A Dual-Mechanism Framework for Evaluating Cultural Fidelity in Intangible Cultural Heritage Redesign: Integrating Designer Aesthetic Judgment and Computational Similarity

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Abstract. With digital design increasingly shaping cultural production, intangible cultural heritage (ICH) redesign has become an important way to connect traditional inheritance with contemporary visual innovation. However, existing studies often emphasize the translation of cultural elements into new designs, while paying less attention to whether redesigned works continue the cultural features of the originals. To address this gap, this paper proposes a dual-mechanism framework for evaluating cultural fidelity in ICH redesign. The framework combines designer aesthetic judgment, which captures cultural meaning and craft temperament, with computational similarity analysis, which measures visual continuity in color, form, and semantic features. A small-scale experiment on papercut, embroidery, and blue-and-white printed cloth shows that the framework can distinguish surface-level borrowing from meaningful cultural continuation, offering an interpretable reference for ICH redesign assessment.

Keywords: intangible cultural heritage redesign; cultural fidelity; design evaluation; designer aesthetic judgment; computational similarity; digital design.

1 Introduction

Digital media, intelligent design tools, and creative industries have moved ICH from archival preservation to contemporary design translation[1]. Traditional motifs, colors, craft structures, and symbolic narratives are now recomposed across packaging, visual identity, exhibitions, interfaces, and cultural products, supported by extraction, color analysis, and generative methods[2,3].

However, redesign also raises the issue of cultural fidelity. Although technology may improve sustainability and dissemination[4], surface motif borrowing may weaken craft logic, regional identity[5], and cultural meaning[6]. Since evaluation should consider cultural identity, user response, immersion, and communication effects rather than visual novelty alone[7,8], this paper proposes a dual-mechanism framework combining designer judgment and computational similarity to evaluate cultural fidelity in ICH redesign.

© The Author(s) 2026
R. Zur et al. (eds.), *Proceedings of the 2026 5th International Conference on Art Design and Digital Technology (ADDT 2026)*, Advances in Computer Science Research 131,
https://doi.org/10.2991/978-94-6239-737-8_45

2 Method

2.1 Cultural Fidelity and Evaluation Framework

In ICH redesign, fidelity does not mean mechanical replication. It refers to the extent to which a redesign continues the core cultural features, visual language, and craft logic of the original ICH object while allowing simplification, media transfer, functional adaptation, and aesthetic renewal. Cultural fidelity includes formal, cultural-semantic, and craft/process-logical dimensions, covering visible continuity in motifs, colors, composition, contour, and rhythm, as well as symbolic meaning, local identity, generative rules, material impressions, and craft associations. For example, a paper-cut redesign should retain not only symmetry and auspicious motifs, but also cutting logic, positive-negative space, and decorative rhythm.

Therefore, cultural fidelity is treated in this study as a relational concept rather than a static property of either the original object or the redesigned work. A redesign may deliberately simplify motifs, change the carrier, or adjust the visual hierarchy for contemporary use, but it should still maintain recognizable cultural cues and an interpretable connection with the original heritage system. In this sense, a high-fidelity redesign is not necessarily the most visually similar one; it is a design that preserves the cultural logic behind the form while adapting it to a new design context. This distinction is important because many ICH-inspired products rely on direct visual copying, whereas others achieve cultural continuity through more abstract transformation of symbolic meaning, composition rules, or craft temperament.

The proposed framework combines designer aesthetic judgment with computational similarity. As shown in Fig. 1, original ICH objects and redesign cases are paired and preprocessed. Reviewers score each case according to unified fidelity dimensions, while image features are extracted for color, form-pattern, and semantic comparison. The standardized outputs are then fused to identify cases that are visually close but culturally weak, or formally transformed yet semantically continuous.

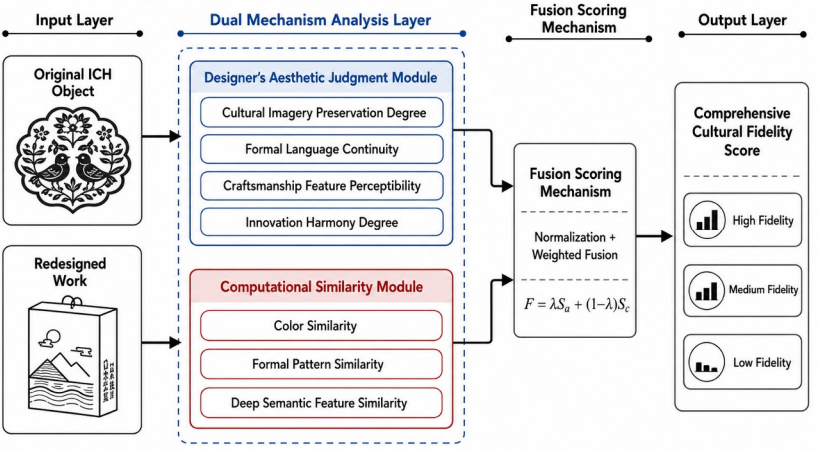

Fig. 1. Dual-mechanism framework for evaluating cultural fidelity in ICH redesign.

2.2 Evaluation Modules and Fusion

The designer aesthetic judgment module evaluates cultural imagery retention, formal language continuity, craft-feature perception, and innovation coordination. After reading the object background, redesign context, and scoring definitions, reviewers use a 5-point Likert scale. The score is calculated as:

$$S_h = \frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{m} w_j\, r_{ij},\ \sum_{j=1}^{m} w_j = 1 \tag{1}$$

where S_h is the designer judgment score,n is the number of reviewers, w_j is the dimension weight, and r_{ij} is reviewer *i*'s score. This study assigns equal weights $w_j = 0.25$ to keep the scoring scale transparent and avoid over-weighting any single dimension.

After image normalization, the computational similarity module measures color, form-pattern, and deep semantic correspondence between the original object and the redesign. The similarity score is defined as:

$$S_c = \alpha Sim_c + \beta Sim_f + \gamma Sim_d, \alpha + \beta + \gamma = 1 \tag{2}$$

where Sim_c, Sim_f and Sim_d represent color, form-pattern, and deep semantic similarity. Each feature value was normalized to 0–1 using min-max normalization within its feature channel. This study used α=0.30, β=0.40, and γ=0.30, giving slightly more weight to form-pattern continuity because motifs and structural organization are central to the three selected ICH categories.

The three computational indicators correspond to different levels of visual continuity. Color similarity mainly reflects whether the redesign retains the dominant color atmosphere and visual identity of the original ICH object. Form-pattern similarity focuses on contour, motif organization, repetition, symmetry, and decorative structure, which are especially important in paper-cut, embroidery, and printed cloth patterns. Deep semantic similarity further captures higher-level visual associations that may not be fully represented by color or contour alone. For instance, two designs may differ in layout but still express similar cultural imagery, such as auspiciousness, floral symbolism, or regional decorative rhythm. By combining these indicators, the computational module provides an objective supplement to human judgment, while still leaving room for designer interpretation in the final fusion stage.

After normalization, the fusion score is:

$$F = \lambda S_h + 5(1-\lambda)S_c \tag{3}$$

where λ is the human-evaluation weight. Since S_h uses a 1–5 Likert scale and S_c is normalized to 0–1, S_c is converted by $5S_c$ before integration. This study sets λ=0.6, giving designer judgment a slightly higher weight because cultural fidelity depends on interpretation as well as visual resemblance.

3 Experiment

3.1 Samples and Procedure

To verify the feasibility of the proposed framework, three visually distinctive ICH categories were selected: folk paper-cut, traditional embroidery, and blue-and-white printed cloth. Twelve paired cases were organized into three groups, with representative pairings shown in Fig. 2. Group A included four folk paper-cut cases characterized by symmetry, auspicious motifs, strong contours, and festive narratives. Group B included four traditional embroidery cases featuring flower-and-bird motifs, layered colors, border decoration, and craft texture. Group C included four blue-and-white printed cloth cases characterized by blue-white contrast, repeated floral and geometric patterns, and border rhythm. The redesign cases covered packaging, brand graphics, posters, UI illustrations, apparel patterns, and cultural-product graphics, representing variations from high formal retention to surface-level borrowing and moderate innovation.

Eight reviewers with design, visual communication, or ICH research backgrounds scored the twelve cases on four dimensions after reading unified case descriptions and scoring criteria. The four-dimensional scale showed acceptable internal consistency, with Cronbach's alpha = 0.86, and inter-rater agreement reached ICC(2,k) = 0.82[9]. In the computational stage, paired images were normalized, color, pattern, and deep visual features were extracted, and the two scores were fused with λ=0.6.

Fig. 2. Representative pairings of original ICH objects and redesigned works across paper-cut, embroidery, and blue-and-white printed cloth categories.

3.2 Results and Discussion

Table 1 reports the comprehensive results. A1, B1, and C1 scored high because they maintained both formal and cultural/craft-process continuity, whereas A4, B4, and C4 scored low because they mainly borrowed decorative elements. A2 had high computational similarity due to close color and contour, but only moderate cultural semantics; in contrast, A3 had lower visual similarity after formal transformation, yet reviewers recognized its auspicious imagery and paper-cut compositional logic. Similar patterns in B2 and C3 show that the framework can distinguish superficial formal borrowing from deeper cultural continuation.

The results also reveal the complementary roles of the two mechanisms. The computational score is more sensitive to visible continuity, such as color consistency, contour similarity, and repeated pattern structures. It is useful for detecting whether the redesigned work maintains an explicit visual connection with the source object. However, this score alone may overestimate cases that only copy decorative fragments without preserving the underlying craft logic or cultural implication. By contrast, designer judgment can identify whether the redesign continues symbolic meanings, craft temperament, and cultural appropriateness, but it may be influenced by subjective aesthetic preferences. The fusion score reduces the limitations of a single evaluation source by integrating measurable visual similarity with interpretive cultural assessment. This explains why cases such as A2 and A3 receive different diagnostic interpretations: A2 is visually close but culturally moderate, whereas A3 is visually transformed but still culturally recognizable.

Table 1. Dual-mechanism comprehensive evaluation of sample cases

Case	S_h	S_c	F	Level	Interpretation
A1	4.45	0.87	4.41	High	Strong formal and cultural continuity
A2	3.68	0.84	3.89	Med-high	Close color and form, moderate semantics
A3	4.12	0.69	3.85	Med-high	Large formal change, strong cultural expression
A4	2.96	0.58	2.94	Low	Surface-level borrowing
B1	4.38	0.83	4.29	High	Craft character is well preserved
B2	4.05	0.64	3.71	Med-high	Innovative but culturally coherent
B3	3.91	0.81	3.97	Med-high	Stable color and pattern continuity
B4	3.08	0.60	3.05	Low	Branding weakens cultural imagery
C1	4.41	0.86	4.37	High	Clear color rhythm and atmosphere
C2	3.84	0.82	3.94	Med-high	Pattern organization is preserved
C3	4.09	0.72	3.89	Med-high	Strong cultural imagery with formal change
C4	3.15	0.62	3.13	Low	Innovation is prominent but fidelity is limited

A sensitivity check showed that changing λ from 0.5 to 0.7 kept the high-fidelity group (A1, B1, C1) and low-fidelity group (A4, B4, C4) unchanged, indicating that classification was not determined by one weight setting. Limitations include the small sample size, image-based cases, and limited use of text, craft-process knowledge, and user perception.

4 Conclusion

This paper proposed a dual-mechanism framework for evaluating cultural fidelity in ICH redesign. By defining formal, cultural-semantic, and craft/process-logical continuity, it distinguishes cultural inheritance from visual similarity. The method integrates designer judgment and computational similarity through standardized fusion and reliability testing, and the experiment shows that it can identify high-fidelity works, surface-level borrowing, and formal innovation that preserves cultural meaning or process logic. Future research will expand samples, introduce multimodal heritage information, and refine adaptive weighting.

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