



## Exploration and Value of Digital Restoration Methods for Costumes in “Hongye Tishi Shinu Tu”

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### Abstract

*Hongye Tishi Shinu Tu (《红叶题诗仕女图》, Court Lady Inscribing Poetry on a Red Leaf) is a contentious painting frequently misattributed to Tang Yin in online discourse. At the same time, academic analysis of its calligraphic style and figural rendering identifies it as a later imitation. The exquisitely detailed depiction of garments in the painting demonstrates exceptional artistic skill and reflects Japan's reverence for and synthesis of Chinese cultural traditions during the Edo period. This study focuses on Hongye Tishi Shinu Tu as its research subject, aiming to reconstruct the depicted garments' material, patterns, and artisanal details through digital technologies. By doing so, it seeks to elucidate the sartorial characteristics and cultural significance of the painting while exploring the broader implications of digital reconstruction for cultural heritage preservation and innovation. The research employs a multidisciplinary approach, integrating data acquisition, AI analysis, and 3D modeling techniques. Image proportion analysis and virtual fitting technologies are utilized to conduct multi-layered modeling and reconstruction of the garments. Photorealistic renderings are generated using Look AI software, while dynamic visualizations are achieved through CLO3D virtual fitting software, ensuring both precision and visual fidelity in the reconstruction outcomes. The study comprehensively reveals the structural features, decorative motifs, and artisanal techniques of the garments in Hongye Tishi Shinu Tu, highlighting its significance as a material witness to East Asian cultural exchange and hybridization. Digital reconstruction successfully restores the attire's spatial morphology and textural properties, offering innovative technical pathways for museum exhibitions and public engagement. This research demonstrates the unique role of digital technologies in enriching traditional cultural representation, enhancing public understanding, and fostering cultural re-creation. The digital reconstruction of historical garments achieves authentic, comprehensive, and three-dimensional restoration of artifacts and provides critical support for the preservation, dissemination, and innovative application of cultural heritage.*

**Keywords:** Hongye Tishi Shinu Tu; Costume Restoration; Hayashi Rōen; Digital Technology

### 1 Introduction

With the rapid advancement of digital technologies, cultural heritage conservation, and transmission

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face novel opportunities and challenges. Traditional attire is a vital component of cultural heritage, and UNESCO has classified it into dual categories of tangible and intangible heritage, embodying both attributes. It preserves substantial historical information and reflects societal aesthetic evolution and artisanal specialization. Within this context, digital reconstruction of traditional garments has progressively emerged as a prominent research domain (Tong M, & Li X F, 2021).

### 1.1 Authentication Analysis of Hongye Tishi Shinu Tu

The research subject *Hongye Tishi Shinu Tu* (《红叶题诗仕女图》, Court Lady Inscribing Poetry on a Red Leaf) is a contentious court lady painting. The “China National Treasure Gallery” website describes it as: “Ming Dynasty, attributed to Tang Yin, Minneapolis Institute of Art.” This work remains undocumented in Tang Yin’s historical records. Compared to Tang Yin’s signature works characterized by bold, unrestrained brushwork, **Hongye Tishi Shinu Tu** exhibits comparatively constrained strokes and numerous stylistic ambiguities, sparking extensive scholarly debate regarding its authenticity.

Du Haoyuan (2016), in *Preliminary Study and Authentication of Human Figures in Tang Yin’s Paintings*, critiques the painting’s two-column inscription as displaying distorted calligraphic forms, awkward compositional flow, and structurally deficient character formations with inferior brush techniques. Comparative analysis of the court lady’s facial rendering—including facial contour, eye/brow articulation, jawline depiction, and hairstyle/hairpin execution—reveals substantial deviations from Tang Yin’s representative work *Wang Shu Palace Courtesans*. Ink application patterns on the painting’s right margin further substantiate its status as a forgery. A seal reading “Lin Langyuan Yin” (林閬苑印) is clearly visible in the lower right corner (Figure 1-1). Du posits this as a collector’s seal belonging to an unverifiable individual, noting that the owner was neither a documented historical figure nor a renowned collector (Du H Y, 2016).



Figure 1-1 of “Lin Langyuan Yin” (林閬苑印)

A contingent of scholars maintains that *Hongye Tishi Shinu Tu* is an authentic work by Tang Yin, with most online resources and certain Tang Yin-focused academic publications categorically attributing it to the artist. However, provenance discrepancies persist regarding its repository, with two prevailing claims: one asserting custody by the Ruth & Sherman Lee Institute for Japanese Art in the United States and the other designating the Minneapolis Institute of Art (MIA) as its holder. Archival investigation clarifies this

ambiguity: the former institution, renamed The Clark Center for Japanese Art and Culture, transferred its collection to the Minneapolis Institute of Art in 2013 (Online Archive of California, n.d.). Thus, the painting's current location is confirmed as the Minneapolis Institute of Art. The Clark Center's collection underwent digitization initiatives in collaboration with the California Digital Library, with digital surrogates accessible via Calisphere and the Online Archive of California (OAC).

Notably, descriptive inconsistencies exist between institutional records: the Minneapolis Institute of Art catalogs the work as "Lady Inscribing a Banana Leaf in a Garden, After Tang Yin." At the same time, the California Digital Library lists it as "Lady Inscribing a Banana Leaf, After Tang Yin" (Figures 1-2, 1-3). The institutions above have erroneously translated the painting's title as "Banana Leaf" (蕉叶), constituting a wrong translation of the Chinese term "红叶" (red leaf). This inaccuracy likely stems from insufficient familiarity with East Asian botanical-cultural symbolism. The phrase "After Tang Yin" explicitly denotes it as a posthumous imitation. According to the Minneapolis Institute of Art Collections' records (retrieved from <https://collections.artsmia.org/art/117377/lady> on March 7, 2025), the painting Lady inscribing a banana leaf in a garden was executed in the late 18th century by Hayashi Rōen (林閨苑) (Hayashi, 18th century), a Karaga painters(唐画家) active in Osaka, Japan during the 1770s–1780s.

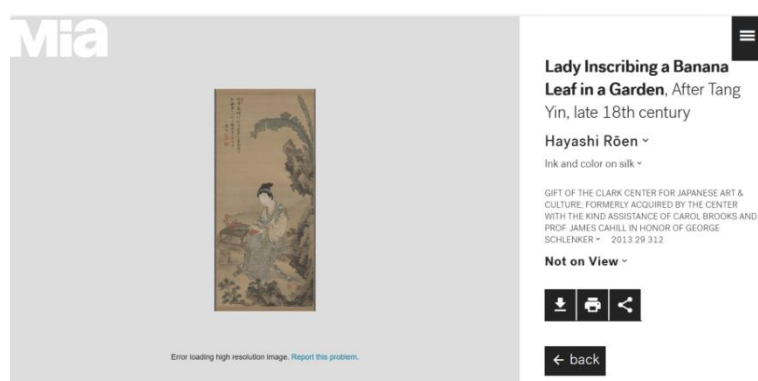


Figure 1-2 of the Minneapolis Institute of Art website introduction page.  
Source: Minneapolis Institute of Art

## 1.2 Hayashi Rōen's Authorship and Research Significance of Hongye Tishi Shinu Tu

This study tentatively attributes *Hongye Tishi Shinu Tu* to Hayashi Rōen as an 18th-century imitation of Tang Yin's style. Despite its disputed authenticity, reconstructing the depicted garments holds multifaceted scholarly significance.

Hayashi Rōen received artistic tutelage under Fukuhara Gogaku, a disciple of Taiga Ikeno, the eminent synthesizer of Japanese literati painting (bunjinga). Hayashi Rōen's oeuvre encompasses opulent bird-and-flower paintings and bold, idiosyncratic ink-wash works. Though biographical details remain obscure, he emerges as an enigmatic figure active during the 1770s–1780s, contemporaneous with China's Qianlong era (1735–1796). This period witnessed intensive Sino-Japanese cultural exchange. Hayashi Rōen's artistic development was notably influenced by Shen Quan (沈铨), a Qing dynasty painter who traveled to Japan in 1731 (Yongzheng 9th year of the Qing dynasty) with disciples, propagating his pictorial theories and techniques. Shen's approach catalyzed the formation of the "Nanpin-wa (南蘋派)", a meticulous

Item information.	
Title	Lady inscribing a banana leaf, after Tang Yin
Date Created and/or Issued	undated
Publication Information	Japan
Contributing Institution	UC Merced, Library and Special Collections
Collection	Clark Center for Japanese Art and Culture collection
Rights Information	Public Domain Material in public domain. No restrictions on use.
Description	<p>Annotations/Markings: No signature. One seal "Hayashi Rōen-in" (painted by Hayashi Rōen) at lower left corner and a second at upper left corner preceding inscription. Two more painted copies of seals of Tang Yin following copied signature of Tang Yin at upper left following inscription.</p> <p>Medium: Ink and colors on silk</p> <p>Exhibitions: Exhibited: "The Japanese Journey: 'Traveling Images' of Edo Period Japan" curated by Catherine David, The Ruth and Sherman Lee Institute for Japanese Art, Hanford, CA, June 4-September 28, 2002; "Woman as Art/Woman as Artist: Two sides to the female figure in later Japanese painting" curated by Maiko Behr, The Ruth and Sherman Lee Institute for Japanese Art, Hanford, CA, September 6-December 3, 2005.</p> <p>Biography/History: Artist also known as 林岡苑. An eccentric Edo period artist who studied with Fukuhara Gogaku.</p>

Figure 1-3 of the Online Archive of California introduction page  
Source: Online Archive of California

observational painting style revered in Japan, earning Shen the epithet “Foremost Imported Painter” (舶来画家第一). Japanese artists widely emulated his aesthetics, including Hayashi Rōen, who synthesized Shen’s influence into compositions marked by distinctive layouts and botanically and ornithologically precise depictions. Japanese practitioners of Sinicized painting traditions were designated “Kara-ga painters” (唐画家). As a prominent Osaka-based artist, Hayashi Rōen collaborated with peers like Suminoe Buzen to popularize Chinese-inspired painting in Japan.

The garments in this imitative work likely amalgamate Hayashi Rōen’s interpretation of Chinese sartorial traditions with distinctively Japanese aesthetic sensibilities and artisanal practices. *Hongye Tishi Shinu Tu* possesses profound cultural resonance and exceptional artistic merit, aligning with modern preferences for classical court lady paintings through its refined aesthetic appeal. Its intricately rendered attire constitutes invaluable material for studying historical garment culture. However, the painting’s two-dimensional format inherently limits the comprehensive representation of sartorial details through conventional methodologies. Recent advancements in digital technologies—including data acquisition, AI simulation, and 3D modeling—have revolutionized traditional garment reconstruction, enhancing efficiency and precision in restoration processes.

## 2. Overview of Hongye Tishi Shinu Tu

### 2.1 Content Analysis of Hongye Tishi Shinu Tu

*Hongye Tishi Shinu Tu* (Figure 2-1) depicts a young court lady seated on a stone bench, engrossed in composing verse on a crimson leaf. Hayashi Rōen executed this work using traditional meticulous-style polychrome painting. He first delineated precise contours for figural representation to define the subject’s

posture, coiffure, layered garments (upper Ru, skirt), accessories (pendants, Pibo), facial features, hands, and writing implements on a small table. The brushwork demonstrates iron-wire line drawing characteristics—slender yet resilient strokes with pronounced textural quality.

Sartorial details were meticulously rendered: textile patterns on the upper garment and Pibo were painstakingly outlined with fine brushes, achieving precision and compositional harmony. The skirt's brocade effect was realized through ochre-green under painting accentuated by white floral motifs, conveying dignified elegance and opulent refinement. The inscribed red leaf's focal element was modeled volumetrically using gradational washes of carmine, with delicately traced venation enhancing its lifelike presence. This motif serves as the emotional core of the painting, vividly symbolizing poetic sentiment. The court lady's visage combines youthful radiance with subtle melancholy, her lifelike expression and posture suggesting internalized emotions channeled into the inscribed leaf (Ren L P,2019).

Inscribing poetry on a red leaf transcends decorative function, embodying rich cultural symbolism. This scene synthesizes the Chinese cultural trope of “red leaves conveying sentiment” with Japanese aesthetic sensibilities. It reflects imperial women constrained emotional landscapes under feudal systems—their suppressed longing for love, silent yearnings, and existential sorrows—serving as a poignant allegory for the tragic realities of palace life. This imagery evokes profound empathy and contemplation regarding the fate of historical court women (Zhang Y S,2024)

The painting was exhibited in “The Japanese Journey: 'Traveling Images' of Edo Period Japan”, curated by Catherine David, The Ruth and Sherman Lee Institute for Japanese Art, Hanford, CA, June 4-September 28, 2002. “Woman as Art/Woman as Artist: Two sides to the female figure in later Japanese painting” curated by Maiko Behr, The Ruth and Sherman Lee Institute for Japanese Art, Hanford, CA, September 6-December 3, 2005. This work constitutes an invaluable primary source for examining cross-cultural dynamics in premodern East Asia, embodying exceptional aesthetic achievements and serving as a material witness to transcultural artistic practices.

## 2.2 Stylistic Parallels Between Hongye Tishi Shinu Tu and Tang Yin's Works

Through comprehensive stylistic, technical, and thematic analyses augmented by historical documentation, this study reveals pronounced visual affinities between Hayashi Rōen's Hongye Tishi Shinu Tu and Tang Yin's Chang'e Holding Laurel (《嫦娥执桂图》) and Lady Ban's Round Fan (《班姬团扇图》) (Table 1). Hayashi Rōen's emulation signifies his reverence for Tang Yin's artistry and provides critical insights into the transmission and evolution of painting styles during this period.







Post-rotational analysis demonstrates striking similarities in facial rendering between the court lady in Hongye Tishi Shinu Tu and the figures in Lady Ban's Round Fan. Consistencies manifest in the rounded facial contours, articulation of eye and brow morphology, nasal structure, and refined execution of coiffure edges. Imitative traces are particularly discernible in angular treatments of ocular alignment, nasal bridge inclination, and hairlines. However, nuanced divergences emerge in precise elements: the precise angular modulation of eyebrow arches, gradient diminution of pigmentation at brow extremities, micro-oscillations in palpebral contour articulation, and non-conformist coiffure shaping defy comprehensive mimetic reproduction. Notably, the ocular rendering and forehead hair treatment in Hongye Tishi Shinu Tu align



Figure 2-1 of Hongye Tishi Shinu Tu



Table 1. Sectional Comparative Analysis of Artworks

	<i>Hongye Tishi Shinu Tu</i>	<i>Chang'e Holding Laurel</i>	<i>Lady Ban's Round Fan</i>
facial rendering			
Collar opening			Unpatterned
Sleeve terminus			Unpatterned
Sleeve			
Ruqun pattern			



closely with Ukiyo-e aesthetic conventions. Given Hayashi Rōen's identity as a Japanese painter, this congruence may derive from entrenched painterly habits cultivated through domestic artistic traditions or personal stylistic predilections. Such stylistic hybridization imbues the composition with polyphonic artistic tonality and materializes the dialectical interplay of cross-school appropriation and transculturation within historical, artistic praxis.

In sartorial terms, *Hongye Tishi Shinu Tu* exhibits closer parallels with *Chang'e Holding Laurel*, particularly in the decorative patterns adorning the collar and cuffs of the upper ru, contrasting with the textile composition of other garment sections. Both figures don pibo draped identically—one end resting on the shoulder, the other cascading to the elbow—with comparable chromatic schemes. The upper Ru's features subdued monochromatic tones, while sleeve dimensions and draping folds mirror those in *Lady Ban's Round Fan*, particularly in linear treatments of fabric pleating. All three court ladies wear Ruqun skirts patterned with cyclically repeated geometric auspicious motifs.

A distinctive iconographic element—partially concealed scarlet shoes beneath skirt hems—appears in both Tang Yin's works as visual subtexts. Hayashi Rōen's replication of this motif raises interpretive questions: whether it constitutes stylistic reinterpretation within his artistic lexicon or mere formal appropriation.

Though Hayashi Rōen never visited China, his devotion to “Kara-ga” (唐画; Japanese designation for Sinicized painting traditions—broadly encompassing Chinese-influenced works or directly imported Chinese paintings, with evolving contextual definitions)—motivated his emulation of Tang Yin's techniques in *Hongye Tishi Shinu Tu*. This work pays homage to Chinese cultural traditions embodied in Tang Yin's artistry and synthesizes indigenous Japanese cultural elements and aesthetic principles, articulating unique artistic sensibilities through intercultural dialogue.



### 2.3 Sartorial Analysis of Hongye Tishi Shinu Tu

The painting's thematic motif of “inscribing poetry on red leaves” constitutes a recurrent subject in historical East Asian art, originating from the narrative in Yunxi Youyi·Tihong Yuan (《云溪友议·题红怨》), which recounts Lu Wo's serendipitous acquisition of a poetic leaf that facilitated his marital union. During the Tang dynasty, the imperial harem housed numerous court ladies, with legends describing Shangyang Palace women inscribing verses on crimson leaves and casting them into palace waterways to convey repressed sentiments (Li C,2022).

As detailed in preceding chapters, the court lady's attire in this painting shares formal similarities with figures in Tang Yin's Chang'e Holding Laurel. The lowered collar positioning features a relatively loose drape at the Jiao ling (交领, crossed collar) intersection, distinctly revealing the clavicle—a design reflecting comparative openness and audacity (Geng M Z,2019). Regarding the skirt component, while maintaining traditional length, the emphasis appears directed toward fluid linearity and natural drape. Pleat treatments are simplified, eschewing excessive intricacy to achieve an overall impression of ethereal grace (Chen S,2022). Uniform auspicious cloud-scroll patterns (卷云纹) adorn the collar and cuffs, complemented by cyclically arranged geometric auspicious motifs (瑞花纹) on the Ruqun.

## 3. Costume Analysis and Digital Reconstruction

### 3.1 Cross-collar Upper Garment (交领右衽上襦)

The cross-collared right-lapelled upper Ru (上襦) represents a prevalent upper garment style within Han style attire, characterized by its intersecting collar structure where the left and right front panels overlap diagonally, forming a distinctive “Y” configuration. The right-lapelled design specifically denotes the wearing method wherein the right panel is positioned beneath the left panel, with the left lapel overlapping the right - a quintessential feature of Han style attire that correlates with the traditional Chinese cultural concept of prioritizing the right side (以右为尊), while simultaneously embodying intrinsic connections to Han ethnic cultural traditions and ritual protocols. The reconstructed specimen demonstrates a comparatively lowered collar positioning that distinctly reveals the clavicular region. The sleeves of this restoration exhibit substantial dimensions, with the Qu (袂, sleeve aperture) width maintaining an approximate 1:3.6 proportion relative to hand size, permitting calculation of a sleeve circumference ranging between 55-60cm, thereby qualifying it as a “large Qu” (大袂) configuration.

### 3.2 Waist-high Ruqun (齐腰襦裙)

As a garment system traceable through material evidence to the Warring States period, the Ruqun underwent distinct evolutionary developments across dynastic eras, including the Han, Wei-Jin, Northern and Southern Dynasties, Sui, and Tang. Han dynasty women adopted early forms of Ruqun, while the Wei-Jin period witnessed a progressive elevation of the waistline, shortening of upper garments, and narrowing of sleeves, later countered by an opposing trend of sleeve expansion to widths measuring two or three chi (approximately 60-100cm). During the Tang dynasty, small-sleeved short Ru and floor-length skirts predominated, though post-high Tang aristocratic fashion shifted toward voluminous, trailing silhouettes.

The skirt component was typically constructed by joining and stitching four fabric panels, creating a trapezoidal form with upper narrowing and lower widening extending to floor length without hem embellishment. The waistband utilized silk ribbons with attached fastening cords at both ends. Though the reconstructed specimen depicts a seated posture, observable features include floor-length skirt dimensions with substantial hem volume and a waist-fastening system involving cords wrapped around the waist and fastened with a front knot, allowing terminal ends to drape vertically at the front (Yu L, Ma J, Chen H Y, Hu X D, 2024). Linear depictions in period artworks are delicate contours with uniform thickness, effectively

conveying Ruqun's characteristic lightweight and supple textile qualities (Lu S Q,2023).



Figure 3-1 of Garment technical flat. Source: draw by the author herself

### 3.3 The Pibo (披帛)

The Pibo (披帛), alternatively termed “Pei Bo” (帔帛), constitutes a prevalent accessory within Tang dynasty sartorial culture. In Tang Yin's artistic oeuvre, including Peony Ladies Painting (《牡丹仕女图》), Chang'e Flying to the Moon (《嫦娥奔月图》), Apricot Blossom Ladies Painting (《杏花仕女图》), Flute-Playing Lady Painting (《吹箫仕女图》), Autumn Breeze and Silk Fan Painting (《秋风纨扇图》), as well as the aforementioned Chang'e Holding Laurel (《嫦娥执桂图》) and Lady Ban's Round Fan (《班姬团扇图》), female figures uniformly exhibit shoulder-draped pibo. This textile accessory demonstrated over a dozen draping configurations, typically arranged in a casual wearing style by wrapping across the shoulder and back with both ends suspended naturally from the arms.

The reconstructed specimen depicts a seated posture, with the pibo draped over the right upper arm and left shoulder, both terminals extending to ankle level. The length of the pibo was adjusted in real-time according to the actual wearing effect (Liu K X, Li X N, & Zhu C, 2022). Through anthropometric estimation of its maximal width measurement – commencing from the mid-left shoulder edge, covering the shoulder structure, and extrapolated to human scale – the Pibo's width was determined as 15cm.

### 3.4 Pattern Reconstruction

Due to the prolonged preservation of the scroll, chromatic discrepancies in garment coloration may arise from paper oxidation; however, discernible hues of the reconstructed attire remain identifiable from the original painting. The Ruqun of the reconstructed specimen exhibits a Gui Bei Rui Hua Wen (龟背瑞花纹, auspicious tortoise-shell floral pattern), executed on a gray-green ground. This motif features a hexagonal framework delineated by double-line ink strokes in darker tones, interspersed with white linear accents. Within each hexagonal unit, verdant floral motifs are rendered with white floral centers centrally accentuated by crimson embellishments.



Figure 3-2 of Gui Bei Rui Hua Wen (龟背瑞花纹). Source: draw by the author herself

The collar opening and sleeve cuffs of the reconstructed upper garment are adorned with cloud-scroll patterns (卷云纹), a traditional Chinese decorative motif whose origins are traceable to the Warring States period (475–221 BCE) or earlier (Dong B,2013). Frequently employed as border ornamentation, this motif enhanced garments' ornamental sophistication. During the Han dynasty, cloud-scroll patterns experienced particular prevalence, emerging as a ubiquitous decorative element on attire, textiles, and artifacts. Their usage persisted and evolved across subsequent dynasties, notable evidence in Tang dynasty artifacts, where cloud-scroll patterns remained observable on select sartorial accessories (Jing A N,2021).



Figure 3-3 of cloud-scroll patterns (卷云纹). Source: draw by the author herself

The Pibo of the reconstructed specimen features a broken-branch white peony motif (折枝白牡丹纹), typically rendered through naturalistic execution that emphasizes realistic floral morphology, the natural curvature of stems, and multi-angular depictions of foliage, collectively manifesting an aesthetic characterized by vivid lifelikeness, natural harmony, and ethereal fluidity (Wang Y,2024). Influenced by pictorial techniques, discrepancies exist between the painted peony branches/leaves in the artwork and those found in excavated broken-branch peony textiles; nevertheless, the motif's identification as a peony pattern remains confirmable through its diagnostic floral morphology.



Figure 3-4 of broken-branch white peony motif (折枝牡丹纹) . Source: draw by the author herself

### 3.5 Analytical Methods of Pictorial Proportions and Anthropometric Dimensions

In costume history research, garment reconstruction has long been a critical methodology with a scholarly focus. Traditionally, scholars predominantly conducted virtual simulation-based reconstructions relying on extant front-opening garments. However, image-based garment reconstruction presents substantial challenges, including the absence of physical artifacts for direct measurement and the inherent informational limitations of two-dimensional imagery compared to three-dimensional garments. Scholars have initiated explorations through pictorial mensuration to address these constraints, investigating proportional relationships between garment dimensions and bodily measurements or correlations between garment sizes and key anatomical landmarks. These analyses are further integrated with supplementary archival records and excavated artifacts to comprehensively examine dimensional data in two-dimensional representations. This study similarly employs image proportion analysis to investigate garment dimensions (Liu X, Wang R M, & Xu Q Y, 2022).

Given the painting's sartorial and thematic alignment with the Tang dynasty, reference was made to the average female stature during this period. Scholarly investigations indicate that the average height of Tang women in the Zhengzhou region measured 158.39cm, approximating the modern female median body height of 160cm (Sun L, 2013). Synthesizing these factors, the study's model height was standardized at 160cm. The depicted female figure exhibits a voluptuous yet dignified physique with well-defined bodily contours. The anatomical proportions analyzed in this research align more closely with contemporary standards of healthy female body morphology (Table 2).

Table 2. Recovered model female body size

Part	Dimension/cm
High	160
Bust	84
Waist	66
Hips	90
Shoulder	38



#### 4. Construction of the Reconstructed Garment Model

Traditional garment reconstruction constitutes an exceptionally intricate process encompassing fabric selection, pattern restoration, and prototype development, with each phase necessitating iterative experimentation and error correction—rendering it both time-consuming and labor-intensive. In contrast, virtual fitting technology demonstrates marked advantages through user-friendly operation and realistic simulation, enabling designers to efficiently accomplish sartorial design. This study employed LOOK AI software to transform hand-drawn sketches into finished garment renderings, subsequently refined using graphic design software. Utilizing these renderings as a reference, CLO3D virtual fitting software was implemented to conduct layered modeling of the reconstructed ensemble—including inner garments, cross-collared right-lapelled upper Ru, Ruqun, and Pibo—thereby streamlining the reconstruction process while maximizing visual restoration of the original attire (Dong B Q, & Wang K, 2024).

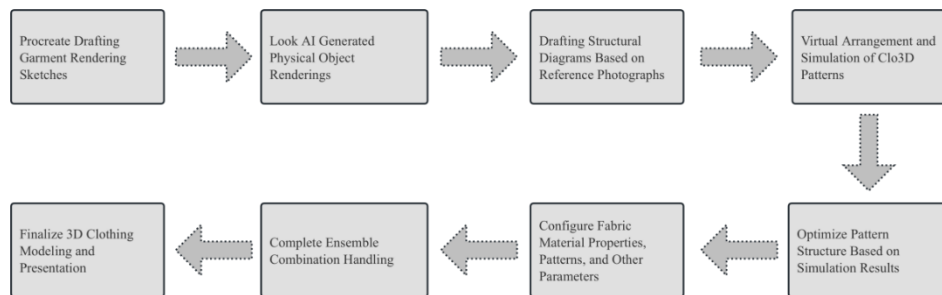


Figure 3-5 of 3D Garment Modeling Workflow. Source: drawn by the author

##### 4.1 Garment Rendering Production via LOOK AI Software

In this study, we initially drafted technical flats and preliminary hand-drawn sketches based on structural analysis of the reconstructed garments. We subsequently utilized LOOK AI software to transform these sketches into realistic garment renderings. Prior iterations employed Midjourney, Jimeng AI, and Shencai AI for sketch conversion yet yielded unsatisfactory outcomes, ultimately confirming Look AI as the optimal tool for sketch-to-rendering transformation. During operation, a curated selection of compatible design features was meticulously chosen within the software's parameter configuration interface, adhering to a realist style to ensure precise restoration of sartorial details. Concurrently, comprehensive descriptive data encompassing the reconstructed garments' structural composition, textural properties of fabrics, and chromatic combinations were fully integrated into the system. Leveraging the software's powerful, intelligent conversion capabilities, this methodology established the crucial first step in the garment reconstruction process.

##### 4.2 CLO3D Modeling

The virtual fitting process primarily adheres to the following workflow: Based on previously analyzed anthropometric data, a virtual mannequin was configured with body parameters including height 160cm, bust 84cm, waist 66cm, hip 90cm, and shoulder width 38cm. Garment panels were sequentially positioned on corresponding anatomical regions of the virtual mannequin, ensuring proximity without physical contact. Structural seams were digitally stitched according to the garment's architectural design. During simulation, a grab tool facilitated dynamic adjustments of the garment drape to complete virtual fitting. Finally, fabric properties—including material type, texture, and coloration—were assigned to garment panels, enhancing three-dimensional realism through material attribute optimization.



Figure 4-1 of Photorealistic Rendering Interface



Figure 4-2 of Restore the actual image

For the reconstructed ensemble, virtual fitting was executed across four stratified layers: first-layer inner garments, second-layer upper Ru, third-layer Ruqun, and outermost-layer Pibo. Upon completing inner garment modeling, these were rigidized (“frozen”) to suspend their simulation participation, facilitating subsequent upper Ru modeling. The upper Ru panels underwent bifurcated simulations: initial modeling focused on the main body with panel layers set to 1 (outer layer), followed by collar border modeling after resetting layers to 0 (base layer) and implementing rigidization. Post-adjustment of first and second layers, these were rigidized to stabilize forms before initiating third-layer Ruqun modeling, including waist ties.

Given the Pibo's unconventional draping configuration, conventional point-based or manual panel arrangement proved inadequate. An alternative methodology was implemented:

- 1) Positioning the panel behind the virtual mannequin
- 2) Creating two internal lines on the Pibo
- 3) Executing folding operations via folding arrangement tools to achieve optimal drape
- 4) Post-simulation, naturally draping terminals along the arms
- 5) Deleting internal lines
- 6) Final length adjustment referencing historical Pibo dimensions in classical paintings.



Figure 4-3 of 3D Simulation of Ruqun Clothing

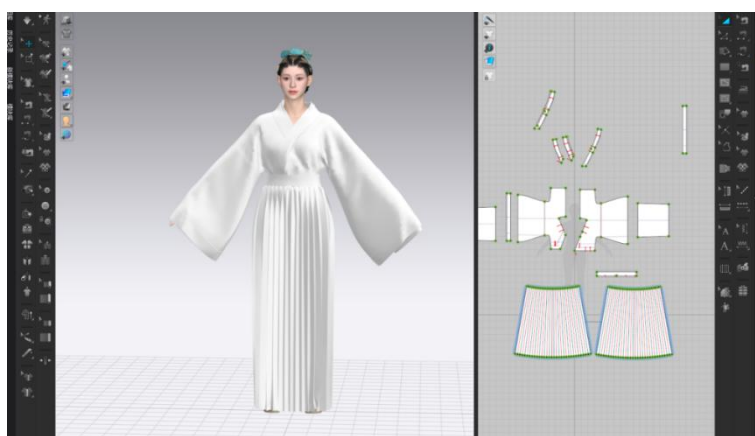


Figure 4-4 of Monochromatic 3D Simulation Effect



Figure 4-5 of Final Simulation Results

## 5. Conclusion

This study employed digital technologies including AI analysis and 3D modeling to reconstruct the materiality and decorative patterns of garments depicted in *Hongye Tishi Shinu Tu*, elucidating the artistic innovation and cultural syncretism embedded in the painting's sartorial design. Virtual fitting technology proved particularly instrumental in accelerating workflow iterations and achieving high-fidelity restoration of historical attire. Through image proportion analysis, virtual simulations, and multi-layered modeling, this research proposes a comprehensive methodology applicable to the diversified reconstruction of garments from two-dimensional imagery, offering novel technical pathways for the digital conservation of cultural heritage. These advancements reinforce the value of historical garments in facilitating cultural dissemination, educational initiatives, and creative industry development while providing theoretical and practical foundations for subsequent research.

Future investigations could extend analogous technologies to garment reconstruction across diverse historical periods and regions, exploring shared characteristics and divergences in cross-cultural attire. For practical applications, derivative cultural products—such as digital garment models, educational resources, and interactive exhibition content—could be developed to promote traditional culture's transmission and innovation. Collaborative efforts with museums, art institutions, educational organizations, and creative industries would further advance the practical implementation of reconstruction outcomes and their societal impact.

Digital technologies, utilizing three-dimensional representations, enable authentic, comprehensive, and spatially accurate reconstructions of cultural artifacts, revolutionizing operational management and public engagement within heritage institutions. While Chinese museums have only recently begun adopting digital technologies for textile and garment exhibitions—with limited participation predominantly among major comprehensive museums and specialized textile museums in the Jiangsu-Zhejiang-Shanghai region—significant breakthroughs in digital presentation methods have been achieved within a short timeframe (He, Sun, & Zhang, 2024). For instance, at the 10th China Museum and Related Products and Technology Expo, Shandong Museum collaborated with Guangzhou OKCO and Inspur Smart Cultural Tourism Group to present “Attire as Ritual: Digital Revitalization of Ming Dynasty Costumes”. This project employed high-precision 3D modeling to 1:1 reconstruct fabric, coloration, and patterns of Ming-era garments from the museum's collection, engaging audiences through contextualized interactive scenarios. Digital reconstructions have transformed exhibition experiences: online thematic displays incorporate dynamic virtual fashion shows for immersive visual engagement, while interactive panoramic virtual halls enable 360-degree exploration. Offline exhibitions integrate virtual fitting mirrors with motion-sensing technology, allowing visitors to “try on” historical attire and fostering cross-temporal sartorial dialogues through playful



interaction.

Despite exploring digital methodologies, this study acknowledges methodological limitations. Subsequent research could refine anthropometric measurement protocols to enhance visual and material accuracy in reconstructions. Strengthening interdisciplinary collaboration—integrating archaeology, history, aesthetics, and technical disciplines—would elevate the comprehensiveness and precision of reconstruction studies.

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