Introduce Mural Artistry into Cartoon Material Creation

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Abstract: Mural is one of the earliest art in human history, which directly painted on the wall recorded people's superb skill and creating artistry. Our ancestors drew up a variety of graphics with charred branches (charcoal) or yellow soil on the wall to record their important events, such as hunting, dance, ritual and war, and form the ancient murals. Subsequently, the murals in Dunhuang of China and pyramids of Egypt developed superbly. They surround some special themes, showed superb artistry and formed the world-renowned historical and cultural heritages. We aim this project to such a long history, high performance capability art form. By self-designed image processing algorithms, the image merge and color-transform algorithm, we create a newly pseudo-archaic mural recreating technology. Based on such a technology, a traditional digital image may be re-created to have a special view similar to an antique mural, so any user may re-create his-own cartoon character or background by himself with some common digital material.

Key words: Mural; Digital Cartoon; Digital Image Processing

1. Introduction

The animation product has a dual character of cultural product and information product. As a cultural product, it is asked to be as funny as possible to make the most users like to see and hear. As an information product, it is asked to be as cheap as possible to get the most benefit. On the other hand, digital media departments have accumulated a huge of different kind materials. How to reuse them as the software reuse does becomes one of the goals in animation industry. Can these digital media reused as an animation material? We are deal with it in this paper.

Mural is one of the earliest art in human history, which directly painted on the wall recorded people's superb skill and creating artistry. Long ago, our ancestors drew up a variety of graphics with charred branches (charcoal) or yellow soil on the wall to record their important events, such as hunting, dance, ritual and war, and form the ancient murals. Subsequently, the murals in Dunhuang of China and pyramids of Egypt developed superbly. They surround some special themes, showing superb artistry and formed the world-renowned historical and cultural heritages. But after the vicissitudes, natural calamities and man-made misfortunes, these historical and cultural heritages are being damaged inevitably. The use of modern technology to in-paint these ancient murals become computer workers problem, and have achieved gratifying results.

We aim this project to such a long history, high performance capability art form in another way that is reusing those digital pictures to re-create cartoon material. Based on self-designed image processing algorithms, the image merge and color-transform algorithm, we create a newly pseudo-archaic mural recreating technology. Based on such a technology, a traditional digital image may be re-created to have a special view similar to an antique mural that is a pseudo-archaic mural. So any user may re-create his-own cartoon character or background himself with some common digital material.

2. Technical Procedure

The project's core algorithm includes image merge and color-transform.

The former algorithm realizes the local modified image merges with the global image seamlessly. With a user determined parameter "variation threshold", this algorithm determines the scale for color merge. In other word, the larger the threshold is, the larger the area is modified according the creating desire. Several kind of re-creating may be done after your operation. For example, if you are desire to show a local damage on the mural, you may modify the original color of these pixels (in a digital image) to earth yellow or gray white, as to simulate the natural color of the ancient mural after a long time natural calamities.
The latter algorithm may get a visual simulation of a mural under a long time vicissitudes, from the original bright colorful to dark yellow fade. We are going to describe the algorithm in detail as definition 1 later (see Figure 1 and figure 2 also).

![Fig 1 Visual compare of colorful murals](image1)

2(a) true mural. 2(b) re-creating mural.

![Fig 2 Visual compare of charcoal drawing murals](image2)

Fig 1 Visual compare of colorful murals

Fig 2 Visual compare of charcoal drawing murals

2.1 Definition

Definition 1. When modify the color of a pixel from the original value to a product with a coefficient, said it implements a pixel color-transform operation. The coefficient, as a multiplier here, may be a negative one or positive one. In particular, when a non-negative coefficient is used, it named as a darken color-transform operation; otherwise, named as a whiten color-transform operation (see Figure 3, figure 4). Detail definition may give as below:

A. The original brightness value \( Y \) of the pixel is calculated by:

\[
Y = 0.257 * r_{in} + 0.504 * g_{in} + 0.98 * b_{in}
\]

(1)

![3(a) original one. 3(b) after a transform operation](image3)

3(a) original one. 3(b) after a transform operation

![4(a) original one. 4(b) after a transform operation](image4)

4(a) original one. 4(b) after a transform operation

Fig 3 A darken color-transform operation

Fig 4 A whiten color-transform operation

Here \( r_{in}, g_{in}, b_{in} \) is the RGB value of this pixel.

B. Color-transforming coefficient \( M \) set is an effective coefficient and correlated with the brightness of \( Y \).

C. The output of this pixel after a color-transform operation is given as:

\[
r_{out} = \text{abs}(r_{in} - (M_{r} * r_{in}))
\]

(2)

\[
g_{out} = \text{abs}(g_{in} - (M_{g} * g_{in}))
\]

(3)

\[
b_{out} = \text{abs}(b_{in} - (M_{b} * b_{in}))
\]

(4)
Definition 2. It is said an image merge operation may be done successfully if the two conditions below are satisfied. First, if the difference between a sample pixel and some pre-selected pixels is less than threshold T. Second, if there is no visual confusion after these (selected) pixels accomplished a color-transform operation (as defined in definition 1). Detail describe may give as below:

A. The visual confusion can be measurement with two indexes below:
   (1) Color-transform range: It is measured by the rate of transform pixels among the total pixels. It correlates with the threshold T. That means, larger the threshold T and larger the range after a color-transform.
   (2) Color variation: It correlates with the coefficient M (in definition 1). That means, larger the coefficient M (average) and larger color variation.
B. By select a suitable T and M, a new image, may be created. Such an image has an allowed color variation but has a different visual scene and in a recognizable manner. (See fig. 3 and fig. 4)

2.2 Set parameters
In order to meet user DIY needs, many parameters, including iteration times, variation threshold, are reserved.

1. Iteration times (iterativeTimes): Because of long time exposed in a natural environment, mural color becomes darken. According the selected iteration times, the program iterates several times to simulate the darker and darker procedure.
2. Color sample pixels (colorSamples): User may choice two pixels as color samples. If the difference between the samples and some pre-selected pixels is less than threshold T, the program executes image merge operation (according to definition 2); otherwise, executes image color-transform operation (according to definition 1).
3. A variation threshold (variationThreshold): This parameter defines a threshold between the samples and the pre-selected pixels (both in RGB component). It turns, larger the threshold and larger color extending region.

2.3 recreating a pseudo-archaic mural
Algorithm 1. The purpose of this algorithm is to create a pseudo-archaic mural. Correlating parameters are iteration times, colorSamples and variation threshold. First, calculate the RGB value of colorSamples and named as color1 and color2 \( (r_1, g_1, b_1) \) and \( (r_2, g_2, b_2) \). And then, if the difference (in RGB value) between samples and those being tested pixels is less than threshold T, the program do darken color-transform, otherwise do darken color-transform.

Step (1) takes a grayish operation to the whole picture.
Step (2) set the whole reserved output image data buffer to white.
Step (3) calculates the RGB value of colorSamples and named as color1 and color2;
Step (4) by completing step (4) ~ (7) column by column and line by line to get the output of every pixel;
Step (5) if the difference between the RGB value of current pixel \( (r_{in}, g_{in}, b_{in}) \) and the samples \( (r_1, g_1, b_1) \) or \( (r_2, g_2, b_2) \) is less than threshold T, do nothing. Because the whole reserved output image data buffer is set to white, so do nothing here equal to set the output of current pixel to white (same as \( r_{out} = 255, g_{out} = 255, b_{out} = 255 \)). Otherwise turn to step (6).
Step (6) according formula (1) gets the original brightness value \( Y \) from \( r_{in}, g_{in}, b_{in} \). Then get M from Y.
Step (7) call a subroutine to do a darken color-transform operation.

Alg 2. The purpose of this algorithm is to create a charcoal stick mural (as fig 2(b)).
Correlating parameters are colorSamples and variation threshold. First, calculate the RGB value of colorSamples and named as color1 and color2 \( (r_1, g_1, b_1) \) and \( (r_2, g_2, b_2) \). And then, if the difference (in RGB value) between samples and those being tested pixels is less than threshold T, the program do darken color-transform, otherwise do darken color-transform.

Step (1) takes a grayish operation to the whole picture.
Step (2) set the whole reserved output image data buffer to white.
Step (3) calculates the RGB value of colorSamples and named as color1 and color2;
Step (4) by completing step (4) ~ (7) column by column and line by line to get the output of every pixel;
Step (5) if the difference between the RGB value of current pixel \( (r_{in}, g_{in}, b_{in}) \) and the samples \( (r_1, g_1, b_1) \) or \( (r_2, g_2, b_2) \) is less than threshold T, do darken color-transform operation. This subroutine is based on formula (2)~ (4).

3. Conclusion
Through this research we found: after an image merge and color-transform operation, a similar to an ancient mural visual effect may get.
Different color-transform coefficient M may affect the effect of color-transform. In contrast to figure 1(b) and figure 3(b) may find a different visual effect from the same source image, due to the different darken color-transform.
We are glad to say that pictures processed by our independently designed technology and algorithm have the similar effect of Photoshop, a well-known image processing software of Adobe company. Picture 5(a) and 5(b) respectively represent the two technical results for comparison.

Further comparison and identification are welcome, as well as inquiries and acquisitions of source code from the company the
authors’ work for.

We hope to get criticisms and corrections on deficiencies in this article.

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