A New Embossing Method for Color Images

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Summary
In this paper, we propose a new embossing algorithm for color images. The conventional embossing method for color images is performed by first applying the embossing operator independently to each component, i.e. R, G, B of color images and then combine them for making an embossed color image. In the proposed approach, an RGB color image is first converted to an HSI color image and next the embossing operator is applied to I component and finally the resulting components are combined for making an embossed color image. The proposed approach has an excellent advantage that the resulting embossed image maintains the color information of an original image.

Key words:
embossing, color image, HSI color space, color processing

1. Introduction

The embossing mask is a filter for taking a relief effect of images and used widely in image tools such as Photoshop, *etc*. In general, the embossed image is represented by flat and slope regions. That is, the sharp regions of an original image result in higher or lower intensity according to the mask degree and the smooth regions in the original image are represented by flat intensity in the embossed image.

Using a conventional embossing method, the embossed image has similar results in both the gray scale image and the color image. It is due to the properties of the embossing mask coefficients. That is, the central coefficient of the embossing mask is 0 and therefore the color information in the color embossed image is significantly reduced. The loss of the color information in the embossed image is the most important disadvantage of the embossing mask[1].

In this paper, a new embossing method for color images is proposed. The proposed method has an advantage that the embossed image has the color information similar to the original image. In the proposed method, an original image of RGB color space is first converted to the HSI color space. Then the intensity(I) component is contrast-reduced and the resulting image is convoluted with an embossing mask. Finally, the exponential functions are applied to both the resulting intensity and saturation(S) components.

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The organization of this paper is as follows. In section 2, we introduce general embossing method for gray scale and color images. The proposed embossing method for color images are described in section 3 and the simulation results using the proposed method are presented in section 4. Finally, conclusions are drawn in section 5.

2. Embossing Operation

2.1 Embossing Operator

The embossing mask is in general composed of 3 filters of 3×3 size as shown in Fig. 1. The selection of an embossing mask is dependent on the direction of the lighting such as 45, 90, or 135 degrees. As shown in Fig. 1, the central coefficient of an embossing mask is 0 and the sum of mask coefficients is also 0. For taking an embossed image, an original image is convoluted with the embossing mask and the average value of the masked area is added to the resulting image for taking approximate gray level of the original image[1].

0	0	-1
0	0	0
1	0	0

(a) 45 degree

0	-1	0
0	0	0
0	1	0

(b) 90 degree

-1	0	0
0	0	0
0	0	1

(c) 135 degree

Fig. 1. Mask for embossing effect

The embossed image for Lena is shown in Fig. 2.

(a)

(b)

Fig. 2. (a) Lena(gray scale) (b) Embossed image for Lena

2.2 Embossing for Color Images

In the conventional approach, the embossing process for the color image is performed by the similar procedure as in the gray scale images. That is, the embossing mask is applied independently to each component of RGB color image as in Fig. 3. By doing so, the color information of the image is almost eliminated in the resulting image. It is because the embossing mask reduces the value difference in each component and therefore the color information of an original image is removed in the resulting image. As an example, the embossed image using the conventional approach is represented in Fig. 4.

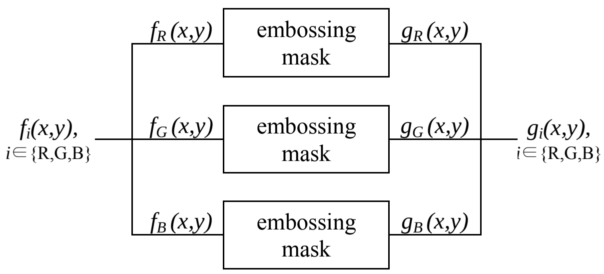


Fig. 3. The embossing procedure of color images using the conventional approach

(a) (b)

Fig. 4. (a) Lena(color) (b) Embossed image for Lena

In Fig. 4, it can be shown that the color information is nearly eliminated in the embossed image. In addition, some color information remaining mainly at the boundary area of the image is mostly distorted. Therefore, it is difficult in the embossed image to discern the color information of the original image.

3. Proposed Embossing Method for Color Images

The overall procedure of the proposed embossing method for color images is depicted in Fig. 5. The first step of making the embossing effect of color images is the color space conversion from RGB to HSI using Eq. (1)[2].

$$
\begin{aligned}
H &= \cos^{-1}\left[\frac{\frac{1}{2}[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right] \\
S &= 1-\frac{3}{(R+G+B)}[\min(R,G,B)] \\
I &= \frac{(R+G+B)}{3}
\end{aligned}
\tag{1}
$$

The embossing process in the proposed method is applied mainly to intensity component. For a preprocessing, the contrast of intensity component is reduced by the following procedure. The intensity component is weighted by a parameter $\alpha (<1)$ by Eq. (2) and the mean values of the original intensity component and the weighted intensity component are determined by Eq. (3). Then the weighted intensity component is shifted by the difference between the mean values as in Eq. (4). The reason of intensity shift is to achieve the equal value of average intensity.

$$f_{mod}(x,y) = f_I(x,y) \cdot \alpha \tag{2}$$

$$
\begin{aligned}
f_{I,avr} &= \frac{1}{M \times N}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f_I(x,y) \\
f_{mod,avr} &= \frac{1}{M \times N}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f_{\mathrm{mod}}(x,y)
\end{aligned}
\tag{3}
$$

$$f_{con}(x,y) = f_{mod}(x,y) + \left(f_{I,avr} - f_{mod,avr}\right) \tag{4}$$

The reason of the contrast reduction is that it is difficult to distinguish the embossing effect if an original image has larger contrast.

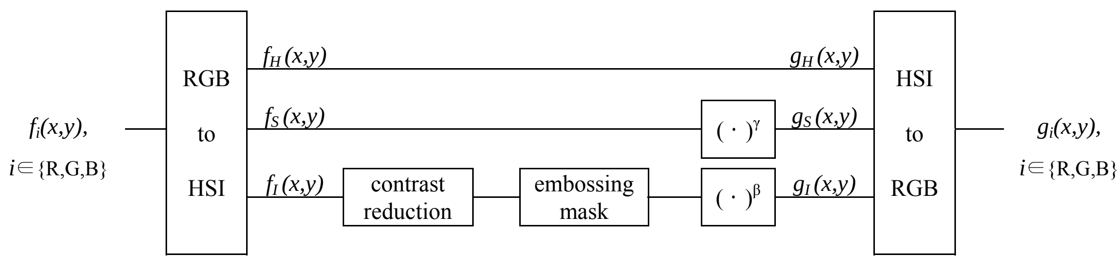


Fig. 5. The proposed embossing procedure for color images

In the next step, the embossing mask is applied to the resulting intensity component using the embossing mask of Fig. 1 by Eq. (5).

$$f_{emb}(x,y) = f_{con}(x,y) \otimes MASK_{emb} \tag{5}$$

As the final step, the masked image is thresholded by a factor *THR* and some pixels above THR are weighted by an exponential parameter $\beta(<1)$ as in Eq. (6).

$$g_I(x,y) = \begin{cases} f_{emb}^{\beta}(x,y) & \text{for } (x,y) \mid f_{emb}(x,y) \geq THR \\ f_{emb}(x,y) & \text{elsewhere} \end{cases} \tag{6}$$

The saturation component is exponentially weighted by a parameter $\gamma(<1)$ by Eq. (7) for improving the color effect.

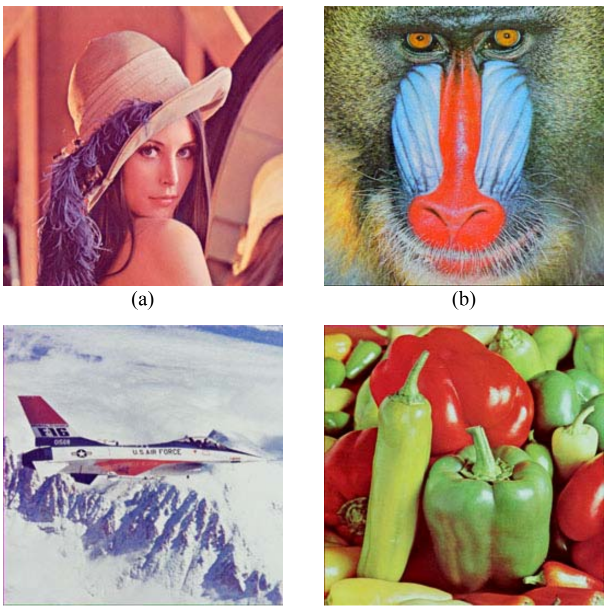
$$g_S(x,y) = \begin{cases} f_S^{\gamma}(x,y) & \text{for } (x,y) \mid f_{emb}(x,y) \geq THR \\ f_S(x,y) & \text{elsewhere} \end{cases} \tag{7}$$

The contrast reduction is not applied to the saturation component because it results in the color distortion.

After the process applied to the intensity and saturation components, the resulting components are converted to RGB color space.

4. Simulation Results

In order to test the performance the proposed embossing method, we simulated our algorithm on several test color images of size 256×256.

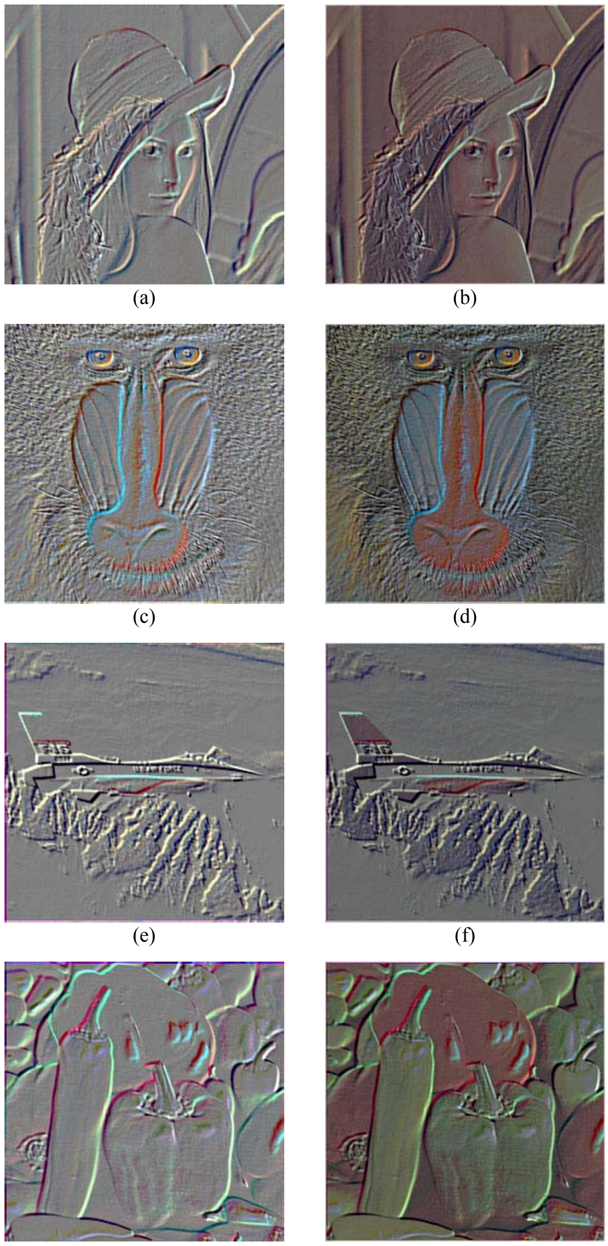


(a) (b) (c) (d)

Fig. 6. Test color images (a) Lena (b) Baboon (c) Airplane (d) Peppers

The test images are Lena, Baboon, Airplane, and Peppers as shown in Fig. 6. In the simulation, the embossing mask of degree 135 is used for all test images. Simulation results are represented in Fig. 7. In Fig. 7, (a, c, e, g) are the results of using the conventional approach and (b, d, f, h) are the outputs of using the proposed method.

As shown in Fig. 7, the color information is nearly eliminated in the embossed images when using the conventional approach. Only some color information is



(a) (b) (c) (d) (e) (f) (g) (h)

Fig. 7. Simulation results. (a, c, e, g): using the conventional method, (b, d, f, h): using the proposed method

remained in the boundary areas of the objects and in addition, the remaining color information is exceedingly distorted. Using the proposed method, the embossing effect is appeared as same as in the conventional approach. But the color information is highly maintained in all test images. In Lena, the feather and background areas are in detail represented and the color information in all areas are well described. In Baboon, the fur in face and nose is finely appeared and the color information particularly in nose is well expressed. The color in wings in Airplane and all peppers in Peppers is well shown. To sum up, the proposed method has good embossing performance similar to the conventional approach but the colors in the embossed image of the proposed method are greatly excellent compared to those of the conventional method.

5. Conclusions

In this paper, an excellent embossing method for color images was proposed. The embossing mask uses for taking contour information of objects and the conventional embossing method has disadvantage that the color information is disappeared in the embossed image when applying to the color images. The proposed approach has the major merit of reserving the color information of the original image. The key point of the proposed approach is that the embossing mask is applied to the intensity component with some additional pre- and post-processing.

From the simulation results, it was shown that the proposed algorithm has better embossing performance than the conventional method and especially the color information is well reserved in the embossed image.

Acknowledgments

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References

[1] Lee Heung Kyu, Digital Image Processing - Theory and Implementation, SciTech Media, 2007.
[2] A. K. Jain, Fundamentals of Digital Image Processing, Englewood Cliffs, Prentice-Hall, 1989.
[3] W. K. Pratt, Digital Image Processing, Wiley, 1991.
[4] H. J. So, I. H. Jang, and J. H. Kim, “Generation of Color Sketch Images Using DIP Operator,” *Journal of Multimedia Society*, Vol. 12, N0. 7, July 2009.

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