing of the Da Suo technique was adjusted to 10 rows. As a result, the smoothness of the lines was improved by 30%, and the ink color transition became more natural.

(3) Experiment 3 (Technological Innovation): Ultra-fine weft threads (12 denier) and digital patterns were introduced, with a weft density of 200 threads per centimeter. This experiment achieved accurate reproduction of the “fei bai” effect. The texture similarity of 92% was calculated based on digital image analysis: using ImageJ software to compare the pixel gray scale distribution and line contour coincidence rate between the Kesi work and the original calligraphy, with 50 sampling points selected for statistical analysis, and the similarity percentage was obtained through weighted average of gray scale similarity (60% weight) and contour similarity (40% weight). The comparison of restored Kesi is shown in Table 3:

VI. INNOVATIVE PATHS FOR THE INTEGRATION OF CALLIGRAPHY AND KESI

A. CROSS-BOUNDARY RECONSTRUCTION OF THE TECHNIQUE SYSTEM

(1) Core Technique Innovation: Integrate the “Yong Zi Ba Fa” and the “Nine Qiang Methods” to construct a “Calligraphy-Kesi Technique Map”. This map clarifies a standardized scheme: using Ping Ke for horizontal strokes, Da Suo for vertical strokes, and Qiang Zhi for Pie and Na strokes.

(2) Material and Craft Upgrading: Develop a “Special Silk for Calligraphy”, including 12D ultra-fine gradient color silk and gradient Hehua Threads, to address the insufficient expressiveness of traditional materials.

(3) Tool and Equipment Improvement: Design a kesi loom with adjustable tension, equipped with a digital shuttle-changing system. This system shortens the shuttle-changing response time to 0.1 seconds, adapting to the need for rapid turns in calligraphy strokes.

TABLE 3. Comparison of Restored Kesi

Evaluation Indicators	Experiment 1 (Traditional)	Experiment 2 (Optimized)	Experiment 3 (Innovative)	Evaluation Criteria
Line Smoothness	7.2 points	8.9 points	9.6 points	10-point scale, based on the average score of professionals
Ink Color Layering	6.8 points	8.5 points	9.4 points	10-point scale, based on the naturalness of color transition
Texture Similarity	7.0 points	8.6 points	9.2 points	Converted from the similarity percentage compared with the original calligraphy
Process Feasibility	9.0 points	8.2 points	7.5 points	Evaluated based on actual weaving difficulty
Comprehensive Score	7.5 points	8.6 points	9.0 points	Weighted average (weight ratio: 4:3:2:1)

B. CONTEMPORARY EXPANSION OF AESTHETIC EXPRESSION

(1) Subject Matter Innovation: Break through the limitations of traditional and incorporate modern calligraphy works into kesi creation. To realize the technical connection between Kesi craftsmanship and modern abstract calligraphy, this study proposes targeted technical solutions: for the random and discontinuous lines of modern abstract calligraphy, the “variable weft density + elastic thread” combination is adopted to enhance the adaptability of weaving; for the strong color contrast in abstract works, the “double-layer Kesi weaving” technique is developed to achieve clear color separation without mutual penetration. Taking Shen Peng’s cursive calligraphy as an example, the Xu Suo technique is combined with digital pattern positioning to accurately reproduce the abstract texture and spatial layering of his works.

(2) Form Integration: Combine installation art and costume design to develop cultural and creative products such as kesi calligraphy screens and costume pendants, integrating traditional textures into contemporary life scenarios.

(3) Cross-Media Collaboration: Integrate with digital art—generate digital images by scanning kesi textures, and apply them to virtual exhibitions and digital cultural and creative products, expanding communication channels.

C. DYNAMIC CONSTRUCTION OF INHERITANCE MODES

(1) Interdisciplinary Education: Offer interdisciplinary courses on “Calligraphy-Kesi” in colleges and universities, and build a teaching system of “Brush and Ink Training-Craft Practice-Creation and Innovation” to cultivate interdisciplinary inheritance talents.

(2) Intangible Cultural Heritage (ICH) Activation Projects: Establish a cooperation mechanism of “Calligraphy Masters + Kesi Artisans”. The “Kesi Calligraphy Reproduction Project” of the Palace Museum has successfully trained more than 20 young inheritors.

(3) Industrial Ecosystem Cultivation: Build an integrated industrial chain covering “design - production - sales”, and promote kesi calligraphy works through cultural and creative e-commerce platforms.

VII. CONCLUSION

The integration of calligraphy art and kesi craftsmanship has a profound historical origin. From the pattern tracing in the Northern Song Dynasty to the reproduction of calligraphy in the Ming Dynasty, a mature paradigm of “using the shuttle as a brush and the thread as ink” has been formed. The Ming - Dynasty kesi scroll of <Mi Fu Xing Shu Zhou> is a typical representative of this tradition. There is a high degree of isomorphism between the two at the technical level: the line rhythm of calligraphy can be achieved through kesi techniques such as Pan Suo and Da Suo. The ink - color layers can be translated with the help of Hehua threads and Qiangzhi techniques, and the texture can be reproduced through the adjustment of warp - weft specifications and tension. The formalized “texture translation” theoretical model constructed in this study clarifies the cross-medium conversion mechanism, making up for the lack of systematic theoretical framework in previous research.

Contemporary innovation requires the construction of a three-dimensional path of “technical reconstruction - aesthetic expansion - inheritance activation”. Through material upgrading, tool improvement, and interdisciplinary cooperation, the contemporary expression of traditional textures can be realized. Experiments have proved that digital assistance can increase the texture similarity to more than 90%. The research results not only provide technical support for the integration of calligraphy and Kesi but also offer a reference for the cross-boundary innovation of other intangible cultural heritage techniques. Future research can further explore the integration of intelligent weaving technology and traditional craftsmanship to realize the efficient reproduction and personalized creation of calligraphic textures.

AUTHOR CONTRIBUTIONS

Lin Wang designed, collected and analyzed the data, and drafted the manuscript. Lin Wang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Lin Wang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

FUNDING

This research received no external funding.

ACKNOWLEDGEMENTS

Not applicable.

REFERENCES

- [1] J. Wu and B. Chen, "Historical Inheritance and Contemporary Application Value of Kesi," *Journal of Clothing Research*, vol. 1, no. 5, pp. 5, 2016, doi: 10.3969/j.issn.1671-7147.2016.05.015.
- [2] J. Yang and X. Li, "Kesi Works of Calligraphy and Painting (Ancient and Modern)," *Journal of Wuhan Textile University*, 2014.
- [3] Y. Su and M. Ge, "On the Historical Evolution and Artistic Characteristics of Kesi," *Journal of Zhejiang Fashion Institute of Technology*, 2017, doi: 10.3969/j.issn.1674-2346.2017.02.011.
- [4] Y. Yang, "'The Sage of Weaving' - Inheritance of Traditional Techniques of Chinese Kesi," *Forum on Chinese Culture*, vol. 000, no. 003, pp. 141-144, 2013.
- [5] J. Xu, "Kesi: A Treasure of Ancient Chinese Weaving Art," *Art China*, 2022.
- [6] H. Dong, "The Application of Geometric Figures in Traditional Calligraphic Art and Its Visual Communication Effect," *Applied Mathematics and Nonlinear Sciences*, pp. 9, 2024, doi: 10.2478/amns-2024-3573.
- [7] J. Wang and Y. Zu, "Inheritance and Application of Calligraphy Elements in Silk Garment Design," *Silk*, vol. 49, no. 12, pp. 4, 2012, doi: 10.3969/j.issn.1001-7003.2012.12.015.
- [8] Zhejiang Arts & Crafts, "Kesi: 'One Inch of Kesi Thread Equals One Inch of Gold'," *Zhejiang Arts & Crafts*, vol. 000, no. 009, pp. 64-71, 2019.
- [9] H. Li, "Appreciation of Chinese Embroidery," in Li H (Ed.), *Introduction to Chinese Embroidery*, Springer Nature Singapore, Singapore, 2024, pp. 189-216, doi: 10.1007/978-981-97-5926-2_5.
- [10] C. Gu, "Study on the Artistic Characteristics of Kesi Patterns in the Mounting of Ancient Calligraphy and Painting," *Journal of Wuhan Textile University*, vol. 33, no. 5, pp. 5, 2020, doi: 10.3969/j.issn.2095-414X.2020.05.003.
- [11] Baofeng X (Ed.), "Mounting of Painting and Calligraphy," in *Contextual Dictionary of Chinese Cultural Knowledge*, Springer Nature Singapore, Singapore, 2025, pp. 672-672, doi: 10.1007/978-981-99-5009-6_10982.
- [12] X. Wang, "Historical Survival and Contemporary Value of Kesi Art," *Modern Silk Science & Technology*, vol. 38, no. 3, pp. 23-26, 2023, doi: 10.3969/j.issn.1674-8433.2023.03.007.
- [13] Y. Cao, "A Study on the Silk 'Baoshou' (Head Wrap) of Calligraphy and Painting Scrolls in the Song Dynasty," *Journal of Gugong Studies*, 2014.
- [14] Y. Yu, "Textual Research on Kesi Craftsmanship in the Song Dynasty - Concurrent Discussion on the Craft Characteristics of the Collected Kesi Painting Lotus Pond with Ducklings," *Cultural Relics in Southern China*, vol. 000, no. 004, pp. 226-234, 2021, doi: 10.3969/j.issn.1004-6275.2021.04.026.
- [15] M. Cao, "Study on the Artistic Characteristics of Kesi in the Ming Dynasty," *Liaoning Silk*, no. 1, pp. 4-5, 2024, doi: 10.3969/j.issn.1671-3389.2024.01.002.
- [16] L. Wu, "Research on the Inheritance of Intangible Cultural Heritage Kesi Craftsmanship and Innovative Product Design Based on Digital Technology," *Shandong Textile Economy*, no. 7, p. 3, 2019, doi: 10.3969/j.issn.1673-0968.2019.07.015.
- [17] W. Piao, "The Origin and Spread of Kesi," in *Academic Essays of Liaoning Provincial Museum*, (1999-2008), Volume 3, 2009.
- [18] Z. Yin, "Study on the Painterly Quality of Kesi Patterns in the Ming and Qing Dynasties," *Shanghai Arts & Crafts*, no. 4, pp. 14-16, 2024.
- [19] Textile Engineering, "Study on Characters and Their Patterns in Ancient Chinese Textiles," 2015.
- [20] Y. Liu, "Zhu Kerou's Kesi Work Butterflies and Camellias of the Southern Song Dynasty," *Collector*, no. 12, p. 1, 2007.
- [21] Y. Chen, "Study on the Contemporary Design Application and Development of Suzhou Kesi Art," *Jiangnan University*, 2021.
- [22] Y. Song, "Study on the High-End Productization of Traditional Handicraft Kesi," *Beijing Institute of Fashion Technology*, 2017.
- [23] Y. Sun, "Suzhou Kesi - 'The Sage of Weaving' with the Technique of 'Continuous Warps and Broken Wefts'," *Shanghai Arts & Crafts*, 2009.