Artificial Intelligence 2D Image Deformation Technology for Digital Art

Yiyang Zhang[1,*]

[1]*School of Design Arts, Xiamen University of Technology, Xiamen 361024, Fujian, China*
yiyangzhang10@163.com

Abstract:
In today's digital age, art design has long since gotten rid of the limitations of traditional media. Visual programming, as a technology with great potential with rapid development, provides a new creative vision for artistic creation in the digital age, bringing unprecedented changes. The main purpose of this paper is to study the technology of using artificial intelligence to deform two-bit images in the context of digital art. This paper reviews the related research fields of image warping technology, including warping algorithms and interpolation algorithms, and introduces related concepts and technologies involved in subsequent warping technologies. Research shows that the algorithm mentioned in this paper has reduced deformation time and interpolation time, and compared with other algorithms, it is reduced by about 1/2.

Keywords: *Digital Art, Digital Image Technology, Artificial Intelligence, Image Deformation*

1 INTRODUCTION

Image, as a kind of information carrier, the amount of information it carries is huge. Things that are difficult to describe with words can be presented and conveyed intuitively with images. With the rapid development of science and technology, information with images as the medium of expression has played a very important role in human life. As an important branch of multimedia technology, image processing technology has received attention in many fields of real-world applications, and has achieved pioneering achievements in recent decades. All of these make computer image processing a frontier subject with great potential and application prospects [4] [10].

In their research on image warping and digital art, Dhibi et al. proposed a new 3D mesh warping process using a multi-mother wavelet neural network architecture that relies on genetic algorithms and multi-resolution analysis [2]. Deficiencies and local minima are prevented by integrating genetic algorithms. Stark et al. interviewed 33 artists working with digital data, focusing on how artists predict and generally challenge computer scientists, researchers, and the wider population with data practices and ethical issues [11]. It is found that the artist often strives to create a sense of strangeness and critical distance from contemporary digital technologies in the audience.

This paper expounds the inevitability of the current need to use visual programming tools and the corresponding value of the times, and believes that the transformation of current tools is not only the need for historical technological progress, but also the difference between art designers and art troupes. The focus of creation is a necessary change under the impact of the era of data and the era of mass production. The current popular application of visual programming in digital art design is analyzed and compared. It is believed that the classification of digital media art design and creation requirements is currently mainly manifested in the simulation of traditional media art creation requirements and the creation requirements of programming as the logical core.

2 RESEARCH ON IMAGE WARPING TECHNOLOGY

2.1 Deformation Technology

Image warping refers to the smooth and natural transformation of a digital image into another digital image. The process of warping is achieved by combining two techniques of image distortion and interpolation. As mentioned above, the first step of feature-based image warping technology is to establish control handles (such as mesh nodes, line segments or points), and then need to specify the corresponding relationship of the control

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handles. In other words, you need to configure the handles on the deformed image. s position. Through the corresponding relationship of the handles, the mapping function can be calculated to obtain the deformed image [5] [12].

In fact, if the two target entities in the graph deformation have completely different topological structures or motion trajectories, it is difficult to establish a suitable matching model between the entities. To solve this problem, it may be necessary to use some feature description techniques of image warping technology to assist in building a model. The finished product of good deformation animation is often completed by the combination of graphics deformation technology and image deformation technology. [3] [7]

2.2 Classic Image Warping Technology

Image warping technology can be divided according to the expression characteristics of warping. The expression feature of deformation, the so-called handle, is the identification unit used to describe the deformation relationship between the original image and the target image. The role of the handle is to identify the associated position on the two deformed images, thereby establishing the deformation relationship. There are three commonly used expression features (control handles), namely grid, line segment and point [1] [6].

As far as the image warping algorithm based on expression features is concerned, how to define the feature correspondence between the original image and the target image is the key to image warping. The feature position is the only factor other than the image itself that determines the quality of the deformation effect. The algorithm has high accuracy requirements for feature positions, which means that expressing features (control handles) and corresponding relationships is the most important and complex operation in image deformation. According to different expression features (control handles), feature-based image deformation algorithms are divided into control grid-based algorithms, control line segment-based algorithms, and control point-based algorithms [8] [9].

2.3 Key Technologies of Deformation

2.3.1 One-dimensional Gaussian function

The one-dimensional Gaussian function follows the maximum median value on the one-way coordinate axis, and presents a decreasing trend from the middle to both sides. The decreasing trend becomes slower and slower as it moves away from the central axis, and visually presents a characteristic symmetrical "bell-shaped profile". " shape, its basic expression is:

$$f(x) = a \cdot e^{-\frac{(x-b)^2}{2c^2}} \tag{1}$$

Where a is the height of the peak of the curve, b is the coordinate of the center of the peak, and c is called the standard deviation and characterizes the width of the bell shape.

2.3.2 Two-dimensional Gaussian function

Its basic expression is:

$$f(x,y) = a \cdot e^{\left(-\frac{(x-x_0)^2}{2\sigma_x^2} + \frac{(y-y_0)^2}{2\sigma_y^2}\right)} \tag{2}$$

Among them, a represents the amplitude, that is, the height of the peak of the curve, x0 and y0 are the coordinates of the center point, and σx and σy are the variances in the x-axis and y-axis directions, respectively.

2.3.3 Least Squares Polynomial Fitting

The least squares method measures the deviation of the surface from the given set of sampling points according to the sum of the squares of the difference between the value of the fitted surface at the sampling point and the true value, as shown in the following formula:

$$E(f) = \sum_{i=1}^{N} \left(f(x_i, y_i) - z_i\right)^2 \qquad i = 1,2,\ldots,N \tag{3}$$

Among them, E(f) is the sum of squares of the calculation error, f(xi,yi) is the function value at the sampling point (xi,yi), and zi is the real value at the sampling point.

2.3.4 Cross-Fusion

The principle of cross fusion is very straightforward: at each pixel point of the output image, linear interpolation is performed with the pixel value of the corresponding point in two source input images with the same size and different content. The interpolation formula is as follows:

$$s(t) = k \times image1(t) + (1-k) \times image2(t) \tag{4}$$

Among them, t is the position of the current pixel point, s(t) represents the gray value corresponding to t at the position, and k is a value between 0 and 1, which represents the dissolution ratio.

3 EXPERIMENTAL RESEARCH ON 2D IMAGE DEFORMATION

3.1 Image Deformation Algorithm Process

The process of image deformation algorithm based on feature line segment can be divided into the following steps:

(1) First, establish the point correspondence between the original image and the target image. The corresponding relationship is usually determined by human-computer interaction, and the user manually sets the corresponding relationship between points or line segments. Thereby, the distribution description of a certain point in the scene on the two images is obtained. This link is the most complicated and difficult link in the deformation technology.

(2) Generate an image deformation sequence through the point or line segment correspondence obtained in the first step. The transition from the original image to the target image is the core of the deformation. It is mainly realized by the first-level mapping function between the feature line segments between the images.

(3) Generate intermediate transition images. After obtaining the image deformation sequence through the second step, use the cross-fusion method mentioned in the mesh deformation method before, and use the interpolation method among the pixels of the two images to generate the image pixel value of the intermediate transition, so as to finally obtain Deformed image.

3.2 Local Deformation Conditions

After determining the grid structure G, the user needs to set the size of the deformation area first. The deformation area is generally a circle. The user determines the size of the deformation area by setting the radius of the circle, and the diameter of the circle generally does not exceed the length of the image. or wide. Then the user randomly selects a mesh vertex in G as the control point C. After that, by moving C to point M, the vertices around point C have an influence, resulting in corresponding movement, and finally local deformation.

Among them, the black mesh is the original mesh, the red mesh is the deformed mesh, and the length of the yellow arrow indicates the displacement of each cell vertex. As can be seen from the figure, the local deformation must meet the following conditions:

(1) The closer the vertices in the deformation area are to the control point, the greater the moving distance; the farther away from the control point, the smaller the moving distance;

(2) The moving distance must be distributed in a bell shape;

(3) If the edge vertex is located in the deformation area, the vertex cannot be moved;

(4) If there are edge points in the deformation area, the points on the upper and lower edges can only be moved left and right, and the points on the left and right edges can only be moved up and down.

4 EXPERIMENT ANALYSIS OF 2D IMAGE DEFORMATION TECHNOLOGY

4.1 Performance Comparison of Each Method

In order to evaluate the time efficiency of each method, for two pictures, the time cost of the two steps in the deformation process is counted, as shown in Table 1.

Table 1. Overhead Statistics for Different Methods

	Deformation time/s		Interpolation time/s		Total/s	
	Figure 1	Figure 2	Figure 1	Figure 2	Figure 1	Figure 2
IDW	0.49	0.51	0.36	0.52	0.87	1.03
RBF	0.52	0.55	0.29	0.47	0.81	1.02
The method of this paper	0.14	0.14	0.25	0.31	0.39	0.45

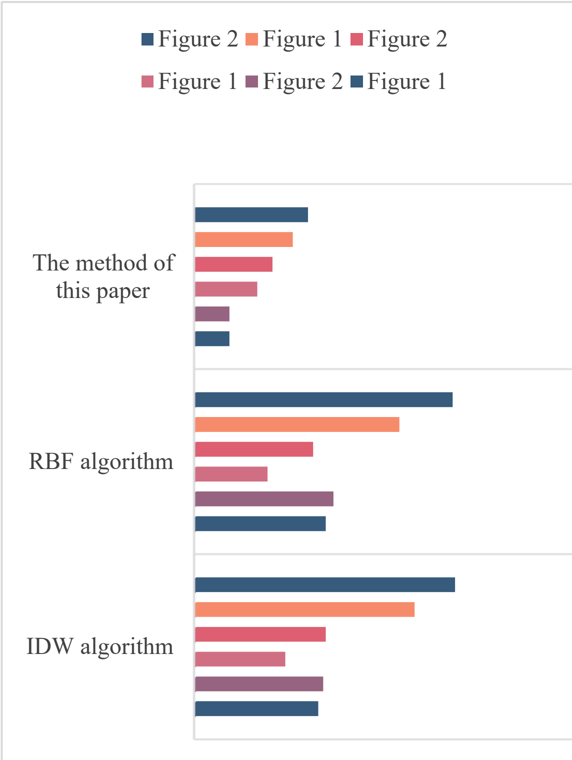

Figure 1. Overhead data analysis for different methods

It is not difficult to see from Figure 1 that the time used by the method in this paper is the smallest in both the deformation step and the interpolation step, because the IDW algorithm and the RBF algorithm are both global deformation algorithms, while the method in this paper is a local deformation, and the related operations are only in a small range. It can save unnecessary time and improve operating efficiency.

4.2 Simulation Results and Analysis of Interpolation

The one-dimensional analog white noise signal is regarded as a continuous function, and the test sequence is equivalent to a 640-point sampling of this continuous function, denoted as S1, and a sequence of 640,000 points is obtained in the same sampling method, denoted as S2, And so on. Next, randomly select 10,000 points at the same coordinates in S2, S3, and S4 to calculate the root mean square error of S2 and S3, S2 and S4, and repeat the experiment to obtain the experimental results in the following table.

Table 2. The experimental results of interpolation and direct interpolation after upsampling

Experiment number	RMSE1	RMSE2	RMSE3	RMSE4
1	0.2423	0.0147	5.4828	5.4176
2	0.2431	0.0147	5.5334	5.4678
3	0.2432	0.0147	5.5009	5.4376
4	0.2426	0.0147	5.4380	5.3734
5	0.2434	0.0147	5.5273	5.4599
6	0.2407	0.0146	5.5684	5.5035
7	0.2414	0.0146	5.5462	5.4818
8	0.2422	0.0147	5.5605	5.4960

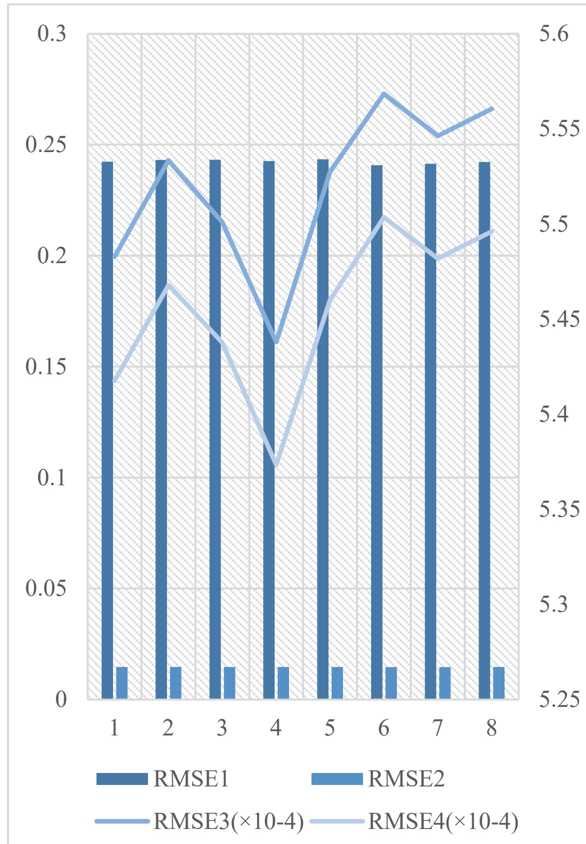

Figure 2. Analysis of different interpolation results

The experimental results in Figure 2 show that the method of resampling the digital sequence in the digital domain and then performing interpolation can effectively improve the interpolation results and improve the interpolation accuracy of the digital sequence.

5 CONCLUSIONS

The artistic creation of digital media is virtual and digital, and is not limited by the real environment. This paper first discusses the image warping techniques and analyzes and compares image techniques with different control features. Based on the image deformation of the moving least squares method, this paper improves the deformation effect and algorithm complexity of the technology, and proposes a new mapping interpolation method to improve the mapping efficiency. Digital image art has gradually entered the daily life of the public and has become an important way to popularize aesthetics. At the same time, it is of strategic significance to cultivate compound talents who are proficient in digital technology and have artistic self-cultivation.

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