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The Application of Color in the Creation of Digital Art Based on Big Data Analysis: A Study of Traditional Chinese Murals

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Abstract. In order to improve the effect of the application of color in the creation of traditional Chinese murals, this paper analyzes the application of color in the creation of traditional Chinese murals with the framework of big data analysis, and analyzes the amplitude-frequency characteristics of the visual axis stabilization ring. This paper uses proportional lead correction to meet the dynamic and steady-state performance requirements of the system. Moreover, this paper designs and implements the fuzzy PID controller to control the vision stabilization gimbal system. Aiming at the gyro drift problem, an algorithm for accelerometer compensation for gyro drift is proposed, and the simulation analysis is carried out. The experimental research shows that the effect of color application in traditional Chinese mural creation based on the big data analysis framework proposed in this paper is relatively obvious.

Keywords: big data; analytical framework; traditional murals; creation; color; creation of Digital Art
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1 INTRODUCTION

According to the subjective needs of the painter, we seek changes in the tone of the inherent color of the object by means of flattening. The purpose of assigning color is not to create a three-dimensional effect of the picture. Therefore, the flat coating method, the overlapping color method, the separate dyeing method, etc. have become the commonly used coloring methods in fine brushwork. In the specific color application process of gongbi painting, the color is generally first painted flat, and after it is dry, the second color is applied flat, and the third color is applied to realize the infinite color change after the overlapping of colors. For example, when red is overlapped for many times, it becomes thicker and richer, and when yellow and blue are overlapped, green is produced, etc. [1].

Planarization does not mean not to show the ups and downs and body structure of objects. In addition to flat painting and color overlapping, fine brushwork also has a unique way to show the ups and downs and body structure, that is, the dyeing method. There are light stone colors on darker

colors, such as white petals on a dark background; Or use darker colors to dye on light colors, such as using ink to dye the shape and structure of objects on a light background [2]. After several times of flat coating, color overlapping and separate dyeing, cover the dyed alum solution to fix the dyed color. Through the comprehensive application of these color setting techniques, the traditional meticulous painting can be seen thick in thin color setting, loose in thick color setting, simple in beauty, and complex in simplicity. The space distance is extended in the virtual and real colors and shades, and the plane processing of the picture and the contrast change and form aesthetic feeling after plane segmentation are emphasized. It has a strong decorative property, and with the help of color and color, color and ink, "From light to thick, one color changes into one color" [3], getting rid of the shackles of natural color changes, and seeking subjective colors that are both from nature and more ideal than nature, forming an oriental artistic style that is beyond the physical image and emphasizes beauty [4].

The emergence of the computer has an impact and significance on human beings beyond imagination. Whether in the history of human science and technology or in the history of art, it is an epoch-making milestone. The original purpose of computer design is to make it become a mathematical tool for processing abstract symbols. With the display running, people can clearly see the operation results. This intuitive vision has led to the generation of electronic images, which eventually become a new artistic expression [5]. The computer makes the object of human production expand from tangible material to intangible electronic, and makes the processing and communication of information become the main content of people's life. While continuously improving the basic functions of computers, people also put forward higher requirements for the "beauty" of digital products, that is, artistry, and thus launched exploration [6]Digital art has also expanded the possibilities for collaboration and interaction. Artists can collaborate remotely by sharing files and working on the same digital canvas. Interactive digital installations enable viewers to actively engage with the artwork, providing a participatory and immersive experience. These interactive experiences often blur the lines between the creator and the audience, as the viewers become active participants in the artistic process.

Digital image technology is the basis of digital image art creation First of all, it should be supported by computer hardware equipment and software technology, which directly affects the speed and quality of image generation and processing. The computer system is composed of CPU (Central Processing Unit, that is, arithmetic unit and controller), memory, display, input and output devices, etc. The speed of updating is increasing by geometric progression [7]. Image technology can be simply summarized as vector graphics technology and pixel bitmap technology. Vector graphics technology refers to the technology that obtains points, lines, surfaces, and volumes through mathematical formula calculation, and then describes the graphics. It is suitable for engineering construction, industrial products, and other areas where standard graphics require accurate calculation. The graphics generated by applying this technology have the advantage of occupying less hardware resources. Arbitrary expansion or reduction will not affect the graphics quality [8]. Pixel bitmap is another technology to solve image based on chromatics, also known as dot matrix image or drawing image It consists of a single point called a pixel (picture element). These points can be arranged and colored differently to form the pattern [9]. The image is input to the computer through an input device, or directly generated into a digital image through computer software. In fact, it exists as digital information, and each pixel of the screen is assigned a specific value. That is, when you modify the screen on the display, you actually change each number of the screen accordingly. Now, with the rapid development of digital image technology, its image simulation technology is incomparable to any traditional media [10]. For example, the color system of the computer has multiple modes: bitmap mode, gray mode, two tone mode, HSB (i.e. hue, saturation, brightness) mode, RGB (i.e. red, green, blue) light primary color mode, CHbIK (i.e. cyan, magenta, yellow, black) printing mode, lab (i.e. brightness, green red axis, and blue yellow axis) mode, index color mode, multi-channel mode, and 8-bit/16 bit mode, Moreover, the principle of image description and color reproduction of each mode and the number of colors that can be displayed are different. The color mode determines the color model for displaying and printing

electronic images (simply speaking, the color model is a mathematical algorithm used to represent colors), that is, how an electronic image is displayed or printed on the computer [11].

The working principle of the computer is to complete each input command through calculation. For this reason, digital image technology is a technology that uses algorithms to program digital image elements with program language to carry out artistic design. Its working procedure is to classify and store the digitized image elements and their images regularly, then call them as needed, and implement them with a logical algorithm. For this reason, it requires creators to cultivate an abstract thinking ability of classification cognition, learn to classify knowledge and experience in different fields, and summarize them to adapt to the working mode of computers, otherwise image creation will become very passive [12]. Digital image technology turns different kinds of art into homogeneous numbers, which can connect the artistic creation and design of various categories. Therefore, digital image artistic creation is the result of the integration of various disciplines and theories, and image creation has improved the requirements for artists' comprehensive quality [13]. In practice, compared with using traditional tools to create with digital technology, on the computer interface, creation requires an all-round overall idea, including the creation steps, and the order and degree of using command effects [14]. If traditional art creation is a kind of creation based on intuition and sensibility, then digital image art creation is a scientific design based on artistic sensibility. For example, for the processing of the texture effect of the screen image, in terms of the understanding and selection of object materials, since the computer has its own algorithm and rules for the simulation of the objective world materials, the performance of the screen objects and the performance of the texture of different materials appeal to different expression effects [15]. How to find the appropriate performance requires that the creator not only has the perceptual knowledge and accumulation of materials in life, but also needs to have the functional knowledge of computer simulation materials, and use the appropriate materials to represent the screen. Therefore, from the perspective of digital image art creation process, the requirements of rational classification and cognitive thinking make digital image creation more emphasis on a rational spirit than traditional art creation, and require artists to use certain logical thinking to fully and rationally analyze and design various related factors, so as to create works with depth [16].

The formation of any art must depend on a certain media for communication. Different forms of media also determine various forms of art. Murals, traditional Chinese paintings, oil paintings and films are all divided by different media. Any kind of art communication media is also composed of its specific technology [17]. Artists' skills in using media are both the ability to restrict and counter restrict materials and technologies. This ability constitutes the basis of the artist's artistic language. When an artist can use this ability to express an idea, he becomes a language. On the contrary, it can only be a technology or skill. All kinds of media have limitations in materials and technology, which restrict artists to create at will [18]. But it is precisely because of this limitation that each art has its own characteristics. If artists can understand and adapt to these limitations, and observe the world and think about problems on this basis, they can form a unique aesthetic consciousness and form a relatively independent style. It can be seen that the division of art forms and categories is mainly based on the difference of relevant media. Different technologies related to specific materials and tools of media, as well as various production methods and thinking angles brought by this technology to creators, constitute the artistic form of language and become the basic elements of artistic language [19].

This paper combines the big data analysis framework to analyze the use of color in the creation of traditional Chinese murals, and to improve the promotion of traditional Chinese murals to modern art

2 VISUAL ANALYSIS ALGORITHM FOR DIGITAL MURALS

2.1 Control System Design and Drift Compensation Algorithm

The visual stabilization pan/tilt is based on the stabilization of the visual axis to ensure that the target is always on the optical axis of the camera, that is, the target is in the center of the image.

Over time, these disturbances will seriously degrade the stability and accuracy of the system and make it impossible to complete the tracking of the target. Therefore, it is necessary to design a reliable servo controller to overcome the influence of disturbances and improve the performance of the entire system.

The pitch frame and azimuth frame of the dual-axis vision gimbal isolate the carrier disturbance by introducing the gyro angular velocity signal, so that the camera's line of sight can be stabilized at a preset angle, and the relative inertial space is stable and has nothing to do with the motion of the carrier. Figure 1 shows the structure of the stable ring:

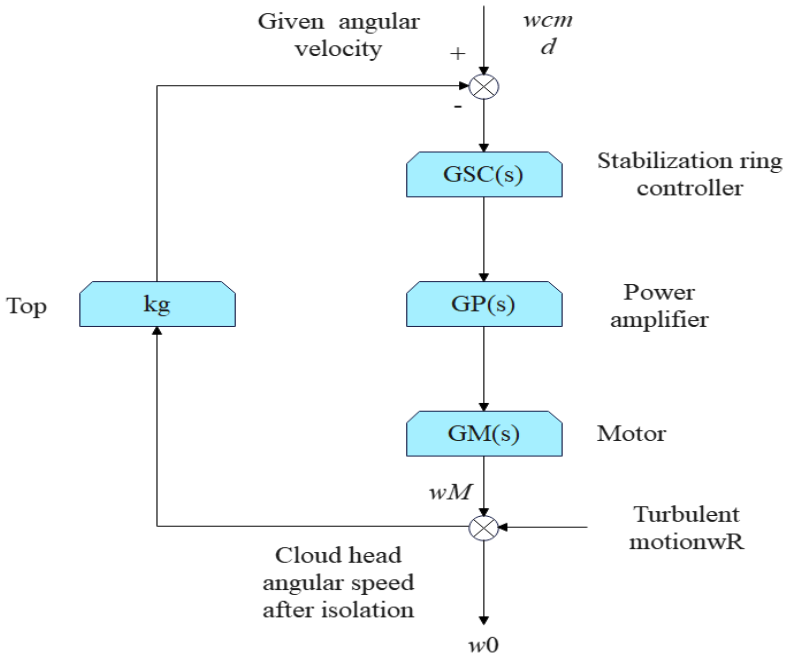


Figure 1: Structure diagram of boresight stabilization ring.

Ideally, when the given angular velocity ω_{cmd} of the gimbal is 0, due to the existence of the carrier disturbance angular velocity ω_R, the stability loop controller drives the motor to rotate at the angular velocity of $\omega_M = -\omega_R$, thereby isolating the disturbance and keeping the gimbal stable, that is, $\omega_0 = 0$. From Figure 1, we get:

$$\frac{\omega_0(s)}{\omega_R(s)} = \frac{1}{1 + k_g G_{SC}(s) G_P(s)} \tag{1}$$

The scale factor k_g of the gyroscope and the gain of the motor driver $G_p(s)$ are limited to a certain extent. By adding the correction link, it can ensure that the stability loop has a large enough additional gain, and the system performance is better.

The open-loop transfer function of the stable loop is:

$$G_W(s)=\frac{k_P/k_e}{\tau_m\tau_e s^2+\tau_m s+k_P/k_e+1} \tag{2}$$

Taking the pitch ring as an example, after simplification and parameter determination, we get:

$$G_W=\frac{2.13}{5.6s^2+1.02s+0.07} \tag{3}$$

In the Bode diagram, the low frequency region of logarithmic frequency characteristics reflects the steady-state characteristics of the closed-loop system, the intermediate frequency region reflects the relative stability of the system, and the high frequency region reflects the anti-interference of the system.The open-loop amplitude-frequency and phase-frequency characteristic curves are obtained through simulation, as shown in Figure 2.

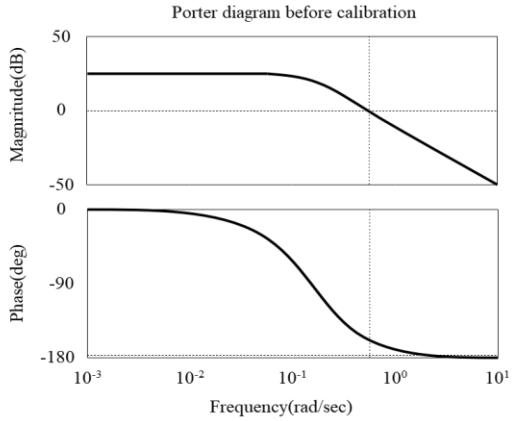


Figure 2: Characteristic curve of uncorrected stabilization loop.

It can be seen from the figure that the low-frequency gain of the uncorrected stabilization loop is only 29.7dB, and the phase angle margin is only 17°, which cannot meet the requirements of the stabilization loop system.

The transfer function of the lead correction network is:

$$G_F(s)=\frac{1+aTs}{1+Ts}(a>1) \tag{4}$$

Its characteristic curve is shown in Figure 3, and the maximum leading phase is:

$$\varphi_m=arcsin\frac{a-1}{a+1} \tag{5}$$

The frequency of occurrence of the maximum leading phase angle is:

$$\omega_m=\frac{1}{\sqrt{aT}} \tag{6}$$

Through multiple Matlab simulations and calculations, it is determined that the ratio K is 8, T is 0.053, and a is 29.4, and the transfer function of the correction network is obtained as:

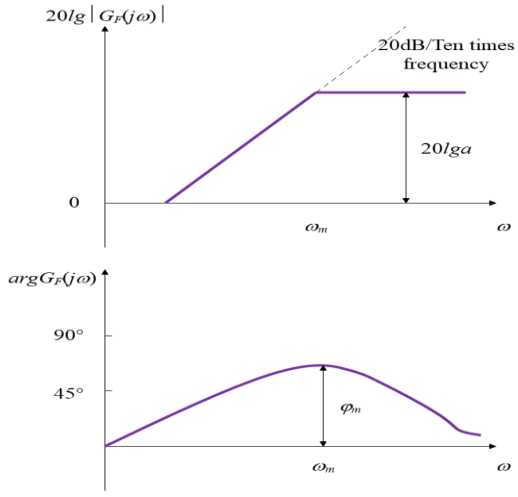


Figure 3: The characteristic curve of the lead correction network.

$$G_F = 8 \times \frac{1.558s+1}{0.053s+1} \tag{7}$$

The amplitude-frequency and phase-frequency characteristics after the correction of the stabilization loop are shown in Figure 4:

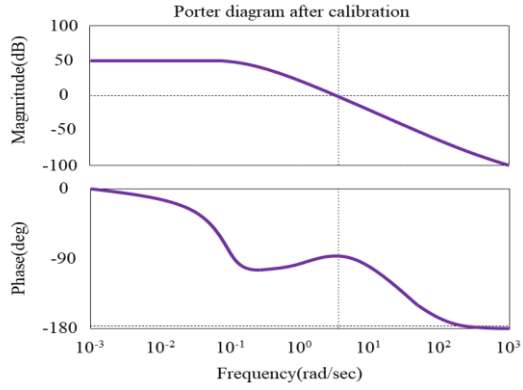


Figure 4: Corrected amplitude-frequency and phase-frequency characteristics.

Figure 5 is a comparison diagram of the unit step response curves of the stability loop before and after correction. It can be seen from the figure that the rise time of the corrected stability loop unit response curve is shorter, the overshoot is reduced, the adjustment time is shorter, and there is no steady-state error. Therefore, after the proportional lead correction, the steady-state performance and dynamics of the system.

2.2 Control Method Of Visual Stabilization System

The position loop is the outermost loop of the system. In order to obtain better control accuracy and reliable stability, the fuzzy PID controller is used for servo control of the vision pan/tilt system. The structure of traditional PID controller and fuzzy PID controller is analyzed, and the controller suitable for this system is designed according to their respective advantages and disadvantages.

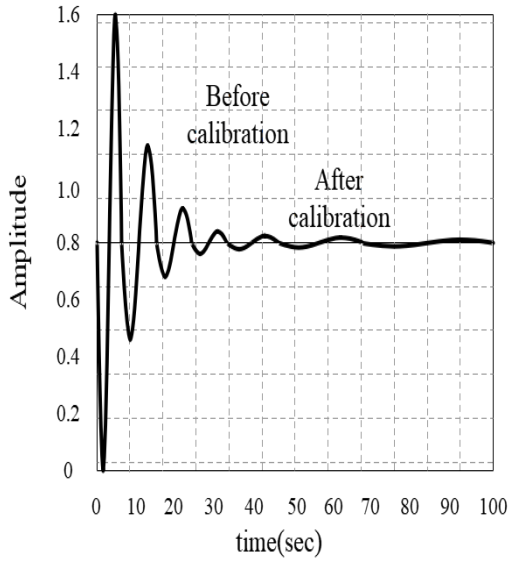


Figure 5: Comparison curve of step response before and after correction.

The PID controller is simple and easy to implement, and is widely used. The input-output relationship is as follows:

$$u(t)=k_P\left(e(t)+\frac{1}{T_I}\int_0^e e(t)dt+T_D\frac{de(t)}{dt}\right) \tag{8}$$

Its transfer function is:

$$G_{PID}(s)=\frac{U(s)}{E(s)}=k_P\left(1+\frac{1}{T_l s}+T_D s\right) \tag{9}$$

In practical application, in order to adapt to the characteristics of the computer, discrete processing is required, that is, digital PID control. The digital PID algorithm expression is obtained from the above formula:

$$u(kT)=k_P e(kT)+K_I\sum_{j=0}^{k}e(kT)+k_d[e(kT)-e(K-1)T)\Big] \tag{10}$$

In the formula, u(kT) is the output of the algorithm at the time of kT, e(kT) is the deviation of the input at the time of kT, e(K-1)T is the deviation of the input at the time of (K-1)T, k_P is the proportional coefficient, and $k_D=k_P(T_D/T)$ is the differential coefficient.

The digital PID is beneficial to the programming of the single chip computer and the adjustment of parameters, so as to realize the feedback control of the vision stabilization PTZ.

The traditional PID is simple and easy to implement, and has good control accuracy and stability, but for the nonlinear, uncertain or time-varying links of the system, such as motor dead zone, saturation and structural resonance, the system has serious distortion and affects the stability. Therefore, only using traditional PID control cannot meet the requirements of high stability, high precision and rapidity of the system.

Fuzzy control is a simple and practical control method developed rapidly in recent years, and it is the application of fuzzy theory in control technology. It is suitable for the controlled process without a mathematical model or it is difficult to establish a mathematical model, which can adapt to the nonlinear, uncertain and time-varying parameters of the system, and has better dynamic response characteristics..

In view of the strong complementarity of fuzzy control and PID control, the fuzzy PID control algorithm is used in this design to meet the system's requirements for rapidity, stability and high precision. Its structure is shown in Figure 6.

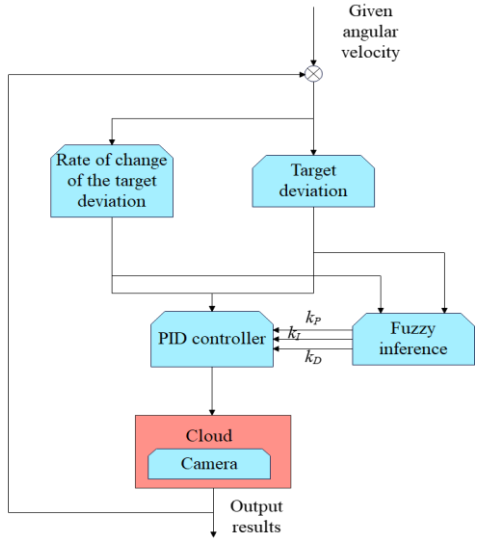


Figure 6: Structure of fuzzy PID control algorithm.

According to the structure of the fuzzy PID control algorithm and the stability control law of the visual pan/tilt system, the input and output membership function, fuzzy rule table and defuzzification algorithm are designed.

The fuzzy PID controller is designed using Simulink, and the system transfer function is simulated. The fuzzy inference is established for the three parameters k_p, k_I and k_D respectively. Each fuzzy rule table has two inputs and one output, e and cc are inputs, and k_p, k_I and k_D are outputs. The Simulink simulation program of the vision gimbal fuzzy PID control system is shown in Figure 7. On the basis of simulation, the fuzzy PID control algorithm is realized by the PTZ stability control chip MC9S12DG128.

2.3 Gyro Drift Compensation

The instability of the visual stabilization gimbal is caused by many factors. It relies on the gyro-sensitive deflection angular velocity to control the work of the stabilization loop before the target is calibrated or when it is purely aerial video surveillance. Gimbal stability and accuracy are key.

Kalman filtering is a linear minimum variance estimation that combines two estimates of a variable to form a weighted average, which is recursive. Updating the previous optimal estimate according to the known equations of motion yields one estimate, while the other estimate is obtained from measurements. In a vision gimbal system, the first estimate is directly provided by the gyro, and the second estimate is the measured value, provided by the accelerometer.

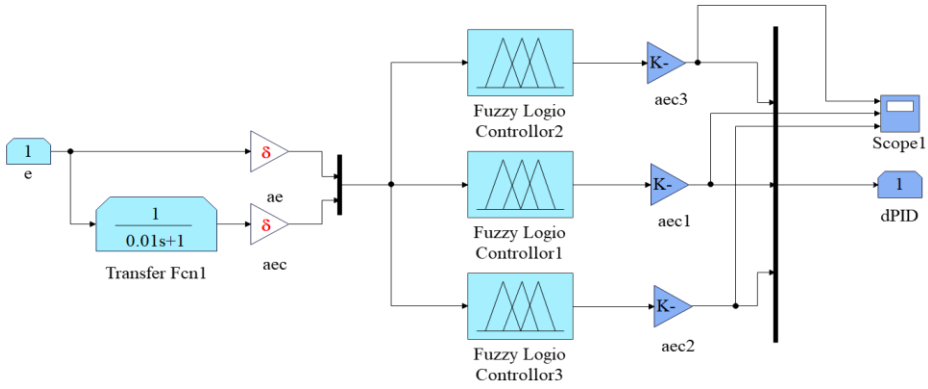


Figure 7: Block diagram of fuzzy control.

Its general method is described as follows. The state one-step prediction is $\hat{X}_{k,k-1} = \Phi_{k,k-1}\hat{X}_{k-1}$, the state estimate is $\hat{X}_k = \hat{X}_{k,k-1} + K_k\left[Z_k - H_k X_{k-1}\right]$, the one-step prediction error matrix is $P_{k,k-1} = \Phi_{k,k-1}P_{k-1}\Phi_{k,k-1}^T + T_{k,k-1}Q_{k-1}T_{k,k-1}^T$, the gain matrix is $K_k = P_{k,k-1}H_k^T\left(H_k P_{k-1}H_k^T + R_k\right)^{-1}$, and the estimate error square matrix is $P_k = \left[I - K_k H_k\right]P_{k,k-1}\left[I - K_k H_k\right]^T + K_k R_k H_k^T$.

In this design, the value of the accelerometer is introduced, and the characteristics of the accelerometer with high precision and no accumulation of errors are used. In the gimbal system, the accelerometer installed on the pitch frame can only obtain the pitch angle of the gimbal. For the yaw angle, a magnetic heading device can be considered. Since the direction of the system is basically unchanged during operation, only the gyro compensation of the pitch axis is considered.

When the carrier has no acceleration and deceleration movement and the gimbal is horizontal, that is, the z_f -axis of the pitch frame coordinate system coincides with the z_n -axis of the geographic coordinate system, and the output of the y_{Acc} -axis of the accelerometer is 0. When the carrier moves and the gimbal is not horizontal, the output value of the y_{Acc} -axis of the accelerometer is not 0, which is assumed to be Y_A. Using the trigonometric function, the pitch and deflection angle can be obtained as:

$$\theta_{Acc} = -arcsin\left(Y_A\right) \times 180 / \pi \tag{11}$$

This angle is compared with the pitch angle θ_{Gyro} obtained by integrating the gyro signal, and the compensation angle is obtained by certain limitation and scaling, and the gyro drift is corrected.

When the carrier continues to accelerate and decelerate, the signal output by the accelerometer contains the acceleration information of the carrier, and the deflection angle of the gimbal cannot be extracted and compensated. However, for the instantaneous acceleration, deceleration and vibration of the carrier, it can be removed by data filtering and the threshold limit of the total acceleration value, and it can still be compensated

3 THE APPLICATION OF COLOR IN THE CREATION OF TRADITIONAL CHINESE MURALS BASED ON THE FRAMEWORK OF BIG DATA ANALYSIS

The preservation and reproduction process of a complete set of mural information must go through multiple links, such as the collection of cave materials, close-up stereo digital photography, digital image color restoration, digital measurement and extraction, cave geometry data correction, computer mural digital image processing and storage, and wall surface reproduction and printing (Figure 8).

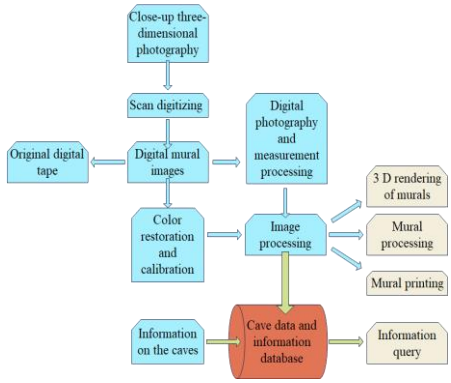
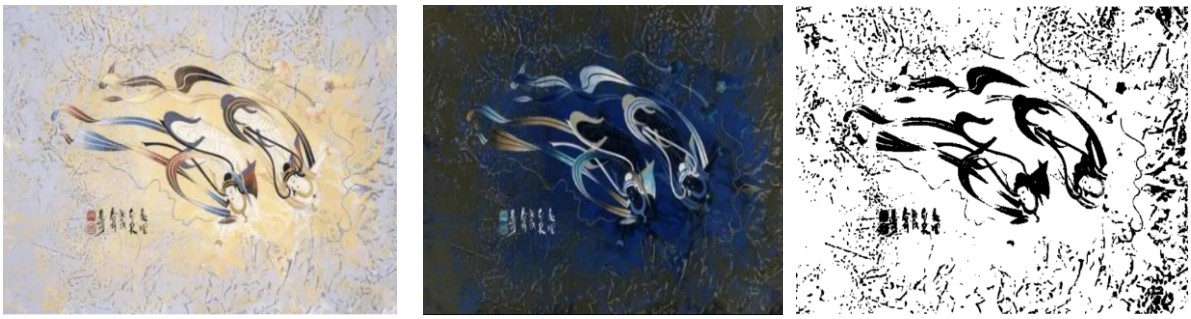


Figure 8: The computer processing flow of the mural.

According to the above process, the image data of the mural can be obtained by shooting with a digital camera. In order to obtain a high-precision mural image, first, a whole mural is divided into several areas for shooting, and the adjacent photos are partially overlapped for splicing. The captured mural image is preprocessed and then synthesized into the entire mural image. For the structure of the grotto, 3D modeling tools were used directly from the known measurement data to model, and the murals and floor tile textures were mapped to the surface of the cave wall by projection mapping. The method of bump mapping is used to simulate the relief on the cave wall, and the degree of concave and convex is changed according to the original condition of the cave wall to increase the realism. For colored sculptures and other 3D objects with complex shapes and high requirements for recording accuracy, 3D scanning technology can be used to obtain their models. Geometric models of 3D objects can be easily obtained using a professional 3D scanner. On the other hand, most of the cultural relics have rich color information, which can be realized by the method of obtaining the texture map of the object by scanning the monochrome model obtained by the 3D scanner and a series of digital photos taken around it.

The creation of Chinese painting material murals has its own color matching characteristics according to the different types of paintings, such as simple, symbolic, and natural ink art, courtyard painting pays attention to the law and attaches great importance to the form and spirit and the style is gorgeous and delicate, literati paintings that emphasize the interest of the brush and ink, delineate the similarities in the shape, emphasize the charm, and attach great importance to literature, calligraphy, and the creation of artistic conception in the paintings, and landscape painting with mineral azurite and stone green as main colors, blue-green paintings with big blue-green and small blue-green, light-colored painting with ochre as the main color on the basis of ink hook and chapped dyeing, and Jinbi landscape paintings mainly composed of mud gold, azurite and stone green. The environmental murals combine various expressions of the material and color of Chinese painting to create a brand-new visual language. This paper takes Dunhuang murals as an example for analysis, as shown in Figure 9. It can be seen from Figure 9 that the intelligent vision technology proposed in this paper can play a certain role in the color analysis of murals. Combined with big data technology, the application effect of traditional Chinese mural color is evaluated, and Table 1 is obtained.



(a) (b) (c)

Figure 9: Color analysis of traditional Chinese murals based on machine vision: (a) Original mural image,(b) Color recognition processing of mural images,(c) Intelligent grayscale processing of mural images.

Number	*Effect of color*	*Number*	*Effect of color*
1	*83.028*	*19*	*89.838*
2	*83.687*	*20*	*84.164*
3	*85.141*	*21*	*84.461*
4	*86.121*	*22*	*84.458*
5	*87.185*	*23*	*85.551*
6	*84.601*	*24*	*88.683*
7	*85.103*	*25*	*90.743*
8	*87.384*	*26*	*86.518*
9	*88.965*	*27*	*89.228*
10	*90.818*	*28*	*87.624*
11	*88.635*	*29*	*87.681*
12	*85.817*	*30*	*90.026*
13	*89.293*	*31*	*85.570*
14	*88.792*	*32*	*88.307*
15	*87.052*	*33*	*89.020*
16	*83.009*	*34*	*83.134*
17	*89.868*	*35*	*89.539*
18	*83.877*	*36*	*84.209*

Table 1: Color application effect of traditional Chinese murals.

From the results shown in Table 1, it can be seen that the effect of color application in the creation of traditional Chinese murals based on the big data analysis framework proposed in this paper is relatively obvious.

4 CONCLUSION

When murals appeared in ancient times, it was destined to have certain social attributes in function. The functionality of the mural requires the theme content and form of the mural to meet the aesthetic needs of the public or a certain social group. It carries the functions of promoting nationality, folk

customs and cultural orientation of the times, and has the purpose of social welfare. The "image color" of traditional meticulous painting is often realized through the comprehensive application of color-painting techniques such as flat painting, overlapping colors, and sub-dyeing, which is in the same line with the traditional Chinese color aesthetics ideology. The coloring method of Claborate-style painting is different from that of Western painting. This paper combines the big data analysis framework to analyze the use of color in the creation of traditional Chinese murals to improve the promotion of traditional Chinese murals to modern art. The experimental research shows that the effect of color application in the creation of traditional Chinese murals based on the big data analysis framework proposed in this paper is relatively obvious.

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