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Optimization of Digital Inheritance Pathway of Folk Art in Information Age

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Abstract How to make full use of digital information technology to realize the digital heritage of folk art has become a key concern in the field of non-legacy. Based on digital information technology, this paper proposes image restoration technology to assist folk art digital heritage research. Folk art images are acquired by double mirror reflection method, and pre-processing operations such as defogging, denoising and edge detection are carried out on the images to reduce the influence of interference information in the original pictures on the image restoration effect. The Criminisi algorithm is improved and optimized by combining the structure tensor theory, the improved priority calculation function, the matching criterion and the confidence updating method, and then the research design of image restoration technology assisting folk art digitization is completed and analyzed by examples. The results show that the repair effect of the improved Criminisi algorithm is better than that of the classical Criminisi algorithm, but the repair time of the improved Criminisi algorithm is longer than that of the traditional algorithm by 64.25%, but it is still less than 0.500 seconds, which is within the acceptable range, and it has certain practicability for the digitization and inheritance of folk art in the information age. algorithm has some practicality. Compared with other digital inheritance paths, the method proposed in this study can restore the original appearance of folk art to the maximum extent, and it has theoretical guidance value for the study of optimizing the digital inheritance of traditional folk art.

Index Terms criminisi algorithm, bimirror reflection method, image restoration techniques, folk art

I. Introduction

Intangible cultural heritage contains rich cultural values, is a vivid display of human cultural diversity and a spiritual home that nourishes the spiritual world [1]. Folk art is a visual cultural image summarized and refined by the regional people in their daily production life according to the real needs, they are rooted in the vernacular culture, originated from the daily production life of the folk masses, with a wide range of culture and popularization, and are an important intangible cultural heritage of human society [2].

With the deepening of modernity, especially the rapid development of modern science and technology, the cultural development ecology of folk art has undergone great changes. On the one hand, modernity characterized by fast pace has led to an existential crisis of the folk art which mainly develops at a slow pace, and the folk art relying on the traditional vernacular cultural environment has gradually separated from the original survival soil to enter into a brand-new context of existence. The development of folk art is declining, and the local culture is facing an increasingly serious "cultural dilemma", i.e. the cultural rupture between tradition and modernity. On the other hand, the development of digital electronic information technology has enriched the content and form of folk art protection and inheritance, especially the three-dimensional image modeling and virtual reality technology has created a brand new audio-visual experience for the public, which has provided a new opportunity for the research and protection of folk art. On the other hand, the development of digital electronic information technology has enriched the content and form of folk art protection and inheritance, especially three-dimensional image modeling and virtual reality technology has created a new audio-visual experience for the public, which provides a new cultural space and development path for the research and protection of folk art, and the folk art and other vernacular cultures can be more widely and conveniently disseminated and developed [3]–[5].

As an important part of intangible cultural heritage (ICH), folk art occupies an important position in cultural history. Incorporating elements of folk art into local art design is an effective way to protect and pass on intangible cultural heritage [6].

Intangible cultural heritage should be adapted to digitization in the new era, pay attention to the important role of digitization in the collection, storage, processing, display and dissemination of intangible heritage, and form a renewable digital form, so as to revitalize the vernacular culture in the context of modernity [7]. Based on this, in order to better protect and inherit folk art, and give full play to its unique cultural

value and social function in the context of the new era, it is necessary to discuss in depth the development of the digital protection of folk art, the principle of the requirements and the development path, so as to break through the limitations of the development of folk art and other vernacular cultures, and to provide ideas for the promotion of digital protection of China's intangible cultural heritage and the revitalization of the countryside and other related issues [8].

Folk art is rooted in deep vernacular culture, embodies the survival wisdom of harmonious coexistence of people, nature and society, has rich cultural value and sustained life tension, and is an important part of intangible cultural heritage. Huang, Z. et al. expounded the importance of non-heritage culture as the soft power of the country's culture, as well as the importance of the digital protection of non-heritage in the present time and combined with the linked data technology to manage non-heritage knowledge standardization and structuring to improve the capacity of NHM inheritance and protection [9]. Zhang, L et al. based on the theory of embodied cognition, analyzed the potential application value and application scenarios of 5G/8K/AI/VR technology in the inheritance and protection of non-genetic heritage, and the study provides an important reference for the digital protection and inheritance of non-genetic heritage [10]. Li, J. et al. revealed the trend of cultural and creative industry development in the context of the knowledge economy era and empirically explored the cultural and creative development of arts and crafts based on the spatial agglomeration characterization method, which is of positive significance for understanding and promoting the benign combination and development of NRH and cultural and creative industries [11]. Bodner, R. explores the history of the development and evolution of folk costume artifacts in the People's Museum of Tyrol, pointing out that these folk costume artifacts have become more and more highly tied to political and economic interests in both design and display as the context of the times has changed [12].

Digital media technology has interactive, convenient, immersive and other cultural characteristics, which can provide more development space, support, cultural experience and development path for the protection and inheritance of intangible cultural heritage. Therefore, taking folk art as an example, exploring the digital protection path of intangible cultural heritage can effectively solve the "cultural dilemma" faced by vernacular culture in the process of social transformation, and better inherit and carry forward the excellent traditional Chinese culture. Wu, C. et al. in their study on root carving in the Central Plateau region learned that in the stage of development from craft to non-heritage, more attention needs to be paid to the deep excavation of the humanities and the investment of intellectual capital [13]. Zhang, Y et al. developed an adversarial analytical framework by combining literature search methodology and Melfi theory in order to investigate the main factors affecting kite culture inheritance, and were informed that the policy formulation and guidance of the relevant authorities, as well as the nature of kites' products, significantly affect kite culture inheritance [14]. Shi, X lists the challenges encountered in the inheritance and protection of folk painting art, covering the lack of mantle inheritors, backward inheritance methods, etc., and tries to promote the inheritance of painting art based on artistic value, multi-form and multi-content perspectives, and the study provides some new ideas and perspectives for the inheritance and protection of NGPs [15]. Zhang, L. discusses the development of folk dance culture in the context of the information age, and tries to promote the combination of folk dance culture and modern information technology in order to promote the promotion and display of the artistic value and culture of folk dance, and then promote the inheritance and protection of folk dance art and culture [16].

In view of the problem of folk art protection and inheritance, this paper firstly starts from the digital inheritance status of folk art in the information age, and adopts the image restoration technology in digital information technology to assist the digital inheritance of folk art. Secondly, based on the principle of two-mirror reflection to obtain the digitized format of folk art images, in order to avoid the impact of image interference information on the results of the research and analysis, the image denoising, edge detection and other preprocessing operations. Then the image restoration technology based on the traditional Criminisi algorithm is optimized and improved by combining structural tensor theory, improved priority calculation function, matching criterion and confidence updating, so as to complete the research and design of image restoration technology to assist the digital heritage of folk art. Finally, the digital inheritance and protection of folk art is analyzed by examples.

II. Image Restoration Technology to Assist the Digital Heritage of Folk Art

The traditional preservation of folk art is in the form of paper, books, written records or physical preservation and teaching. Paper, books and physical objects are prone to aging, mold and loss, and the teachings are not recorded in writing, which is arbitrary and not standardized enough, and are carried out in a fragmented and vague way. These factors are not conducive to the long-term development of folk art, so the traditional sense of the folk art digital inheritance can not meet the current stage of reality. Image restoration technology is a reasonable way to solve these problems. Image restoration technology can not only restore folk art works, but also digitize and save the restored folk art works in digital format on hard disk and CD-ROM, without interference from external conditions, and due to the non-destructive copying characteristics of digital format, it can be copied and saved indefinitely, so it can not only save the digital information, but also facilitate the long-term development of folk art. Due to the non-destructive copying characteristics of the digital format, the information resources can be copied and preserved indefinitely, which not only can preserve the digital information for a long time, but also can be conducive to the subsequent inheritance and restoration of folk art.

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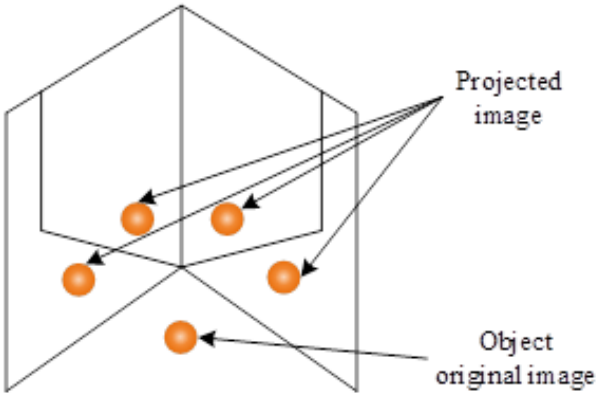

Figure 1: The principle of the collection of folk art based on double mirror reflection

A. Folk Art Image Acquisition Based on Double Mirror Reflection

The double mirror reflection image acquisition method mentioned in this paper, specifically through two mirrors reflecting each other, forming the projection of the object in the mirror, when the intersection angle of the two mirrors is 72 °, the mirror and the image is exactly the plane where the object is divided into five equal parts, so as to be able to get five images corresponding to each other in a photo. The principle of folk art image acquisition based on double mirror reflection is shown in Figure 1. In this way, each side of the object is basically completely reflected in a photo, thus avoiding the problem of taking photos several times. With this, we can know that to get all the three-dimensional information of an object, it is only necessary to take the front and back sides of the object and two photos.

B. Folk Art Image Preprocessing

In this paper, in order to reduce the impact of the interference information in the native images on the algorithmic effect in the study of folk art digitization and conservation, so we can do some preprocessing work on the native images, such as defogging, de-noising, and edge detection on the folk art images.

1) Image Denoising

In our subsequent work, we need to use Canny edge detection algorithm to extract the contours of folk art work images for network training, and edge detection is very sensitive to noise in the image, so we need to denoise the image first. Image denoising is a traditional direction in the field of computer vision, aiming to extract cleaner images from images with noise interference, which is also the ultimate goal of image enhancement. It is easy to think of the denoising method is mean value filtering, that is, using the average of the current pixel and the surrounding pixels as the value of the current pixel, the actual processing of the image using an n * n template matrix for convolution, the value of the current pixel is equal to the surrounding pixels, including the average of its own, as shown in Equation (1):

$$g(x,y) = \frac{1}{n^2} \sum_{i=\frac{n-1}{2}}^{\frac{n-1}{2}} f(x+i, y+i). \tag{1}$$

The disadvantage of mean filtering is that it blurs the image, especially the sharpness of the edges of the image will be affected. For Gaussian noise in an image whose probability density function follows a Gaussian distribution, the use of Gaussian filtering can often achieve better results, and in the standard Canny algorithm, the first step of the denoising process is also to use Gaussian filtering algorithm. Gaussian filtering is simply a linear smoothing filter based on the shape of the Gaussian function to select the weights to do the convolution operation, first select a specific variance parameter σ, according to the formula (2) to get the Gaussian kernel. It is represented as follows:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}, \tag{2}$$

where x, y represents the value of the horizontal and vertical coordinates of each position with the Gaussian kernel right in the center of the kernel as the coordinate origin, respectively, and the coordinates of each position of the 3*3 Gaussian kernel, for example, are as follows:

$$\begin{bmatrix} (-1,-1) & (0,-1) & (1,-1) \\ (-1,0) & (0,0) & (1,0) \\ (-1,1) & (0,1) & (1,1) \end{bmatrix}. \tag{3}$$

Assuming that $\sigma = 1$ is obtained, the value of each position can be obtained according to equation (4):

$$\begin{bmatrix} 0.0585 & 0.0965 & 0.0585 \\ 0.0965 & 0.1592 & 0.0965 \\ 0.0585 & 0.0965 & 0.0585 \end{bmatrix}. \tag{4}$$

Summing all the elements gives the value sum, and dividing all the positions by sum gives the final Gaussian kernel:

$$\begin{bmatrix} 0.0751 & 0.1238 & 0.0751 \\ 0.1238 & 0.2042 & 0.1238 \\ 0.0751 & 0.1238 & 0.0751 \end{bmatrix}. \tag{5}$$

After that, the Gaussian kernel is shifted and convolved with the gray scale image to get the result. Most of the noise in the image belongs to Gaussian noise, so Gaussian filters are widely used.

2) Edge Detection

Edge detection is has been an important research topic in the field of image processing, the edge is actually related to the properties of the pixel, the region with sharp change in brightness is likely to be the edge of the object in the image, the edge can be detected by the change in brightness of the pixel point in the digital image. Using edge detection algorithm we can get the outline of the object in the image. Its main process is divided into 6 steps:

1) Grayscaling Denoising

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Rapid color changes in the image belong to high-frequency information, smooth changes belong to low-frequency information, "edges" and noise belong to high-frequency information, in order to reduce the impact of noise on the extraction work, first of all, the original image denoising process. In the previous subsection, we introduced the use of deep learning model ADNet for image denoising.

2) Calculate the gradient value and gradient direction

The Canny algorithm uses operators (common ones such as Roberts, Prewitt, Sobel, etc.) in the horizontal and vertical directions and the 8-neighborhood window of the pixel to do the convolution and then summation as in Eq. (6), which returns the derivative G_x of the pixel in the horizontal direction and derivative G_y in the vertical direction. can be derived:

$$G_x = sum\left(A \odot S_x\right), G_y = sum\left(A \odot S_y\right), \tag{6}$$

where A is the 8-neighborhood window of a pixel, and S_x and S_y are the horizontal and vertical Sobel operators, respectively:

$$S_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & -1 \end{bmatrix}, S_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}. \tag{7}$$

The gradient value G and direction θ of the pixel point can then be obtained according to equations (8) and (9):

$$G = \sqrt{{G_x}^2 + {G_y}^2}, \tag{8}$$

$$\theta = \arctan \frac{G_y}{G_x}. \tag{9}$$

3) Non-great value suppression

Figure 2 shows the schematic diagram of non-extremely large value suppression, if only based on the size of the gradient value to extract the edge will be relatively fuzzy, the use of non-extremely large value suppression can be "thin" edges so that the outline becomes clearer. The step of non-extreme value suppression is the direction of the gradient of each pixel θ according to the principle of approximation to the horizontal, vertical and two diagonals of a total of 8 directions, P point of the gradient direction of θ, closer to the direction of the SW to NE, so the P point should be compared with the gradient value on the NE and SW.

The current pixel gradient value is retained as an edge point if it is greater than the gradient values of the other two pixels, otherwise the pixel point is suppressed and set to zero.

4) Dual Threshold Detection

Due to the effect of noise and color variations in the image, there will still be some spurious response edge pixels after non-extremely large value suppression. In order to optimize the sharpness of the edges, the edge pixels can be filtered by high and low thresholds. If the gradient value of an edge pixel is higher than the high threshold, it is labeled as a strong edge pixel. If the gradient value of an edge pixel is less than the high threshold and greater than the low threshold, it is labeled as a weak edge pixel. If the gradient value of an edge pixel is less than the low threshold, it is suppressed.

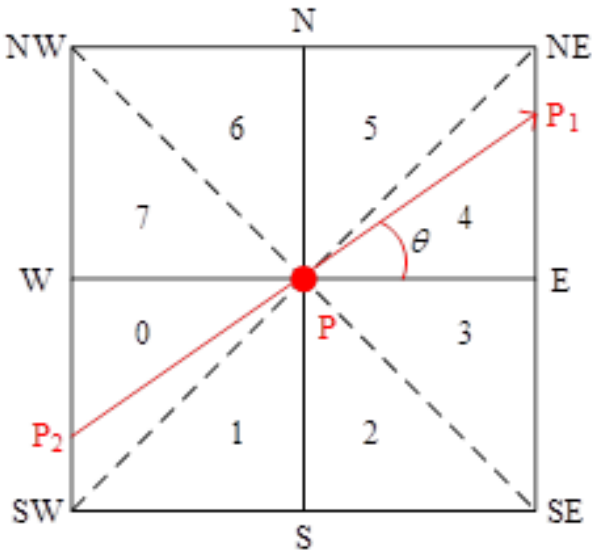

Figure 2: Non-maximal value suppression schematic

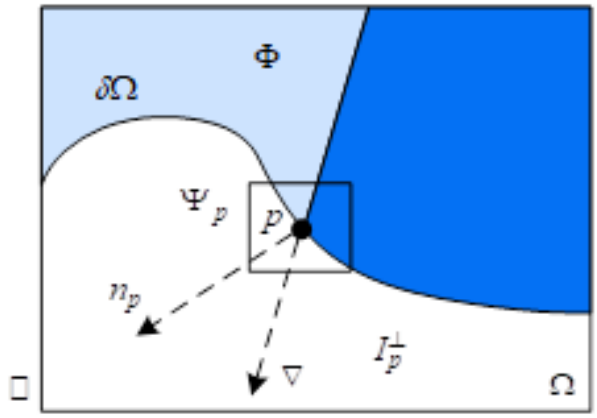

Figure 3: Criminisi algorithm schematic

5) Suppressing isolated low threshold points

Strong edge pixels can be directly identified as true edges are retained and all weak edge pixels directly connected to them in the eight neighborhoods around the strong edge pixels are retained as true edges and all the rest of the pixel points are directly deleted and laid down for subsequent work.

C. Criminisi's Algorithm and its Shortcomings

1) Criminisi Algorithm

Criminisi algorithm principle is a graphic repair algorithm based on Bayesian probability, Figure 3 shows the schematic diagram of Criminisi algorithm, I represents an image containing a broken region, Ω is the broken to be repaired region, $\delta\,\Omega$ is the boundary of the region to be repaired, Φ is the known source region of the image, p is a unit pixel point on the boundary, and Ψ_p is the target block to be filled centered on p.

In the whole process of image restoration, the priority order

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is a key factor in determining the final restoration result of the image, and thus plays an irreplaceable role in the process of restoration. The priority $P(p) = C(p)D(p)$ of p, where Eq. $C(p)$ denotes the confidence level of the current block. $D(p)$ over the Isophote intensity of p points. It can be derived:

$$C(p) = \frac{\sum_{q \in \Psi_p \cap \Phi} C(q)}{|\Psi_p|}, \tag{10}$$

$$D(p) = \frac{\left|\nabla I_p^{\perp} n_p\right|}{\alpha}, \tag{11}$$

where: $\nabla I_p^{\perp}$ represents the tangent direction of the iso-illumination line. n_p is the unit normal vector of p points. $|\Psi_p|$ is the number of pixels within Ψ_p. α is the normalization factor, which is taken as 255.

After finding the block to be repaired with maximum priority Ψ_p, the most similar matching block Ψ_q of Ψ_p is searched in the region of known valid information so that it satisfies the relation:

$$\Psi_q = \arg\min d_{\Psi_{q \subset \Phi}}\left(\Psi_p, \Psi_{p'}\right), \tag{12}$$

$$d_{\Psi_{q \subset \Phi}}\left(\Psi_p, \Psi_{q'}\right) = \sum \left[\left(I_R - {I_R}'\right)^2 + \left(I_G - {I_G}'\right)^2 + \left(I_B - {I_B}'\right)^2\right]. \tag{13}$$

$\Psi_{q'}$ is the matching block in figure $d_{\Psi_{q \subset \Phi}}\left(\Psi_p, \Psi_{q'}\right)$ is $\Psi_p, \Psi_{q'}$ the sum of squares (SSD) of the errors of the RGB values of the corresponding pixel points. I is the pixel value corresponding to each color channel.

After finding Ψ_p the most matching matching block Ψ_q using the above two formulas, the pixel information in the matching block Ψ_q corresponding to the broken unknown portion of the target block Ψ_p is copied into Ψ_p.

During the repair process, after each repair of the to-be-targeted block Ψ_p having the highest priority, the confidence of the repaired pixel point in the block Ψ_p is replaced with the confidence of the center point p of this target block, and the boundary $\delta\Omega$ of the to-be-repaired area is updated, which can be derived:

$$C(p) = C\left(p'\right), \forall p \in \Omega \cap \Psi_{p'}. \tag{14}$$

Repeat the repair steps described above until all areas to be repaired have been repaired.

2) Criminisi Algorithm Flaw Analysis

By analyzing the principle of Criminisi's algorithm, the following shortcomings are found:

(1) Decline in the priority function. The priority function is calculated in the form of multiplication, and as the repair work progresses, the decline of either the confidence term or the data term will lead to a rapid decline in the priority value. In the subsequent repair process, the size of the priority value cannot correctly reflect the repair order of the blocks to be repaired.

(2) Single matching criterion. When searching for matching blocks, relying only on the sum of squared color differences as a criterion for judging the similarity between the block to be repaired and the matching block is too single, which is prone to the problem of wrong matching and affects the visual connectivity of the repair results.

(3) Confidence updating problem. Every time the repair is completed, the unknown region in the block to be repaired will be filled by the corresponding region in the best matching block, and the confidence level will be changed accordingly. However, there are certain differences between the blocks to be repaired and the matching blocks, and the confidence updating method in the original algorithm can easily lead to the accumulation of such errors as the repair proceeds, which in turn affects the stability of the repair sequence.

D. Criminisi Algorithm Improvement

1) Structural Tensor Theory

In the field of image restoration, the intensity information of a local region of an image, the dominant direction of the gradient in the neighborhood of a particular pixel, and the degree of coherence between them can be represented by the image structure tensor. Let the color image be I, then its gradient is:

$$\nabla I_i = \left[I_{xi}, I_{yi}\right]^T. \tag{15}$$

The subscript i takes the values of 1,2,3, which correspond to the three RGB channels in the color image. The subscript ∇I_i represents the gradient value of each channel, and the subscripts I_{xi} and I_{yi} represent the bias of the pixel point in the horizontal and vertical directions, respectively. The structure tensor J_ρ of the color image is:

$$J = \sum_{i=1}^{n} \nabla I_i \nabla I_i^T = \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}, \tag{16}$$

$$J_\rho = \begin{pmatrix} j_{11} & j_{12} \\ j_{21} & j_{22} \end{pmatrix} = G_\rho * J = \begin{bmatrix} G_\rho * I_x^2 & G_\rho * I_x I_y \\ G_\rho * I_x I_y & G_\rho * I_y^2 \end{bmatrix}. \tag{17}$$

In the above equation, G_ρ is the Gaussian kernel function with a variance of ρ and a mean of 0, i.e:

$$G_\rho = \frac{1}{2\pi\rho^2} \exp\left(-\frac{x^2 + y^2}{2\rho^2}\right). \tag{18}$$

The calculation can be obtained by solving for the two eigenvalues of the structure tensor matrix J_ρ:

$$\lambda_{1,2} = \left(j_{11} + j_{22} \pm \sqrt{\left(j_{11} - j_{22}\right)^2 + 4j_{12}^2}\right)/2. \tag{19}$$

λ_1 and λ_2 denote the maximum and minimum eigenvalues of the structure tensor matrix corresponding to an image pixel point, respectively, and according to the change of the values of the two, the structural characteristics of the local region of the image can be reflected. The details are as follows:

(1) When both λ_1 and λ_2 are small (close to 0), it means that the grayscale values in the neighborhood of the point in the image do not change much in the horizontal and vertical directions, and the point is in the flat region of the image.

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(2) When λ_1 is larger and λ_2 is smaller, it means that the gray scale rate of change of the point in the horizontal and vertical directions is obviously different, there are edge or line features, at this time the point should be in the edge of the image region.
(3) When the values of λ_1 and λ_2 are larger, it means that the gray scale change in the neighborhood of the point is very drastic in both horizontal and vertical directions, and the point should be in the corner region at this time.

2) Improvement of the Priority Calculation Function

In addition, according to the analysis in the previous section, it is known that the local feature information of an image can be expressed by the eigenvalues of the structure tensor corresponding to it. Therefore, in this paper, the local feature function of the image defined by the eigenvalue of the structure tensor is introduced into the formula of the priority, and the priority function is improved.

The local eigenfunction $F(p)$ is defined as:

$$F(p) = 1 - \frac{1}{1 + (\lambda_1 - \lambda_2)^2}. \tag{20}$$

In Eq. (20), λ_1 and λ_2 are the two eigenvalues of the structure tensor, when $F(p) \approx 0$, the pixel is located in a flat region in the image. When $F(p) > 0$, it means that the pixel is in the edge or corner region with strong changes. By calculating the local eigenfunction $F(p)$, the local information of the image can be accurately represented.

By introducing $F(p)$ into the calculation of the priority function, the new segmented adaptive priority function can be obtained as:

$$P(p) = \begin{cases} (\alpha + \beta) \cdot C(p) \cdot D(p) + \gamma F(p) & C(p) > \lambda \\ \alpha C(p) + \beta D(p) + \gamma F(p) & C(p) \leq \lambda \end{cases}. \tag{21}$$

In the above equation, α, β and γ are the weight values of each component, respectively, and the three satisfy $\alpha+\beta+\gamma = 1$, and in order to make the structural information in the image can be restored preferentially, $\alpha, \beta < \gamma$. In this paper, we set the values of α, β and γ as follows: 0.2, 0.2 and 0.6.

λ for the control function segmentation selected threshold, in order to ensure that the known information in the block to be repaired can be fully utilized, this paper sets: $\lambda = 0.8$. When the confidence level term $C(p) > 0.8$, indicating that the block to be repaired at this time contains more known information, the confidence level term has a great impact on the repair order of the algorithm, at this time to maintain the multiplication of the original algorithm in the form. When the confidence term $C(p) \leq 0.8$, and then the confidence term and the data item is changed to the form of addition, to avoid the rapid decline of the confidence term and reduce the impact of the data item on the priority calculation.

3) Improvement of the Matching Criterion and Confidence Updating Methods

(1) Improvement of the matching criterion

In the matching criterion of Criminisi's algorithm, the best matching block is determined only by comparing the sum of squared pixel differences between the block to be repaired and the matching blocks in the search area. However, it does not take into account the question of how to make trade-offs when multiple matching blocks are searched with the same SSDs between the blocks to be repaired, which can lead to the occurrence of false matches.

Due to the existence of image continuity, images in two neighboring regions are highly similar in texture and structure, and the further away two pixel blocks are, the lower the correlation between them. Therefore, it can be assumed that in the process of image restoration, the closer the image block to the broken region, the more similar the information contained therein is to that of the broken region, i.e., the closer the matching block to the block to be restored is, the more likely it is to contain the missing information required for the restoration, and the optimal matching block required for the filling work is more likely to be contained therein. The matching criterion can be improved by using the Euclidean distance between the center pixel points p and q of both the block to be repaired ψ_p and the matching block ψ_q. The Euclidean distance $S(p, q)$ between p and q is defined as:

$$S(p,q) = \sqrt{(x_p - x_q)^2 + (y_p - y_q)^2}. \tag{22}$$

In the above equation, (x_p, y_p) and (x_q, y_q) represent the coordinate values of p and q points in the image, respectively.

In order to ensure the accuracy and comprehensiveness of the search process, it is still chosen to use the global search mode in the process of finding the best matching blocks. When searching for multiple matching blocks that have the same sum of squared color differences as the block to be repaired, the Euclidean distance between the blocks is used as a selection criterion, and the closer the distance, the higher the probability that the matching block will be identified as the best matching block.

(2) Improvement of confidence updating method

Criminisi's algorithm will fill the missing regions in the block to be repaired with the information of the corresponding position in the best sample block searched for every time it completes the repair, so that the missing regions become known regions, and then the confidence level on the repaired pixel block has to be updated. Although the best matching block is determined by the SSD criterion and the Euclidean distance, if the pixel block with a large difference from the block to be repaired is still selected to be filled and the confidence updating method in the original algorithm is used, it will inevitably lead to errors in the updated confidence, and this kind of error will affect the stability of the repairing sequence after continuous accumulation.

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To address the above problem, a new confidence update method can be formed by combining the SSD value between the matching block and the best block to be repaired. If the SSD value between the matching block and the block to be repaired is smaller, it means that the difference between the two is smaller, and the information filled in is more credible, while the larger the SSD value is, it means that the information filled in is less credible, which implies that this repair produces unreasonable repair results. At this point, it is necessary to reduce the confidence level of the points on the edge of the fill, and prioritize other areas as the block to be repaired. The improved confidence update formula is as follows:

$$C(p) = \frac{C(\hat{p})}{|\psi_{\hat{q}}|} \quad \forall p \in \psi_{\hat{p}} \cap \Omega. \tag{23}$$

III. Analysis of Examples of Digital Heritage of Folk Art

A. Empirical Analysis of Image Restoration Based on Criminisi Algorithm

Quantifying the difference between the improved algorithm and the traditional algorithm repair, this paper utilizes the comparison indexes are root mean square error, peak signal-to-noise ratio, repair time, average absolute error, weighted peak signal-to-noise ratio. The results of empirical analysis of image restoration based on Criminisi algorithm are shown in Table 1, and the average speed results are shown in Figure 4. The results show that the improved Criminisi algorithm compared to the classical Criminisi algorithm root mean square error is reduced by 44.34%, the peak signal-to-noise ratio is improved by 6.42%, the average absolute error is reduced by 23.67%, and the weighted peak signal-to-noise ratio is improved by 7.57%, and these indexes indicate that the repair effect of the improved Criminisi algorithm is better than the classical Criminisi algorithm. These indicators show that the improved Criminisi algorithm repair effect is better than the classical Criminisi algorithm repair effect, but the improved Criminisi algorithm repair time is longer than the traditional algorithm time increased by 64.25%, but it is still less than 0.500 seconds, which is within the acceptable range. At the same time, subjective evaluation, the improved Criminisi algorithm is smoother than the traditional Criminisi algorithm in repairing the defective areas of folk art, which is more in line with the flow field law. Therefore, the improved Criminisi algorithm has some practicality for the digitization and inheritance of folk art in the information age.

B. Research and Analysis of Image Restoration Technology Assisted Art Digitization

1) Analysis of the popularity of the concept of digital heritage of folk art

The results of the analysis of the popularity of the concept of image restoration technology-assisted folk art digitization are shown in Table 2, which shows that the number of people who have heard of the concept of "image restoration technology-assisted folk art digitization" accounts for 67.1% of the total number of people, which is only at an average level. Although many people know that the digital inheritance of folk art can be preserved by means of pictures, audio, video and multimedia, they do not know that it belongs to the category of "image restoration technology assisting the digital inheritance of folk art". In addition, it can be seen that the number of users under 30 years old who have heard of the concept of image restoration technology assisting the digital heritage of folk art accounts for an average of 63.04% of the total number of users in this age group, while the average percentage of users over 30 years old reaches 68.82%. This indicates that the popularity of the concept of image restoration technology-assisted folk art digital inheritance is different between different age groups. Users under the age of 30 are the generation that tends to pursue modernized life, and it is expected that they may pay relatively less attention to the digital heritage of folk art assisted by image restoration technology. It can be inferred that there is a positive correlation between literacy and whether or not they have heard of the concept of "image restoration technology assisting folk art digital heritage". People with higher education have broader knowledge and more opportunities to contact digital technology, so most of them have heard of the concept of "image restoration technology assisting the digital heritage of folk art", while other people have closed access to information on folk art digitization, so they have not paid much attention to the digital heritage of folk art.

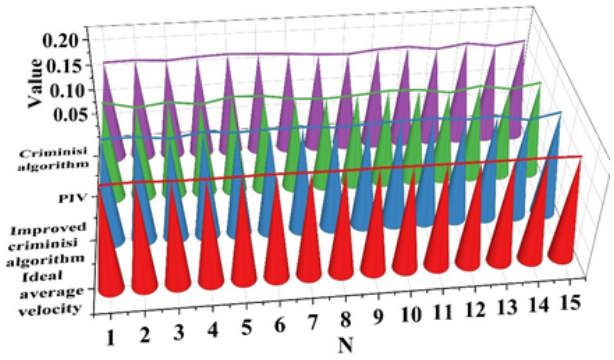

Figure 4: Average velocity result

2) Analysis of the Effect of Folk Art Digital Experience

Folk art digital experience effect analysis results shown in Table 3, the results show that the number of users visit the image restoration technology assisted art digitization activities is low, 43.33% of people did not visit, 45.42% of people only visited 1-3 times. The reason for this is that image restoration technology assisted folk art digitization technology is in its infancy, and some folk art works have a more complex process image restoration technology can not realize the digital experience, such as Guangxi paper-cutting folk art, Jiangxi Jingdezhen ceramics and so on. Museums, cultural centers and other places have also begun to use image restoration technology to obtain the folk art of multimodal, such as video,

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A Multidisciplinary Journal

Project	Defect field	Classic criminisi algorithm	Improved criminisi algorithm
MSE	10.082	2.914	1.622
PSNR	40.682	45.772	48.709
T/S	0	0.235	0.386
MAE	0.922	0.376	0.287
WPSNR	32.889	41.552	44.697

Table 1: An empirical analysis of image restoration based on criminisi algorithm

Content		Frequency	Percentage	Cumulative percentage
In effect	Yes	155	67.1%	67.39%
	No	75	32.47%	100.00%
	Total	230	99.57%	
Deletion	System	1	0.43%	
Total		231	100.00%	
Content		Yes	No	Total
Age group	Under 20	35	20	55
	21-30	52	31	83
	31-40	26	15	41
	41-50	22	8	30
	Over 51	16	6	22
Total		151	80	231
Content		Yes	No	Total
Cultural degree	Junior middle school and below	8	6	14
	High school	18	16	34
	Junior college	34	18	52
	undergraduate	74	33	107
	Graduate student	17	7	24
Total		151	81	231

Table 2: Analysis of the popularization of digital concept of folk art

audio, pictures to display folk art, but the pavilion of folk art digital resource richness is still at a general level, the user's favorite way of digital display is the "physical + digital" display form, but the realization of the display form is not easy. Users' favorite digital display method is the "physical + digital" display form, however, the results of the realization of this display form are not ideal, virtual human-computer interaction, image restoration technology and other advanced technical concepts have not yet been fully applied to the folk art experience, and the results of the operation have also proved this, the folk art digitized display form is single, and the audience can't experience the effect of interacting with the folk art, which gives a discount to the attractiveness of the folk art. Overall, the cultural administration and all relevant departments should actively cooperate with each other to jointly promote the digital protection of non-heritage. At the same time, the relevant academic research institutions, universities and colleges, enterprises and institutions, social organizations and other aspects of the force to jointly carry out the protection of non-heritage. Virtual reality, image restoration and recognition technology, 3D modeling, motion capture, panoramic video and other advanced digital technologies are often concentrated in colleges and universities, research institutes and some outstanding enterprises, the cultural sector can work with these units to carry out digitization projects of folk art.

3) Evaluation of the Effect of Digital Preservation of Folk Art

The results of the evaluation of the effect of folk art digitization protection based on image repair technology are shown in Table 4, from which it can be seen that the users' evaluation of the effect of folk art digitization protection based on image repair technology is average (52.08%), and even a part of the people's evaluation is poor (1.67%). In addition, in the cross-analysis of people of different occupations, the evaluation of the protection effect by the authorities and institutions and students is higher, the authorities and institutions specializing in folk art protection and some colleges and universities have more contact with the digitized knowledge of non-heritage than other occupations, and they understand the actual level of the protection effect of digitization of folk art based on the image mending technology, so their evaluation is more comprehensive and objective. Therefore, their evaluation is more comprehensive and objective. Generally speaking, folk art consists of art, dance and drama, and when data collection is carried out, the focus must be on the collection of images, music and video, and on the basis of guaranteeing its original appearance to the maximum extent possible, the required functional modules should be designed to highlight the characteristics and promote the digital inheritance and protection of folk art at the same time.

C. Research and Analysis on the Inheritance Mechanism of Folk Art

Participate in the digital inheritance of folk art				
Project		Frequency	Percentage	Cumulative percentage
In effect	No visit	104	43.33%	44.44%
	1-3 times	109	45.42%	91.03%
	4-6 times	13	5.42%	96.58%
	Above 6	8	3.33%	100.00%
	Total	234	97.50%	
Deletion	System	6	2.50%	
Total		240	100.00%	
The digital resource richness				
Project		Frequency	Percentage	Cumulative percentage
In effect	Rich	30	12.50%	12.55%
	Enrich	98	40.83%	53.56%
	General	92	38.33%	92.05%
	Scarcity	18	7.50%	99.58%
	Scarce	1	0.42%	100.00%
	Total	239	99.58%	
Deletion	System	1	0.42%	
Total		240	100.00%	
User preference				
Project		Frequency	Percentage	Cumulative percentage
In effect	Pure entity	35	14.58%	14.71%
	Entity + digitization	195	81.25%	96.64%
	Pure digitization	8	3.33%	100.00%
	Total	238	99.17%	
Deletion	System	2	0.83%	
Total		240	100.00%	
The reason for not interacting with the digital platform				
Name		Respond		Cumulative percentage
		N	percentage	
Content	Other disadvantages	33	13.75%	13.75%
	Less digital products	77	32.08%	45.83%
	Digital expertise	55	22.92%	68.75%
	Digital content is tedious	45	18.75%	87.50%
	Digital display form is single	30	12.50%	100.00%
Total		240	100.00%	

Table 3: Results of the analysis of the results of the digital experience of folk art

Project		Frequency	Percentage	Cumulative percentage
In effect	Very good	15	6.25%	6.30%
	Good	72	30.00%	36.55%
	General	125	52.08%	89.08%
	Difference	16	6.67%	95.80%
	Very bad	4	1.67%	97.48%
	Unacquaintance	6	2.50%	100.00%
	Total	238	99.17%	
Deletion	System	2	0.83%	
Total		240		

Project		Digital protection of folk art						
		Very good	good	general	difference	Very bad	Unacquaintance	total
Occupation	Business unit	12	16	22	6	1	3	60
	Corporate staff	1	12	26	0	1	1	41
	Freelancer	1	9	16	2	0	1	29
	Student	1	22	38	9	1	4	75
	Peasantry	6	1	3	0	1	1	12
	Other	1	9	8	3	1	1	23
Total		22	69	113	20	5	11	240

Table 4: Evaluation of the digital protection effect of civil art

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1) Analysis of Variables of Users' Perception of the State of Folk Art Inheritance

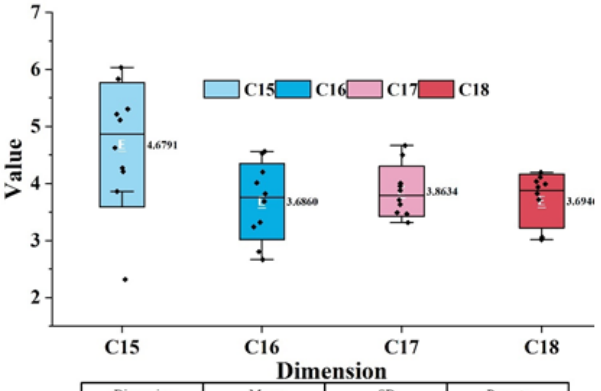
Table 5 shows the results of the analysis of the user's perception of the state of folk art inheritance, and it can be seen that there are a total of 9 variables, and there are 5 variables with a score of 3.50 or above, namely "C3 inheritors have a high social status and are respected", "C4. I think that the protection and inheritance of folk art is mainly the business of the government", "C5 I think the protection and inheritance of New Year paintings are mainly the business of intangible cultural heritage inheritors", "C7 I do not have many opportunities to participate in activities such as folk art transmission and training", "C9 folk art is not easy to sell, and the new products developed are more popular with the market". It can be seen that the community residents recognize the status of the inheritor, and at the same time, they also believe that the inheritance of folk art is more a matter of the government and inheritance. They don't have many opportunities to learn on their own. The new products are more popular in the market. There are three variables with a score of 2.50 or less: "C1 folk art is well inherited", "C6 I think villagers should actively participate in the protection and inheritance of folk art", and "C8 I am willing to learn, and I will let my next generation learn folk art". These three statistics show that the community residents are not willing to participate in the inheritance of folk art.

2) Analysis of Perceived Variables of the Impact of Tourism on Community Residents

The results of the analysis of the variables of community residents' perceptions of tourism impacts are shown in Table 6, and the data illustrate that the community residents' perceptions of the impacts related to tourism development are highly recognized, with the average value of the five dimensions from C10-C14 reaching 3.67736. Such perceptions have benefited from the joint efforts of the Folk Art and Rural Tourism in the last decade or so. However, in terms of the standard deviation value and approval rate, there are also inconsistent perceptions and attitudes in the perception of tourism impacts among the interviewed community residents due to the fact that tourism development has increased the employment opportunities and incomes of the community residents, and that tourism development has promoted the preservation and inheritance of the folk yushu. At the same time, the negative impacts of tourism, such as breaking the tranquility of the countryside and affecting the lives of residents, also exist objectively.

3) Analysis of Variables in Community Residents' Perceptions of the Overall Benefits of Heritage

The results of the analysis of the variables of community residents' perception of the comprehensive benefits of inheritance are shown in Figure 5, with C15 improving the popularity and influence of folk art, C16 improving the living environment of the community, but the traffic is not smooth during the peak season, C17 improving the community infrastructure, and C18 enhancing the pride of the local community residents. The



Dimension	Mean	SD	Pro rate
C15	4.6791	0.9331	0.848
C16	3.686	1.1189	0.6615
C17	3.8634	1.0222	0.848
C18	3.6946	0.9354	0.7645

Figure 5: Analysis of the perceptual variables of the integrated benefit of the user

results show that the interviewed community residents have a high degree of agreement with the comprehensive benefits brought by the protection and inheritance of folk art, with the average value of C15-C18 reaching 3.980775. They are most in agreement with the increase in the popularity and influence of folk art, and have a strong positive effect on the improvement of the community infrastructure brought about by the folk art, which has strengthened the sense of pride of the community residents, and improved the human living environment, and the positive effect is obvious.

IV. Conclusion

In this paper, for the sustainable development of Chinese folk art, image restoration technology is proposed to assist the research of folk art digital inheritance, and based on the statistical analysis method, the digital inheritance of folk art is analyzed by examples. The research results of this paper are shown as follows:

(1) Through the empirical analysis of image restoration technology based on Criminisi algorithm, it is concluded that the improved Criminisi algorithm reduces the root-mean-square error by 44.34%, improves the peak signal-to-noise ratio by 6.42%, reduces the average absolute error by 23.67%, and improves the weighted peak signal-to-noise ratio by 7.57% compared with the classical Criminisi algorithm, and these indicators show that the improved Criminisi algorithm has a better restoration effect than the classical Criminisi algorithm. These indicators show that the repair effect of Criminisi algorithm is better than that of classical Criminisi algorithm, which confirms that the improved Criminisi algorithm has some practicality for the digital inheritance of folk art in the information age. The research results of this paper can let the people of the world know more about and recognize the excellent traditional

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Dimension	Symbol	Mean-Value	Standard deviation	Pro rate
Folk art is well passed on	C1	2.4178	0.91813	17.57%
The government attaches importance to the heritage of folk art	C2	3.1365	0.94851	37.25%
The inheritances of people are high and respected	C3	4.3231	0.74176	91.15%
I think that civil art protection and heritage are mainly government	C4	3.7488	0.62657	84.33%
I think the protection and inheritance of folk art is the inheritance of people	C5	3.9428	0.72261	85.25%
I think the villagers should actively participate in the protection and inheritance of civil art	C6	2.2011	0.92334	8.55%
I am involved in activities of civil art and training	C7	4.3156	0.84247	88.45%
I am willing to learn, and I will let my next generation learn the art of folk art	C8	2.409	0.85254	8.35%
Folk art is not good to sell, and the new products developed are more popular with the market	C9	4.1485	1.12831	80.15%

Table 5: The user analyzes the state perception variables of folk art

Dimension	Symbol	Mean-Value	Standard deviation	Pro rate
Folk art attracted visitors, but broke the peace of the country	C10	4.0432	0.83467	87.45%
Tourists are interested in folk art, but tourism development is not strong	C11	4.0432	0.84565	87.25%
People who master folk art skills benefit more from tourism development	C12	4.0817	1.0065	86.25%
Because tourism development increases the employment opportunities and incomes of community residents	C13	3.0529	0.93613	33.28%
Tourism development promotes the protection and inheritance of civil art	C14	3.1658	1.0135	50.22%

Table 6: Analysis of sensory variables of community residents' tourism impact

culture of the Chinese nation, and win the initiative of the international cultural competition mechanism.

(2) In the analysis of the research on image restoration technology-assisted fine art digitization, it was found that the number of users aged under 30 who had heard of the concept of image restoration technology-assisted folk art digitization inheritance accounted for an average of 62.14% of the total number of people in that age group, while the average percentage of users aged 30 or older was 68.82%, which suggests that the popularity of the concept of image restoration technology-assisted folk art digitization inheritance varies in different age groups is different. In conclusion, through the use of image restoration technology to repair and protect some damaged, deteriorated and dying folk art works, virtual and restore the most original appearance and present it to everyone, thus realizing the "seamless connection" of the means of folk art protection in terms of time and space and time sequence.

(3) Based on the research and analysis of folk art inheritance mechanism, it presents that the interviewed community residents have a very high degree of agreement with the perception of the comprehensive benefits brought by the protection and inheritance of folk art, and the average value of C15-C18 reaches 3.980775.Overall, it is necessary to make full use of the current mobile Internet technology and information dissemination technology, and effectively and adequately go to explore the user's behavior, cognition and perceptual "space", to find new thinking and new channels for the inheritance and protection of folk art.

V. Fund Project

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