A Study on Digital Translation Methods for Liaoning's Intangible Cultural Heritage Patterns in Winter Wear and Fashion Design Products

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Abstract

Liaoning holds a large stock of intangible cultural heritage (ICH) visual material-Manchu embroidery, Liao–Jin decorative motifs, and oak-silkworm silk patterns among them. With the 15th National Winter Games approaching, demand for winter-sports cultural and creative (C&C) apparel is growing quickly. In practice, however, these patterns are hard to put to use: their craft is intricate, the ways of adapting them are few, and they do not fit the small-batch production that local small and medium-sized garment enterprises run. Drawing on fieldwork in the Xiliu and Donggang clusters and on our own work digitizing Xiuyan Manchu embroidery and Liao–Jin artifact motifs, this paper identifies four bottlenecks that arise when ICH patterns move into winter-sports C&C products. It then lays out a five-step workflow-selecting and reading the pattern, extracting its features, rebuilding it as vectors, adapting it to the garment context, and prototyping with feedback-and proposes a lightweight version of this workflow that local SMEs can actually run. In our trials it lowered both pattern-processing cost and sample difficulty without diluting the pattern's regional character. The method offers one workable route for developing Liaoning's ice-and-snow apparel C&C products and a practical channel for keeping local ICH alive in production.

Keywords

Liaoning intangible cultural heritage patterns, winter sports clothing and cultural products, digital adaptation, lightweight development.

1. Introduction

The growing popularity of the ice and snow economy has fueled increased consumer demand for commemorative event-related products as well as cultural and tourism-themed creative goods. The apparel category, which combines practical wearability with cultural commemorative value, stands as one of the most widely embraced product segments among consumers. Liaoning boasts abundant intangible cultural heritage resources; Manchu embroidery, Sibe ethnic folk patterns, Liao–Jin dynasty architecture and artifact decorations, and traditional tussah silk patterns collectively form a highly distinctive regional visual symbol system, providing an ample material foundation for the development of cultural and creative products featuring winter sports-themed clothing.

Digital design tools are now common in garment printing, yet they have not taken root in Liaoning's county-level clusters. In Xiliu and Donggang, we found that most SMEs work as contract manufacturers and keep no in-house C&C designer. When they do use an ICH pattern, it usually means pulling an image off the web and scaling it onto a print. The results fall into two traps. The pattern is so intricate that it pushes past what the factory can actually print, and the sample cost climbs; or the shop copies the outline and misses the meaning

underneath it-sometimes putting a ritual symbol onto an everyday garment without realizing it.

Existing research predominantly focuses on the development of fabrics and structures for functional winter sports apparel, or on exploring macro-level pathways for the ice-and snow-based cultural and creative industries; however, there is relatively limited research on pattern translation methodologies for cultural and creative commemorative clothing designed for the cultural and tourism sectors-particularly a lack of lightweight design solutions tailored for small and medium-sized garment enterprises.Building upon the preliminary work involving the organization of pattern materials, corporate field visits, and practical digital design prototyping, this study explores a practical methodology for the digital translation of intangible cultural heritage patterns-one that balances cultural accuracy, craftsmanship suitability, and cost controllability-providing a methodological reference for local enterprises in Liaoning Province when developing cultural and creative products for ice-and snow-themed apparel.

2. The Practical Challenges in Applying Liaoning's Intangible Cultural Heritage Patterns to Cultural and Creative Products for Ice and Snow Apparel

Based on field visits to 12 small and medium-sized garment enterprises and 3 cultural and creative operation companies in Xiliu, as well as a questionnaire survey conducted among tourists at ice and snow scenic areas, the current transformation and implementation of intangible cultural heritage patterns into ice and snow-themed cultural and creative apparel products face four primary challenges.

2.1. Traditional Pattern-making Techniques Are Complex and Do Not Align with the Production Requirements of Cultural and Creative Industries

The intangible cultural heritage patterns associated with Liaoning's Manchu embroidery and oak silkworm brocade mostly originate from traditional handcraft techniques, featuring richly layered lines and intricate decorative details[1].Winter sports and winterwear cultural and creative products are primarily commemorative merchandise; orders typically feature small batch sizes and a wide variety of designs. Most manufacturers utilize digital printing or thermal transfer techniques for pattern production.Directly scanning and importing original intangible cultural heritage patterns into production files can easily lead to issues such as fragmented lines, excessive color overlap, or edge smudging, significantly increasing both the sampling cost and the defect rate.

Our interviews with local printers put numbers on this. Most Xiliu shops run offset printing and handle no more than four colors; a complex color separation adds over 30% to the bill. Few SMEs can strip a pattern down themselves, so they simply drop the local ICH element and reach for a generic clip-art image online. The result is that Liaoning's ice-and-snow C&C apparel looks much like anyone else's, and the regional identity that should make it sell gets lost.

2.2. Translational Reproduction of Appearance; Lack of Constraints on Cultural Semantics

Much of today's C&C design treats an ICH pattern as a picture to be copied. Designers pull out the shape and leave behind the folklore, the period it came from, and the occasions it was meant for. Some Liao, Jin, and Manchu motifs carry ritual or ceremonial weight. Printing them onto casual wear without checking that context can turn a meaningful symbol into a decorative mistake.

Many frontline designers lack a systematic understanding of Liaoning's intangible cultural heritage; in their digital processing workflow, they merely perform operations such as zooming or color adjustment, without completing the adaptation of cultural semantics to modern wearable application scenarios.The final product may appear to feature traditional patterns, but in reality it has lost the core of regional culture; as a result, consumers find it difficult to perceive the distinctive cultural characteristics of Liaoning, which significantly diminishes the cultural communication value of this creative product[2].

2.3. The Absence of Standardized Processes Creates a High Adoption Barrier for Small and Medium-sized Enterprises

Large brands can establish dedicated design teams to perform pattern analysis, vector-based reconstruction, and process adaptation; however, the county-level garment industry clusters in Liaoning are predominantly composed of small and medium-sized enterprises, which generally lack specialized personnel for pattern digital processing and do not have the means to procure high-end design software or material libraries.Currently, there is a lack of lightweight operational guidelines tailored for small-batch cultural and creative applications within the industry; moreover, standardized digital materials for intangible cultural heritage – which can be directly applied to garment printing – are exceedingly scarce.

When enterprises obtain intangible cultural heritage materials from public sources, they often need to invest significant manpower into basic tasks such as image cleanup, edge detection, and layering – a process that is time-consuming and inefficient.Excessively high technical barriers and time costs directly hinder the widespread adoption of intangible cultural heritage patterns in the cultural and creative products produced by small and medium-sized garment enterprises.

2.4. Lack of a Proofing and Validation Phase Leads to a Disconnect between Design and Market Needs

Many patterns are directly delivered for production after digital translation, without undergoing physical prototyping or market validation.When well-rendered computer graphics are printed on various fabrics-such as down jackets, knitted scarves, or fleece hoodies-issues such as color discrepancies, uneven pattern proportions, or blurred details often arise.

Furthermore, the design team rarely proactively gathers feedback from either the production or consumer end; once the translation is completed, the task is considered finished, without continuous optimization of pattern designs based on fabric characteristics or market aesthetics. As a result, a large number of digital design outcomes remain at the visualization stage, making it difficult to truly translate them into industrial implementation[3].

3. Overall Approach for the Digital Adaptation of Intangible Cultural Heritage Patterns into Winter Sports Apparel and Cultural Creative Products

Winter sports apparel and cultural products differ from professional competitive winter wear; their core product categories include event commemorative hoodies, cultural tourism scarves, thermal accessories, and casual winter outfits, with a greater emphasis on commemorative significance and aesthetic expression; production is primarily conducted using small-batch digital printing techniques.Therefore, the digital translation of intangible cultural heritage patterns should not be merely a simple conversion between image formats; instead, three fundamental principles must be adhered to during the translation process.

We followed three rules when we turned a pattern into a printable file. The first was cultural fidelity. A pattern is not something we could deconstruct at will; we kept the markers that identify it and the folk meaning attached to it, and cut only the decorative clutter. This also kept us from putting a ritual or sacred motif on everyday clothing. The second rule was printability. We worked within what digital printing and thermal transfer can actually do-few color layers, broken lines mended, layers kept clean, and files matched to the fabric they would land on. The third rule was cost. We sized the workflow to the tools an SME already has: mainstream vector software, output files the factory could open and send to sample without a designer on call[4].

Based on these three dimensions, the overall translation process can be divided into five consecutive workflow stages: selection and cultural analysis of intangible cultural heritage patterns; deconstruction of visual elements and extraction of core characteristics; vectorization, digital reconstruction, and lightweight processing; adaptation and optimization tailored for ice and snow apparel scenarios; and physical prototyping followed by iterative refinement based on market feedback.The entire workflow can either be centrally executed by a university design team to create a standardized asset library for enterprise use, or the operational steps can be simplified to guide enterprise designers in independently conducting secondary pattern development.

4. Specific Implementation Methods for the Digital Translation of Liaoning's Intangible Cultural Heritage Patterns

4.1. Pattern Selection and Cultural Analysis

The first step of translation is material screening and cultural semantic analysis – a preliminary phase designed to prevent cultural distortion.The source materials primarily consist of three categories: publicly available images from museum collections, authorized physical works by intangible cultural heritage practitioners, and publicly published documentary collections.Prioritize patterns suited for ice-and snow-based cultural and tourism themes or event commemorative themes-such as auspicious animal and floral motifs found in Manchu embroidery, geometric decorative patterns from Liao and Jin dynasty artifacts, or traditional round-pattern designs on oak silkworm silk; patterns bearing specific sacrificial or ritual connotations that are not suitable for mass-market cultural and creative products should be excluded.

A simple pattern analysis card can be created to record the origin of each pattern, its cultural symbolism, traditional usage scenarios, and usage tips.For example, the Haidongqing pattern found in Manchu embroidery embodies the cultural heritage of northern fishing and hunting traditions and aligns well with ice-and-snow themes; however, the original compositional proportions of this pattern and any usage restrictions must be clearly indicated-it should not be arbitrarily distorted or altered.First, complete the cultural-level review and assessment; then proceed to the image processing phase – this prevents the focus from being solely on image manipulation while neglecting the cultural context.

4.2. Visual Element Deconstruction and Core Feature Extraction

After completing the cultural analysis, the pattern is subjected to visual deconstruction to distinguish between "core identification elements" and "secondary decorative details."Core identifying elements refer to the main silhouette, typical composition, and distinctive colors that determine a pattern's regional recognizability; secondary decorative details refer to the fine stitches and intricate auxiliary patterns created by hand embroidery – these can be appropriately reduced or simplified to suit the printing process.

Taking the scrolling vine pattern on a Liao Dynasty bronze mirror as an example, the curved main structure is preserved while numerous fine dot-like decorations on the surface of the object are removed; for the peony pattern found in Xiuyan Manchu embroidery, the typical shape of the petals is retained, and overly fine local pleats are merged.Extract the traditional dominant colors at the color level, create a limited color palette, control the number of color combinations, and prevent the final printed colors from becoming overly complex.The core of this approach is to preserve cultural identity characteristics, rather than faithfully replicating every detail as it existed in the handcrafted process.

4.3. Vectorized Reconstruction and Lightweight Processing

Patterns obtained through physical photography or scanning are all bitmap images; using them directly for printing may result in issues such as blurring or jagged edges; therefore, these patterns must be vectorized and reconstructed.Taking into account the software configuration landscape of small and medium-sized enterprises, priority should be given to using widely adopted general-purpose vector graphics software for path drawing, thereby avoiding situations where niche specialized software would prevent enterprises from opening the files.Re-define the outlines of the extracted core, remove stray points, merge overlapping paths, and split layers by color.

Given the small-batch production characteristics of cultural and creative products, a specialized lightweighting optimization should be implemented: remove overly fragmented individual small graphics and moderately thicken the lines to mitigate the risk of printing misalignment; consolidate the original multiple color schemes – typically limiting cultural and creative prints for apparel to 4–6 color sets – to align with the production capabilities of most small and medium-sized factories.Upon completion of the processing, the output is in the Universal Vector Format, accompanied by a pattern analysis documentation document that specifies cultural symbolism and usage recommendations, thereby creating reusable digital pattern units.The Liaoning Intangible Cultural Heritage Cultural and Creative Digital Pattern Resource Library developed under this project adopts this processing standard.

4.4. Adaptation and Optimization for Winter Sports Apparel Scenarios

The same intangible cultural heritage vector pattern, when applied to down jacket fabrics, knitted scarves, or cotton hooded shirts, creates vastly different visual effects; therefore, it must be adapted to the specific product context.Based on the application area on the garment, these patterns can be broadly classified into three categories: large-scale prints across the body of the garment, localized embellishments at the neckline or cuff, and small decorative patterns on accessories; for each category, adjust the pattern's size, density, and line thickness accordingly.

For large-scale printed designs, moderately enlarge the unit patterns and reduce the graphic density to avoid visual clutter; for localized accent designs, compress the pattern size while thickening key lines to prevent the patterns from appearing blurry at smaller scales.Given that ice and snow-themed clothing is primarily designed for winter use, adjust the color brightness appropriately to match common winter color palettes such as navy blue, off-white, and dark red.For commemorative edition products designed for the 15th Winter Games, it is also possible, subject to compliance requirements, to combine intangible cultural heritage patterns with the event logo in a unified design to create commemorative design source files.

4.5. Sample Production and Pilot Sales with Feedback Iteration

Exporting the file is not the end of the job; the pattern still has to meet cloth. We printed it out with a local factory, checking line clarity and color reproduction on the actual fabric and catching problems that only show up on a press. After that, we ran a small pilot at a C&C shop

inside an ice-and-snow scenic area, asking visitors directly whether the pattern read as "Liaoning," whether they liked how it looked, and whether they would actually wear it[5].

Based on sampling-related issues from the production side and user feedback from the market, vector files are modified in reverse to complete one or more rounds of iterative optimization.For example, certain patterns may look excellent in digital renderings, but their may decrease when printed on thick fleece fabric; in such cases, it is advisable to reinforce the core silhouette and remove certain secondary decorative elements.Through a closed-loop process of "digital design – physical prototyping – market feedback – pattern optimization," we ensure that the outcomes of digital translation truly possess tangible industrial implementation value.

5. Conclusion and Outlook

Turning an ICH pattern into a winter-sports product is more than converting a file format. It has to hold the line on three things at once: the pattern's cultural meaning, what the factory can print, and where the product will sell. The five-step sequence we used-select and read, extract features, rebuild as vectors, fit the garment, and test with samples-was built around the constraints we actually saw in Liaoning's SMEs. The point is to keep it light: lower the skill bar for putting a local pattern onto a winter garment, without sanding off the regional character that makes the pattern worth using. It can serve the commemorative apparel tied to the 15th National Winter Games, and it can keep feeding the Liaoning ICH Digital Pattern Resource Library.

Subsequent research can be further deepened along two lines: first, by integrating generative AI tools to transform this translation logic into prompt-based constraint conditions, thereby exploring human–machine collaborative pathways for pattern derivation and further enhancing design efficiency; second, by continuously expanding the pattern database by incorporating additional intangible cultural heritage resources from Liaoning-such as the Hezhe ethnic group's fishskin patterns and Yingkou woodblock New Year painting patterns-refining the classification system of the material library, broadening the application of these patterns across a wider range of cultural and creative wearable products for cold-climate regions, and facilitating the dynamic preservation of Liaoning's intangible cultural heritage through the ice and snow economy.

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