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Color transfer and image enhancement by using sorting pixels comparison

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ABSTRACT

Fast color transfer is valuable in digital images. In this study, we devised a new algorithm called color transfer by using sorting pixels comparison. Firstly, according to color information, sort the pixel distribution separately on color images and grayscale images. Then, equalization is implemented on rearranged color images, appropriately weakens the proportion of the over bright and the over dark saturated zone. Finally, using the color transferring algorithm rearranged pixels comparison, color the grayscale images. Experiments on large numbers grayscale images show that this method is concise and clear, efficient for dyeing process and the results can be further used for automatic coloring of multiple targets color enhancement.

1. Introduction

Fast algorithms of transferring color to grayscale images are widely used in image processing. It transfers color information to a grayscale image, then the grayscale image has the similar color distribution with the color one. It has been one of the most practical techniques.

Many methods have been developed for color transfer [1–3]. Welsh [4] proposed an algorithm due to color component color component. However, this method suffers from the ambiguity in image details and the background error. Pitie [5] improved it with *N*-dimensional probability density function. However this method suffers from time-consuming. Guoying Zhao [6] adjusted the slope of the source image data to preserve some details. Irony [7] or Zhenhua Li [8] proposed colorizing algorithms based on texture match or wavelet. However all of the above methods need a large number of complex algorithms and caused the background error.

To achieve better results, some new approaches based on manual intervention have been proposed. Li and Hao [9] proposed a learning-based colorizing algorithm, which will easily cause color distortion. Levin [10] proposed a colorizing algorithm based on chromaticity statistics. Qu [11] and Luan [12] improved these methods using constraint of texture similarity, which significantly reduced the complex texture error diffusion. Additionally, Guofei Hu [13] and Horiuchi [14] proposed adaptive colorizing algorithm and probability relaxation algorithm. However these methods are complex and targeted.

In this study, we propose a new algorithm based on sorting pixels comparison. The proposed comparison of rearranged pixels color transfer method is compared with conventional color transfer methods.

The rest of the paper is structured as follows. In Section 2, works related to rearranged pixels, including in lab color space. In Section 3, the low-complex equalization method is presented. Experimental results are demonstrated in Section 4. And Section 5 presents our discussions and conclusions.

2. Sorting pixels

2.1. Color spaces

Three primary colors (RGB) space is a more commonly space of chromatics, each of them is independent.

In this paper, we may convert RGB color images into grayscale images. We use a usual transformation as follows:

$$\mathrm{Gray} = 0.299 * G + 0.587 * G + 0.114 * \mathrm{B} \tag{1}$$

Lab color space can convert from the RGB space. Here we convert an RGB image to the lab color space as follows:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.433910 & 0.376220 & 0.189860 \\ 0.212649 & 0.715169 & 0.072182 \\ 0.017756 & 0.109478 & 0.872915 \end{bmatrix} * \begin{bmatrix} \frac{\mathrm{R}}{255} \\ \frac{\mathrm{G}}{255} \\ \frac{\mathrm{B}}{255} \end{bmatrix} \tag{2}$$

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0	0	0	0	0
0	254	148	155	0
0	135	255	253	0
0	158	168	250	0
0	0	0	0	0

(a)

135	250	0	0	0
148	253	0	0	0
155	254	0	0	0
158	255	0	0	0
168	0	0	0	0

(b)

Fig. 1. The size of the example-grayscale image is 5×5, respectively. (a) is the original image, and the 0-pixels area is the background. (b) is the rearranged-pixel image.

Here *XYZ* is a transitional color space. Then:

$$L = \begin{cases} 116 * Y^{1/3} & (Y > 0.008856) \\ 903.3 * Y & (Y \le 0.008856) \end{cases}$$
$$a = 500 * (f(X) - f(Y))$$
$$b = 200 * (f(Y) - f(Z)) \tag{3}$$

Here $f(t)$ is

$$f(t) = \begin{cases} t^{\frac{1}{3}} & (t > 0.008856) \\ 7.787 * t + \dfrac{16}{116} & (t \le 0.008856) \end{cases} \tag{4}$$

2.2. Sorting pixels

A pixel is a physical point in digital imaging. Every image has a large number of pixels. First divide an image into object area or background. Then sort them by their color values (Fig. 1).

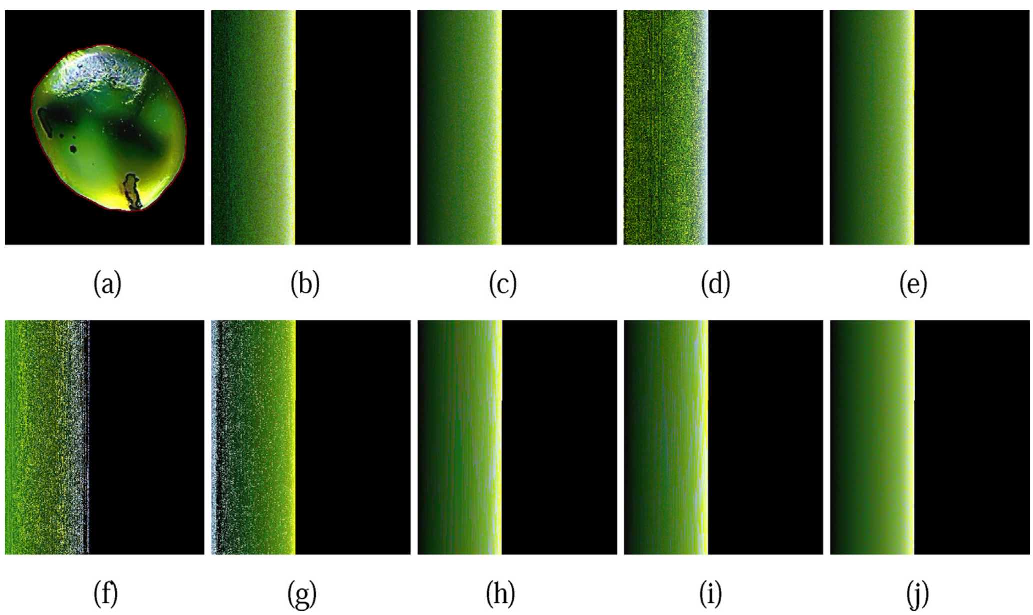

Fig. 2. The size of the Green Stone is 363×393. (a) is the original image, and the studying object is within the red line. The outside area is the background. (b), (c) and (d) are respectively the R-channel-sorting, G-channel-sorting and B-channel-sorting images. (e), (f) and (g) are respectively the L-channel-sorting, a-channel-sorting and b-channel-sorting images. (h) is the rearranged-pixel image, which firstly sorting by L channel, when appearing some pixels same in L channel, then sorting these pixels by a channel, finally in the same way, when appearing some pixels same in L channel and a channel, sorting them by b channel. Similarly (i) is the L-channel, b-channel and a-channel image. (j) is the gray-channel-sorting image, using Eq. (1).

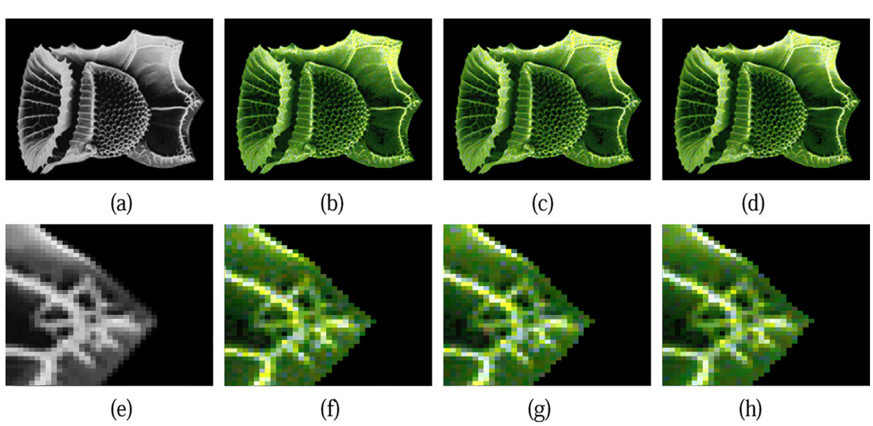

Fig. 3. The size of the grayscale image called Biology is 232×180, respectively. (a) is the original images; (b) is the G-channel-sorting color transfer result; (c) is the L-a-b sorting color transfer result; (d) is the gray-channel-sorting color transfer result; (e), (f), (g) and (h) are the enlargements of (a), (b), (c) and (d).