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Visualisation Space Design of Non-Heritage Culture in the Context of Rural Revitalisation

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Abstract Nowadays, the problems of rural cultural heritage such as fractured cultural lineage, unorganized development of space and poor cultural dissemination are still prominent. For this reason, this paper combines visualization technology to research on the design of non-heritage cultural space under the perspective of rural revitalization. Through the image recognition technology under machine vision, the features of rural non-heritage culture are extracted, which cover the features of non-heritage culture including shape, gray scale, texture, color and shape. The extracted NRH cultural features are then applied to the practice of rural cultural heritage information visualization design, which integrates the virtual display technology with NRH cultural visualization, and the statistics on the poverty alleviation effect of rural tourism after the application of NRH cultural space design are carried out to test the effectiveness of the study. The data show that among the positive economic effects, the most obvious one is the increase of local residents' income (3.42) by the development of non-heritage cultural space visualization tourism for poverty alleviation. In addition, 74.02% of the residents believed that the design could bring benefits to the poor. This paper shows a significant effort in the application of technology and theory, and provides a new perspective on the protection and inheritance of intangible cultural heritage.

Index Terms image recognition, feature extraction, visualization space, non-heritage culture.

1. Introduction

Intangible cultural heritage constitutes a pivotal component of the exquisite traditional Chinese culture, representing a cherished treasure that mirrors the progression and development of Chinese civilization. Furthermore, its inheritance and preservation form a crucial avenue for the comprehensive enactment of the national strategy aimed at rural revitalization and fostering rural development [1-2]. Over the course of prolonged social development and evolution, while certain original functions of intangible cultural heritage may have faded, its rootedness in the profound traditional Chinese culture ensures its cultural significance and influence within local communities. Notably, the living legacy of intangible cultural heritage has the potential to generate novel cultural expressions imbued with diverse historical values [3-5].

Intangible cultural heritage, transmitted from generation to generation, constitutes the living embodiment of the universal national spirit and serves as a vital symbol of cultural identity [6]. It represents a global consensus and simultaneously presents a crucial avenue for China to advance the great rejuvenation of the Chinese nation through Chinese-style modernization [7]. Amidst the rapid evolution of digital technology, information is increasingly stored and presented in diverse, visually rich forms within digital media. The intro-

duction of visualization techniques has fundamentally altered the traditional understanding of non-material inheritance, offering an innovative approach and expansive landscape for its preservation and evolution [8]. However, current research on the visualization of intangible cultural heritage inheritance faces two major challenges. Firstly, it tends to be "theory-heavy and practice-light," focusing primarily on theoretical explorations of visualization storage and design for non-heritage works, while lacking corresponding design practices to support the proposed theories [9-10]. Secondly, commonly employed visualization methods are often "technology-centric but inheritance-neglecting," exhibiting technical limitations that hinder their ability to fully cater to the diverse needs of non-material inheritance. Consequently, these methods risk being utilized solely for technological demonstration, overlooking the inherent subjectivity and uniqueness of the intangible heritage itself in the visualization process [9-10].

Chinese intangible cultural heritage represents the outstanding cultural achievements of the Chinese nation, accumulated over centuries and imbued with the purest cultural sentiments of the nation. It serves as a condensed reflection of the wisdom garnered from the lives of the working people and a spiritual pillar underpinning the development history of the Chinese nation. In the face of contemporary opportunities and diverse

challenges, the adoption of innovative methods to empower intangible cultural heritage is a crucial pathway for advancing heritage inheritance in the new era [11]. Zhao, H. et al., drawing on relevant data and policies from 31 provinces in China, underscore the role of sustainable development policies in promoting drama-based non-heritage tourism, which in turn fosters the revitalization of rural areas through the stimulation of the rural service industry [12]. Yuan, C. et al. endeavor to investigate and analyze the coupling of cultural tourism with the non-heritage industry, as well as the current state of non-heritage development, thereby offering a significant reference for the development of non-heritage cultural tourism [13]. Dang, Q. et al. consolidate relevant research in the field of non-heritage protection, emphasizing that digital protection is a pivotal avenue for future non-heritage inheritance [14]. Furthermore, Lu, W. et al. endeavor to incorporate the theory of authenticity into the development of intangible cultural heritage tourism, demonstrating through case studies that dual-dimensional non-heritage displays can enhance travelers' viewing experiences to a certain degree [15].

Intangible cultural heritage encompasses a diverse array of expressions, such as oral legends and expressions, traditional performing arts, traditional handicraft skills, social customs, traditional rituals, and festivals, among others. These knowledge and practices, which embody understandings of the natural world and the universe, exude a profound atmosphere of rural life. They represent the accrual of history and possess rich spiritual and cultural value. Tavares, D. S. et al. conducted a review and analysis of the intricate relationship between urban resilience and intangible cultural heritage, with a particular focus on intangible cultural heritage architecture and sustainable discourse. They advocated for the inclusion of intangible cultural heritage elements within the metrics utilized for assessing urban resilience [16]. Champion, Erik et al. reviewed and examined publications and studies pertaining to the digitization of intangible cultural heritage (ICH). They highlighted the scarcity of research on the digital transmission and preservation of ICH, noting its limited impact at present. Ultimately, they underscored the pivotal role that digital assets of ICH play in facilitating public comprehension and exploration of this heritage [17]. Ceccarelli, M. et al. devised an innovative artifact framing service robot, endowed with both flying and ground motion capabilities. Through simulation experiments, they validated the robot's stable performance, deeming it satisfactory for fulfilling the demands of artifact framing services [18]. In their report, Johnson, E et al. assessed crowdsourcing designs for cultural heritage in New Zealand. They observed that the evaluation process not only enhanced the authenticity but also underscored the significance of crowdsourcing projects in this domain [19].

This paper employs a combination of image preprocessing and recognition technologies to extract features of rural intangible cultural heritage, notably encompassing shape, grayscale, texture, color elements, and modeling. Subsequently, leveraging these acquired features, a spatial visualization design of intangible cultural heritage is undertaken,

guided by the concept of rural revitalization and structured around four key dimensions: culture, space, time, and augmented reality (AR). Ultimately, leveraging big data analysis techniques, the paper concludes by summarizing the effectiveness of this visualization space design, which integrates the concept of rural revitalization. This synthesis offers valuable methodological insights for both the research and practical application of rural cultural heritage design.

II. Research Design of Non-Heritage Culture in the Perspective of Rural Revitalization

This study, grounded in the prevailing context of rural non-material cultural heritage, endeavors to fortify the progress of rural revitalization and the preservation of non-material cultural heritage. To achieve this, we harness image recognition technology within the framework of machine vision to extract the defining features of non-material cultural heritage, which encompass shape, grayscale, texture, color elements, and modeling. Subsequently, utilizing these acquired features as a foundation, we embark on the spatial visualization design of rural cultural heritage, guided by the four dimensions of culture, space, time, and augmented reality (AR). Ultimately, leveraging big data analysis techniques, we summarize the efficacy of this visualization design, which is integrated with the concept of rural revitalization, offering valuable methodological insights for the research and practical application of rural cultural heritage design.

A. Non-heritage cultural feature extraction based on image recognition technology

1) Shape characteristics

- a) Area: Area is a measure of the size of a target to describe the size of the target region with respect to the boundary of that target. The area calculation method in this paper is to count the number of pixels inside the boundary of the target, the target is the largest defective region in the binary image R . In the binary image, 1 represents the target object, 0 represents the background, the area is to count the number of pixels that are 1, the formula is expressed as follows:

$$\text{Area} = \sum_{(x,y) \in R} 1. \quad (1)$$

- b) Densification: Roundness represents the complexity of an object's boundaries, and densification is a measure of roundness. Densities represent the perimeter of an area per unit area, defined as the ratio of the square of the perimeter of the area P to the area $Area$. The smaller the densities, the more aggregated the area is, the simpler the shape, and conversely, the larger the densities, the more discrete the area is, the more complex the shape. When the area is a circle, C has a minimum value of 4π , and for other shapes, C has a value greater than 4π . The formula is:

$$C = \frac{P^2}{\text{Area}}. \quad (2)$$

- c) Rectangularity: Rectangularity is the ratio of the image area $Area$ to its smallest external rectangular area A_{MER} , the formula is:

$$R = \frac{Area}{A_{MER}}. \quad (3)$$

Rectangularity represents the degree to which the region fills the smallest outer rectangle, when the region boundary is curved and irregularly distributed, $0 < R < 1$, when the region is circular, $R = \pi/4$, when the region is rectangular, $R = 1$.

- d) Aspect Ratio: The aspect ratio r is the ratio of the width to the length of the smallest outer rectangle, and can be used to differentiate between elongated targets and approximate rectangular or circular targets. The aspect ratio of elongated defects such as scratches and approximate circular defects such as black spots varies greatly. The formula for the aspect ratio is defined as:

$$r = \frac{Width}{Length} = \frac{R_{max} - R_{min}}{L_{max} - L_{min}}. \quad (4)$$

- e) Invariant moments: Moment characterization is similar to the concept of moments in mechanics, i.e., the pixels inside the region are used as mass points and the coordinates of the pixels are the force arms, and the moments of each order of the pixels inside the region can never be obtained, which in turn characterize the region. For a continuous 2D image $F(x, y)$, its $p+q$ nd order moments are:

$$M_{pq} = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} x^p y^q F(x, y) dx dy, \quad (5)$$

where $p, q = 1, 2 \dots$.

By the Papulis uniqueness theorem: all moments of each order exist and $F(x, y)$ determines uniquely the sequence of moments $\{M_{pq}\}$ as long as $F(x, y)$ is segmentally continuous, i.e., as long as there are nonzero values in a finite region of the xy -plane: conversely, $\{M_{pq}\}$ uniquely determines $F(x, y)$.

The center distance is:

$$m_{pq} = \sum \sum (x - \bar{x})^p (y - \bar{y})^q F(x, y), \quad (6)$$

here $\bar{x} = \frac{M_{10}}{M_{00}}, \bar{y} = \frac{M_{01}}{M_{00}}$.

The normalized center distance is defined as:

$$\hat{\lambda}_{pq} = \frac{m_{pq}}{m_{00}^r}, \quad (7)$$

here $r = (p + q)/2 + 1$ $p + q = 2, 3, 4 \dots$

Based on the normalized center distance, seven moment invariants with translational, proportional and rotational invariance can be obtained:

$$\gamma_1 = \lambda_{20} + \lambda_{02}, \quad (8)$$

$$\gamma_2 = (\lambda_{20} - \lambda_{02})^2 + 4\lambda_{11}^2, \quad (9)$$

$$\gamma_3 = (\lambda_{30} - 3\lambda_{12})^2 + (3\lambda_{21} - \lambda_{03})^2, \quad (10)$$

$$\gamma_4 = (\lambda_{30} + \lambda_{12})^2 + (\lambda_{21} + \lambda_{03})^2, \quad (11)$$

$$\gamma_5 = (\lambda_{30} - 3\lambda_{12})(\lambda_{30} + \lambda_{21}) \left[(\lambda_{30} + \lambda_{12})^2 - 3(\lambda_{21} + \lambda_{03})^2 \right] + (3\lambda_{21} - \lambda_{03})(\lambda_{21} + \lambda_{03}) \times \left[3(\lambda_{30} + \lambda_{12})^2 - (\lambda_{21} + \lambda_{03})^2 \right], \quad (12)$$

$$\gamma_6 = (\lambda_{20} - \lambda_{02}) \left[(\lambda_{30} + \lambda_{12})^2 - (\lambda_{21} + \lambda_{03})^2 \right] + 4\lambda_{11}(\lambda_{30} + \lambda_{12})(\lambda_{21} + \lambda_{03}), \quad (13)$$

$$\gamma_7 = (3\lambda_{21} - \lambda_{03})(\lambda_{30} + \lambda_{12}) \left[(\lambda_{30} + \lambda_{12})^2 - 3(\lambda_{21} + \lambda_{03})^2 \right] - (\lambda_{30} - 3\lambda_{12}) \times (\lambda_{21} + \lambda_{03}) \left[3(\lambda_{30} + \lambda_{12})^2 - (\lambda_{21} + \lambda_{03})^2 \right]. \quad (14)$$

2) Gray scale characteristics

The gray level histogram of an image serves as an estimation of the probability density distribution of the gray levels within that image. By analyzing this histogram, we can derive the gray level characteristics of the image.

Let b be a certain gray level of the image with L levels, $N(b)$ denotes the number of pixels with gray level estimate of b , and M denotes the total number of pixels of the image. The corresponding gray level histogram formula is described as:

$$P(b) = \frac{N(b)}{M} \quad 0 \leq b \leq L - 1. \quad (15)$$

Image Gray Scale Histogram, which represents the distribution of gray values of an image, describes all the gray values of an image as a whole. Image defective regions have different gray levels, so we can extract the following gray level feature quantities by using the gray level histogram:

- a) Average gray value:

$$\text{Mean} = \bar{b} = \sum_{b=0}^{L-1} bP(b). \quad (16)$$

- b) Standard deviation:

$$\text{std} = \sqrt{\sum_{b=0}^{L-1} (b - \bar{b})^2 P(b)}. \quad (17)$$

- c) Poor:

$$\text{Entropy} = - \sum_{b=0}^{L-1} P(b) \log_2[P(b)]. \quad (18)$$

3) Texture characteristics

Texture refers to the locally irregular yet macroscopically regular characteristic present in an image. Being a pivotal aspect of images, texture features are ubiquitous across various image types. In this paper, we employ a texture feature extraction approach that is grounded on the gray level covariance matrix, among the myriad of methods available for this purpose.

Texture determines the spatial correlation of gray levels in an image: because texture is formed by the recurrence of gray

level distribution in spatial locations, there will be a certain gray level relationship between two pixels separated by a certain distance in the image space. Gray scale covariance matrix is to characterize the texture by studying the spatial correlation of gray scale. The grayscale co-production matrix integrally reflects the information of image grayscale about the adjacent interval, direction, and change amplitude, which can be used as the basis for analyzing the image texture [20].

The grayscale covariance matrix $P_\delta(i, j)$ ($i, j = 0, 1, 2 \dots$) is a two-dimensional correlation matrix defined as follows: first a displacement vector $\delta = (\Delta x, \Delta y)$, Δx and Δy are specified to represent the distance between two pixels in the directions x and y , respectively, and then the number of all pairs of pixels with a distance of δ and a grayscale level of i and j are computed. The texture feature parameters extracted from the gray level covariance matrix are as follows:

a) Contrast:

$$\text{contrast} = \sum_{n=0}^{L-1} n^2 \left\{ \sum_{i=0}^{L-1} \sum_{j=0}^{L-1} P_\delta(i, j) \right\}, \quad (19)$$

where, $|i - j| = n$.

Of, the shallower the image furrows, the less contrast, the blurrier the image.

b) Relevance:

$$\text{correlation} = \frac{\sum_{i=0}^{L-1} \sum_{j=0}^{L-1} ij P_\delta(i, j) - u_x u_y}{\sigma_x^2 \sigma_y^2}, \quad (20)$$

where the row averages in the horizontal direction of the grayscale covariance matrix:

$$u_x = \sum_{i=0}^{L-1} i \sum_{j=0}^{L-1} P_\delta(i, j). \quad (21)$$

Column averages:

$$u_y = \sum_{j=0}^{L-1} j \sum_{i=0}^{L-1} P_\delta(i, j). \quad (22)$$

Row variance is,

$$\sigma_x^2 = \sum_{i=0}^{L-1} (i - u_x)^2 \sum_{j=0}^{L-1} P_\delta(i, j). \quad (23)$$

Column variance is,

$$\sigma_y^2 = \sum_{j=0}^{L-1} (j - u_y)^2 \sum_{i=0}^{L-1} P_\delta(i, j). \quad (24)$$

Correlation reflects the degree of correlation between rows and columns in the gray scale covariance matrix and the magnitude reflects the local gray scale correlation in the image. If the values of individual pixels in the image matrix are very different, the correlation value is small, and conversely, if the pixels in the matrix are uniformly equal, the correlation value is large. In an image, if it has texture in a certain direction, the correlation value is larger in that direction.

c) Energy:

$$\text{energy} = \sum_{i=0}^{L-1} \sum_{j=0}^{L-1} P_\delta^2(i, j). \quad (25)$$

The texture energy represents the degree of uniformity of the gray scale distribution of the image, when the distribution of elements in $P_\delta(i, j)$ is more concentrated on the diagonal, it means that the gray scale distribution of the image is uniform when viewed from the local area. When the value of $P_\delta(i, j)$ is the same everywhere in the image, the energy value is minimized, and when the value of $P_\delta(i, j)$ is large in some parts of the image and small in some parts, the energy increases. Moreover, the coarser the texture, the greater the energy, and the finer the texture, the lesser the energy, when viewed from the whole image meter.

d) Homogeneity:

$$\text{homogeneity} = \sum_{i=0}^{L-1} \sum_{j=0}^{L-1} \frac{1}{1 + (i - j)^2} P_\delta(i, j). \quad (26)$$

A larger value of homogeneity signifies that the texture within different regions of the image exhibits minimal variation, indicative of local homogeneity. Given the distinctiveness of texture features among individual defects, we proceed to extract the texture features from the largest rectangular defective region of the original grayscale image, in order to differentiate among various defects.

4) Color characteristics

Intangible cultural heritage encompasses a diverse array of forms, with rural art and architecture being prominent vehicles for presenting certain types. For such heritage, we can directly harness its color palette in visualizing its designs. This involves extracting the distinctive color combinations unique to the intangible cultural heritage and refining them with contemporary color aesthetics, ultimately integrating them into rural architecture and cultural artifacts. Additionally, there exists a category of intangible, non-heritage elements that lack inherent color. In these cases, color cannot be directly extracted but must be synthesized through a harmonious blend of emotional and cultural symbols, as well as the cultural connotations associated with the non-heritage. This process involves selecting appropriate colors that embody the character and emotional expression of the rural non-heritage cultural space. The utilization of color in the visualization of such spaces not only transforms cultural color language into a personalized visual narrative, but also enriches the cultural heritage of rural areas. Rural non-heritage cultural visualization space design boasts a potent visual impact while profoundly conveying cultural essence. The incorporation of color serves to enhance both the aesthetic appeal and the cultural depth of these spaces.

5) Modeling elements

Given the definition of intangible cultural heritage, its modeling elements often remain ambiguous, with certain skills, arts, crafts, and other forms of intangible heritage exhibiting discernible patterns that can be emulated. In the case of skills, arts, crafts, and other such intangible cultural heritage, we can directly incorporate their distinctive graphic and textual elements into the design of personalized tourism-oriented rural spaces, akin to the utilization of the Kabuki imagery found on the cultural backdrop walls of the Dunhuang Mogao Caves. As for intangible cultural heritage that lacks tangible forms, such as vocal music and medicine, while it may seem unfeasible to directly visualize and develop their shapes, we can nevertheless explore extractable shapes through the tools, objects, and narratives that are integral to their respective cultures. Subsequently, these elements can be redesigned to create novel visual representations. The Village Eaves series of *Materia Medica* models serves as a prime example of this approach, collating and recombining stylized elements derived from non-heritage-related items.

B. Spatial visualization design of non-heritage under the concept of rural revitalization

It has been observed that the architectural relics of numerous villages continue to suffer from degradation, with cultural resources remaining underutilized and underpromoted. Consequently, the protection and utilization of rural cultural heritage necessitate heightened attention and further promotion. Drawing upon the non-heritage cultural attributes identified previously, this subsection applies a spatial visualization design approach to rural cultural heritage, aiming to address the pivotal challenge of disseminating information sources pertaining to both tangible and intangible rural cultural heritage. This endeavor seeks to elevate the visibility of cultural and spatial information, with its innovative aspect lying in the introduction of spatial visualization design practices specifically tailored for rural cultural heritage. Ultimately, this serves as a valuable reference point for future investigations into non-heritage culture within the broader context of rural revitalization.

1) Enhancing cultural visibility

As depicted in Figure 1, the spatial arrangement of rural clan culture, folk culture, and trade culture is intricately woven together, leveraging the non-heritage cultural characteristics previously identified. With the Hundred Hall as the focal point, the clan culture spaces, such as the Family Tradition Square and Vernacular Exhibition Hall, are radiated outwards. Similarly, centering on the Hundred Arts Hall, various folk culture spaces are integrated, including a calligraphy exhibition hall, bamboo weaving workshop, paper-cutting paradise, and stone carving garden. To foster a vibrant trade atmosphere, the old village street's original stores have been revitalized through the introduction of emerging businesses like ginger noodle soup restaurants, food cafes, and corner cafes. Furthermore, environmental improvements have been undertaken to

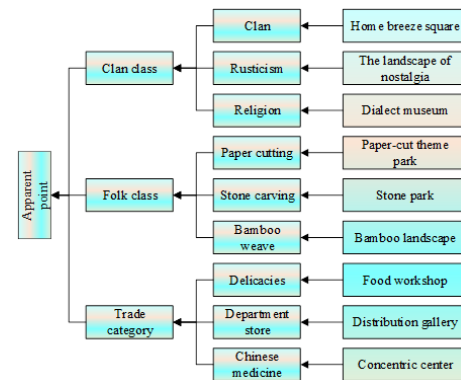


Figure 1: Enhanced cultural vision

enhance the overall aesthetic, involving the removal of abandoned and disused structures like the vegetable market shed, thereby enhancing the openness of the space. Specifically, the short house located on the left side of Hong's Chaste Square has been demolished, and its historical appearance has been restored using traditional materials and techniques. This restoration process encompasses the columns, beams, and decorations, emphasizing the clan culture atmosphere within the area and enhancing the cultural visualization efforts.

Relying on the deep clan culture in the study area, the "Surname" interactive landscape wall is created. The shape of the landscape wall draws on the traditional architectural form of the old street, with a built-in reversible grid of different sizes connected by bearings, and the front of the grid is the main surnames of the countryside and the face of the corresponding surnames is the information on the origin and evolution of the surnames, so that information can be conveyed through the reversal of the grid and the people, enhancing the conveyance of information on clan culture and the development of the clan. Enhance the communication and visualization of clan culture information. On the other side of the plaza, set up the Zide promenade, green vegetation to enrich the spatial environment, enhance the distribution of people, not only to increase the number of people receiving information on the clan culture point of view, but also to meet the function of local residents' recreation and interaction. Overall, the visual + design strategy is adopted to strengthen the inheritance and promotion of intangible cultural heritage in the countryside of a certain region. On the basis of the intangible cultural heritage, we set up the viewpoints of trade culture, restoring the pharmacy, wine shop, cloth shop, Ye Zaiden department store and other businesses, recreating the old market style of the old street. In addition, the implantation of 24-hour bookstores, corner cafes, Hanbok experience halls, Jiaojiang snack stores and other emerging businesses, not only to coordinate with the overall style of the old street environment, but also to adapt to the needs of modern life.



Figure 2: Village street structure

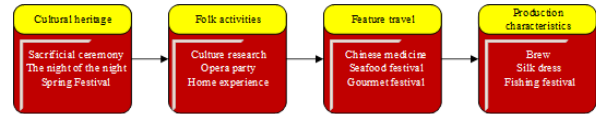


Figure 3: Non-heritage planning

2) Enhanced spatial visibility

There are a large number of old and new buildings inside the old rural street, and the buildings are arranged along the street to form the interface of the old street. The redundancy of the traditional building interface and the lack of visual language make people have a negative visual experience. The rural street structure is shown in Figure 2. Aiming at the spatial characteristics of spontaneity, mobility and complexity of the informal bazaar in Xinjie and the needs of residents and tourists, the comprehensive improvement of Xinjie Bazaar is carried out with full consideration of its spatial relationship with the study area. Emphasizing the continuity and continuity of spatial vision, it can produce a harmonious visual order and visual feeling, which is mainly manifested in the regularity of spatial interface decorative techniques, building materials and scale proportions. The interface composition of the old rural street includes: doors, windows, walls, roofs and other material elements, which are further subdivided into shape, grey scale, texture, color, modeling and other constituent elements, and the consistency and continuity of these elements in the horizontal can create a sense of rhythm in the street space, while strengthening people's spatial visibility and perception of the old street through the repeated presentation of the elements. Fully consider the diversity of the use function of the barge, implanting characteristic structures, such as bamboo promenade, paper-cutting sketches, seats, etc., to meet the needs of leisure and recreation, to create the best visual viewpoints, and to accentuate the artistic atmosphere of the ecological waterfront landscape space.

3) Enhanced time visibility

Based on the cultural characteristics of non-heritage to develop the rural non-heritage cultural space vision, to guide the diversion of tourists. After clearing the site, landscape greening is implanted, planting low trees such as osmanthus, chicken maple, and bamboo, with different colors of trees properly matched. Experiential functions such as seats along the wall and photo stops are set up to guide the crowd to stay here, evacuating the flow of people in the narrow old street and forming a stopping zone. The roof area is a core component of traditional architecture night scene shaping, should be reasonable control of the building facade lighting levels, the roof brightest increase the contrast with the dark night, the roof outline light strip outline, the ground using diffuse reflective lighting, to create a sense of hierarchy and different parts of the light effect of the contrast between the relationship. Non-heritage cultural activities planning as shown in Figure 3, the top tile set miniature floodlight illumination, forming a rhythmic light spot, LED linear light strip outlining the building's outer contour, detailed ridge decoration set small

floodlight focus illumination, combined with the surrounding green floodlight, to create a lively atmosphere of the exchange space at night. To do a theme in January, a season a characteristic, improve the planning area characteristics of the distribution of activities in the month, heritage characteristics of culture, experience folk customs, tasting rural food, to create a rural characteristics of culture and tourism fusion system.

4) Virtual augmented reality visualization

Building upon the unique cultural attributes of non-heritage locales, this proposal outlines the conception of a "Digital Intelligent Countryside Map," capitalizing on the prowess of digitalization, the internet, blockchain, and other vanguard technologies. Inspired by visionary endeavors in futuristic and digitized rural landscapes, the objective is to intertwine intelligent lifestyles with environmental aesthetics, giving rise to a comprehensive "smart" ecosystem. This ecosystem, nestled within the digital village framework, encapsulates healthcare, gastronomy, housing, transportation, culture, scholarly pursuits, leisure, and commerce. In healthcare, the blueprint envisions smart clinics, designed to address the routine health requirements of inhabitants through remote consultations, medication deliveries, and longitudinal health analytics, accompanied by proactive interventions. Regarding sustenance, a Rural Non-Heritage Cloud Application is envisaged to not only facilitate orders of local culinary delights but also offer a window into their production chains. Housing accessibility is augmented through the app's integration for effortless reservations at venues like Gongji Inn and Yi'an Qingju.

Transport infrastructure is set for an upgrade with the deployment of vehicle tracking and geofencing systems, enabling meticulous monitoring of village traffic dynamics, thereby enhancing public safety through informed crowd management strategies. Cultural immersion deepens as facial recognition and motion capture technologies are infused into cultural hubs, allowing participants to virtually experience the attire and makeup of Taizhou's Chaotic Bomb Opera, invigorating individual-heritage engagement. The research sphere benefits from a digital pavilion exploration, enabled by VR technology, while aesthetic appreciation soars with the fusion of holographics, synchronized audiovisual effects, manifesting in nocturnal spectacles like water screen cinema and luminous displays.

Commercially, the cloud platform streamlines marketplace stall applications for a diverse user base, introducing adaptable and mobile retail solutions. Distinct architectural motifs, such as intricate cloud motifs, Republican-era arches, and horse-head wall features, are meticulously extracted to inform the

design of smart modules, infusing locality's essence into technological innovation. Moreover, the countryside's digital transformation extends to intelligent tree pools, optimized waste management systems, and interactive information kiosks, collectively enriching residents' daily experiences and advancing the vision of a smart, contemporary rural lifestyle.

III. Analysis of Visualization Space Design of non-Heritage Culture

A. Analysis of the types of visualization of rural non-heritage

1) Abstract type

In the era of big data, professionals across various disciplines are increasingly in need of understanding the intricate relationship between massive information and the latent laws and developmental directions embedded within it. Figure 4 presents the outcomes of an abstract visualization analysis conducted on rural non-heritage data. While figurative spatial visualization design endeavors to narrate stories to the general public, abstract spatial visualization design aims to elucidate information for professionals, effectively revealing the underlying patterns and connections within the data in the most concise manner. This approach facilitates the identification and resolution of issues.

On the one hand, most of the information about national intangible cultural heritage is just related audio, text, video, pictures, etc. As we all know, this huge amount of information is useless if it cannot be reasonably utilized by us. On the other hand, the relationship between the information, the implied law and the development trend, etc., are the information that relevant professionals need to use in their research fields. The purpose of abstract spatial visualization design is to reveal and summarize the inner connection and structure behind the complex information, to discover useful information from a large amount of abstract information, and to creatively present the information through artistic graphic design, to dig out the deep information hidden in the depths of the visualized objects. Through artistic graphic design, we can creatively present the information and explore the deeper meaning hidden in the visualization objects. For example, in the design of this project, the number of inheritors, the number of non-heritage items and the types of non-heritage items owned by each city in thirteen villages in a certain region are presented in rectangular and hexagonal abstract graphics, and the comparison of the heights of the vertical rectangles clearly shows that the number of national non-heritage items owned by K villages (91, 15, 120) among thirteen villages in a certain region is far ahead of the number of inheritors (120), and the number of inheritors (120) is also far away from the number of national non-heritage items owned by K villages. (120) is also much higher than the other villages in a region.

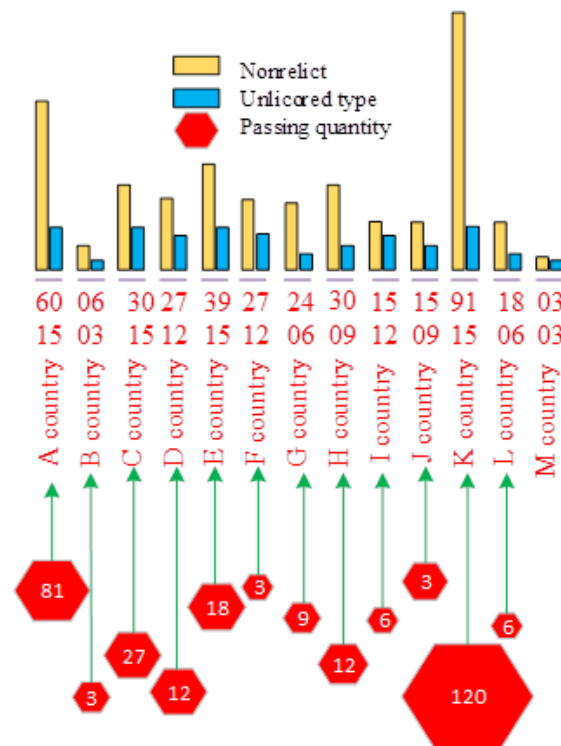


Figure 4: The rural unleft abstract visual analysis results

2) Lyrical

Emotional design, an emerging discipline, has demonstrated potential applicability in the realm of spatial visualization. This approach endeavors to render designs alluring to their audience, fostering enjoyment through various attributes such as intrigue, playfulness, aesthetics, captivation, or other alluring qualities that resonate with the intended audience.

First of all, it is important to recognize that "designing for the masses" is particularly difficult in a wide range of designs because of the range of audience preferences, which on the one hand suggests that the impact of emotional design is very subtle, and that it is not possible to quantify this impression, and it is even more impractical to standardize the technical evaluation of it. In fact, each design element influences each other in spatial visualization, so the designer cannot consider these factors in isolation, in other words, the final design may contain more content or meaning than the sum of its parts, and the lyrical spatial visualization design is exactly like this, the results of the analysis of the rural non-heritage lyrical visualization are shown in Figure 5. The five colored cones in the spatial visualization design of rural intangible cultural heritage represent the five categories of arts and crafts, folk literature, folk music, drama and opera, and the horizontal axis of this infographic corresponds to the thirteen villages in a certain region, and it can be seen from this figure that the highest point of the curve represents the arts and crafts of village K, whose number (33) occupies a larger share of the national intangible cultural heritage. share of the national intangible cultural heritage.

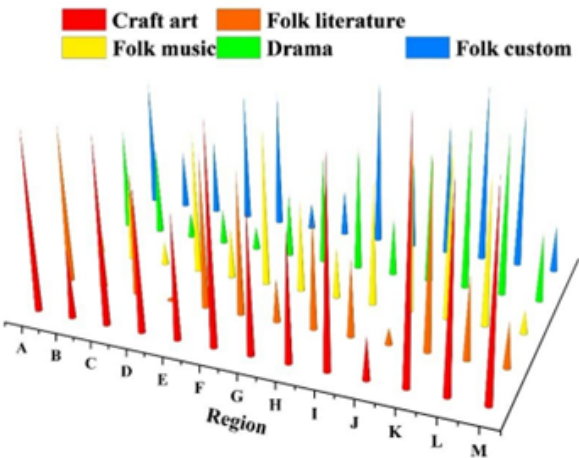


Figure 5: The rural unwritten lyric visual analysis results

3) Time-distributed

The conventional paradigm for visualizing temporally distributed non-heritage cultural spaces revolves around a temporal axis, adorned with annotations of textual data. Yet, from the vantage point of design, this endeavor necessitates a holistic strategy inclusive of a thematic underpinning, the meticulous selection of critical temporal milestones for nuanced interpretation, and the refinement of graphical layouts. Such an integrated methodology not only elevates the aesthetic appeal of the visuals but also fosters an augmented comprehension of the embedded data for the viewer. Moreover, the spatiotemporal visualization diagrams, through their temporal expression, convey supplementary layers of meaning embedded within multifarious data sets, thereby imbuing the narrative with a richer visual tapestry. Adherence to a chronological sequence in temporal distribution-based visualization designs meticulously maps temporal data onto the nodes of respective epochs. By deploying graphical representations, this methodology visually narrates the transformative journey of information across a spectrum of time periods. Contrasting starkly with mere numeric renditions, this approach infuses the data presentation with a captivating and intuitive dimension. As exemplified in Figure 6, the fruits of this temporal distribution analysis are manifested within the context of a village’s non-heritage cultural milieu.

The investigation focuses on two categories of intangible cultural heritage: folk arts and crafts, and folklore. Utilizing folded line diagrams with variable widths, the research visually represents the quantity of national intangible cultural heritage items originating from each historical dynasty. Notably, the time frames witnessing the highest production are the Republic of China era (with a peak of 83 entries), followed closely by the Ming Dynasty (64) and the Qing Dynasty (58). A striking contrast emerges when comparing the cumulative totals across historical periods, illustrating that the arts and crafts category significantly outnumbers the folklore category, totaling 351 instances versus 161 for folklore.

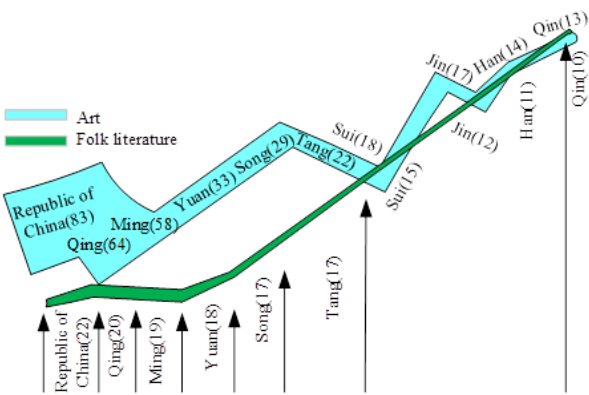


Figure 6: The rural non-reprinted time distribution visualization analysis results

B. Analysis of the integration degree of spatial visualization vision of non-heritage culture

The degree of integration within the visual field refers to the extent of what an individual can perceive while standing stationary and surveying their surroundings. In theory, a flat space can be conceptually divided into an infinite array of pixels, giving rise to a myriad of spatial field-of-view relationships. The field of view encapsulates the accessibility of any given observation point within a spatial configuration to other observation points, with the primary impediment to this visibility being the boundary buildings that obstruct the line of sight. Conversely, minor obstructions such as plants and greenery are generally disregarded in this context. This study specifically addresses the spatial environment of industrial streets, where the absence of greenery occlusion simplifies the analysis. Hence, only the occlusion caused by buildings is considered in the mapping process. The outcomes of analyzing the integration degree of the spatial visualization pertaining to the rural non-heritage visual domain are presented in Table 1.

According to the visual domain integration degree level, it is divided into blue-high (visual domain value 8000), green-higher (visual domain value 4000), orange-lower (visual domain value 2000), and brown-low (visual domain value 1000), and then according to the focus level of the 25 industries on the industrial street, it is divided into characteristic industries (8000 visual field degree), general industry (4000 visual field degree), supporting industry (2000 visual field degree), and museum (1000 visual field degree). The red visual field range is arranged for featured industries, the yellow and orange visual field range is arranged for general industries, the cyan visual field range is arranged for supporting industries, and the lowest blue color is for indoor museums (visual field value of 1000). In this way, according to the importance of the industry and the visibility of the formation of a positive correlation, more prominent focus on the visibility of the store, increasing the exposure. Therefore, the most influential brand stores such as ethnic woolen weaving and Han Palace milk food are

arranged in the red area, while the management office of the industrial street and e-commerce stores are located in the cyan range of visibility, and the Ethnic Museum is located in the blue range of visibility, which is a reasonable division based on the visibility value and the level of the industry. Compared with the original layout of the industrial street, people must walk to the entrance of the alley to see the whole picture of the industrial street; while the adjusted spatial layout, the specialty industries can be witnessed in the street with the highest degree of selection, which undoubtedly increases the exposure of the industrial street and achieves zero-cost publicity. There is also one less step in the topological path, with lower depth values and better accessibility.

C. Effectiveness of visualization space design of non-heritage culture

Drawing upon the aforementioned concept of rural revitalization through non-heritage spatial visualization design, this subsection delves into the economic implications of such spatial design by examining the perception of poverty alleviation effects, participation attitudes, and behaviors within non-heritage spatial visualization tourism. The objective is to foster the ongoing advancement of rural revitalization efforts and the safeguarding and perpetuation of non-heritage cultural traditions.

1) Demographic characteristics

The questionnaire of this study consists of two main parts, namely, the respondents' basic personal information and their perception, participation attitudes and participation behaviors on the effects of rural intangible cultural heritage visualized tourism poverty alleviation. The basic information of the surveyed residents shows that: gender, the number of females accounted for 67.20% of the total number of respondents, so there were fewer males than females among the respondents in the field. Age, 25-45 years old, accounting for 88.70% of the total number of respondents, totaling 300 people. Educational level, 80.00% of the respondents had junior high school education or below, so the overall educational level of the respondents was low. Occupation, nearly 70.00% of the respondents were farmers and herdsmen. Per capita annual income, 90.00% of the respondents had an income of less than 10,000 yuan.

2) Perception of non-heritage spatial visualization tourism poverty alleviation effect

Typically, the Likert scale's mean scores fall within established ranges to denote varying attitudes: 1.0 to 2.4 suggests opposition, 2.5 to 3.4 implies neutrality, and 3.5 to 5.0 signifies favorability. The findings from the perception-based assessment of non-heritage spatial visualization's impact on tourism-driven poverty alleviation are tabulated in Table 2. Here, individual items probe various aspects: Item 1 gauges the promotion of local cultural diversity; Item 2, enhancement of national cohesion; Item 3, improvement in existing infrastructure; Item 4, elevation of regional prominence; Item

5, reinforcement of non-heritage conservation and revitalization; Item 6, interference with residents' daily routines; Item 7, alteration of traditional lifestyles and customs; and Item 8, encroachment on traditional cultural heritage and significant loss of arable land, leading to land strain. Notably, Item 5 garners the highest mean score (3.43), highlighting that among positive socio-cultural repercussions, the most conspicuous outcome of implementing non-heritage spatial visualization for tourism-oriented poverty reduction is the bolstering of heritage preservation efforts. Conversely, Item 1 records the lowest mean (3.26), suggesting that the most salient adverse socio-cultural effect pertains to the potential disruption of indigenous lifestyle and customs due to the advent of such tourism initiatives.

Residents' perceptions of the economic effects of non-heritage spatial visualization tourism for poverty alleviation are shown in Table 3, in which item 9 is the increase of local residents' income, item 10 is the promotion of the development of local industries, item 11 is the better selling of agricultural specialties at higher prices, and item 12 is the increase in the cost of living. As shown in the table, among these items, item 9 has the largest mean value (3.42), indicating that among the positive economic effects, the most obvious one is that the development of non-legacy spatial visualization tourism for poverty alleviation increases the income of local residents. Question 12 has the smallest mean value (3.31), indicating that the most obvious negative economic effect is that the development of non-legacy spatial visualization tourism for poverty alleviation will lead to a certain degree to an increase in the price of daily necessities in the local area, which will lead to an increase in the cost of living as a negative phenomenon.

3) Attitude of participation in poverty alleviation through tourism visualized by NRHs

The findings from the examination of stakeholder attitudes toward NRM (Non-Revenue-Making) visualization initiatives aimed at tourism-driven poverty alleviation are summarized in Table 4. These reveal that a substantial 84.21% of residents endorse the local implementation of NRM visualization for poverty alleviation. Furthermore, 69.47% express satisfaction with the present state of NRM visualization development for this purpose. Regarding economic impact, 42.50% of respondents perceive non-heritage visualization tourism as a potent catalyst for local economic growth, positing that the region's economic prosperity is intertwined with tourism development. Conversely, 31.23% acknowledge a notable yet not exclusive role of such tourism in stimulating economic progress, asserting that the local economy's growth is not solely dependent on tourism. On the alleviation benefits for impoverished populations, 74.02% of residents affirm the positive impact, while 11.33% note some, albeit limited, benefits, and a minority of 3.28% report no discernible effect. The majority, 75.42%, advocate for intensified efforts in NRM visualization for poverty alleviation, whereas 13.45% voice opposition to such intensification. Regarding workforce engagement, an

Industrial grade	Business name	Space number	Visibility	Improved visibility level	Improved pre-visibility level
Characteristic industry	National instrument	1	Blue	High (field value:8000)	Low
	Hair planting	2	Blue		Low
	Folk custom	3	Blue		Low
	Hangong milk	4	Blue		Low
	Stirrup	5	Blue		Low
	Dress	6	Blue		Low
	Leather carving	7	Blue		Low
	Fuzz products	8	Blue		Low
	Dried meat	9	Blue		Low
Ordinary industry	Animal specimen	10	Green	Higher (field value:4000)	Low
	Gallery	11	Green		Higher
	Antiques	12	Green		Low
	Silver	13	Green		Low
	Crafts	14	Green		Low
	National photography	15	Green		Low
	Jade stone	16	Green		Low
	Civil trade	17	Green		Low
	Agate	18	Green		Low
Supporting industry	Cultural public service center	19	Orange	Lower (field value:2000)	Low
	Book club	20	Orange		Low
	Banquet town	21	Orange		Low
	Industrial street management	22	Orange		Low
	E-commerce	23	Orange		Low
	Supermarket	24	Orange		Higher
Increase industry	Travel company	25	Orange		Higher
	Museum	26	Brown	Low (field value:1000)	

Table 1: The analysis of the integration degree of visual field in rural non-left space

Item	Mean	Results	Approval rating	Objection rate
1	3.26	In favor	63.92%	5.49%
2	3.41	In favor	64.69%	5.08%
3	3.39	In favor	61.97%	3.27%
4	3.37	In favor	67.96%	7.16%
5	3.43	In favor	78.78%	4.45%
6	3.28	Object to	17.91%	54.65%
7	3.35	Object to	19.99%	54.65%
8	3.32	Object to	19.85%	56.79%

Table 2: The results of the visual analysis of the visual tourism poverty alleviation effect

Item	Mean	Results	Approval rating	Objection rate
9	3.42	In favor	73.82%	2.08%
10	3.38	In favor	69.64%	4.16%
11	3.36	In favor	66.78%	5.08%
12	3.31	Object to	14.91%	55.97%

Table 3: The perception of the economic effect of the visual tourism poverty alleviation

overwhelming 87.58% of residents exhibit willingness to participate in tourism-related tasks linked to NRM visualization. Notably, there seems to be a typographical repetition error in the original text regarding residents' willingness to engage in tourism work; however, maintaining the integrity of the original content as requested, the figures are restated as intended: 87.58% are willing, with 4.26% expressing unwillingness to work in tourism activities associated with NRM visualization.

4) Non-heritage visualization tourism poverty alleviation participation behavior

The analysis of the participation behavior of intangible cultural heritage visualization tourism for poverty alleviation is

Survey project	Attitude	Proportion
Supporting non-legacy visual tourism poverty alleviation in local development	Stand by	41.71%
	Support	42.50%
	Somehow	6.33%
	Unheld	8.32%
Whether to be satisfied with the development of non-revisional tourism poverty alleviation	Unsupported	1.14%
	Very satisfied	28.04%
	Satisfaction	41.43%
	Somehow	11.59%
Unleft visual tourism poverty alleviation	Discontent	13.39%
	Unsatisfactory	5.55%
	It's a big deal	42.50%
	Important action	31.23%
Whether tourism poverty alleviation is a good thing for the poor	Not much	11.33%
	Somehow	10.25%
	Inaction	4.69%
	No sense	3.28%
We will further strengthen the attitude of non-spending visual tourism poverty alleviation and development	Somehow	8.98%
	There are some, but not obvious	13.72%
	Act	32.24%
	It's obvious	41.78%
Whether you are willing to engage in non-legacy visualization of tourism	Stand by	62.69%
	support	12.73%
	It doesn't	11.13%
	Object to	6.74%
Whether you are willing to engage in non-legacy visualization of tourism	Stand against	6.71%
	Very willing	32.17%
	Be willing to	55.41%
	somehow	5.21%
	unwillingness	4.26%
	Very unwillingness	2.95%

Table 4: The analysis of the attitude analysis of tourism poverty reduction was not taken

Participative	Proportion
Direct participation in non-legacy visual tourism services	75.78%
Farm music	17.92%
Home hotel	17.62%
Tourist traffic	7.85%
Handicraft production	65.65%
Business shop	40.84%
Other	3.42%
Limiting factor	Proportion
Financial support	70.55%
Cultural technology	55.56%
Policy support	22.71%
Rich information	43.72%

Table 5: Analysis of the behavior of tourism alleviation and poverty reduction

shown in Table 5, and it can be seen that the three most popular ways are residents directly involved in the service work related to intangible cultural heritage visualization tourism (75.78%), residents involved in the production of handicrafts (65.65%), and operating agricultural specialties selling stores (40.84%). Fewer residents chose to participate in running a farmhouse (17.92%), running a homestay (17.62%), and picking up and dropping off tourists in tourist transportation (7.85%). According to the field interviews and surveys, it is found that the residents have high motivation to participate, but their actual ability to participate is insufficient. Among the constraints on the residents' participation in the non-heritage visualization tourism, it can be found that the percentage of its ranking in order of financial support (70.55%), cultural technology (55.56%), information on how to get rich (43.72%), and policy support (22.71%). Among them, financial support and culture and technology are the two main constraints, both of which account for more than 50% of the total.

IV. Conclusion

Rural intangible cultural heritage (ICH) serves as a pivotal vessel for transmitting Chinese traditional culture, yet the majority of it remains confined within the rudimentary realm of cultural heritage archiving. This study, taking the visualization of ICH culture as its starting point, leverages big data technology to delve into the spatial design aspects of ICH visualization within the context of rural revitalization. Our findings reveal that rural K stands out from the other twelve villages, boasting a significant lead in both the quantity and diversity of ICH, as well as the number of inheritors (91, 15, 120). Furthermore, a notable observation is that the count of rural arts and crafts ICH within a specific region (375) vastly exceeds the total number of folklore ICH (255) amassed over an extensive historical period.

To gain a deeper understanding of the interplay between spatial visualization of rural intangible cultural heritage (ICH) and rural revitalization, we analyze the statistics pertaining to ICH-visualized tourism within the framework of rural revitalization. Notably, the mean value for strengthening the protection and revitalization of non-heritage elements emerges as the highest (3.43), signifying that among the positive socio-

cultural impacts, the most prominent is the enhancement of local popularity achieved through the development of non-heritage cultural space visualization tourism for poverty alleviation. Furthermore, a substantial proportion of residents (87.58%) express willingness to participate in non-heritage visualization tourism-related endeavors. The majority of villagers recognize the integration of rural revitalization concepts into the design and development of non-heritage cultural visualization spaces, as evidenced by the high percentages of those directly engaged in non-heritage visualization tourism services (75.78%), those involved in handicraft production (65.65%), and those operating agricultural specialty product sales stores (40.84%).

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