Method for background replacement of certification photos

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ABSTRACT

In order to overcome defects resulted from replacing the photo background color, an improved method is proposed for background replacement. The α-values in the alpha matte are transformed to enhance the details in the transition area. The new photo is composited by comprehensively considering the foreground portrait, new background, old background and the alpha matte. The experimental results show that the foreground portrait appears clearer and more complete, and the transition area between the foreground and background is more harmonious and more natural.

Keywords: Portrait matting, trimap, alpha matte

1. INTRODUCTION

A certification document is usually attached to a personal photo, for example, passport, driver's license, or student ID. Moreover, the style of the certification photo is strictly regulated, especially the photo size and the background color. In order to ensure that the photo meets the specific requirements, the background color needs to be edited and replaced according to the different rules[1].

The current method for background replacement of certification photos mainly utilizes image processing techniques[2]. By taking advantage of various softwares[3,4], the foreground portrait is extracted and the background color is edited. However, this method relies on manual operation and it is not efficient. In order to improve the efficiency and performance of background replacement, image matting[5,6] is exploited. Firstly, a trimap[7,8] is constructed based on the old certification photo. Secondly, an alpha mate[9,10] of the foreground portrait is generated. Based on the alpha matte, the foreground portrait and a specific background color are composited.

When the new photo is composited, only the foreground portrait, the new background color, and the alpha matte are considered. The composited photo after background replacement has defects, especially in the transition area between the foreground portrait and background[11].

In order to obtain satisfied certification photos, we propose an improved method for background replacement of certification photos. The trimap and alpha matte are generated and a nonlinear transformation is implemented. By transforming α-value of the alpha matte, the details in the transition area are enhanced. Besides, the new photo is composited by comprehensively considering the foreground portrait, the new background color, the old background color and the alpha matte.

2. METHODOLOGY

The improved method for photo background replacement consists of 6 steps. The algorithm diagram is shown in Figure 1. The old certification photo is firstly inputted for processing. It is denoted as I'. A new background color is selected to replace the old photo background. The new background color is denoted as B.

The foreground portrait is extracted by using matting techniques. An alpha matte is obtained. The α-value in the alpha matte ranges from 0 to 1. 0 represents the corresponding pixels belong the background and 1 represents the pixels belong the foreground. For pixels in the transition area, the α-value is greater than 0 and less than 1.

The α-values of the alpha matte are transformed to highlight the details in the transition area between the foreground portrait and the background. A nonlinear function is used to transform the α-value.

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International Conference on Optics, Electronics, and Communication Engineering (OECE 2024), edited by Yang Yue, Proc. of SPIE Vol. 13395, 133953Y · © 2024 SPIE · 0277-786X · Published under a Creative Commons Attribution CC-BY 3.0 License · doi: 10.1117/12.3049174

The old background color is extracted in order to composite the new photo. The old background color is denoted as B'.

The new photo is composited by comprehensively using the old photo I', new background B, old background B' and the alpha matte.

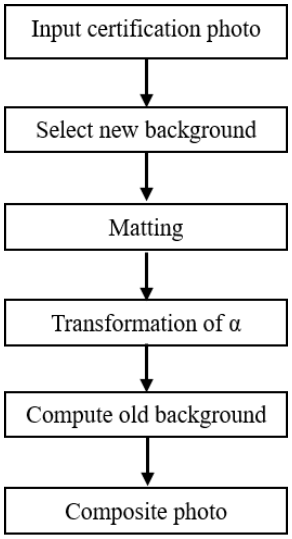

Figure 1. Algorithm diagram.

3. PORTRAIT MATTING

There is a certification photo with a pale background. It is shown in Figure 2. Due to the background color does not meet the specified requirement, it is necessary to replace the photo background with blue color.

Figure 2. Old certification photo.

Firstly, the trimap is generated based on the certification photo. Then, an alpha matte is calculated based on the generated trimap and the corresponding certification photo.

3.1 Trimap

In order to distinguish the background area, foreground portrait and transition area in the old photo, a coarse trimap is constructed. In the trimap, white pixels represent the foreground portrait, black pixels represent the background area, and gray pixels represent the uncertain area to be furtherly segmented. It is the transition area between the foreground portrait and the background. Based on the certification photo, the constructed trimap is shown in Figure 3.

Figure 3. Trimap.

3.2 Alpha matte

Using the image matting algorithm, the corresponding alpha matte is obtained based on the old photo and the trimap. The generated alpha matte corresponds to the opacity of each pixel in the photo. In the alpha matte, the opacity of each pixel is denoted as α'. The α'-value corresponding to pixels in the portrait area is 1 and the α'-value corresponding to pixels in the background area is 0. The α'-value corresponding to pixels in the transition area is 0<α'<1. The generated alpha matte is shown in Figure 4.

Figure 4. Alpha matte.

4. α-VALUE TRANSFORMATION

The α'-value in the alpha matte are nonlinearly transformed in order to highlight or suppress the details of the transition area between the foreground portrait and the background.

A nonlinear transformation function is shown in Figure 5. It is used to enhance the details in the transition area. It is as follows:

$$f(x) = 1 - (1 - x)^2 \tag{1}$$

With the above transformation function, all α'-values in the alpha matte are transformed as:

$$\alpha = f(\alpha') \tag{2}$$

After transformation, the α corresponding to the pixel in the portrait area is 1 and the α corresponding to the pixel in the background area is 0. The α-value is greater than 0 and less than 1 in the transition area.

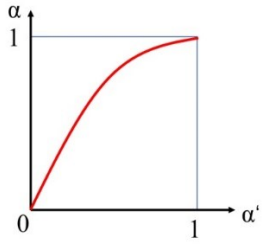

Figure 5. Nonlinear transformation.

5. BACKGROUND REPLACEMENT

5.1 Extracting the old background color

In the old certification photo, those pixels that the corresponding α-value in the alpha matte equals to zero are searched. The red, green, and blue color components of these pixels are averaged respectively. The averaged red, green and blue values are looked as the background color B' of the old photo.

For the certification photo shown in Figure 2, the calculated background color B' is:

$$(R,G,B) = (229,241,239)$$

The old background color is used to composite the new photo as one of factors.

5.2 Selecting the new background color

According to the specific requirements of the certification photo, the photo background color should be blue color. Therefore, we replace the old certification photo with the new background color. The new background color B is:

$$(R,G,B) = (0,0,255)$$

5.3 Photo composition

Based on the alpha matte, the foreground portrait is composited with the new background. The color value of each pixel in the new certification photo is computed. The certification photo with required background color is obtained.

When calculating the color values of pixels in the new photo, the old photo I', old background B', new background B, and alpha matte are considered comprehensively. The calculation formula is:

$$I(z) = I'(z) + \big(1 - \alpha(z)\big)B(z) - \big(1 - \alpha(z)\big)B'(z) \quad (3)$$

Where, I(z) represents the color value of pixel z in the composited photo. I'(z) is the color value of pixel z in the old photo. B(z) is the color value of pixel z in the new background. B'(z) is the color value of pixel z in the old background. α(z) is the α-value corresponding to pixel z in the alpha matte.

With the above formula, the old photo, old background, new background are combined based on the alpha matte. The photo background was replaced with the selected background color. The composited certification photo is shown in Figure 6.

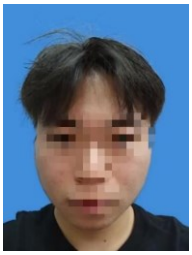

Figure 6. Composited certification photo.

6. EXPERIMENTAL RESULT

The proposed method for photo background replacement is tested on a set of photos. Firstly, a trimap is constructed and an alpha matte is generated based on the old certification photo. Then, a nonlinear transformation is implemented on α-values in the alpha matte. An enhanced alpha matte is obtained. Finally, the new certification photo is composited with the required background color.

The resultant composited photos are also compared with them composited using the current method, which neighter exploit α-value transformation nor consider the old background color. Two sets of experimental results are shown in Figure 7. On the left, a photo with pale background is processed. On the right, a photo with white background is processed. Where, (a) list the old photos, (b) list the composited results using the current method, and (c) list the composited results using the proposed method. Main differences are labeled with rectangular boxes.

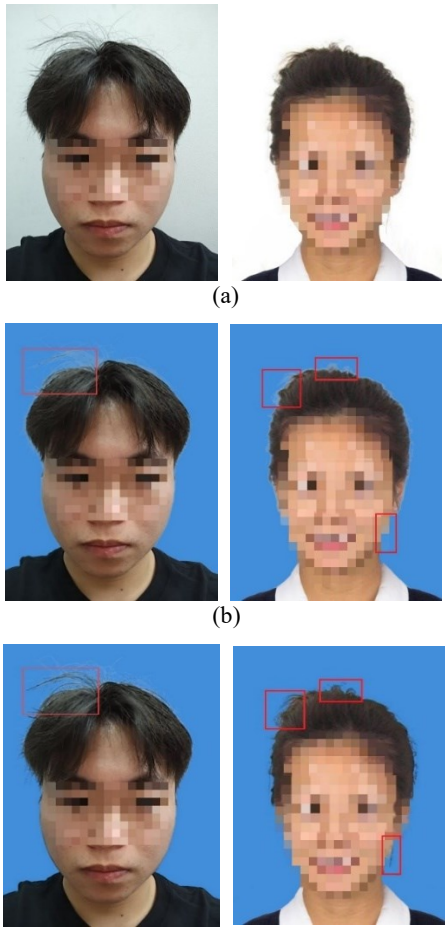

Figure 7. Background replacement of photos.

According the experimental results, the composited photos resulted from the proposed method are better than them from the current method. The details in the transition area are highlighted and the foreground portraits are clear and complete, for example hair strands.

7. CONCLUSIONS

There are two main contributions. The α-values in the alpha matte are transformed to enhance the details in the transition area. Besides, the old background color is also considered when the new photo is composited.

By transforming the α-value in the alpha matte, the details attached to the foreground portrait are highlighted. The composited portrait is clearer and more complete.

By considering comprehensively the foreground portrait, new background color, old background color, and the alpha matte, the composited photo are more natural. In fact, the foreground portrait will be affected by the interference of the background color, especially in the transition area between the foreground and background. If only the foreground portrait and the new background color are used to composite photo, the composited transition area is uncoordinated and unnatural. Therefore, the old background is also considered to calculate the composite photo.

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