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Virtual Reality and Augmented Reality Integration Technology of Sichuan Miao Family Weaving Technique Digital Display System

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Abstract Chuannan Miao weaving technique is a precious cultural heritage of the Chinese nation, carrying thousands of years of cultural deposits of the Miao people, and its traditional display method has problems such as poor interactivity and weak experience. For this reason, this paper proposes a digital display system based on the fusion of virtual reality and augmented reality technology for the weaving techniques of the Miao people in Chuannan. Methodologically, the study adopts the improved G-SIFT algorithm to replace the traditional Gaussian function, uses the guided filter function for feature extraction, and constructs a 4-layer architecture system based on J2EE Web technology. Experimentally selected three types of images of embroidery, batik and brocade are verified, and the results show that: in terms of feature extraction matching efficiency, this paper's algorithm outperforms the traditional SIFT, SURF, ORB, and AKAZE algorithms on the three types of images; in terms of the evaluation indexes, the G-SIFT algorithm shows significant improvement in the information entropy, the mean squared error, and the generalized image quality index; in the system performance test, the The average response time for concurrent login of 5000 users is 2.149s, the response success rate is 100%, the CPU utilization rate is lower than 50%, and the memory utilization rate is lower than 60%. The conclusion shows that the VR/AR fusion technology based on G-SIFT algorithm can effectively extract the characteristics of weaving techniques, and the constructed digital display system has good performance, which provides a new technical path for the inheritance and protection of the weaving techniques of Sichuan Miao.

Index Terms Virtual Reality, Augmented Reality, Miao Weaving Technique, G-SIFT Algorithm, Digital Display, Feature Extraction

I. Introduction

In the Miao people, the hand weaving technique has a long history of thousands of years, which completely reproduces the life scene of “men plowing and weaving” and “self-sufficiency” in the traditional society of the Miao people, and also records the development history of the early hand weaving industry [1]-[3]. Home weaving cloth, commonly known as earth cloth, also known as old coarse cloth and handwoven cloth, is a kind of primitive fabric processed by using kudzu, hemp, cotton and other raw materials, utilizing old spinning wheels and wooden looms [4]. As a major feature in the traditional culture of the Miao people, home weaving cloth, during the primitive social period, was mainly the use of original materials to weave cloth to meet the needs of life [5], [6]. With the development of the times, the scale and production of home weaving cloth increased, and not only became an inseparable part of the Miao folk life, but also promoted the development of the Miao economy by processing and making all kinds of clothing and accessories and household items on this basis [7]-[9]. Under the impact of rapid development and globalization in contemporary society, the home weaving technique of the Miao people in southern Sichuan is facing the challenges of aging inheritors, loss of skills and other problems [10]. How to effectively protect and pass on this precious cultural heritage has become an urgent problem for us to solve.

The progress of science and technology has brought a brand new opportunity for the protection of this kind of cultural heritage. Digital technology, with its unique advantages, provides a new perspective and solution for the protection and inheritance of home weaving techniques [11]. Through digitalization, we are able to record and display the elements of the family weaving techniques in a more comprehensive and in-depth way [12], [13]. This not only helps us to recognize and understand the family weaving technique more deeply, but also helps to pass on the family weaving technique, so that more people can appreciate the charm of this precious cultural heritage [14].

As an ethnic group with a deep historical heritage, the Miao people of South Sichuan carry thousands of years of cultural inheritance in their weaving techniques. As a result of historical migrations and wars, the Miao ancestors

used oral tradition and patterns to record the history of the nation, forming a unique culture of weaving techniques. The Miao people in South Sichuan are mainly located in Xuyong County, Xingwen County, Gong County, Gulin County, Gyunlian County and other areas, and their weaving skills not only reflect the characteristics of the ethnic culture, but also carry precious historical memories. The traditional weaving techniques of the Miao people in southern Sichuan include a variety of needlework techniques such as clip yarn, yarn insertion, picking flowers, riding yarn flowers, flat embroidery, etc., each of which has its own unique cultural connotations and technical characteristics. These techniques usually use abstract insects, fishes, birds, flowers, grasses, figures and geometric shapes as decorative elements, which are distributed in the front lapels, sleeves, waistband, fluttering belt, shoulder support, neckline, headgear and other positions of the women's clothing, forming a complete clothing system. However, in the process of modernization, this traditional skill is facing the crisis of inheritance rupture, especially in the way of display, the traditional graphic panels and video introductions lack of interactivity and immersion, and it is difficult to fully show the essence of the skill and cultural connotation. The rapid development of Virtual Reality (VR) and Augmented Reality (AR) technology provides a new opportunity to solve this problem.VR technology is able to create a completely virtual three-dimensional environment, while AR technology is able to combine the virtual objects with the real environment, and the fusion of the two applications opens up a new path for the digital display of traditional culture. The goal of this research is to develop a digital display system of Chuannan Miao weaving technique based on VR/AR fusion technology, and to break through the limitations of traditional display methods through technological innovation. Research Ideas Firstly, in view of the technical difficulties of the image feature extraction of the weaving technique, an improvement scheme based on the G-SIFT algorithm is proposed, which replaces the traditional Gaussian function with the guided filter function to improve the accuracy and speed of feature extraction. Secondly, the display framework of VR/AR fusion technology is designed to construct a real Chuannan Miao weaving technique scene model to realize the immersive experience of combining reality and fiction. Again, a 4-tier architecture of J2EE Web technology is used to design the system to ensure the stability and scalability of the system. Finally, the practicality and effectiveness of the system is verified through multi-dimensional performance tests to provide strong technical support for the inheritance and protection of Sichuan Miao weaving techniques.

II. Digital Display System for Sichuan Miao Weaving Technique

II. A. Weaving techniques of the Miao family in south Sichuan Province

II. A. 1) Humanistic Overview of the Miao Family in Sichuan Province

The Miao in southern Sichuan, like the Miao in other regions, have gone through a journey of constant migration due to wars and other reasons. According to historical records, the ancestors of the Miao people migrated continuously from the middle and lower reaches of the Yellow River to the south and west, and slowly entered the mountainous areas in the southwest. The Miao in southern Sichuan are mainly located in Xuyong County, Xingwen County, Gong County, Gulin County, Gyunlian County and other areas. The Miao make up a larger percentage of the population in Sichuan Province. Miao is an ancient people, it does not have their own text record of the experience of the little by little, out of the treasure and love of their own people, the ancestors with their own wisdom to create a historical imprint, in order to make their own culture and history not to be drowned by the changing times, the Sichuan Miao with the form of oral traditions and patterns of the record of the history of the nation, drop by drop, passed from generation to generation, thus creating a memorable and praiseworthy folk skills. This has led to the creation of folkloric arts that are memorable and highly appreciated by the people. It is this twisted history that reinforces their awareness of preserving their own culture, and now embroidery has taken an irreplaceable place in people's daily lives. The Chuannan weaving techniques and the unique patterns reflect the thousands of years of cultural accumulation of the nation and contain rich cultural treasures from generations. The Miao people have forged their extraordinary works of art with their unique ethnic culture and distinctive personality traits.

II. A. 2) Development of Hmong Weaving Techniques in South Sichuan Province

With the rapid development of cultural and economic construction and other aspects, the state of the national folk skills more and more attention, increased protection and inheritance of folk skills and policy support, so that the South Sichuan Miao family weaving skills and again from the trough slowly recovered and developed. In-depth excavation of the South Sichuan Miao family weaving techniques, to carry out the collection and organization, protection and publicity and research and application, and to strengthen the national cultural heritage has played a positive role. In the production workshop, each machine can be inputted into the code and then made into different Miao embroidery patterns: there are various geometric patterns and fancy patterns, all reflecting the Sichuan Miao people's giving back to life, singing praises, memories of the past and enthusiasm for life are interspersed in each part of the pattern.

II. A. 3) Types of techniques

The embroidery patterns of Chuanmiao costumes have been passed down from generation to generation and cannot be changed at will, and each fixed pattern has a corresponding fixed position. The motifs are usually found on the front lapel, sleeve cover, waistband, belt, shoulder support, neckline and headgear of women's clothing. The patterns are mainly decorated with abstract insects, fishes, birds, flowers, grasses, figures and geometrical shapes, and there are more than ten kinds of needlework techniques, such as flat embroidery, stacked flowers, appliquéd flowers, entangled embroidery, knot embroidery, drawings, hitting, braid embroidery and crepe embroidery, etc. The Miao people in southern Sichuan have a variety of weaving techniques, such as the “Haikou” technique, which is a kind of “Haikou” technique. The weaving skills of the Miao people in South Sichuan have a long history and have been passed down from generation to generation, so much so that every Miao woman has exquisite weaving skills.

The first kind: clip yarn, general fabric selection of white cloth, and then choose the green thread, every distance from the three warp and weft yarn stab a needle, show flowers and grass and butterflies and other decorations. Embroidery is mainly distributed in the sleeves, waistband and belt.

The second type: insert yarn, will be prepared to make the pattern on the cloth, with colorful silk thread in accordance with the pattern embroidery, this is similar to appliqué embroidery.

The third type: picking flowers, commonly known as “cross stitch”, this needlework and technique is widely used in Sichuan Miao embroidery. This stitch and technique is widely used in South Sichuan Miao Embroidery. The operation of picking flower technique and counting yarn embroidery is similar, both of them are picking the embroidery threads into the same size of “ten” on the warp and weft lines of the cloth, and then the countless small “crosses” as the basic constituent units, which will make up the overall pattern according to the requirements of the pattern.

The fourth type of embroidery, riding yarn flowers, can be used many times in the embroidery technique of picking flowers. According to the required pattern and the width of the width of the thread, up and down, left and right needle, with a number of crosses or “X” shaped crosses constitute the shape of the pattern, the cross line a ride on the other one cycle alternately, so it is called riding yarn flower.

The fifth type: flat embroidery, flat embroidery stitch is the most basic embroidery method among all the stitches, and it is also the basic embroidery method in Miao embroidery. It is based on different shapes of patterns, the line from the top of one side of the pattern to the other side of the end of the needle, a needle next to a needle, stitches side by side in an even order, do not overlap, with the required color threads to follow the order of the pattern can be filled.

II. B.Woven Fabric Technique Feature Extraction Based on G-SIFT Algorithm

In this paper, based on the original SIFT (Scale Invariant Feature Transformation) algorithm, the template function of the scale transformation is improved, and the scale function is replaced by the guided filter function from Gaussian function. The main idea of guided filtering is to assume that a pixel (x, y) in the guided map (G-map) M is linearly related to the output image O in the local neighborhood τ_k, denoted as:

$$O_i = \theta_1^k M_i + \theta_2^k \quad i \in \tau_k \tag{1}$$

When the radius of the filter window r is determined, (θ_1^k, θ_2^k) the two coefficients are also uniquely determined. This means that if there are image edges within a window, then the output image is guaranteed to contain edge information after filtering. The gradient is obtained for both sides of Eq:

$$\nabla O_i = \theta_1^k \nabla M_i \tag{2}$$

Therefore, in order to find (θ_1^k, θ_2^k), using the least squares method, there is:

$$\ell(\theta_1^k, \theta_2^k) = \sum_{i \delta \tau_k} \left[(\theta_1^k M_i + \theta_2^k - I_i)^2 + \vartheta (\theta_1^k)^2 \right] \tag{3}$$

where, ℓ is the value of the noise loss between the output image O_i and the input image I_i in the non-edge region. In fact, the idea of guided filtering is to minimize the noise. In Eq. (3) ϑ is the regularization parameter, which is introduced to prevent the derived coefficient value from being too large. A partial derivative is applied to it:

$$\frac{\partial \ell}{\theta_1^k} = \sum_{i \in \tau_k} \left[2M_i (\theta_1^k M_i + \theta_2^k - I_i) + 2\vartheta \theta_1^k \right] = 0 \tag{4}$$

$$\frac{\partial \ell}{\theta_2^k} = \sum_{i \in \tau_k} \left[2(\theta_1^k M_i + \theta_2^k - I_i) \right] = 0 \tag{5}$$

The joint calculation of Eqs. (4) (5) yields:

$$\theta_1^k = \frac{\frac{1}{|\tau|}\sum_{i\in\tau_k} M_i I_i - \mu_k \bar{I}_k}{\sigma_k^2 + \vartheta} \tag{6}$$

$$\theta_2^k = \bar{I}_k - \theta_1^k \mu_k \tag{7}$$

where, μ_k and σ_k^2 denote the mean and variance of the orientation map M_i in region τ_k, respectively; $|\tau|$ is the number of pixels in region τ_k: $\bar{I}_k$ The computational expression is:

$$\bar{I}_k = \frac{1}{|\tau|_i}\sum_{i\in\tau_k} I_i \tag{8}$$

From the filtering results, it can be found that when the value of ϑ is 0.46, the outer edge of the flat needle can still be seen relatively clearly, but the inner stitch texture has been slightly blurred; when the value of ϑ is 0.96, the edge of the half-needle is also blurred, and the inner texture has been indistinguishable; and when the value of ϑ is 1.76, it is no longer possible to distinguish the target object. Order:

$$\psi_{ik} = \frac{1}{|\tau|_i}\sum_{i\in\tau_k} M_i I_i - \mu_k \bar{I}_k \tag{9}$$

So the relationship between the final output image O and the guiding diagram M can be expressed as:

$$O(i,\vartheta) = \frac{\psi_{ik}}{\sigma_k^2 + \vartheta}\left[M(i) - \mu_k\right] + \bar{I}_k \tag{10}$$

To wit:

$$O(i,\vartheta) = \frac{\eta_{ik}}{\sigma_k^2 + \vartheta} + \bar{I}_k \tag{11}$$

where, $\eta_{ik} = \psi_{ik}\left[M(i) - \mu_i\right]$, is related only to the guided map M and the input image I.

Thus, replacing the Gaussian function in Eq. (8) with the guided filter function in Eq. (11) yields:

$$\begin{aligned} D(x,y,\vartheta) &= \left[O(x,y,k\vartheta) - O(x,y,\vartheta)\right] * I(x,y) \\ &= \Theta(x,y,k\vartheta) - \Theta(x,y,\vartheta) \end{aligned} \tag{12}$$

where, Θ denotes the result after convolution of the input image with the guided filter kernel. In order to derive equation (12), the second order derivative of O is also required, which is obtained from the derivation of ϑ in equation (11):

$$\nabla O(i,\vartheta) = -\frac{\eta_{ik}}{(\sigma_k^2 + \vartheta)^2} \tag{13}$$

The derivation of ϑ in Eq. (13) is again obtained:

$$\nabla^2 O(i,\vartheta) = \frac{2\eta_k}{(\sigma_k^2 + \vartheta)^3} \tag{14}$$

After receiving the input image, the algorithm first grayscales and performs preliminary filtering, and then calculates the scale pyramid of the image using the guided filter function. Since the guided filter function is an algorithm based on the principle of statistics, the algorithm runs faster than the SIFT algorithm, and the final feature points of the image are finally derived and then feature point matching can be performed.

II. C.System design

II. C. 1) Overview of Virtual Reality and Augmented Reality Technologies

Virtual Reality (VR) technology is capable of creating virtual worlds, and there are a large number of computer applications that fuse data from multiple sources of information to form a human-computer interaction system that simulates three-dimensional scenes and real movements to immerse the user [15]. Augmented reality (AR) technology recognizes the position and angle of a camera image in real time and combines virtual objects with reality in binocular vision imaging [16], [17]. At present, many large international companies have realized the huge market potential and value of virtual reality technology and augmented reality technology, Oculus launched the Oculus Rift headset, Google spared no expense to build Google Glass, and Microsoft is also actively developing Micro-soft Holo -lens. in the early days, virtual reality technology and augmented In the early days, virtual reality technology and augmented reality technology relied on computers and large workstations to build the system operation platform, with the arrival of the Internet era, especially the rapid development and popularization of smart phones, the application of virtual reality technology and augmented reality technology has been well promoted on

mobile terminal equipment. The vision-based virtual reality and augmented reality fusion technology can reach a frame rate of 45 fps in the process of converting RGB-D sequences into 3D models.

II. C. 2) Modeling Scene Construction for Demonstration

The model scene construction of the display of Sichuan Miao family's weaving technique should be based on the important historical data and characteristic elements of Sichuan Miao family's weaving technique, and a physical model scene of the living environment of Sichuan Miao family's weaving technique should be constructed with the help of the fusion technology of virtual reality and augmented reality, so as to create a suitable scene display environment and space for the content of virtual reality imaging. The hologram display design of Sichuan Miao family weaving technology takes the environment of wide screen, virtual objects, scene models and various lighting changes as the virtual imaging background, and then superimposes the above extracted elements of Sichuan Miao family weaving technology into the virtual scene, so that the virtual reality imaging content in the scene of Sichuan Miao family weaving technology is combined with the virtual reality imaging content, and there is a real one and a virtual one in the real one, which together constitute a perfect combination of static and dynamic video interaction. Picture, for the audience to bring a new visual and auditory experience, can create a traditional props and characters can not simulate the effect, has a strong sense of depth. At the same time, it can also be matched with appropriate music, lighting and smoke effects, giving people visual and auditory enjoyment and leaving a deep impression of the Miao family weaving culture in southern Sichuan.

II. C. 3) Imaging effect control for displays

For the specific display scene, display apparatus, activity portrait and story script involved in the ancient papermaking story content of various eras to build three-dimensional imaging effect, the use of virtual reality and augmented reality fusion technology will display model in the form of true-color 3D image of the form of realistic in the suspension of the real environment. Different imaging carriers are combined with stage machinery, which can freely shape the stage environment according to the changes of the plot. Join to help virtual reality and augmented reality fusion technology of Sichuan Miao family weaving technology stage performance restoration of Sichuan Miao family weaving technology, present the most primitive ecological civilization, to the virtual combination of the way the formation and development of Sichuan Miao family weaving technology of the historical story vividly demonstrated, the audience to see, although only the papermaking image rather than the real Sichuan Miao weaving in kind, but it is a very good way to create and present a good environment for the on-site visitors to see the real Sichuan Miao weaving technology. Although the audience only saw the paper-making image instead of the real Miao weaving object, it created and presented an immersive performance of Miao weaving technique, which was more shocking than the traditional performance, and made the audience deeply feel the profound cultural heritage of Miao weaving technique in the south of Sichuan Province.

II. C. 4) Interactive experience of Sichuan Miao weaving techniques

For the demonstration of the weaving process of the Miao family in southern Sichuan, the widely used methods at present are the graphic introduction carried by exhibition boards and the filming and production of the papermaking process into a video with narration. These display methods are only for visual viewing, visitors can not touch and smell, lack of interactivity and participation, and ultimately the amount of information and feelings that can be obtained is also less. Setting up a VR/AR experience area for the weaving skills of the Miao family in southern Sichuan. Chuannan Miao family weaving technology is handmade, the process is more complex, to allow visitors to feel the unique charm of Zhaoqing ancient paper making technology, in-depth mobilization of vision, hearing, touch three senses, to provide the majority of visitors with multi-sensory experience. Virtual reality and augmented reality fusion technology for the Chuannan Miao family weaving technology display design provides a new technical method, design and production simulation of Chuannan Miao family weaving technology of three-dimensional visual effects, when visitors wear the equipment to watch, can be as immersed in the Chuannan Miao family weaving technology, to get more enjoyable interactive experience and immersive interactive feeling.

II. C. 5) System architecture

In the design, the paper mainly adopts the layered and distributed structure to build the Chuannan Miao family weaving technology system, and the specific realization of the Chuannan Miao family weaving technology system will be analyzed separately in the representation layer and the business logic layer, so that the consistency and stability of the application service logic can be effectively guaranteed. Not only that, the Chuannan Miao family cloth weaving technology system through the specific realization of the use of reasonable software architecture and mode, but also take into account the system development process and the application process economy. Therefore, after comprehensive consideration, the Chuannan Miao family weaving technology system adopts the 4-tier architecture

commonly used in J2EEWeb project development technology to realize the design of the Chuannan Miao family weaving technology system.

III. System Detection and Analysis

III. A. Feature Extraction Analysis of Weaving Techniques

III. A. 1) Evaluation indicators

In view of the inability to clearly distinguish the weaving technique feature extraction effect of the proposed algorithm under different conditions, this paper adopts the rate and accuracy to evaluate the matching results, and uses three metrics, namely, the image information entropy IE, the mean square error MSE, and the generalized image quality index UIQI, to assess the quality of the weaving technique feature extraction results.

Information entropy (IE) is a metric often used to assess the quality, complexity, and feature richness of an image. The greater the information entropy of an image means that the image is richer and more complex, containing more details, textures and variations. The formula is as follows:

$$E = -\sum_{l=0}^{L-1} P(l)\log P(l) \tag{15}$$

where $P(l)$ is the probability of occurrence of gray level l, L is the total number of gray levels

The mean square error (MSE) is commonly used to measure the difference between 2 images. The smaller the value, the smaller the error between the processed image and the original image, the better the fusion effect, i.e., the higher the similarity. The formula is shown below:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M-1}\sum_{j=0}^{N-1}\left[I(i,j) - K(i,j)\right] \tag{16}$$

where, I and K are the pixel values of the two images, M and N are the height and width of the images respectively.

The Universal Image Quality Index (UIQI) is a comprehensive index that considers brightness, contrast and structural information in a global context.The UIQI is calculated between 0 and 1, and the closer the value is to 1, the more similar the two images are, i.e., the higher the quality of the results of the weaving technique feature extraction is evaluated. The specific calculation process is shown below:

$$UIQI = \frac{4 \bullet \sigma_{xy} \bullet \mu_x \bullet \mu_y}{\left(\sigma_x^2 + \sigma_y^2\right) \bullet \left(\mu_x^2 + \mu_y^2\right)} \tag{17}$$

In the calculation formula, σ_{xy} denotes the covariance of image 1 and image 2, μ_x and μ_y are the mean of image 1 and image 2, respectively, and σ_x^2 and σ_y^2 are the variance of image 1 and image 2, respectively.

III. A. 2) Data analysis

In order to verify the feature extraction effect of Chuannan Miao family weaving technique based on G-SIFT algorithm, the images of Chuannan Miao family weaving technique were collected in the form of network resources download, which were categorized into A (embroidery), B (batik) and C (brocade). The experimental platform is PYTHON3.7.06, running on windows 11, CPU is Intel(R) Core(TM) i7-12100F, and memory is 32GB.

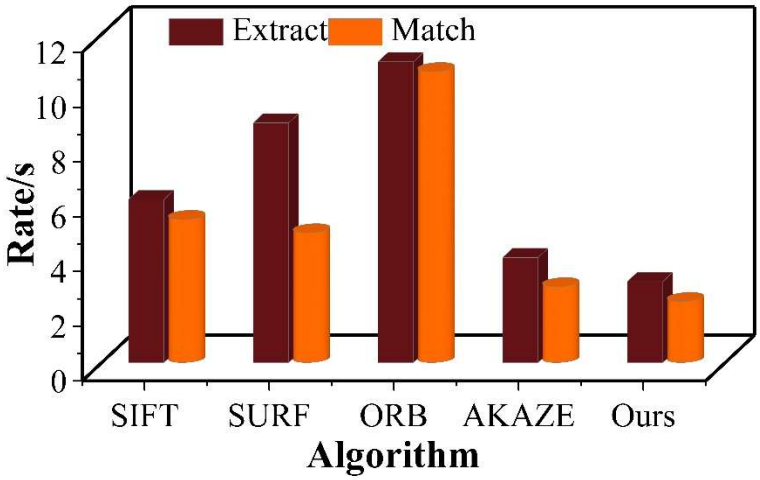

Figure 1: The matching efficiency of image A feature extraction

SIFT, SURF, ORB, and AKAZE are set as control algorithms, and the feature extraction matching efficiency of different algorithms of Chuannan Miao family weaving technique is explored on the basis of three kinds of image data of Chuannan Miao family weaving technique, and the comparative analysis of the feature extraction matching efficiency is shown in Figs. 1~3. The results show that the algorithm proposed in this paper has a better feature extraction matching rate than the traditional SIFT algorithm and SURF algorithm. Compared with the traditional SIFT algorithm, the algorithm in this paper has achieved improvement in feature point extraction and matching speed.

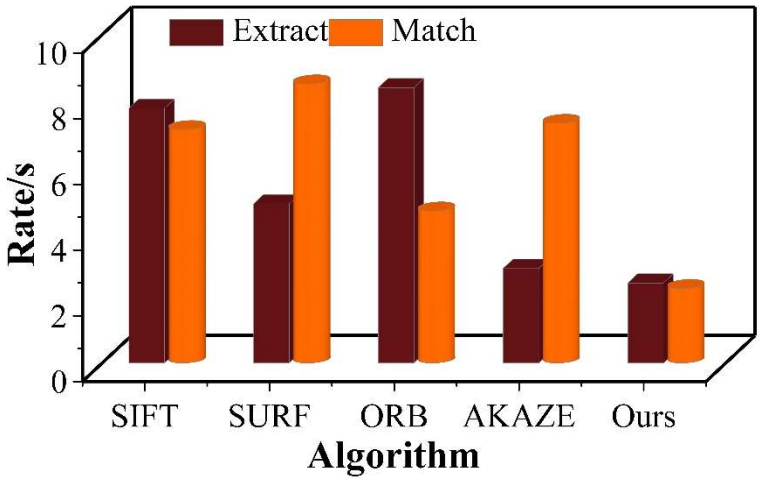

Figure 2: The matching efficiency of image B feature extraction

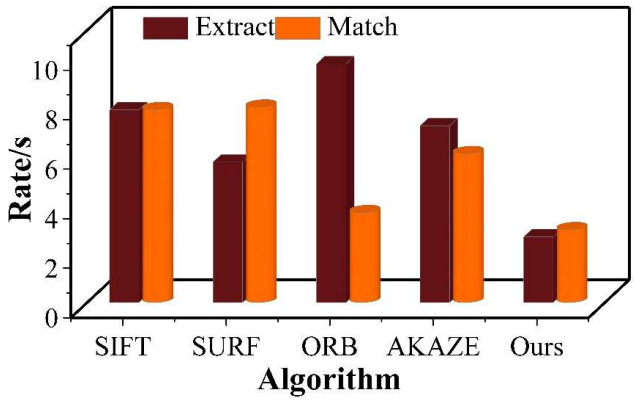

Figure 3: The matching efficiency of image C feature extraction

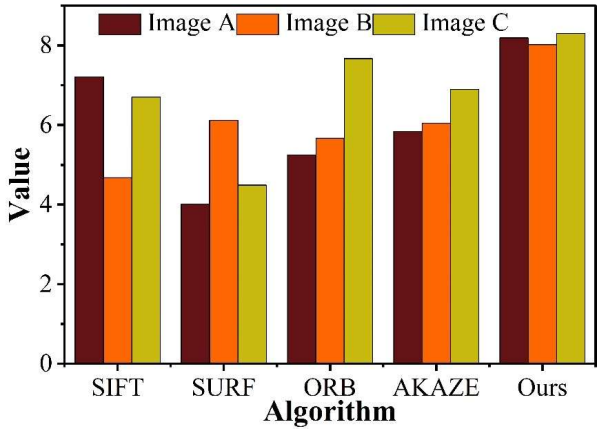

Figure 4: Image information entropy comparison

Under the theoretical guidance of the evaluation index, the results of the evaluation index of the three kinds of image feature extraction by different methods are explored and analyzed, and the comparison results of the three kinds of image feature extraction evaluation indexes are shown in Figs. 4~6. The data show that the algorithm proposed in this paper has improved in the three aspects of information entropy, mean square error and general image quality index compared with the other four algorithms, which can better extract the features of Chuannan Miao family techniques and provide good elemental feature support for the digital display system.

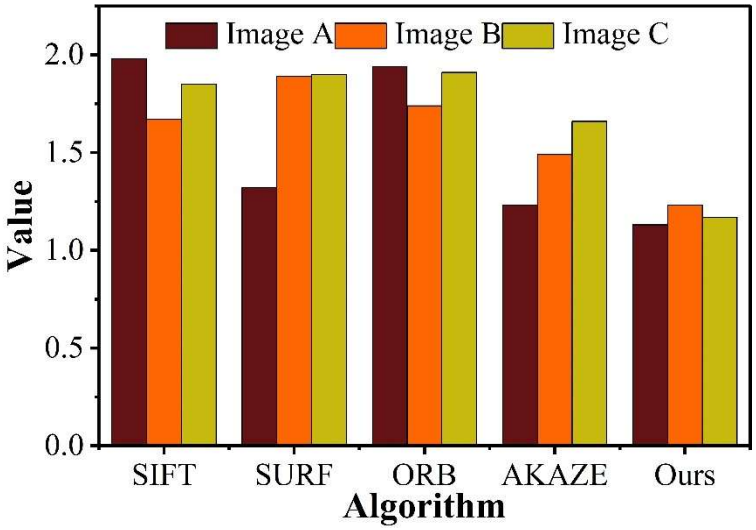

Figure 5: Comparative analysis of Mean square Error

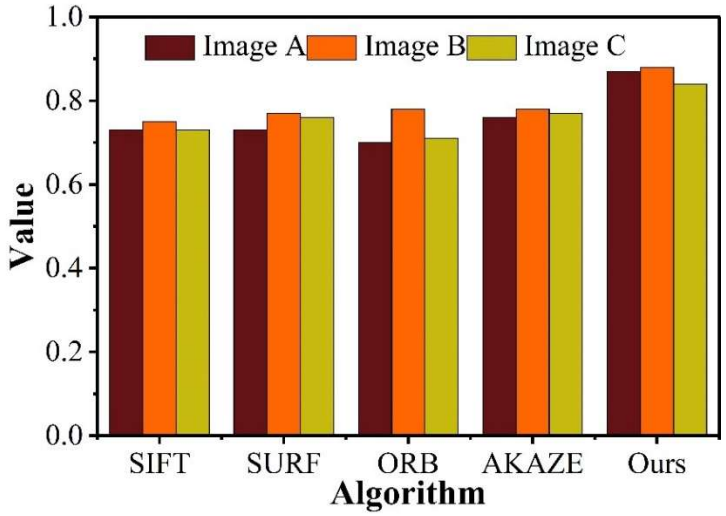

Figure 6: Comparative Analysis of General Image Quality Index

III. B. Test of Digital Display System for Sichuan Miao Weaving Technique

III. B. 1) Overview of performance testing

In the whole Chuannan Miao family weaving technology digital display system, the stability and concurrency of the server side have a very big impact on the performance of the whole system, therefore, in order to ensure the overall performance of the Chuannan Miao family weaving technology digital display system, this section mainly examines the high concurrency and stability of the server through the performance test.

III. B. 2) Performance testing model

The test model graphically describes the relationship between the test machine and the server under test. The test machine simulates a large number of clients mainly with the help of automation tools, so as to complete the load and stress test on the server.

III. B. 3) Performance test cases

Performance test cases mainly refer to the test plan prepared to test the server-side performance. Through the execution of this plan, the test data of the server side is obtained. This test data mainly refers to the test information such as utilization, memory usage, response time, etc. of the server. The performance test case of the server is to simulate user login to test the utilization of the server, memory usage and the response time of the server to the user login. Table 1 describes the test cases of the system user login to test the CPU and memory utilization of the server and the response time of the server to the user login with the help of the user login of the digital display system of the weaving technology of the Miao family in Chuannan.

Table 1: Performance test cases on the server side

Use case Number:001
Test scenario: System user login: A total of 5000 users logged in. All users performed concurrent operations simultaneously and the operation lasted for 8 minutes
Preset conditions: There are 1000,000 user records in the user table
Operating steps: 1:Start the client login interface 2:Enter the username, password and verification code 3:Click the login button 4:Enter the main interface of the system
Expected result: 1:All business transactions were successful 2:The average response time for user operations does not exceed 6 seconds 3:The CPU utilization rate of the Web server and database server is less than 52.3% 4:The memory utilization rate of the Web server and database server is less than 65.7%

III. B. 4) Performance test results

The performance test results record various data obtained through the execution of the test cases, mainly including the actual CPU and memory usage, and the actual response time of the user. Table 2 records the test items, expected values, and actual values of the Chuannan Miao Family Weaving Technique Digital Display System, and determines whether the test passes or fails by comparing the actual values with the expected values. By analyzing the test results, the response time (2.149s), response rate (100%), and resource usage rate (CPU<50%, memory<60%) of the server side of the Chuannan Miao family weaving technology digital display system to the client side are all within the planned control, and the test results fully proved the high loadability and pressure resistance of the server side, so that the digital display system of the Chuannan Miao family weaving technology can better serve the This makes the digitalized display system of Sichuan Miao family cloth weaving technology better serve the user groups and plays an important role in promoting the inheritance and protection of Sichuan Miao family cloth weaving technology.

Table 2: Performance test results

Test items	Expected value	Actual value	Whether to pass or not
Login user response time	<=6 seconds	2.149s	YES
The response success rate of logged-in users	100% of 5000 users	100% of 5000 users	YES
CPU usage rate	<52.3%	<50%	YES
Memory usage rate	<65.7%	<60%	YES

IV. Conclusion

This digital display system successfully realizes the innovative display of the weaving techniques of the Miao ethnic group in southern Sichuan by integrating virtual reality and augmented reality technologies. The improved G-SIFT algorithm performs excellently in feature extraction, and compared with the traditional SIFT algorithm, it achieves a significant improvement in matching speed, and at the same time, there is a significant improvement in the three evaluation indexes, namely, information entropy, mean squared error, and generalized image quality index. The system performance test shows that in the 5000-user concurrent scenario, the average response time is only 2.149 seconds, much lower than the expected 6-second standard, the response success rate reaches 100%, the CPU

utilization rate is controlled at less than 50%, and the memory utilization rate stays below 60%, which fully verifies the system's high concurrency processing capability and stability. The system breaks through the limitations of traditional display methods, and provides an immersive experience for the audience by constructing a three-dimensional virtual scene, combining sound effects, lighting and other multimedia elements. The application of VR/AR fusion technology not only enhances the interactivity and participation of the display, but also explores new possibilities for the digital protection of the weaving skills of the Miao ethnic group of southern Sichuan. The 4-layer architecture design of the system ensures good maintainability and scalability, providing a solid foundation for subsequent functional expansion and system optimization. This innovative digital display solution provides an important technical reference for the protection and inheritance of traditional cultural heritage, and is of positive significance in promoting the modernization and dissemination of national culture.

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