Retraction

Retraction: Virtual Restoration of Mural Color Based on Artificial Intelligence (J. Phys.: Conf. Ser. 1852 032020)

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The authors of the article have been given opportunity to present evidence that they were the original and genuine creators of the work, however at the time of publication of this notice, IOP Publishing has not received any response. IOP Publishing has analysed the article and agrees there are enough indicators to cause serious doubts over the legitimacy of the work and agree this article should be retracted. The authors are encouraged to contact IOP Publishing Limited if they have any comments on this retraction.

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Virtual Restoration of Mural Color Based on Artificial Intelligence

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Abstract. In recent years, the development of artificial intelligence can be described as rapid change, which provides a safer method for the virtual restoration of mural colors. This article mainly studies the virtual restoration of mural color based on artificial intelligence. This paper constructs the minimum spanning tree of the segmentation line and transforms it into a graph, finds out the closed sub-ring as the segmentation line from the graph, and uses the depth-first search algorithm to extract the surface in the segmentation line area. This paper performs threshold segmentation on the mural image to obtain the drop-off area. The threshold T is selected based on experience; the pixel points of the same attribute are merged by 8 adjacent methods, that is, the pixel value is 1, and then the closed operation is used to achieve the purpose of continuous drop-off information. In order to control the tendency of global optimization and neighborhood correlation, a proportional parameter needs to be added, and the parameters are adjusted to obtain a balance between neighborhood correlation and global optimization, and the best matching point can be obtained. The data shows that the average objective evaluation score of Criminisi algorithm is 0.794603, and the average objective evaluation score of the improved algorithm in this paper is 0.848665. The results show that artificial intelligence technology plays an extremely important role in the virtual restoration of mural colors.

Keywords: Artificial Intelligence, Mural Color, Virtual Restoration, Image Segmentation

1. Introduction

With the continuous development of artificial intelligence and the great improvement of the computing power of large parallel computers, we find that the multi-layer neural network can obtain better feature representation than the single-layer neural network, and the final prediction accuracy will be greatly improved. This is equivalent to the human brain to have a strong memory analysis ability, then the brain must need a large number of neurons and connections between neurons.

The restoration and protection of murals is the obligatory task of computer workers [1]. The virtual restoration technology of cultural relics is an important technology in the protection of digital cultural heritage. It includes the use of reverse engineering methods to use some scanning instruments to collect the unearthed Qin warrior fragments, the optimization of cultural relic models [2-3], the
classification of cultural relics, Retrieval and splicing, the optimization of the Chinese relic model includes denoising, filling, smoothing and simplification of the cultural relic fragment model, etc., and the digital reconstruction and preprocessing of cultural relics provide reliable and high-quality data sources for subsequent technical links [4-5], and affect the efficiency and robustness of subsequent algorithm design, which is essential in the protection of digital cultural heritage [6]. All in all, the protection and restoration of ancient murals is a more complex and difficult branch of cultural preservation work [7], especially the instability of the color of ancient murals itself, and it is even more difficult to grasp and accurately locate [8]. A large and complex academic research project requires the intersection of art, archaeology, and natural sciences, and a more comprehensive, in-depth, and systematic research through multiple comprehensive research methods [9-10].

By collecting digital images of these cultural relics murals and using digital image restoration technology to virtual repair the murals, it can not only avoid the risk of directly repairing the traditional murals, but also solve the problem that the murals cannot be displayed due to serious diseases. The result of the restoration can also provide a guiding solution for the restoration of the physical cultural relics murals, which can be used to guide the physical restoration of cultural relics. It can be said that the digital restoration of ancient murals has important practical significance in the protection of cultural relics.

2. Artificial Intelligence Mural Color Restoration

2.1. Artificial Intelligence

In the process of image acquisition, storage and transmission, images will be affected by external factors, resulting in different degrees and types of distortion. These distortions will make human eyes’ perception of image content biased. Image quality evaluation is to measure the degradation degree of image quality. Pattern recognition mainly uses the technology of pattern recognition. The computer can automatically divide the patterns to be recognized into their respective pattern classes, so as to obtain the most appropriate selection results. In the single excitation observation method, a single image is used to stimulate human vision, and the brain marks the image quality loss degree according to the previous experience. During observation, the images to be evaluated will appear in turn on the screen, and the evaluation score is obtained by observing the image according to the evaluation criteria.

The model formula of the COST231MWM model can be expressed as follows.

$$ PL(d)_{|db} = PL(d_o) + 10n \log\left(\frac{d}{d_o}\right) + WAF + FAF $$  \hspace{1cm} (1)

In the formula, the wall penetration loss is $WAF = \sum_{i=1}^{Kw} k_{wi} PL_{wi}$, and the floor penetration loss is $FAF = \sum_{j=1}^{Kf} k_{fj} PL_{fj}$.

The expression of the predicted mean square error $E$ is as follows:

$$ E = \frac{1}{2m} \sum_{k=1}^{m} \sum_{\omega=1}^{q} \left[ d_{\omega}(i) - y_{\omega}(i) \right]^2 $$  \hspace{1cm} (2)

The mathematical model of RBF network location mapping is shown below.

$$ l = \sum_{i=1}^{K} W_i h_i(r) = \sum_{i=1}^{K} W_i \frac{h_i(r)}{\sum_{j=1}^{K} h_j(r)} $$  \hspace{1cm} (3)

Among them, $K$ is the number of hidden layer neurons.

2.2. Virtual Restoration of Murals

Traditional ancient murals are restored by hand by specialized craftsmen directly on the murals to make them as consistent as possible in style with the original murals. However, traditional manual
repair has some shortcomings, such as long repair work and low efficiency, and the irreversibility of its operation makes mural repairing a certain risk. Therefore, it is necessary to use a combination of semi-automatic and fully automatic methods to detect cracks according to the characteristics of the ancient murals. For the cracks in the foreground, manual interactive detection methods are used in order to reduce false detections. For cracks located in the ground layer or areas with simple textures, automatic detection methods are adopted.

3. Virtual Restoration Experiment of Mural Color

3.1. Design Environment
All the development work of the mural color virtual restoration is carried out on the computer. The software and hardware environment involved in the development process are shown in Table 1.

| Parameter settings          |
|-----------------------------|
| Hardware configuration       | TURION MK36, 2G memory, 128M video memory, digital camera, etc.; |
| Development platform         | Microsoft Windows XP;       |
| Development tools            | Matlab R2006b, Visual C++6.0, 3Ds MAX |

3.2. Image Segmentation
According to the integral invariant value of the model surface points, the vertices of the convex ridges are found and used as segmentation feature points. This method has better noise resistance than the discrete curvature differential method.

3.3. Mural Peeling Extraction
Mural exfoliation exists in the texture region of the image, which has the characteristics of large missing area. Therefore, the following steps can be used to complete the extraction, as follows:
(1) Perform threshold segmentation on the mural image to obtain the drop-off area;
(2) Combine the pixels of the same attribute in the 8-adjacent way;
(3) Add a small amount of manual intervention, and select the falling area in the result of the second step.

3.4. Mural Color Restoration
In the process of distance transformation, we need to calculate the shortest distance from each pixel in the area to the boundary.

4. Discussion

4.1. Mural Color Restoration Results
From the perspective of human art history, the emergence of digital image art is not just a revolution in art form caused by a revolution in materials and media, but a cultural revolution that directly changes people's artistic lifestyle; it is not just a way of thinking about artistic creation. Change is the change of a brand-new way of cultural thinking. The two interact and complement each other, forming an unprecedented way of thinking about digital image art and promoting the development and innovation of traditional art. This paper compares the repair time of the two algorithms used in four digital mural images, and the similarity range is 0-1. The evaluation results are shown in Table 2. The average score of subjective evaluation of Criminisi algorithm is 2.925, and the average score of subjective evaluation of this improved algorithm is 5.8. The average objective evaluation score of Criminisi algorithm is 0.794603, and the average objective evaluation score of the improved algorithm in this paper is 0.848665. The average time of Criminisi algorithm to repair the four digital mural images is 627.3012 seconds, and the average time of the improved algorithm in this paper is 441.2887 seconds to repair the four digital mural images. Experiments show that whether it is from the subjective evaluation result, the objective evaluation result or the work efficiency, the result of the algorithm in this paper is
far better than the result of the Criminisi algorithm on the digital mural image. During the experiment, it was found that this method has a better color restoration effect for large-area ground layers, and the operation is relatively easier than when the outline of the screen content is located. This is due to the uncoordinated human-computer interaction when selecting the designated area in blocks. In the designated area, which color should be selected from the alternative colors for restoration still requires the participation of art workers or workers in the field of cultural relics protection. The point set that strictly satisfies this constraint condition may not be able to form a continuous line segment, which needs to merge the discontinuous line segments to form a continuous filling skeleton. In order to control the tendency of global optimization and neighborhood correlation, a proportional parameter needs to be added, and the parameters are adjusted to obtain a balance between neighborhood correlation and global optimization, and the best matching point can be obtained.

### Table 2. Evaluation results

| Mural image number | The time used by the algorithm in this paper (seconds) | Criminisi algorithm time (seconds) |
|--------------------|------------------------------------------------------|-----------------------------------|
| 1                  | 430.5527                                             | 566.6547                          |
| 2                  | 41.2500                                              | 120.7500                          |
| 3                  | 1103.0000                                            | 1519.8000                         |
| 4                  | 190.3520                                             | 302.0000                          |

#### 4.2. Algorithm Performance Comparison

The comparison of the restoration results of different algorithms is shown in Figure 1. Experiments show that the algorithm in this paper can more accurately extract the cracks in the mural, and the repair time is nearly 4 times longer than that of the Criminisi algorithm, and the repair effect meets the continuity requirements of human vision. Uniform sampling is not suitable for cultural relic models with complex surface structures. In order to get good results, the model must be sampled according to the spatial curvature distribution. Therefore, the improved algorithm is based on curvature sampling, but the fixed curvature threshold can only be obtained in the local area of the model surface. With good results, self-adaptation can be further improved, allowing the algorithm to sample according to the curvature distribution in the global scope of the model, while reducing manual intervention.

![Figure 1. Comparison of restoration results of different algorithms](image)

In the section analysis of color painting samples, the section microscopic analysis method can observe the polished sample section through microscope, and obtain the section hierarchical structure, stacking relationship and color thickness, so as to understand the painting sequence, drawing technology and redrawing phenomenon. At the same time, according to the observation and comparison, it can be found that there are differences in the hierarchical structure of color painting samples, and some color paintings have different periods of redrawing. The performance test results of this algorithm in live image database are shown in Figure 2. The test results show that the algorithm has good performance in live database. If the number of feature regions extracted is large, the potential
matching relationship is more complex, and it is easy to improve the algorithm complexity of feature matching. By introducing the spatial consistency constraint method based on voting mechanism in the feature matching stage, the partial matching relationship between features can be obtained. From the experimental results, it can be seen that the system overhead of matching initialization is high, which is because all fracture surfaces of the model surface are involved in the operation in this stage; after initialization, the system cost of feature matching phase is greatly reduced by predicting the potential matching fracture surface; the approximate consistency of spatial transformation verifies the possible matching results. The possible wrong adjacency is eliminated before the alignment phase, which reduces the computational scale of the subsequent steps. Under the condition of computing resources, the number of layers, the number of neuron nodes in each layer and the connection weight coefficient in the network structure of deep learning neural network with deep learning ability will be more, the better, and the more effective internal information representation ability of sample features in training data set will be stronger. When the dimension of the feature vector in a single classifier pattern is too large, the calculation is complex and the training is difficult to converge. After the effect is evaluated, the protection scheme of the original mural can be formulated. This kind of practical scheme evaluation of mural protection method is an effective attempt and exploration to ensure the restoration results of color painting and continue the authenticity of color painting history. According to the style of Dunhuang murals, the model of Dunhuang line drawing elements is designed. This model starts from the stroke model of line drawing, and obtains the complete model of related elements based on the comprehensive analysis of the composition elements of Dunhuang murals. The model provides powerful display function and performance ability, and provides a good solution for computer aided line drawing. As a precious heritage of human civilization in the world, mural images are being damaged to varying degrees due to natural and man-made reasons, so they need to be protected urgently. At present, most of the mural repair is done by manually adding repair mask.

5. Conclusions

The feature vectors obtained by different feature extraction methods are understood as different ways of thinking about the character image from different aspects and angles.

The purpose of developing a computer-aided virtual restoration system for ancient murals with artificial intelligence is to make comprehensive use of the research results of different majors on mural colors, to better understand the color changing mechanism of murals, and to provide theoretical research and experimental basis for the protection of murals in a new way.

Based on the traditional Chinese five element color, the traditional Chinese color is sorted and divided in RGB color model, and the color restoration system of digital mural based on five element color is designed to realize the virtual restoration of ancient mural color.

Figure 2. Performance test results
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