

Research on Digital Design Innovation and Practice of Traditional Cultural Elements in Western Guangdong in the Era of Digital Intelligence

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ABSTRACT In the era of digital intelligence, traditional cultural resources in western Guangdong, including Lady Xian culture, Leizhou stone dog culture, annual customs, Lei opera, Nuo opera, Wuchuan floating colors, Gaozhou puppetry, Yangjiang lacquer art, and related marine and Gaoliang cultural elements, face difficulties such as traditional dissemination methods, low youth acceptance, insufficient digitalization, weak design transformation, and unclear industrialization paths. This study systematically sorts regional cultural resources, extracts cultural genes and visual symbols, and constructs a digital material library covering graphics, patterns, color systems, forms, audio, video, and 3D models. It further proposes a design innovation path involving digital archiving, visual symbol reconstruction, immersive experience, digital cultural-creative products, and network dissemination. Techniques such as 3D scanning, photogrammetry, AI-assisted symbol extraction, virtual IP design, and holographic exhibition are integrated into cultural activation. The approach provides a reproducible model for cultural inheritance and regional design innovation, and its use of optical imaging, wireless interaction, and immersive display also supports engineering-oriented digital cultural communication systems.

INDEX TERMS digital intelligence, western guangdong culture, digital design, optical imaging, wireless interaction

I. INTRODUCTION

A. RESEARCH BACKGROUND

THE western Guangdong region mainly includes Zhanjiang, Maoming, and Yangjiang, backed by Lingnan and facing the South China Sea. In history, it has been a region where Central Plains culture, Minnan culture, Guangfu culture, Hakka culture, and ancient Liao culture have long intersected and integrated, forming a unique and profound traditional cultural system in western Guangdong. Taking Lady Xian's "good hearted spirit" as the spiritual core, intangible cultural heritage and folk resources represented by Leizhou Stone Dog Totem belief, annual customs, Lei Opera, Nuo Opera "Jumping Flower Shed", Wuchuan Floating Colors, Gaozhou Puppet Show, Yangjiang lacquer art, human dragon dance, lion dance, etc., constitute the unique symbol of western Guangdong culture and are an indispensable and important part of Lingnan culture[1-2]. With the deepening implementation of the strategies of digital China, cultural power, and rural revitalization, big data, artificial intelligence VR/AR, Digital technologies such as 3D reconstruction, interactive design, and digital media provide revolutionary means for the protection,

inheritance, innovation, and dissemination of traditional culture. Cultural digitization has become the core path for traditional culture to come alive and become popular. However, the inheritance and dissemination of traditional culture in western Guangdong still face many bottlenecks: most cultural resources are still mainly based on physical objects, exhibitions, and oral inheritance, with insufficient digital collection and preservation; The extraction of cultural symbols is not systematic enough, and the transformation of modern design is insufficient; Young people have low awareness and traditional communication channels; Serious homogenization of cultural and creative products, lack of technological and contemporary sense; The form of cultural and tourism experience is single, with insufficient immersion and interactivity; Lack of systematic digital design path and sustainable operation mode[3]. In this context, it is of great practical necessity and urgency to carry out digital design innovation and practical research on the traditional cultural elements of western Guangdong in the era of digital intelligence, empower traditional culture with digital intelligence technology, and revitalize culture with modern design. This will protect the cultural heritage of western Guangdong,

continue cultural roots, enhance regional cultural soft power, promote cultural tourism integration and rural revitalization.

B. RESEARCH SIGNIFICANCE

1) Theoretical significance

Construct a theoretical framework for digital design innovation of traditional cultural elements in western Guangdong, and improve the theoretical system of cultural digital inheritance and innovative design; Extract the cultural genes and visual symbol library of western Guangdong, and establish a methodology for integrating traditional culture with digital design; Enrich the theory of digital protection and revitalization of intangible cultural heritage in Lingnan region, and provide academic reference for the modernization transformation of regional characteristic culture[4].

2) Practical significance

Realize the systematic, standardized, and high-definition digital archiving of traditional cultural resources in western Guangdong, and promote the permanent preservation of cultural heritage; Through digital design innovation, create a youthful, fashionable, and technological cultural expression, and enhance the acceptance and dissemination of youth; Develop innovative achievements such as immersive cultural and tourism experiences, digital cultural and creative industries, virtual IPs, interactive devices, etc., and promote the transformation of cultural resources into industrial advantages; To provide practical paths that can be implemented, replicated, and promoted for cultural and tourism promotion, urban image, rural revitalization, and cultural and creative industries in western Guangdong, and to assist in the high-quality development of local economy and culture.

C. CURRENT RESEARCH STATUS AT HOME AND ABROAD

1) Research on Digital Protection and Inheritance of Traditional Culture

While a mature technological system exists for digital archiving, its application in Western Guangdong has been hindered by fragmented data standards and a lack of regional-specific semantic frameworks. Previous efforts focused on 'static preservation' rather than 'dynamic activation.' The proposed visual symbol system bridges this gap by transforming raw archival data into standardized, modular design components, specifically tailored to the unique multi-cultural intersection (Central Plains, Minnan, and Liao) of Western Guangdong, which generic archiving systems fail to categorize effectively[5-6].

2) Research on Design Innovation and Cultural Creative Development of Traditional Cultural Elements

Existing research has mostly focused on well-known IPs such as the Forbidden City, Dunhuang, Sichuan Opera, Kunqu Opera, etc. The design methods mainly include graphic extraction, pattern application, and product modeling, and the results are relatively rich. However, there is

a lack of systematic design symbol extraction, innovative methods, and industrialization research for cultural elements with strong regional characteristics such as Lady Xian culture, Shigou, Nian Ju, and Lei Ju in western Guangdong. There are problems such as scattered theory, insufficient practice, and scarce achievements[7].

3) Research on the Application of Digital Intelligence Technology in Cultural Creativity

VR/AR immersive experience, AI art generation, virtual digital humans, interactive devices, digital exhibitions and other technologies have been widely applied in the cultural field, significantly enhancing the sense of experience and dissemination. There have been preliminary practices in the western Guangdong region, such as using robots to assist with annual events, reproducing folk customs with VR, and protecting ancient buildings with digital modeling. However, the overall situation is still in the stage of scattered attempts, lacking systematic, large-scale, and sustainable design innovation and operation models.

4) Current Status of Traditional Culture Research in Western Guangdong

The existing achievements are mostly focused on historical research, folk record keeping, and artistic ontology research, with a focus on cultural sorting and protection inheritance. There is a significant lack of research on digital translation, design innovation, experiential design, industrial transformation, dissemination and promotion. The integration of digital technology and design innovation is particularly lacking, and a complete digital innovation system has not yet been formed[8].

5) Insufficient existing research

Based on existing research, there are four prominent shortcomings:

One is the lack of systematic, visual, and standardized gene extraction and symbol library construction for traditional cultural elements in western Guangdong;

The second issue is that the integration of digital technology and western Guangdong culture is still limited to shallow applications, with insufficient deep design and experiential innovation;

Thirdly, there is a lack of a full chain innovation path from cultural resources to digital products, and then to dissemination and promotion;

Fourthly, there are relatively few practical cases and weak implementation of results, making it difficult to support industrialization and large-scale promotion[9-10].

D. MAIN RESEARCH CONTENT AND TECHNICAL ROUTE

1) Main research content

1. Sorting out traditional cultural resources in western Guangdong, extracting core elements, and constructing a visual symbol system;

2. Theoretical basis, technological path, and innovative principles of digital design for traditional culture in the era of digital intelligence;

3. Digital collection, 3D reconstruction, and gene translation methods for traditional cultural elements in western Guangdong;

4. Innovative methods for digital visual design targeting modern aesthetics and youth groups;

5. Innovative design practices such as immersive experiences, interactive storytelling, digital cultural and creative industries, and virtual IP;

6. Application verification in scenarios such as cultural tourism integration, rural revitalization, urban IP, and cultural and creative industries;

7. Digital sustainable inheritance and promotion strategies for traditional culture in western Guangdong.

2) Technical roadmap

Following the complete technical route of “cultural sorting gene extraction digital intelligence integration design innovation practical development effectiveness verification promotion strategy”, with cultural core as the foundation, digital intelligence technology as the means, modern design as the method, and practical implementation as the goal, a complete research system combining theory and practice is formed[11].

II. RELATED THEORIES AND FOUNDATIONS OF DIGITAL INTELLIGENCE TECHNOLOGY

A. CONNOTATION AND CHARACTERISTICS OF TRADITIONAL CULTURE IN WESTERN GUANGDONG

The traditional culture of western Guangdong is the sum of historical accumulation, folk customs, art forms, belief systems, and humanistic spirit that have been formed for a long time in the Zhanjiang, Maoming, and Yangjiang regions. It has four core characteristics:

1. Diversified integration: the fusion and coexistence of Central Plains culture, Minnan culture, Daliao culture, marine culture, and Hakka culture;

2. Unique folk customs: Seasonal customs, worship of stone dogs, Nuo opera, Lei opera, and other cultural forms unique to western Guangdong;

3. Spiritual identity: With Lady Xian’s “good hearted spirit” as the core, form a humanistic character of loyalty, kindness, inclusiveness, and pragmatism;

4. Livelihood inheritance: A large number of folk customs, operas, and skills are still being passed down in a lively way among the people, with strong potential for revitalization[12].

B. CULTURAL DIGITALIZATION AND CULTURAL CREATIVE DESIGN THEORY

Cultural digitization emphasizes the full process technological empowerment of the collection, storage, processing, presentation, and dissemination of cultural resources; Cultural and creative design emphasizes the transformation of

cultural connotations into visual symbols, product forms, experiential scenes, and emotional values. By combining the two, we can achieve “culture that can be felt, experienced, consumed, and disseminated”[13].

C. CORE SUPPORTING TECHNOLOGIES OF THE DIGITAL INTELLIGENCE ERA

1. Digital acquisition and reconstruction technology: 3D scanning, photogrammetry, texture reconstruction, digital twin;

2. Immersive interactive technology: VR virtual reality, AR augmented reality, MR mixed reality;

3. Intelligent generation and auxiliary design: AI graphic generation, style transfer, intelligent color matching, intelligent typesetting;

4. Digital media and interactive design: interactive devices, motion sensing interaction, touch interaction, holographic projection;

5. Digital exhibition and communication technology: virtual digital humans, digital exhibitions, live cultural and creative broadcasting, short video communication;

6. Digital cultural and creative industries and IP development: IP image design, blind boxes, emoticons, digital collectibles, and peripheral derivatives[14].

D. CULTURAL GENE THEORY AND SYMBOL TRANSLATION METHODS

Cultural genes are the most stable and recognizable core elements in culture, including shapes, colors, patterns, motifs, movements, rituals, spiritual connotations, etc. Symbol translation follows a three-stage verifiable logic:

1) Morphological Decomposition (breaking down physical artifacts into geometric primitives);

2) Semantic Mapping (linking shapes to specific historical records); and

3) Aesthetic Synthesis (reconstructing symbols for modern resolution).

This ensures the ‘standardized cultural gene library’ is built on precise geometric and historical data rather than subjective descriptors[15].

E. EXPERIENCE DESIGN AND NARRATIVE DESIGN THEORY

Experience design emphasizes user engagement, sensory immersion, and emotional resonance; Narrative design emphasizes using stories to connect cultural content, enhancing infectivity and memory points. In the era of digital intelligence, cultural design is moving from “watching” to “participating”, and from “passive acceptance” to “active experience”.

III. TRADITIONAL CULTURAL ELEMENT SYSTEM AND VISUAL SYMBOL EXTRACTION IN WESTERN GUANGDONG

A. OVERALL SORTING OF TRADITIONAL CULTURAL RESOURCES IN WESTERN GUANGDONG

This article summarizes the traditional culture of western Guangdong into five core systems, achieving full coverage and systematic sorting:

1. Spiritual belief culture: Lady Xian culture, kind-hearted spirit, Thunder God belief, Mazu belief, Stone Dog totem;
2. Folk festival culture: annual ritual, god tour, Nuo opera and flower shed dance, floating color, Loong Boat, lion awakening, human dragon dance;
3. Traditional arts and culture: Lei Opera, Gaozhou Puppet Show, Lei Zhou Song, Yangjiang Lacquer Art, Clay Sculpture, Wood Carving;
4. Traditional skills and creation: traditional architecture, cattail weaving, pottery, Loong Boat making, and ancient ship building skills;
5. Regional lifestyle and culture: dialects, cuisine, clothing, dwellings, marine production, and agricultural customs, as shown in Table 1 below.

TABLE 1. Core Cultural Elements of Western Guangdong

Category	Typical Elements	Cultural Symbols
Spiritual Belief	Madam Xian, Leizhou Stone Dog, Thunder God	Loyalty, blessing, guardian
Folk Custom	Nianli Ritual, Nuo Opera, Piaose	Celebration, blessing, reunion
Traditional Art	Leiju Opera, Puppetry, Yangjiang Lacquer	Local art, craftsmanship
Traditional Craft	Woodcarving, Clay Sculpture, Weaving	Texture, pattern, shape
Regional Culture	Marine Culture, farming Culture	Adaptive navigation, tidal patterns, agrarian seasonality

B. EXTRACTION OF CORE CULTURAL ELEMENTS AND VISUAL SYMBOLS

1) Cultural Symbols of Lady Xian

Appearance: Statue of Lady Xian, armor, battle flag, military drum, saddle;

Pattern: cloud pattern, thunder pattern, auspicious pattern, bronze drum pattern;

Color: Red, gold, black, navy blue, solemn and upright;

Spirit: Kindness, loyalty, patriotism, unity, and harmony, as shown in Table 2.

TABLE 2. Visual Symbol Extraction System

Culture	Shape Symbols	Color System	Representative Patterns
Madam Xian	Statue, helmet, drum, flag	Red, gold, black, blue	Cloud pattern, thunder pattern
Stone Dog	Squat, head, carving	Stone gray, bronze	Petal, rope, totem
Nianli	Lantern, drum, parade	Red, yellow, green	Festival pattern
Leiju Opera	Facial mask, costume	Contrasting colors	Drama pattern

2) Leizhou Stone Dog Symbol

Styling: squatting, looking up, grinning, carved patterns, stone texture;

Pattern: Cloud thunder pattern, petal pattern, rope pattern, totem pattern;

Meaning: Guarding, guarding the house, auspiciousness, praying for blessings, Lingnan totem;

Visual features: quaint, rough, solemn, and highly recognizable.

3) Seasonal Folk Symbols

Styling: Ceremonial procession, gongs and drums, lanterns, floating colors, stage, banquet;

Actions: Nuo opera masks, dance moves, lion dance moves, street parade formations;

Colors: bright red, golden yellow, emerald green, lively and festive;

Atmosphere: Collective cultural synergy, social cohesion, prayer, local sentiment, and high-intensity festive engagement.

4) Lei Opera and Nuo Opera Symbols

Styling: facial makeup, mask, clothing, headgear, props;

Patterns: theatrical patterns, ethnic patterns, geometric patterns;

Actions: Steps, body movements, gestures, dance patterns;

Color: Strong contrast, high saturation, programmatic coloring.

5) Yangjiang Lacquer Art and Traditional Craft Symbols

Material: paint, leather body, metal mother of pearl, carving;

Patterns: flower and bird, landscape, geometric patterns, curled grass patterns;

Color: Black, red, gold, elegant and steady, warm and heavy;

Texture: glossy, delicate, antique, and refined.

C. EXTRACTION OF TRADITIONAL CULTURAL COLOR SYSTEM IN WESTERN GUANGDONG

Building a standardized cultural color system for western Guangdong:

1. Orthodox colors of faith: Chinese red, imperial yellow, dark black, Tibetan blue (Lady Xian, ritual system, faith);

2. Folk festive colors: bright red, bright yellow, emerald green, orange red (seasonal, festive, lion dance, floating colors);

3. Totem antique colors: stone gray, clay yellow, antique copper, green gray (stone dog, ancient architecture, creation);

4. Elegant colors in art: pitch black, vermilion red, gilded, pearl white (lacquer art, puppetry, opera).

D.CONSTRUCTION OF CULTURAL GENE LIBRARY AND DIGITAL MATERIAL LIBRARY

Establish a complete digital material library for traditional culture in western Guangdong, including graphics library, pattern library, color library, styling library, audio library, video library, and 3D model library, to achieve standardization, reusability, and scalability, and provide unified material support for subsequent digital design.

E. SYMBOL EXTRACTION PRINCIPLES

1. Adhere to the nuclear principle: retain the most recognizable cultural genes;
2. Simplicity principle: Simplify complex shapes and adapt to modern communication;
3. General principle: Suitable for multi scenario, multi carrier, and multi media applications;
4. The principle of the times: in line with modern aesthetics and the aesthetic preferences of young people.

IV. THEORY AND PATH OF DIGITAL DESIGN INNOVATION IN THE DIGITAL ERA OF WESTERN GUANGDONG CULTURE

A. CORE CONCEPTS OF DIGITAL DESIGN INNOVATION IN THE DIGITAL INTELLIGENCE ERA

Following the cross policy of “guarding the core, translating, integrating, innovating, and disseminating”:

Guarding the Core: Adhering to the Cultural Spirit Core and Cultural Genes;

Translation: Transforming traditional symbols into modern design language;

Integration: Deep integration of digital technology and cultural connotations;

Innovation: formal innovation, experiential innovation, product innovation, and communication innovation;

Communication: Lightweight and efficient communication aimed at youth, the entire network, and the future.

B. FIVE PRINCIPLES OF DIGITAL DESIGN INNOVATION

1. Principle of cultural authenticity: no misinterpretation, no joking, and no vulgarization;
2. Aesthetic principles of the times: simplicity, fashion, technology, and youthfulness;
3. Immersion principle: watchable, playable, interactive, shareable;
4. Principle of Moderate Technology: Cultivate a culture of technical service, without showing off or piling up skills;
5. Industrial landing principles: producible, saleable, operable, and sustainable.

C. FIVE IN ONE DIGITAL DESIGN INNOVATION PATH

1) Digital Archiving and Protection Path

High precision 3D scanning, photogrammetry, digital archiving, digital restoration of cultural relics, motion capture of intangible cultural heritage, and construction of a permanent digital archive, as shown in Table 3 below.

TABLE 3. Digital Design Innovation Paths

Path	Core Method	Application Scenario
Digital Archive	3D scanning, reconstruction	Cultural relics, heritage
Visual Innovation	Symbol extraction, IP design	Brand, vision, communication
Immersive Experience	VR/AR, holography	Museum, tourism
Digital Cultural & Creative	IP, derivatives, gifts	Market, industry
Communication Promotion	Short video, mini-program	Youth, network

2) Path of Visual Symbol Innovation

Simplify graphics, reconstruct colors, unify styles, shape IPs, and design modern layouts to form a serialized visual system.

VR folk roaming, AR real-life interaction, holographic exhibition, digital museum, and motion sensing interactive devices enhance immersion.

IP image, emoticons, blind boxes, digital collectibles, stationery, home furnishings, clothing, cultural and tourism peripherals, achieve commercial transformation. Short video dissemination, live cultural and creative broadcasting, virtual digital human endorsement, mini program interaction, social media fission, expanding influence.

D. VALUE OF DESIGN INNOVATION DRIVEN BY DIGITAL INTELLIGENCE

1. Inheritance value: permanent preservation, dynamic inheritance, and sustainable utilization;
2. Aesthetic value: Enhance cultural aesthetics and conform to modern aesthetics;
3. Experience value: from passive viewing to active immersion;
4. Commercial value: monetization of cultural and creative industries, increase in cultural and tourism revenue, and industrial empowerment;
5. Communication value: Breaking through barriers, loved by young people, and covering the entire network.

V. KEY TECHNOLOGIES AND IMPLEMENTATION METHODS OF DIGITAL DESIGN

A. DIGITAL COLLECTION AND RECONSTRUCTION OF CULTURAL RESOURCES IN WESTERN GUANGDONG

By using close range photogrammetry, 3D laser scanning, high-definition image acquisition, audio acquisition, and motion capture, full element digital acquisition is carried out on stone dogs, ancient buildings, opera movements, and folk rituals, generating high-precision 3D models and texture maps to complete digital archiving.

B. AI ASSISTED EXTRACTION AND DESIGN OF CULTURAL SYMBOLS

To implement the ‘intelligence’ aspect of the DI era, a Generative Adversarial Network (GAN) framework is utilized for symbol extraction. Specifically, the system employs

StyleGAN-XL to perform deep style transfer from high-definition archival images of Lady Xian and Leizhou Stone Dogs into modular vector patterns. By training the model on the regional color system defined in Section 3.3, the AI autonomously generates over 50 design iterations for each cultural element, which are then screened for visual salience using a Convolutional Neural Network (CNN) to ensure design consistency and efficiency beyond traditional manual tracing.

C. DIGITAL IP IMAGE AND VIRTUAL CHARACTER DESIGN

Based on the prototypes of Lady Xian, Shi Gou, Lei Ju characters, and Nian Nian Doll, design a Q-version, Chinese style, and technologically advanced multi style digital IP, create virtual digital characters, emoticons, and dynamic stickers, suitable for short videos, live broadcasts, and social media dissemination.

Around the visual symbol library, develop a full range of cultural and creative products including stationery, accessories, clothing, home furnishings, gift boxes, digital collectibles, etc., adopting modular, serialized, and branded design to form a unified visual image.

By utilizing holographic projection, light and shadow shows, interactive screens, and digital stages, we aim to reconstruct annual parades, thunder opera performances, and Nuo opera rituals, creating a digital exhibition that combines technology and traditional culture. This exhibition is suitable for cultural and tourism attractions, urban squares, and cultural venues.

The transition from high-fidelity 3D archives to simplified IP images follows a topological reduction logic. High-precision 3D scans serve as the 'geometric truth' from which core structural vertices are extracted; these vertices are then mapped onto a simplified low-polygon mesh to create the Q-version digital IP. This process ensures that even in 'simplified' or 'youthful' expressions, the skeletal proportions and traditional symbolic alignment of the Lady Xian and Stone Dog prototypes remain architecturally accurate to the source material.

D. LIGHTWEIGHT COMMUNICATION AND INTERACTION MINI PROGRAM

Develop a mini program called "Yuexi Cultural Digital Experience Hall" that integrates VR roaming, AR photography, knowledge popularization, cultural and creative mall, and interactive games, enabling users to experience traditional Yuexi culture with just one mobile phone and reducing the barriers to dissemination.

Comprehensively evaluate the design results from six dimensions: cultural fit, visual aesthetics, smooth experience, technological adaptability, communication attractiveness, and commercial feasibility, to ensure high-quality and implementable design outcomes.

VI. INNOVATIVE PRACTICE AND CASE DEVELOPMENT IN DIGITAL DESIGN

A. OVERALL FRAMEWORK OF PRACTICE

Carry out systematic practice around "one database, one IP, five scenarios, and multiple products":

One library: Digital material library of traditional culture in western Guangdong;

One IP: Brand image of the main IP of Yuexi Culture;

Five scenarios: digital museum, immersive cultural tourism, cultural and creative products, urban IP, rural revitalization;

Multiple products: visual system, VR experience, AR interaction, digital cultural and creative, digital exhibition, mini program, as shown in Table 4 below.

TABLE 4. Practice Cases and Application Effects

Case Type	Main Products	Application Effect
Digital Material Library	Graphics, models, colors	Standardized design basis
Visual System	Logo, VI, posters	Unified brand image
Cultural & Creative Products	Gifts, stationery, clothing	Commercialization realization
Immersive Experience	VR/AR, interactive tour	Young people attraction

B. CASE ONE: CONSTRUCTION OF DIGITAL MATERIAL LIBRARY FOR TRADITIONAL CULTURE IN WESTERN GUANGDONG

Complete the digital collection and organization of six major categories of materials including Lady Xian, Leizhou Shigou, Nian Ju, Lei Ju, Nuo Opera, and Yangjiang Lacquer Art, and construct an integrated material library of graphics, patterns, colors, 3D models, and audio and video, achieving retrievability, recall, and scalability.

C. CASE TWO: DESIGN OF VISUAL SYMBOL SYSTEM FOR WESTERN GUANGDONG CULTURE

Extract the shape of the stone dog, elements of Lady Xian, vintage patterns, and thunder drama colors, design a unified logo, standard font, main color tone, auxiliary graphics, and layout specifications to form a complete visual system that can be used for urban promotion, cultural tourism brands, and cultural and creative products.

D. CASE THREE: DEVELOPMENT OF DIGITAL CULTURAL AND CREATIVE PRODUCTS FOR "GIFT IN WESTERN GUANGDONG"

Develop four major series of cultural and creative industries:

1. Stone Dog Prayer Series: Q-version Stone Dog figurine, pendant, emblem, prayer card;
2. Madame Xian's Kind hearted Series: Stationery, Notebooks, Bookmarks, Gift Boxes;
3. Annual Celebration Series: Red Envelopes, Lanterns, Cultural and Creative Mooncakes, Festival Gift Boxes;
4. Lei Opera China-Chic Series: clothing, canvas bags, mobile phone cases, facial expression bags.

E. CASE FOUR: IMMERSIVE VR FOLK EXPERIENCE HALL

Create four major experience modules: VR Year Parade, VR Thunder Drama, VR Stone Dog Totem, and VR Nuo Opera. Users can immerse themselves in the year parade, watch thunder drama performances, interact with stone dogs virtually, and experience Nuo opera rituals in a 360° immersive manner, enabling them to explore the folk customs of western Guangdong facilitating remote cultural accessibility and spatio-temporal transcendence of folk custom exploration.

F. CASE FIVE: AR REAL SCENE INTERACTION AND CULTURAL TOURISM GUIDE

Develop an AR tourism mini program that can scan real-life scenes in scenic spots, ancient villages, temples, and museums to trigger virtual commentary, animation demonstrations, historical restoration, interactive photography, and virtual blessings, enhancing tourist experience and stay time.

G. PRACTICAL EFFECT VERIFICATION AND USER FEEDBACK

To verify the system's effectiveness, a pilot study was conducted with 240 participants (aged 18–35). Using a 5-point Likert scale, the 'Cultural Fit' scored 4.6/5.0 and 'Visual Aesthetics' scored 4.4/5.0. A T-test ($p < 0.05$) confirmed a significant increase in cultural recognition compared to traditional display methods. These metrics indicate that the design method is scientific and provides a feasible foundation for industrial promotion.

VII. CONCLUSION AND PROSPECT

A. RESEARCH CONCLUSION

1. The system has sorted out and constructed the five major systems, core elements, visual symbols, and color systems of traditional culture in western Guangdong, and established the first systematic, standardized, and reusable digital material library of traditional culture in western Guangdong in China, filling the research gap in regional cultural digitization.

2. Proposed the five in one digital design innovation theory and path of "guarding the core, translating, integrating, innovating, and spreading" of traditional culture in western Guangdong in the era of digital intelligence, and clarified the core principles and methodology of cultural inheritance and the integration of digital intelligence design.

3. Develop multiple key digital design technologies, covering the entire process of digital acquisition, 3D reconstruction, AI assisted design, immersive experience, digital cultural and creative, interactive communication, etc., to form a complete and feasible technical solution.

4. Completed the development of practical cases in seven major areas including digital material library, visual system, cultural and creative products, VR experience, AR tourism, digital exhibition, and mini program, verifying the effectiveness, practicality, and industrialization potential of theories and methods.

5. A sustainable digital inheritance and promotion model for traditional culture in western Guangdong has been established, which can provide a demonstration paradigm for the digital revitalization of regional culture in Lingnan region and even the whole country. It has important practical value for promoting cultural confidence, cultural tourism integration, and rural revitalization.

B. MAIN INNOVATION POINTS

1. For the first time, establish a systematic, visual, and standardized library of traditional cultural elements and digital materials in western Guangdong, providing a unified foundation for subsequent design.

2. Propose a complete innovation path of digital intelligence driven, design innovation, and experience upgrade to achieve the full chain transformation from cultural resources to digital products.

3. Create an immersive, interactive, and youthful cultural experience paradigm in western Guangdong, effectively addressing the challenges of weak dissemination of traditional culture and low acceptance among young people.

4. Form a practical model that can be implemented, replicated, and promoted, with academic value, application value, and industrial value.

C. RESEARCH PROSPECTS

1. Deepen the application of AI generated design in cultural innovation in western Guangdong, achieving intelligent creation, personalized customization, and large-scale production.

2. Expand cutting-edge scenes such as virtual digital humans, digital collections, and metaverse exhibition halls, and promote the wider dissemination space of western Guangdong culture.

3. Promote the digital design of traditional culture in western Guangdong into campuses, communities, scenic areas, and e-commerce, and build a comprehensive communication ecosystem.

4. Strengthen cross regional cooperation, promote the linkage development of cultural IP between western Guangdong and the Guangdong Hong Kong Macao Greater Bay Area, and enhance regional cultural influence.

5. Establish a long-term dynamic update mechanism, continuously enrich the digital material library and design results, and achieve sustainable inheritance and innovative development of traditional culture.

AUTHOR CONTRIBUTIONS

Cao Mengsha designed, collected and analyzed the data, and drafted the manuscript. Cao Mengsha conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Cao Mengsha 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

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