Journal of Combinatorial Mathematics
and Combinatorial Computing
www.combinatorialpress.com/jcmcc

Combinatorial Press

Algorithm Optimization and Innovative Design of Digital Inheritance System for Miao Family Weaving Handicraft in South Sichuan Province

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ABSTRACT

With the maturity of digital display technology, its application scope is also more and more extensive, and there are more and more application cases in the protection and inheritance of minority hand-weaving skills. This paper builds a general framework for the design of the digital inheritance system for the handloom weaving techniques of the Miao family in southern Sichuan, and applies three-dimensional modeling technology, three-dimensional animation technology, digital imaging technology and interactive interface design to complete the preliminary establishment of the digital display system for the handloom weaving techniques of the Miao people in southern Sichuan. Combined with the information dissemination characteristics of mobile intelligent terminals, relevant improvement programs are proposed. At the same time, the optimization and improvement of the digital display system is further improved to meet the needs of users. Comparing the users' experience and perception of the digital display system, the system designed in this paper is superior to R-Space in terms of functional scope and technology, and the average score of the system designed in this paper is 4.193, which is higher than the score of 3.985 of the R-Space system, and the system designed in this paper has a higher score. At the same time, the user's satisfaction with the system's interactivity is more stable in the three aspects of login start, system home page, and Chuannan humanities resources. In the login start, the scores of very satisfied, more satisfied, and general are 2, 3, and 2.5 respectively, which indicates that the user's experience of this paper's system is better.

Keywords: three-dimensional modeling technology, digital imaging technology, digital display system, Chuannan Miao family cloth weaving handicraft technology

1. Introduction

Miao costumes are colorful and splendid, which are an important part of the Miao culture and a glorious treasure in the cultural treasury of the Chinese nation [1]. Miao batik in the southern region

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Received 15 January 2024; Revised 10 February 2024; Accepted 30 November 2024; Published Online 16 April 2025.
DOI: 10.61091/jcmcc127b-391
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of Sichuan is unique among Miao costumes, and the local people are very good at embroidery and picking flowers [2]. They embroider exquisite patterns on the soft, delicate and wear-resistant linen cloth they weave and pick out brilliant flowers with a very distinctive color layout [3-4]. Miao weaving techniques usually feature birds, insects, fish, flying birds and animals, in addition to motifs reflecting the history and culture, customs and religious beliefs of the people [5-6]. It is also possible to combine a variety of techniques to produce weaving styles with a sense of relief and infectiousness, which appear particularly exquisite and moving [7-8]. However, in a globalized and modernized society, the entry of foreign cultures strongly influences people's lifestyles and cultural identities, making the Miao weaving handicrafts with strong national characteristics gradually disappearing, and how to use effective communication media to promote the inheritance and development of the Miao weaving handicrafts in southern Sichuan is a hot topic in social research.

As we all know, traditional handicrafts are rich in content, including the display of traditional handicrafts, the explanation and demonstration of the production process, as well as the inheritance of traditional handicrafts [9-10]. In the production process of traditional handicrafts, each link can directly reflect the birth of handmade artifacts under unique natural conditions, where human thoughts are transformed through natural materials and handicrafts to realize handmade artifacts [11-13]. In the current social form, digital technology can, on the one hand, realize the inheritance and innovation of Miao family cloth weaving handicrafts based on science and technology, so that the audience of Miao costumes can be increased, and at the same time, it can also be used to preserve the imprint of Miao family cloth weaving techniques [14-16]. The development of Miao family weaving handicrafts in digital technology can be combined with the needs and preferences of the current users to make corresponding innovations, targeting the needs of the general public, and on the basis of preserving the characteristics of traditional handicrafts, research on users, which will lead to the national handcrafts can be effectively disseminated [17-20]. On the other hand, the inheritance of Miao family cloth weaving handicrafts with digital technology can also make it have a more novel way of display [21]. Based on digital technology, the weaving pattern can be more conveniently created by digital modeling, and at the same time, the creator's idea can be better presented by using digital media in the dissemination process of handcraft skills [22-24]. Combined with digital communication media, the designed and presented digital images of traditional handicrafts can be empowered to be effectively disseminated in the digital context [25-26].

In this paper, we propose a method for designing a digital heritage system for the weaving handicrafts of the Miao family in southern Sichuan, using 3D modeling technology to create virtual props including spinning machines, looms and other weaving and a weaving workshop of the Miao people in southern Sichuan. The virtual scene image is segmented through the ASIS network framework, and the detailed features, positional features and significant features of the virtual scene space are screened. Match the virtual scene and feature elements to highly restore the location of the virtual scene. After completing the scene simulation, use the Biped skeleton to align with the artisan's character model, create the 3D character model of the weaver, and complete the creation of the 3D animation of the weaving of the Miao family in southern Sichuan. Use digital imaging technology to improve the scene and character images in the 3D animation, and add color effects. From the aspects of mobile terminal design and user-oriented requirements, the design improvement plan of the system is proposed, and combined with empirical research and system testing, the final design effect of the digital display system of Sichuan Miao family cloth weaving handicrafts is evaluated.

2. Design of a digital inheritance system for the handloom weaving techniques of the Miao family in Sichuan Province

2.1. Design methodology

In order to increase the promotion of the hand-woven skills of the Miao people in southern Sichuan and to explore diversified dissemination channels for this traditional art form, the project team developed a digital display system for the hand-woven skills of the Miao people in southern Sichuan. The system is displayed in museums, libraries, memorial halls and exhibition centers, and promoted on major web portals. Further development of mobile devices is planned. Further development of mobile devices is planned. The system incorporates case studies and uses digital technologies such as 3D modeling, 3D animation, digital imaging and human-computer interaction to enhance the attractiveness of the exhibition and dissemination of the art of hand-woven Hmong weaving in southern Sichuan. The design method is as follows:

First, through reviewing relevant literature, the challenges faced by the inheritance and dissemination of Chuannan Miao weaving art in the current smart media era are clarified.

Secondly, through combing the cultural resources of the Miao people in Chuannan and studying the typical cases of domestic digital display systems, the modular structure of the digital display system for the hand-woven art of the Miao people in Chuannan is studied and planned. The system design includes five modules: an overview of the Miao culture in south Sichuan, a display of the Miao weaving process, an explanation of traditional weaving principles, an introduction to weaving tools, and a virtual tour of the weaving workshop.

Third, according to the characteristics of each module, different interactive forms are adopted. Overview of Miao Culture in South Sichuan" mainly involves the collection and organization of documentary materials, and is presented in a combination of figures and graphics. The "Illustrated Guide to Miao Weaving Craft" is presented with page-turning illustrations. Principles of Traditional Weaving" is difficult to understand for the general public, while it is presented through new media short videos and MG animations, which are more intuitive and attractive. The weaving tools are relatively decentralized, so a window-type interactive display is used, with a 360° display of the 3D model controlled by the mouse and accompanied by text and voice explanations. The Chuannan Miao weaving environment is the focus of the display of the Chuannan Miao weaving process, and is also a major highlight of this digital display system. Using 3D modeling technology, the compounds and weaving workshops of the Miao in South Sichuan are made into 3D virtual scenes, so that users can be completely immersed in the virtual scene and perceive the cultural charm of the weaving craft of the Miao in South Sichuan.

Fourthly, the interaction logic framework of the digital display system of the hand weaving technology of the Miao people in the south of Sichuan Province is organized. Starting from the design ideas, methods and technologies of the digital display system of Chuannan Miao hand weaving technology, the interaction logic demonstration is completed.

Fifth, determine the artistic style of the digital display system of the Chuannan Hmong hand-woven skills. Given that the system is expected to be used in museums, libraries, memorials, exhibition centers, and major online portals, and is expected to be developed for mobile devices, the target audience includes individuals of all ages. Therefore, the interface design is proposed to be in a realistic style that reflects the characteristics of the Miao people of southern Sichuan, which is consistent with the aesthetic preferences of the general public and facilitates the promotion and publicity of the system.

Sixth, we will investigate the current situation of display and dissemination of the hand-woven handicrafts of the Miao people in southern Sichuan, summarize the current situation of their display and dissemination, and explore the promotion and application of the digital display system of the hand-woven skills of the Miao people in southern Sichuan.

2.2. Technical Analysis of the Digital Display System for Sichuan Hmong Hand-Weaving Techniques

2.2.1. Three-dimensional modeling techniques. The Chuannan Miao hand weaving technique digital display system uses 3D modeling technology to create virtual props and scenes, including spinning machines, looms, proofing knives, dyeing cylinders, cloth washing stones and other common weaving tools, as well as Chuannan Miao compounds and weaving workshops.

1) Acquiring multi-view 3D data. Taking a single build as a unit, each instance of the multi-view image is traversed separately to obtain the unit parameters of the scene. In order to ensure a high degree of 3D scene reproduction, this paper sets the acquired multi-view 3D data to consist of four essential parameters. Parameter 1 is the coordinate positioning value in three directions and the relative position coordinates, parameter 2 is the constructed color information, parameter 3 is the semantic label of the view image, which is used to indicate the category and cut-off region of the unit Parameter 4 is the common data, which is used for the later data compilation and extraction of the feature parameter. The four parameters are used to locate the view unit from the three aspects of location, details and features respectively, which makes the acquired data meaningful for analysis.

2) Initial three-dimensional image preprocessing. For the three-dimensional image data preprocessing are two parts, the first is to traverse the multi-view three-dimensional database, through the ASIS network framework for virtual scene image segmentation, in addition to screening out the details of the virtual scene space features, location features, significant features.

The segmentation module is based on coordinating the information of semantic labels and location labels of the 3D data to categorize each instance, and then accounting for the demarcation line between the different instance categories through the costum regression network calculation. For the total multiple instances within a component, a two-layer encoding is used to record, one layer records the component unit to which it belongs, and the second layer encodes the instances within the dimension, distinguishing the position to which each point belongs. The feature matrix is shown in equation (1):

$$M^T = R_O^T \times K_O^T + \frac{\sqrt{\kappa}}{I} \tag{1}$$

Where M^T denotes the point feature matrix, R_O^T denotes the input matrix, κ denotes the scaling factor, K_O^T denotes the weight matrix, and I denotes the bias factor.

Components, after instance cutting, the data within each region is screened, and the representative feature quantities are extracted through the feature matrix, which lays the relative position foundation for the multi-view architecture reconstruction of the virtual scene.

3) Multi-view parallel matching of virtual scenes. The elements of multi-view parallel matching of virtual scene are detail features, positional features, and significant features, and only by constraining the construction model from multiple perspectives can the position of the virtual scene be highly restored [27]. The principle of parallel matching is shown in Figure 1:

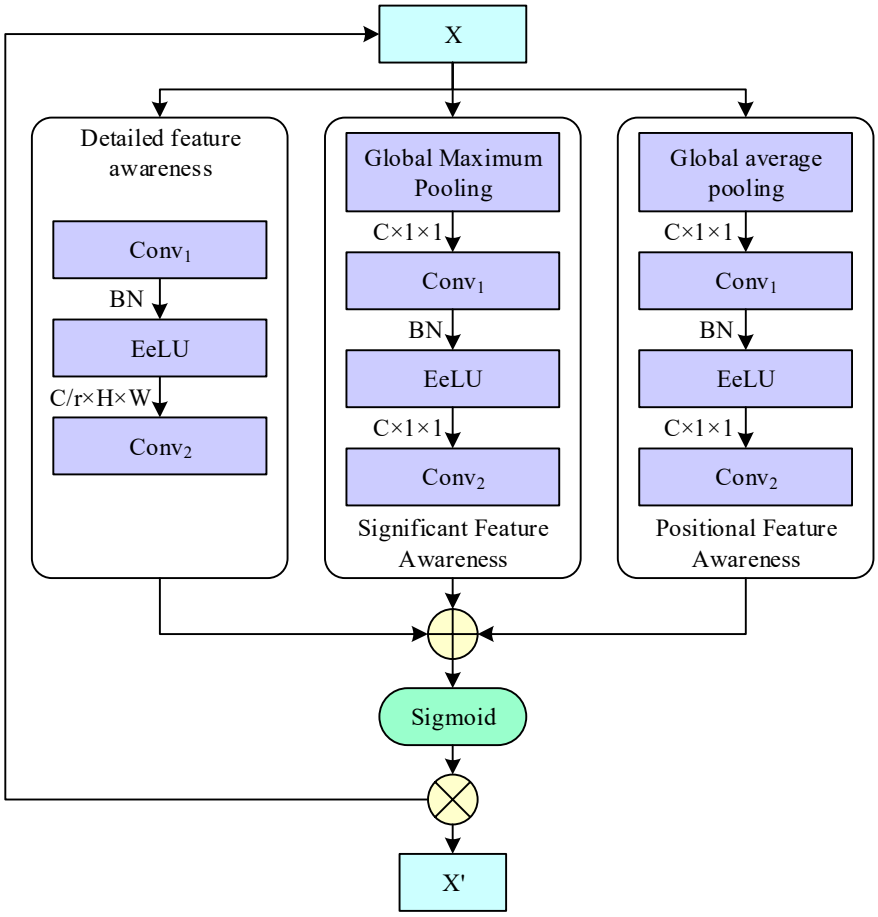


Fig. 1. Principle of parallel matching of multiple views in virtual scenes

The detail characterization includes the shape characteristics and size characteristics of the member, and the detail characterization formula is as follows:

$$L(X)=\beta\left(\frac{ConV_2}{w\times_{\alpha}Con(X)}\right) \tag{2}$$

where $L(X)$ denotes the detailed feature expression, w denotes the batch normalization, $\alpha Con(X)$ denotes the modified linear unit, β denotes the convolution kernel size, and $ConV_2$ denotes the feature vector.

The significant feature expression is as follows:

$$G(X)=L\left(\frac{\varepsilon(X)}{\sqrt{b}}\right) \tag{3}$$

Where $G(X)$ denotes the salient features, L denotes the number of global channels, $\varepsilon(X)$ denotes the global maximum pooling, and b denotes the salient probability ratio.

The recognition of salient features is filtered by global pooling on the input data, in advance will be set to the features that already exist voxels, the use of convolutional operations to identify the salient features and other features show voxel differences, matching correspondence can be done.

The positional features are as in equation (4):

$$G_2(X)=L\left(\frac{\varphi\times\sum b\times\sqrt{A}}{a\times\varepsilon\left(\overline{X}\right)}\right) \tag{4}$$

Where $G_2(X)$ denotes the positional eigen-expression, φ denotes the relative variable latitude, φa denotes the relative element position, b denotes the relative variable scale, $\varepsilon(\bar{X})$ denotes the global average pooling, and A denotes the nonlinear activation function.

Finally, the equilibrium point of the three eigenvalues is calculated using the weight function, and the weight formula is shown in equation (5):

$$X' = \frac{L(X)}{w} \otimes \frac{\sum G_2(X) \oplus G(X)}{\beta} \tag{5}$$

Where X' denotes channel attention weight, $\otimes$ denotes matrix multiplication, $\oplus$ denotes broadcast addition, and the other unknowns have the same meaning as above.

Detailed features, positional features, and salient features are matched in parallel in all channels of the virtual scene, and the attention weight of the channel tends to 1, the best reconstructed position of the component at this point, and the positional matching of the individual components of the complete virtual scene.

4) Multi-view three-dimensional visual reconstruction model generation. Virtual scene multi-view three-dimensional reconstruction model using a penalty function to optimize the individual components within the scene, the output of the built whole, the penalty test function as shown in equation (6) [28]:

$$D = \frac{M^T}{g} + \sqrt{(\tau + 1)^2} \tag{6}$$

Where D denotes the penalty function, g denotes the binary cross entropy, and τ denotes the penalty weight.

The penalty function is a fusion of the overall layout of the 3D space using the penalty function in a global perspective to optimize the articulation of the details between the components and ensure the continuity and integrity of the reconstructed model.

2.2.2. 3D animation techniques. After completing the 3D modeling of the weaving scene and tools, a 3D character model of the weaver needs to be created. Incorporating the character, tools and scene into the 3D animation can bring the entire scene to life.

The character animation uses the CS skeleton system in Autodesk 3ds Max 3D software. Align the Biped skeleton with the artisan's character model, then resize the Biped skeleton to match the size of the character model.

The algorithm based on the medial axis transformation approximates the object shape by maximizing the diameter of the internal tangent circle, which must have at least two points of contact with the object shell. The medial axis in the medial axis method is the set of centers of all the internal tangent circles. The center axis describes the topological connection of the object. This method deals with more image data and the algorithm is relatively complex, but it can approximate the geometry of the target very well and the details are retained better. Figure 2 shows the trajectory of the center of the circle based on the diameter of the largest internal tangent circle. For shapes X, X, the circle B inside X is called the maximal internal tangent circle with the sufficient condition that $\forall B$, and that $B \subseteq B \subseteq X \Rightarrow B = B$ is the maximal internal tangent circle for any $r \geq 0$ and $2p \in R^2$, the circle with p as the center and r as the radius can be denoted as Equation (7), where the d function denotes the Euclidean distance, and noting that $B_r^{\max}(p)$ denotes the maximal circle of X with radius of r and center of the circle at the point of p, the median axis M can be denoted as Equation (8):

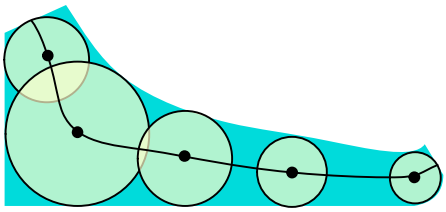


Fig. 2. Center locus of the maximum intangential ball diameter

$$B_r(p)=\{q\,|\,d(p,q)\le r\} \tag{7}$$

$$M=\left\{P\in X\,|\,B_r^{\max}(p)\subseteq X, B_r^{\max}(p)\neq\varnothing\right\} \tag{8}$$

The algorithm based on topological refinement originates from the simulation of burning grass model, assuming that at the moment of $t=0$, the places on the shape boundary will be ignited at the same time to ignite the fire, the front of the fire spreads to the interior of the shape at a uniform speed, and the flame is extinguished at the moment when the fronts of the fire intersect, the collection of the flame-extinguished points constitutes the central axis, i.e., the target skeleton, and the method of describing the skeleton is known as the grass-fire method. The method extracts the target skeleton without affecting the topological relationship of the original image, and the connected skeleton is very suitable for subsequent skeleton information extraction.

1) Hilditch Algorithm. Hilditch algorithm is a classical serial refinement algorithm, its refinement principle is to delete the marked pixels, but will not affect the image connection and direction, etc., and finally get 8 near-neighbor connection lines. The specific step is to iterate each pixel on the image from left to right from top to bottom, and this step is considered as one iteration cycle. In each iteration cycle, for each pixel p, it is labeled if it satisfies 6 conditions at the same time. At the end of the current iteration cycle, then the values of all labeled pixels are set to the background value. If no pixel satisfying the 6 conditions exists in a particular iteration cycle, the algorithm ends. Deleting this target pixel requires that the 6 conditions are satisfied as follows.

(1) The gray value of p is 255, i.e., p is not the background

(2) $x0, x2, x4, x6$ are not all 255, otherwise deletion of p will result in a hollow image

(3) $x0-x7$ has at least 2 255, if there is only one 255, then p is an endpoint of the image, which cannot be deleted or else it will affect the nature of the image, if there is no 255, then p is an isolated point, which also cannot be deleted

(4) The number of 8-connected region connections of p is 1, i.e., $Nc(p)=1$, at this time, p is called a deletable point ($(Nc(p)=2$ is a connection point, $Nc(p)=3$ is a branching point, and $Nc(p)=4$ is a crossover point), where the number of 8-connected connections is calculated as:

$$N_c^8(p)=\sum_0^3\left(\bar{x}_{2i}-\bar{x}_{2i}\bar{x}_{2i+1}\bar{x}_{2i+2}\right) \tag{9}$$

(5) Assuming that $x2$ is marked for deletion and $x2=0$, the number of connected connections of p is 1

(6) Assuming that $x4$ is marked for deletion and $x4=0$, the number of connected links of p is 1

2) 3D animation. 3DS MAX built-in Autodesk Biped bone system, with the help of this system do not have to manually set the relationship between the skeletal hierarchy, do not have to make a special IK, view the process of clicking and dragging the mouse to complete the creation of the human skeleton. Compared to the basic skeletal system, it is much easier to operate, and you can set the key points of the Biped skeleton manually. In addition, Autodesk also has automatic step animation, which allows the Biped skeleton to walk after a step has been created, and manually adds keyframes to the animation to increase the number of movements.Autodesk also has motion blending, which allows

you to edit multiple Biped skeleton animations and superimpose multiple motions to make the motions appear more complex.Autodesk has enabled the creation of many complex motions, but the creation of these motions is not as simple as the basic skeleton system. Autodesk has realized the production of a variety of complex movements, but it needs to flexibly utilize both automatic and manual methods, and the overall smoothness and authenticity of the animation is insufficient.

3) Three-dimensional animation character action generation technology. For Autodesk 3ds Max 3D software, it is mainly developed by a British company and supported by biodynamics, artificial intelligence and genetic algorithms to simulate the real movements of the human body [29]. The advantage of this software is that it can obtain a very high accuracy of movement, and the production efficiency is guaranteed, and it can be able to produce such difficult movements.The craftsman in Autodesk 3ds Max 3D is made by virtual production, and it can simulate a variety of movements, which eliminates the need for the application of specialized hardware equipment, and improves the level of production of three-dimensional character animation. For example, to produce the animation of craftsman spinning, the 3D model of the craftsman can be placed in front of the spinning machine, and the initial pose can be adjusted from the center of mass of the character. The craftsman spinning is mainly based on hand movements, so it is necessary to link the hand with the spinning machine, so that the hand movements drive the movement of the spinning machine. The animator needs to repeatedly watch videos of real people spinning, or even try spinning in person, to understand the key points of this action, in order to accurately analyze the key frames and movement details of the animation. The speed and rhythm of the animation should seek to mimic the speed and rhythm of the craftsman's actual spinning. Although the movements of the craftsman spinning are subtle, animation of the hands and feet alone is not enough. Weaving and spinning are full-body movements, and the torso and head should also move slightly in synchronization with the hand movements to mimic a realistic and natural animation.

2.2.3. Digital imaging techniques:

1) Character image design and special effects production. For an excellent animation work of Chuannan Miao family weaving handicraft, it is essential to have a compact and vivid storyline. To ensure the stability and smooth development of the storyline and to create a good image of the character in the animation, it is necessary to create an image of the character and to make the character look completely different in the process of creating it. Character design is an important part of animation, which directly affects the quality of the character's work and movement, voice, image and appearance.

2) Animation scene design and scene special effects production. The use of 3D digital media can simulate the real scene through light and shadow, enriching the characters in animation and bringing greater visual effects. While 3D scene design can provide more space for MG's animation creation. For example, using light and shadow space to make the image brighter, or using natural materials, the combination of figure to make the construction of the scene brighter. And by utilizing three-dimensional digital media technology, fantasy scenes can be created in animation, thus stimulating the imagination of users.

3) Character behavior design and action effects production. In animation creation, character behavior is a very important component, which is not only a key point for characterization, but also a key point throughout the plot. The design and production of the character gives it unique characteristics, increases the user's vision and trust, and gives the user complete visual pleasure. After completing the character model, it is necessary to adjust all of the character's movements, carefully consider the character's features and emotions, and use actions to convey the character's mental and emotional state. In animation, expression and body movement are the more common forms of behavior.

4) Application of Color Effects. The correct use of digital media can create richer, more layered

images that can give users a better visual experience.

2.2.4. Interactive interface design techniques:

1) Interactive interface design principles. First, user experience is the core in interface design [30]. Ensure that users get a good perceptual, emotional and cognitive experience in the process of use. Comprehensively consider the keywords extracted in the preliminary research, including but not limited to the rationality and aesthetics of the interface layout, the smoothness and convenience of the interactive operation, the attractiveness and comfort of the visual design, and the clarity and accuracy of the information presentation. Secondly, the interface visualization design incorporates traditional elements. Combining the basic needs of users for the sharing of Sichuan Miao family cloth weaving handicraft app and the experience expectations of the interactive interface, it can be summarized that in the process of constructing the app, the interface style should be integrated with illustration elements to show the national characteristics. Research on the history, inheritance, regional characteristics and other representative cultural elements of the handmade cloth weaving techniques of the Miao family in South Sichuan Province can enhance the cultural infectivity of the App by subtle influence. Third, the wholeness of interface design. After clarifying the overall interface layout and presentation, the content of the interface and the presentation of information should be consistent, so as to bring users a concise, orderly and attractive visual experience.

2) Interactive interface prototype design of digital inheritance system. This design aims to promote the protection and inheritance of the handmade cloth weaving skills of the Miao family in southern Sichuan, and based on the analysis of design needs and cultural research, a number of conceptual design solutions with different overall concepts and functional characteristics of the production product were compared. The most promising conceptual design was selected after user research, and the corresponding digital prototype was created. The main interface design is simple and clear, and after semantic analysis of the weaving crafts of the Miao family in southern Sichuan, the Forbidden City's red RGB (165,24,45), which represents traditional Chinese culture, was chosen as the main color of the interface, and the low-fidelity prototypes used in the previous tests were designed as high-fidelity models. The overall objective is to highlight the content and functionality of the handmade cloth weaving skills of the Miao family in southern Sichuan, and the main information structure includes: home page, publishing and personal center interface, navigation bar, including selected, attention, search, interactive community, classification, etc., which is convenient for users to quickly find the required functions.

Users can browse the selected contents and recommended craftsmen's works on the homepage, and the selected contents of Sichuan Miao family weaving handicrafts in the central area are mainly displayed in the form of picture rotation and video playback to attract users' attention. In the focus list, users can browse the contents they are interested in; in the community interaction, users can mainly use the text, pictures and videos posted by other users; in the search function board, users can quickly find the handcrafts and related topics they are interested in. And provide classification function, design a variety of classification browsing mode modular user needs, such as geographical, ethnic, type, personalized recommendations, etc., according to the user's interests and historical browsing records, analysis of non-heritage cultural content of interest to users. The display page of each Sichuan Miao family cloth weaving handicraft includes detailed introduction, related pictures, videos and other multimedia materials, as well as related recommended contents, so that users can have an in-depth understanding and experience of the handicraft projects they are interested in, learn the production methods of handicrafts with handicraftsmen, exchange and share their experiences, and check the user's homepage profile and the handicrafts they have released, so as to obtain a convenient purchasing experience. The personal information management interface is used to display the user's personal information, posted content, comment records, etc. It also provides channels for feedback and contacting customer service, allowing users to provide timely feedback

and suggestions.

3. Optimization of the digital display system for the hand-woven techniques of the Miao people in south Sichuan Province

3.1. Design Ideas for Digital Display of Handicrafts Based on Mobile Terminals

According to the analysis and law summary of the previous excellent cases of digital display of Sichuan Miao family cloth weaving handicraft, combined with the information dissemination characteristics of the mobile intelligent terminal and the theory of situational cognition, the design idea of digital display of Sichuan Miao family cloth weaving handicraft is proposed at three levels of display content structure, visual transformation and interactive experience, and the design path is sorted out as shown in Figure 3, which provides strategic support for the subsequent design practice.

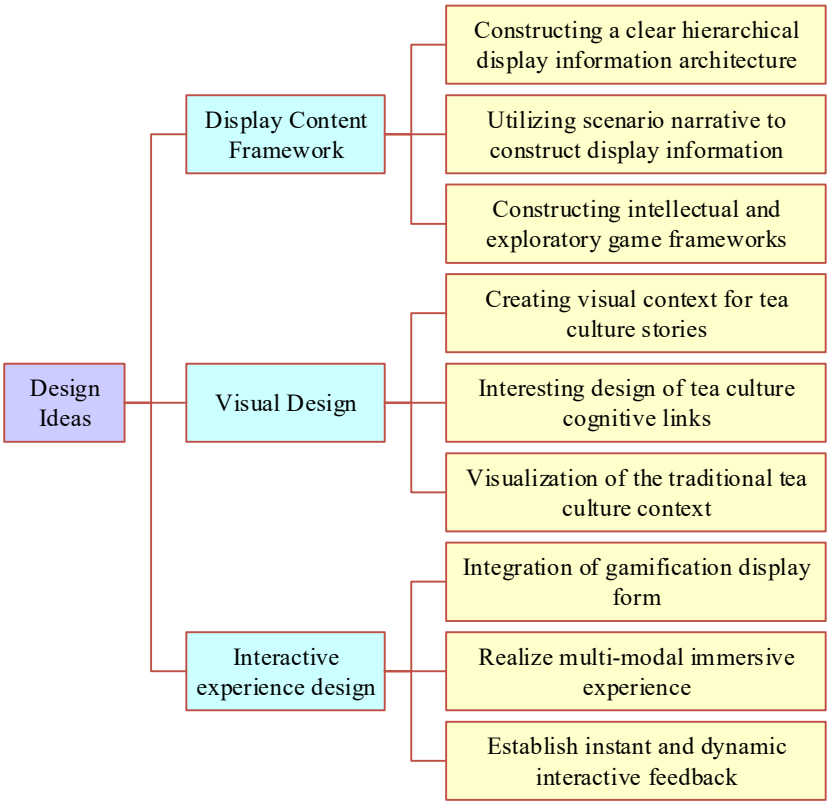


Fig. 3. Design path

3.1.1. The content framework of the display of Sichuan Miao family cloth weaving handicraft technology:

1) Constructing a clear hierarchical display information architecture. A clear information architecture and intuitive interface layout can enable the audience to quickly understand the core content and main functions of the display, so it is necessary to optimize the information architecture and interface layout on the basis of a clear display of the content and functional hierarchy, highlighting the display of thematic content and functions, and enhancing the effectiveness of the audience's operation. According to the results of the audience research, the audience expects clear section division and simple interactive operation experience, therefore, in the information structure of the digital display of Sichuan Miao family cloth weaving handicraft, the guide icon can be placed in the visual center position, so that the audience can pay attention to the main functions of the display directly after entering the page, including the map navigation function, the scene switching function, and the information of the exhibits, etc. In addition, in the display experience, it is necessary to

optimize the information architecture and interface layout based on the clear display content and function level, so as to highlight the display theme content and function, and improve the effectiveness of audience operation.

In addition, when displaying the experience, the number of display pages needs to be controlled and streamlined to improve the efficiency of the audience in performing operations. The content of the knowledge system related to the handmade cloth weaving techniques of the Miao family in Sichuan is complex, so it is necessary to classify and organize the complicated information, select the most characteristic content to present in combination with the audience's needs, optimize the information display level, and simplify the steps of the audience in the selection of content.

2) Using scene narrative to construct display information. In this paper, the content of the display of Sichuan Miao family cloth weaving handicraft includes traditional Sichuan Miao family cloth weaving handicraft as well as characteristic regional culture and folk culture, etc. Based on the audience's cognition and communication objectives, it is necessary to construct the cultural content through the narrative, guide the audience to enter into the situation with vivid and intuitive story clues, and let the audience cognize the cultural content through the contextualized narrative scene, and construct the exhibition information through the combination of the audience's life experience and cognitive characteristics. Through contextualized narrative scenes, the audience can recognize the cultural content and construct the exhibition information by combining the audience's life experience and cognitive characteristics, so that the audience can internalize the knowledge into values and obtain emotional resonance. In the digital display design of Sichuan Miao family cloth weaving handicraft, on the one hand, it is necessary to make a reasonable narrative of the story content, fully mobilize the subjective initiative of the audience, and on the other hand, it is also necessary to create a vivid visual scene, so as to encourage the audience to participate in it in an immersive way.

Based on this, when building the game framework for the digital display of Sichuan Miao family cloth weaving handicrafts, we can first set up the game content from the perspective of popularizing the knowledge of Sichuan Miao family cloth weaving handicrafts, and adopt a reasonable narrative to let the audience understand the Sichuan Miao family cloth weaving handicrafts according to the storyline in the game. At the same time, diversified game levels are set according to the audience's experiential needs, and relevant tasks are set according to different tea-making steps. After completing the tasks and unlocking the levels, the audience can obtain multiple experiences in knowledge and behavior, so as to form a deeper and more comprehensive understanding of the handmade craftsmanship of the Sichuan Miao family's weaving.

3.1.2. Cultural Visual Design of Miao Weaving Handicrafts in Sichuan Province. Through the preliminary research on the audience's aesthetic interest and the visual style of the products of Sichuan Miao family weaving handicrafts, it is found that the aesthetic acceptance and visual design of Sichuan Miao family weaving handicrafts are mainly characterized by a fresh, light and elegant style and a natural rustic style, and at the same time, the traditional Chinese aesthetic elements are also incorporated. Based on this, the style with the characteristics of traditional Chinese aesthetics and the rustic and elegant tone was also selected in the visual design. At the same time, in order to make the audience feel the meaning of traditional Chinese aesthetics, in the visual scene design of the digital display of the Sichuan Miao family's weaving handicrafts, it is also necessary to explore the arrangement of the characters, looms, scenery and other elements and the combination of the composition, lines, colors, etc., so as to highlight the aesthetic connotations of the Sichuan Miao family's weaving handicrafts by means of the stylistically unified design language.

As an important part of the handmade craftsmanship of the Miao family in the south of Sichuan Province and a distinctive embodiment of the meaning of the handmade craftsmanship of the Miao family in the south of Sichuan Province, the traditional weaving craftsmanship also provides a reference for the design of this paper. By depicting the people, events and objects associated with the

South Sichuan through traditional cloth weaving craft to show the spiritual symbolism and aesthetic concepts contained therein, its formal language fully reflects the aesthetic characteristics of the South Sichuan Miao family cloth weaving handicraft technology.

3.1.3. Interactive experience design of Sichuan Miao family cloth weaving handicraft culture. In digital display, different modal information will bring rich perception to the senses, prompting the audience to understand the information in a comprehensive way, so as to form a complete cognition [31].

Based on the communication characteristics of the mobile intelligent terminal, the digital display modality of Sichuan Miao family weaving handicraft is mainly based on the visual, auditory and tactile modalities. First, in the visual modality, it can build the scenes of Sichuan Miao family cloth weaving handicraft with local characteristics, choose appropriate color and composition to create the situation of Sichuan Miao family cloth weaving handicraft and the mood with Chinese aesthetic flavor, and dynamically express part of the scenes to play a fascinating role. Secondly, as a sensory experience second only to vision, hearing also plays a very important role in digital display. Compared with vision, the stimulation of sound has a more direct correlation with emotion, and at the same time, sound has the ability to emphasize the environmental atmosphere, and the audience can enter a specific situation through listening. Therefore, in the sound design of the digital display of Sichuan Miao family weaving handicrafts, the background music and environmental sound will be used in line with the context of Sichuan Miao family weaving handicrafts, and at the same time, human voices and action sounds will be added to the audience's clicking, sliding and other operations, so as to make the audience have a greater sense of participation. Again, in the haptic aspect of the digital display of the Sichuan Miao family's weaving techniques, vibration can be used to give user feedback during the audience's operation and interaction. Overall, through the comprehensive use of visual, auditory, and tactile multimodal language, we can better create a contextual atmosphere, so that the audience can get a sense of immersive experience, and better promote the dissemination of the display of the handcraft skills of the Miao family weaving in the south of Sichuan.

3.2. Design improvements oriented to user needs

3.2.1. User and Functional Orientation. Audience orientation: roughly divided into three groups of people: learning, popularization of science - for young people to learn and disseminate the handmade techniques of the Miao family weaving in southern Sichuan, scientific research, exploration - for academic research of college users, teachers, experts, expansion, understanding - hobby culture people.

Functional positioning of the product: for the three groups of people: youth, scholars and experts, and cultural enthusiasts, it involves basic knowledge, scholars' exploration, and interactive experience, and the user groups can choose the appropriate section according to their own needs.

Youth users are mainly to popularize knowledge, scholars are mainly to transmit scientific research knowledge and academic seminars, and the audience groups can participate in the interactive experience section.

3.2.2. Principles of interface design improvement. The interface requirements of the Chuannan Miao Family Weaving Handicraft Art mobile application contain functional and non-functional requirements, which include the transmission of weaving culture knowledge, academic scientific research and exploration, and online interactive experience, among which the interactive experience is the feature of this mobile application.

1) Functional Requirements. The home page includes three modules: basic knowledge, scholarly inquiry, and interactive experience. The basic knowledge module conveys the cultural content of

Miao family weaving in South Sichuan, including the popularization of the knowledge of non-heritage culture, the historical value and commercial value of weaving culture. The Scholar Inquiry module provides an academic exchange platform for college users, teachers, experts and scholars to conduct academic discussions on weaving culture. The interactive experience module enables users to learn about the weaving culture of the Miao family in South Sichuan in the process of interesting game experience, and enhances the degree of reception of users' perception of the weaving culture of the Miao family in South Sichuan.

2) Non-functional requirements:

(1) Efficiency requirements: In the process of running the mobile application, the user expects to complete the interface to operate quickly and go to the next step.

(2) Ease of use: The interface gesture operation of the mobile application should be in line with the regular user gesture operation habits, reducing the efficiency of user operation adaptation.

(3) Continuity: It is very important for a mobile application product to have the possibility of long-term existence, and its content and performance need to be constantly updated in order to ensure that the development of mobile application products has unlimited space. Chuannan Miao family weaving mobile applications follow the principle of non-functional requirements, reduce the loading time of the program startup, simple and easy to operate gestures, so that users can easily get started, and focus on the release of real-time news to increase the degree of continuity of the use of mobile applications.

4. The effect of the design of the digitalized inheritance system for the weaving handicrafts of the Miao family in Sichuan Province

4.1. The effect of digital display of Sichuan Miao family weaving handicrafts

4.1.1. User-based system perception research. Investigating users' perceptions of the existing digital display system for the Miao family weaving handicrafts in southern Sichuan was conducted along five steps:

1) Requirements collection: Through one-on-one interviews and case studies, 25 users' perceptions and expectations of the functions that the display system has were collected.

2) Functionality envisioning and sequencing: Based on the collected information, five potential main functionality envisionings of the display platform were proposed to meet the users' needs.

3) Each participating user was asked to prioritize these five major functions according to their needs.

4) Layout preferences: to understand users' layout preferences for several major functional pages.

5) Starting from the three main functions (sub-pages) of work display, work upload, and personal space, provide the corresponding functional requirements to understand the users' willingness to different requirements.

Data summarization and calculation: Collect the sorting results from all participating users and calculate the average priority of each function. Using the above average, a data graph is drawn to visualize the priority of each function. The functions are sorted according to the average priority of the users as shown in Figure 4. “Promote and share your work” has the highest average ranking (2.653), which significantly indicates that users value the increased visibility and influence of their work in the virtual Chuannan Miao weaving environment. Users expect additional promotion and sharing opportunities through the system as a way to attract more attention, including potential employers or partners. “Viewing and learning about other people's work” was ranked second on average (2.965), and users wanted to be able to reach out and learn from other people's work, as communication and inspiration mechanisms are crucial for a system designed to digitally display Chuannan Miao weaving handicrafts.

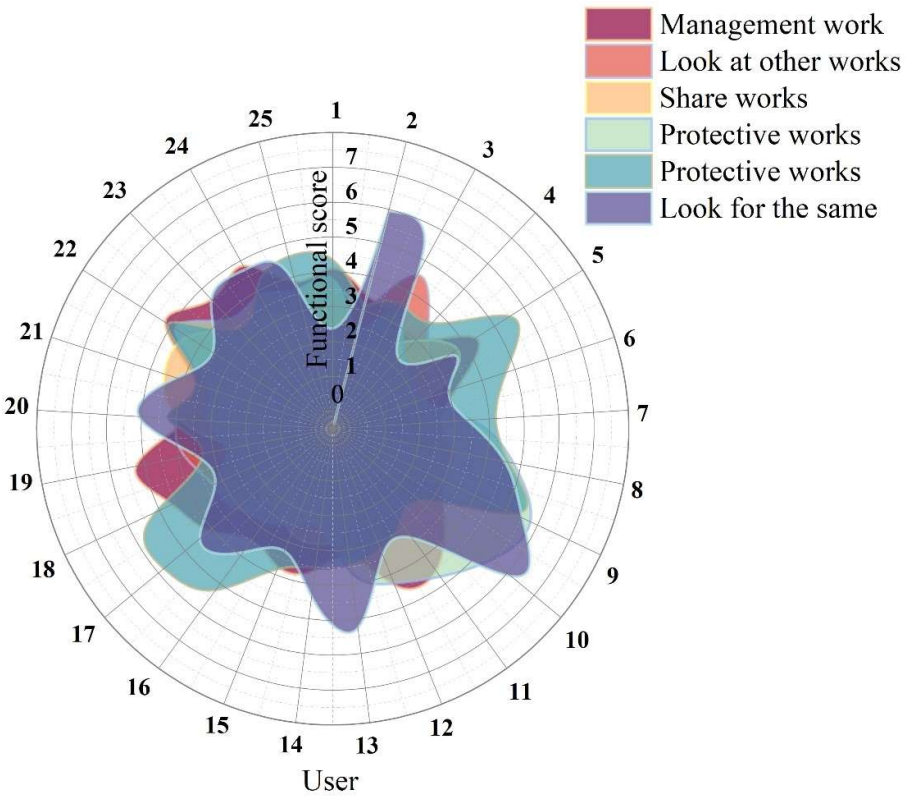
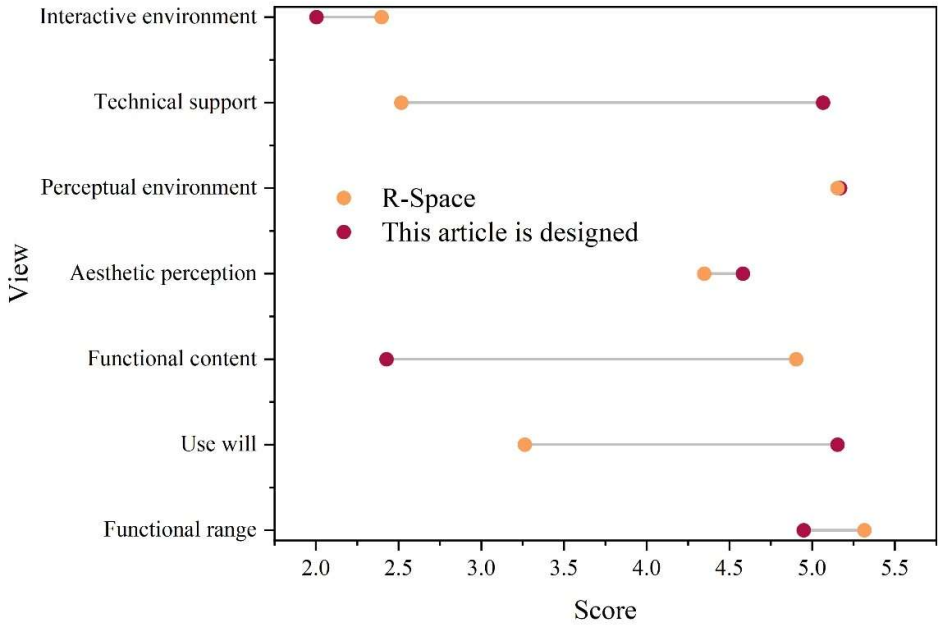


Fig. 4. Demonstrating Platform Feature

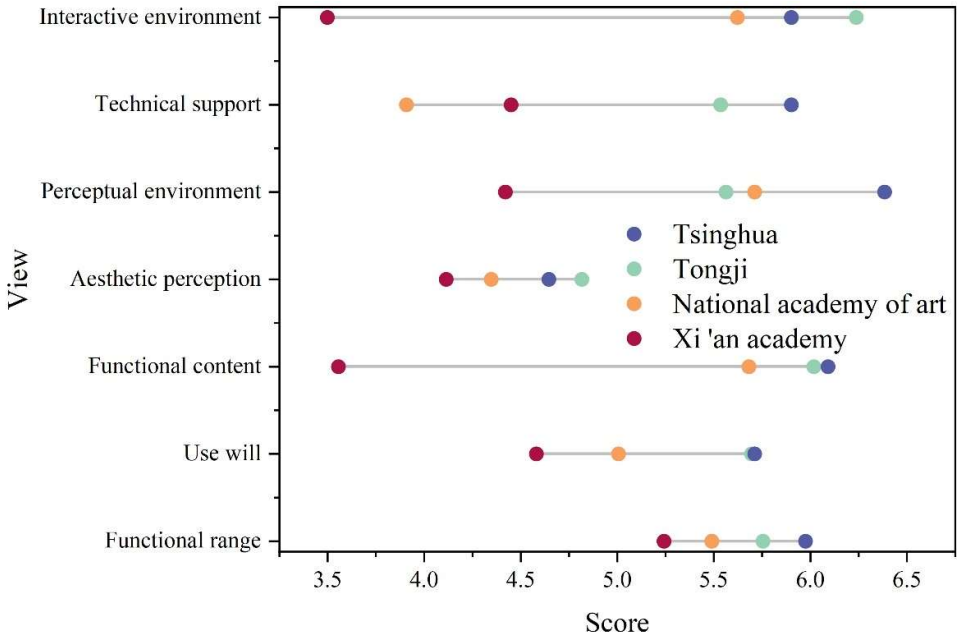
4.1.2. Comparison of user experience and perception of the system. After 25 users were made to browse and use 2 digital display systems of Sichuan Miao family's weaving handicrafts, they were scored by Lister's seven-degree scale on the use experience and personal feelings according to the scores on their functional scope, willingness to use, functional content, aesthetic perception, perceptual environment, technical support, and interactive environment, etc., and the results are shown in Fig. 5, with Fig. (a) showing different systems and Fig. (b) showing different schools.

The user experience scores show that the system designed in this paper is better than R-Space in terms of functional scope and technical support, while the latter scores higher in terms of aesthetics and perceptual environment. Overall, the average score of the system designed in this paper is 4.193, and the score of the R-Space system is 3.985, which is higher for the system designed in this paper.

Students from the Academy of Arts and Design, Tsinghua University, were more satisfied with the system designed in this paper in all aspects, with a satisfaction score of 5.801, due to its reasonable use of responsive design, so that the platform has a better performance in the perceptual environment of different devices.



(a)Different systems



(b)Different schools

Fig. 5. Survey on User Perceptions of Different Display Platforms

4.1.3. The User Experience of Digital Display of Sichuan Miao Weaving:

1) Data testing. Table 1 shows the ANOVA chi-square test, which was used to analyze the data of the questionnaire results in this study through the statistical software SPSS. In order to analyze and test the hypothetical question, the differences in the experience of the four types of users, I (opinion) type, P1 (person) type, O (object) type, and P2 (body) type, on the six digital displays were analyzed respectively by using analysis of variance (ANOVA). First, the reliability and validity of the questionnaire were analyzed, and the test method used was cronbach's a. The coefficient of cronbach's a was 0.912, indicating that the questionnaire had high reliability. Then KMO and Bartiett's test were used to validate the validity of the questionnaire results for the six types of digital

displays respectively, and the results showed that the KMO values were all between 0.7 and 0.8, and the significance was 0.000 suitable for factor analysis. The resulting rotated component matrices indicated that the factor loading coefficients for each question item were greater than 0.85, so all items were retained. Before ANOVA, the experimental data needed to be tested for the homogeneity of variance, and the cognitive experience of the user experience preference type samples for the Miao weaving handicraft records in southern Sichuan ($F=5.248$, $p<0.01$), the physical experience of interaction ($F=8.866$, $P<0.01$), the cognitive experience of 3D animation ($F=12.628$, $P<0.001$), and the cognitive experience of digital imaging ($F=8.084$, PA total of 5 items <0.001) and introspective experience ($F=3.379$, $P=0.039$) did not have variance homogeneity, and the data fluctuation was obviously inconsistent, so the Brown-Forsythe test should be considered to continue to be used, and this method is more prudent when the distribution of the dependent variable does not meet the requirements of variance homogeneity. The results showed that there was no significant difference between the samples of different user types for the above five items, that is, the data fluctuations were consistent.

Table 1. Homogencity of variance and the Brown-Forsythe ANOVA test

/	Variance test		Brown-Forsythe test	
	F	P	Brown F	P
Cognitive experience 1	5.248	0.007**	3.548	0.051
Physical experience 2	8.866	0.002**	1.866	0.194
Cognitive experience 4	12.628	0.000**	3.378	0.053
Cognitive experience 5	8.084	0.001**	2.946	0.079
Experience 5	3.379	0.035*	0.356	0.785

2) ANOVA of user experience. The ANOVA of viewpoint-preferring user experience is shown in Fig. 6, under different digital display samples, the physical and introspective experiences of viewpoint-preferring users show consistency and are not differentiated ($F=1.025,1.198$ and $p>0.05$), while the social and cognitive experiences show significance ($F=5.487,7.169 p<0.05$) and are significantly different.

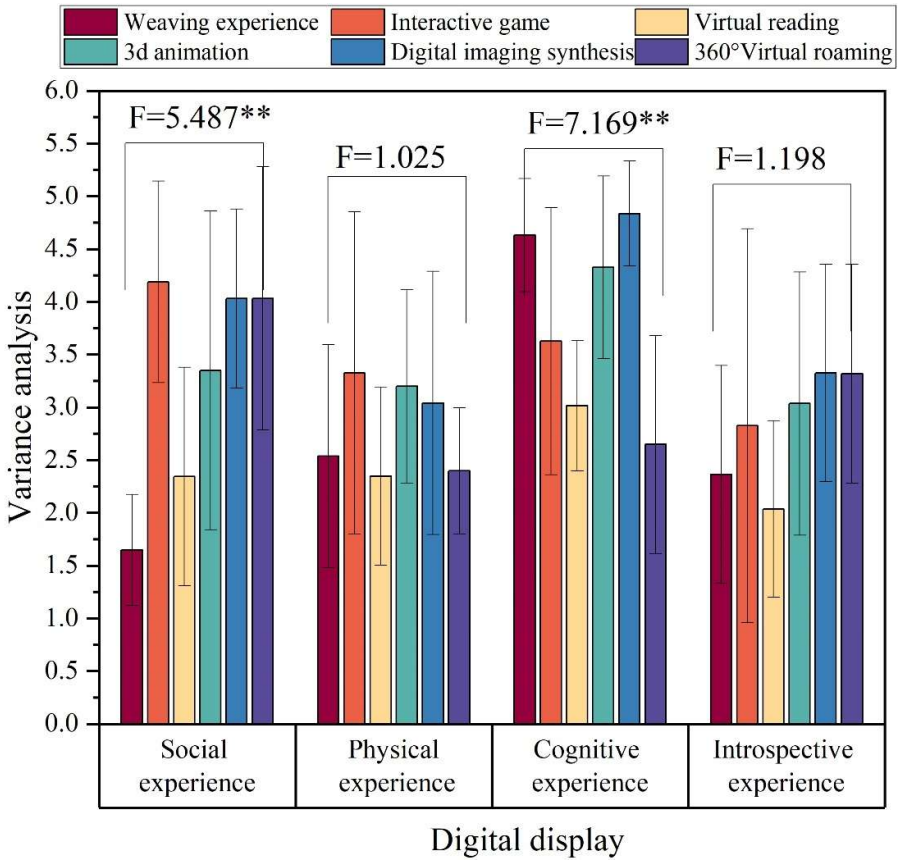


Fig. 6. Variance analysis of I (ideas) audience experience

Note: * p < 0.05, ** p < 0.01

Table 2 shows the in-depth analysis - effect size indicators, the analysis can be seen that the "viewpoint" type of user display on the social experience of the six types of digital displays showed a 0.01 level of significance (F = 5.487, p = 0.001), the magnitude of the difference is large η^2P = 0.498, Cohen's f = 0.948), in cognitive experience showed significance at the 0.01 level (F=7.169, p=0.000). with a significant difference η^2P = 0.532, Cohen's f = 1.096). Specifically analyzing the four types of experience evaluation of digital display types by type I users, their evaluation of different digital displays with poorer perceived effects of digital displays is very low, and higher ratings are given to the types with better display effects, among which, there is a large disparity between type I viewers' evaluation of interactive and social experiences, i.e., type I viewers are more sensitive to the perception of these two types of experiences, and are prone to evaluate the social experience of the interaction on the display surface much more than the other types of displays The cognitive experience of digital imaging synthesis has the highest evaluation.

Table 2. In-depth analysis - effect indicator

Analysis term	SSB(Intergroup difference)	SST(Total deviation)	Bias Eta square(Partial η^2)	Cohen's f value
Social experience	31.978	66.736	0.498	0.948
Physical experience	5.836	40.279	0.147	0.463
Cognitive experience	24.196	44.356	0.532	1.096
Introspective experience	8.808	53.698	0.189	0.432

4.2. Improvement of digital display design of Sichuan Miao family cloth weaving handicraft technology

4.2.1. Digitalization System Test of Sichuan Miao Family Weaving Handicraft Technology:

1) System testing environment. The testing process uses IP network testing environment, LAN selection of 100M network broadband, the presence of MySQL, SQL Server 2003 and other databases in the LAN, the use of database application servers. System test environment: Hard disk memory of 10 GB or more. The system memory is 2 GB, but the test is recommended to choose 4 GB, the CPU selects a processor above 2 GHz, the database is SQL Server 2003, the display pixel is 1 920×1 080, and the operating system is Windows 2003.

During the test, different system operating environment conditions are set, including hard disk memory, processor capacity, response time and running speed. The traditional digital display system is utilized as a comparison object for testing the system. The simulation of the system operating environment conditions is shown in Fig. 7, and the mean values of response time, running speed, processor capacity, and hard disk memory under the operating environment of the digital display system designed in this paper are 2.095s, 1.747GHz, 2.48GHz, and 3.624GB, respectively.Prepare two computers for the comparison test and install the simulation software, and load the simulation data in Fig. 7 into the simulation software. Two no-load tests were conducted before the test to ensure the safety of data loading. According to the data interface of the computer simulation software, access the traditional digital display system and the digital display system of Chuannan Miao family cloth weaving handicraft designed in this paper, and start the simulation test of the digital display ability of Chuannan Miao family cloth weaving handicraft. According to the digitized display situation of Chuannan Miao family cloth weaving handicraft acquired by the two digitized display systems, the results of digitized display in different operating environments were obtained.

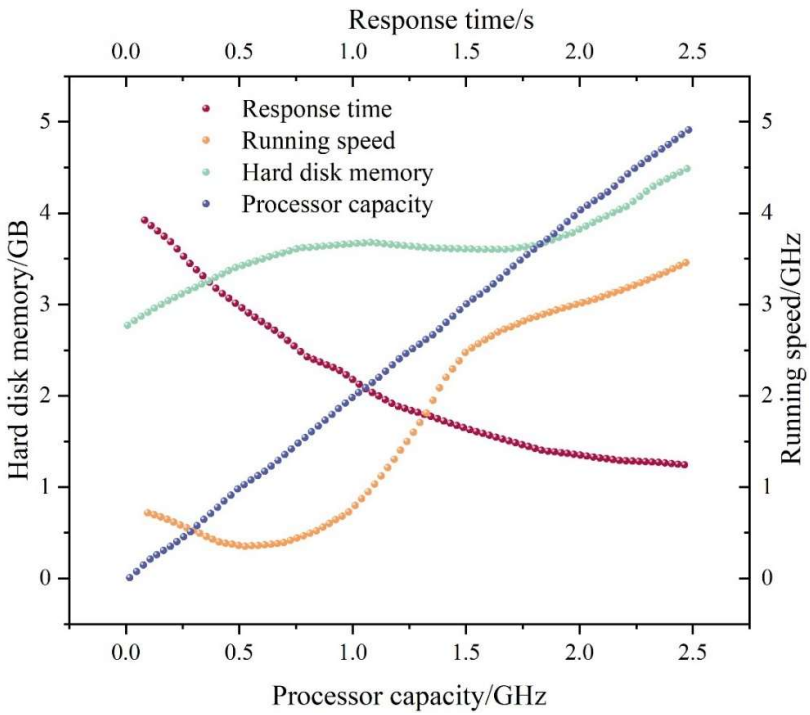


Fig. 7. System operation environment condition simulation

2) Usability test. Ten users were selected to evaluate the effect of the digital display by summarizing the results of the evaluation scale and the paper version of the test questionnaire for each subject as shown in Figure 8. The indicators in the figure are Q1 (the field of view is in line with the real way of observation), Q2 (the system is easy to operate), Q3 (the video, narration, and text are easy to control), Q4 (the scene information is sufficient), Q5 (a better understanding of the culture of Chuannan Miao weaving), Q6 (understanding the steps of the weaving of Chuannan Miao weaving), Q7 (a preliminary understanding of the handmade craftsmanship of the weaving of Chuannan Miao weaving), Q8 (an understanding of the basic roles of weaving craftsmanship), Q9 (easy to be immersed in the scene), Q10 (realistic weaving tools), Q11 (realistic material of the virtual scene), and Q12 (natural and soft environmental light). Then it was recorded into SPSS2.0 software for storage and further data calculation and analysis. In the questionnaire score statistics, among the 12 indicators, Q6 had the highest score with a mean score of 4.1, the second ranked ones were Q1, Q3, Q5, Q11 with a score of 4, and the rest of the indicators scored below 4.

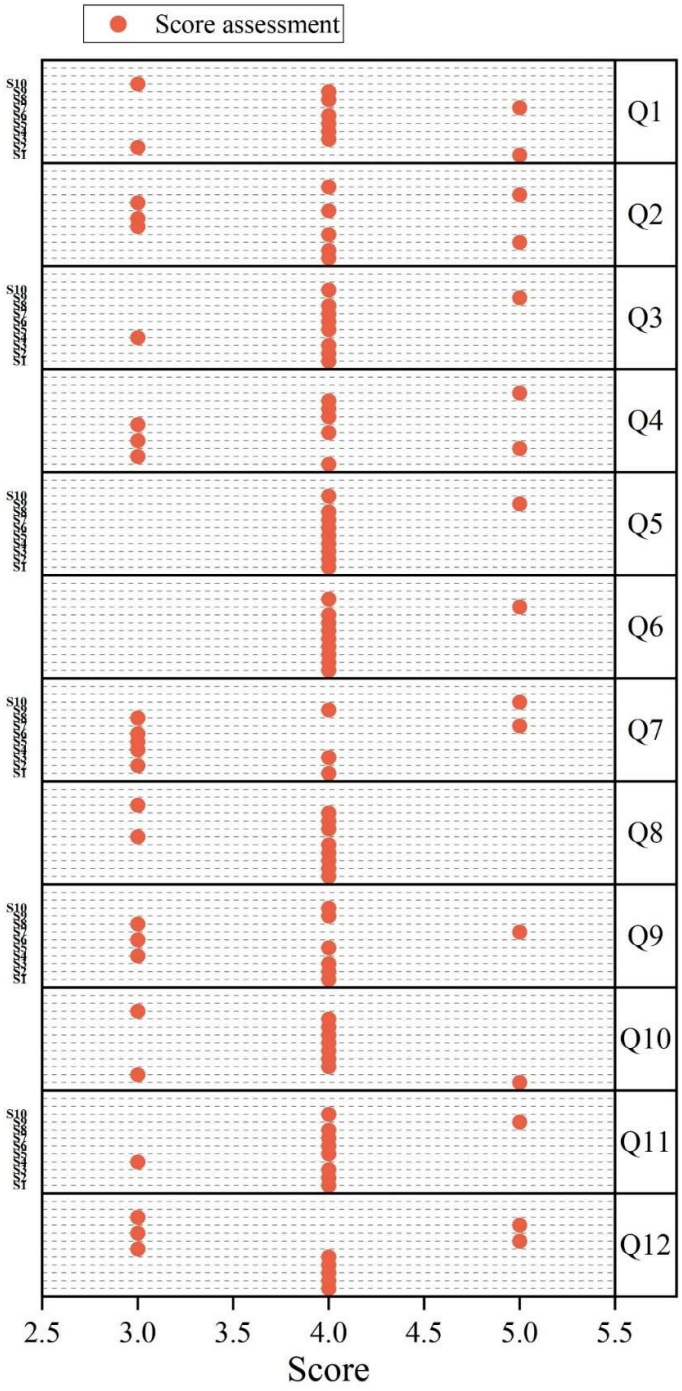


Fig. 8. Assess the quantitative results

4.2.2. Tests of scientific validity. In order to verify the effectiveness of the design and practice of the digital display system for the handcrafts of the Miao family in Sichuan, this paper tests the basic knowledge of 25 visitors who have visited the exhibition area of "Miao Family Weaving in Sichuan" by means of questionnaires issued in the field. After the visitors finished the test, the visitors were invited to experience the digitization project and take the test again, and were given a small gift as a thank you for participating in the test. The test is set up a total of 10 regular questions, each question 10 points. The author conducted a paired-sample t-test on the scores of the two tests before and after, and Figure 9 shows the before and after test of the effectiveness of the digitized display of science popularization. From the results of the t-test, it can be seen that the p (score of the pre-test - score of the post-test) < 0.001 (p=0.000), which indicates that there is a significant difference in the

effectiveness of science popularization of the 25 visitors in the before and after the two visits. It can be seen that the visitors who participated in the digital display of Chuannan Miao family weaving handicrafts had a great degree of knowledge about Chuannan Miao family weaving relative to their own visit, from 10.08 to 50.2, which also proves that the status quo of the science display of the digital display of the Chuannan Miao family weaving handicrafts can be improved to a certain extent through this design.

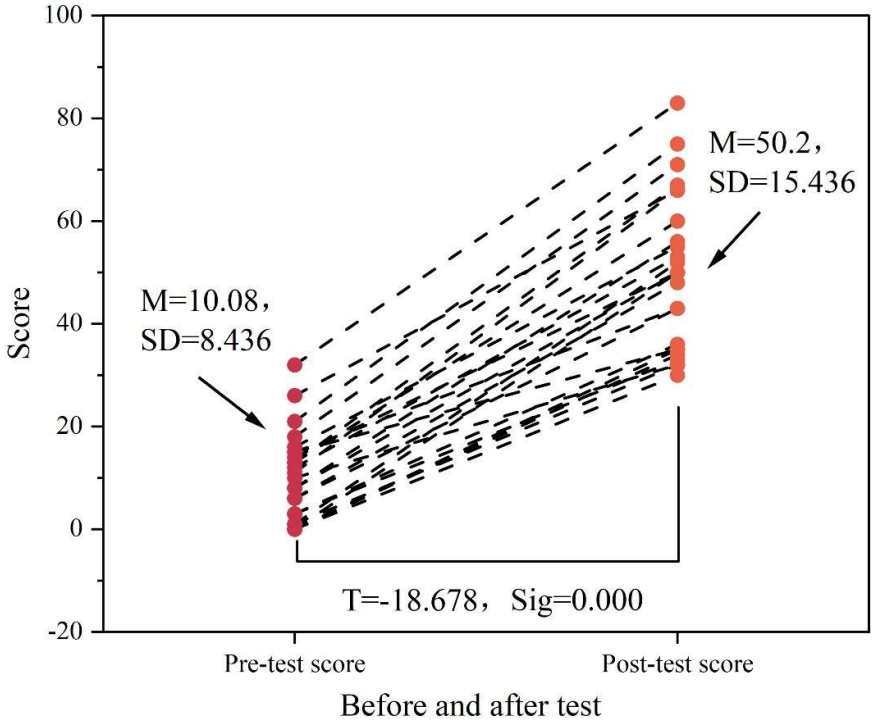


Fig. 9. The digital display is tested before and after the validity of the science

4.2.3. Effectiveness and utility. At the end of the test operation, the overall visual effect of the digital display system of the "Sichuan Miao Family Weaving Handicraft" and its practicality and interactivity of the various sectors were evaluated from the perspective of the effective practicality and interactive satisfaction of the test subjects in completing the task in a timely manner. The results of the practicality evaluation are shown in Figure 10.

In the login startup and Chuannan Miao family human resources operation test, 25 testers reached the level of effective satisfaction with the effectiveness and practicality feeling of these two tasks, and 6 and 5 testers reached the level of satisfaction with the effectiveness and practicality of the Chuannan Miao family home page and the weaving handmade aesthetics thought interface presented, respectively, and the test was effective. For the interface of Chuannan natural resources, the validity was tested by 5 people and the practicality was satisfied by 6 people. For Chuannan Folklore, validity was tested by 6 people and practicality was tested by 4 people. For browsing and playing levels of all sectors, the effectiveness and practicality of 6 people were satisfied, which shows that the overall design of digital display system is more practical.

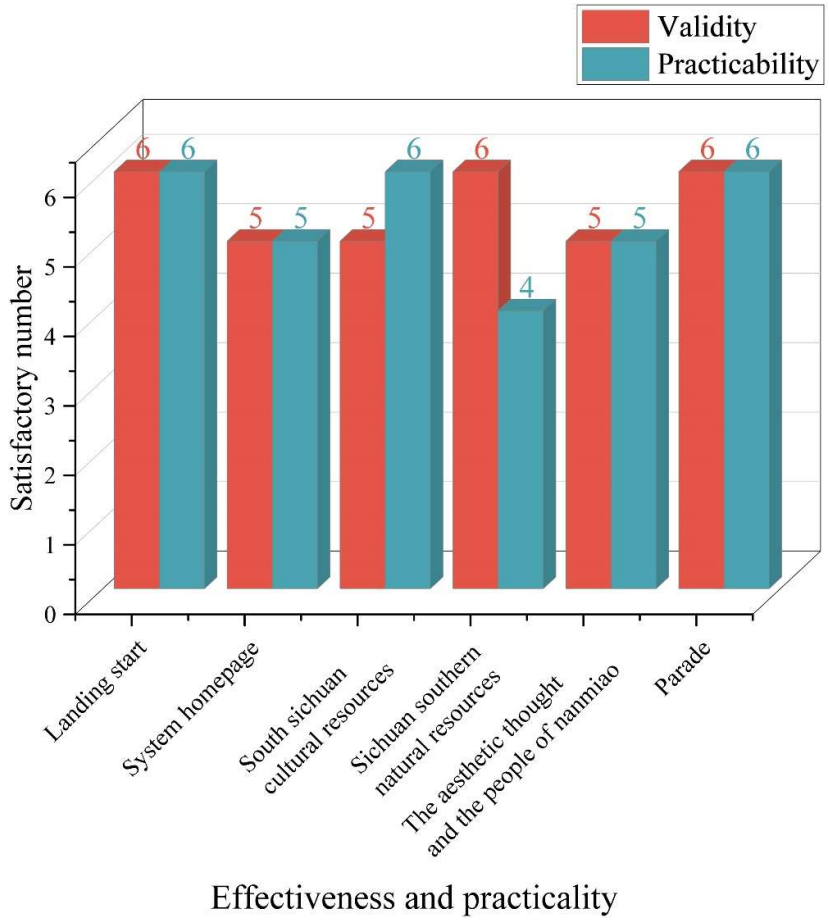


Fig. 10. Digital display system effective practical test

4.2.4. Interactivity satisfaction. Figure 11 shows the test results of interactivity and satisfaction at each level of the digital display system. As a whole, the interactivity and user satisfaction of the digital display system of "Handicraft of Weaving by the Miao Family in Southern Sichuan" are good, and the parameters of individual levels are low. The interactivity and satisfaction of landing start, system homepage and human resources in South Sichuan are more stable, and the interactivity and satisfaction are consistent. For example, in the landing start, the scores of very satisfied, more satisfied and general are 2, 3 and 2.5 respectively. It shows that the user's experience is better, and the natural resources, aesthetic ideas, folklore and companion tour interactivity and satisfaction fluctuation degree is relatively large shows that the system interface design effect needs to be further improved.

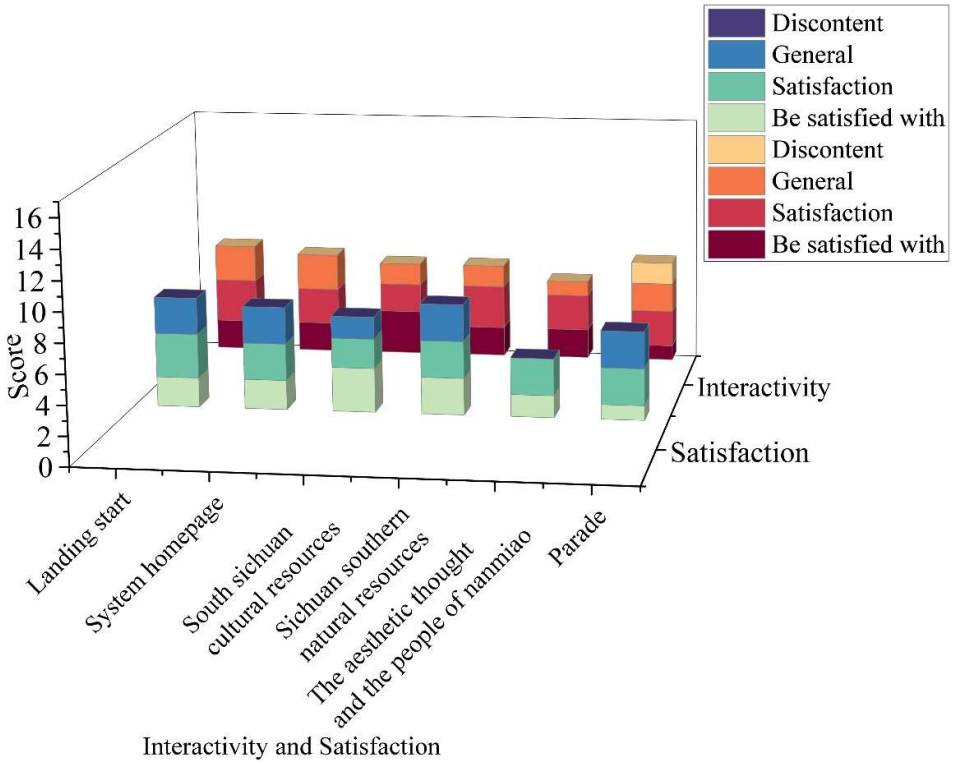


Fig. 11. Digital display system hierarchy interaction and satisfaction testing

5. Conclusion

In this paper, 3D modeling, 3D animation, digital imaging and interactive interface design technologies are used in turn to construct a digital display system for the handcraft skills of Sichuan Miao family cloth weaving, and the improvement plan for the digital display system is proposed from the aspects of mobile terminals and user needs.

In the effect of digital display of Sichuan Miao family cloth weaving handicraft, the user experience preference type samples show significant difference between social experience and cognitive experience for Sichuan Miao cloth weaving handicraft, with F value of 5.487 and 7.169 respectively, and the P value is less than 0.05, which are all significantly different.

Testing the optimized and improved digital system of Chuannan Miao family weaving handicraft, the mean values of response time, running speed, processor capacity, and hard disk memory of the system optimized in this paper in the running environment are 2.095s, 1.747GHz, 2.48GHz, and 3.624GB, respectively, and meanwhile, in the usability test, the user scores on the step of understanding the Chuannan Miao family's weaving were the highest, with a mean value of 4.1, and the second ranked are Q1, Q3, Q5, and Q11 with the score of 4. All the indexes are above 3, and the system usability is strong.

Acknowledgements

1) Funding Project: Research on the Digital Protection and Development of the Handcrafted Weaving Skills of Miao Nationality in Southern Sichuan in the Age of Intelligent Media (Project number: CDCM202004). Funding Party: Center for Digitalized Culture and Media UESTC.
2) Funding Project: Digital Protection Strategies for the Traditional Handicraft Techniques in Luzhou (Project number: KB-2306). Funding Party: Luzhou Vocational and Technical College.
3) Funding Project: Research on the Protection and Inheritance of Luzhou Intangible Cultural Heritage through Digital Media Technology (Project number: JD-WH2410). Funding Party: Luzhou

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