Color simulation method using image processing software

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ABSTRACT

Two points to consider for color simulation using color processing software were examined in this study. They are how to reserve texture of surface in the image and how to change shadow part of the area of color alternation correctly as same as the bright part. For the first point, the technique which changes the luminance separately from the hue and saturation of the color can remain the information of the distribution of luminance. The author found the luminance value calculated by the formula L=0.3*R+0.6*G+0.1*B should change color correctly. For the second point, the mere color matching of the bright area couldn't change the shadow part correctly. According to the measurement of the gradation of several cubes covered by varying achromatic colors in a sample image, the modification method of the "tone curve" dialog in Adobe Photoshop is proposed. The tone curve should be a straight line and the gradient seems to vary according to the luminance distribution of the setting and the surface condition.

Keywords: color simulation, image processing software, lighting condittion, tone curve, luminance distribution

1. INTRODUCTION

The image and impression of interiors, buildings or streetscapes would change when the surface color has changed. Color simulation on personal computer becomes a popular method to check the image of color alternation nowadays. Changing color itself isn't difficult if you use image processing softwares such as Adobe Photoshop. However, the color simulation considering lighting condition isn't simple. This study focuses the color simulation method which simulates the colors in a certain lighting condition of the setting. The basic idea of this color simulation method which takes account of the lighting condition of the setting without complex calculation was proposed by Yoshiki NAKAMURA et al. at 1997.[1] It needs another image of the scene taken from the same point, with color chip on the area for color alternation (Figure 1). The color chip illuminated in same lighting condition as the color simulation scene so that the assignment of the value of RGB gradation in the color chip area into the color alternation area would simulate the view of the color in the real setting.

This is enough for changing areas which have same color, no texture, are in same lighting condition. However, the scene we'd like to simulate colors often has texture and different lighting condition caused by different surface angle (such as table top and their legs) or merely the heterogeneity of illumination. These two points which are important to apply the basic idea of color simulation described above to the color simulation of everyday settings were examined in this study.
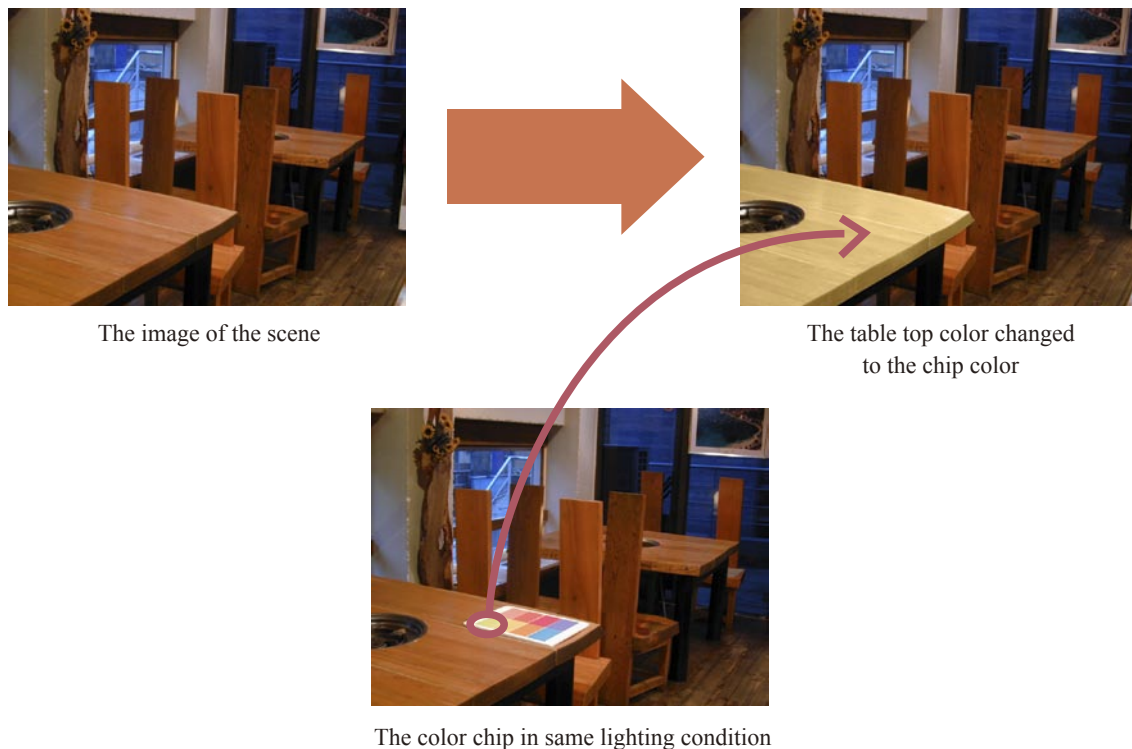
The images used in this examination were taken by digital camera. The image processing was carried out using Adobe Photoshop, the most popular image processing software on personal computer.

2. COLOR SIMULATION WHICH RESERVE THE TEXTURE OF OBJECT SURFACE

If the surface in the color simulation scene is uniform, we merely assign RGB gradation value

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The image of the scene

The table top color changed
to the chip color

The color chip in same lighting condition

Figure 1. The basic idea of the color simulation method proposed in this paper

of the color chip into RGB slider, and then paint the color simulation area using paint tool. In case the surface has texture, luminance should be changed apart from hue and saturation to reserve the information of luminance distribution. The gradation of luminance can be modified on brightness and contrast dialog in Photoshop. The author found the description that the formula L=0.3*R+0.6*G+0.1*B is used for calculation of luminance on NTSC (National Television System Committee) signal transmission. [2]

In a sample case, the luminance value was changed using brightness and contrast dialog based on the value calculated by the formula above, and then, hue and saturation were altered by paint tool using "color" mode (which change hue and saturation only) based on the assignment of RGB values into RGB slider. This procedure makes the same color as the one which was assigned RGB values concurrently. Therefore, it is confirmed that this formula is used to calculate luminance from RGB gradation in Photoshop.

3. COLOR SIMULATION OF THE AREA OF SAME COLOR WHICH IS ILLUMINATED IN DIFFERENT CONDITIONS

We'd like to change the area of same object color concurrently. However, the color alternation based on the measurement of only one point in the area doesn't mean accurate color change of whole area. See Figure 2, the sample case to check the relationship between the luminance and Munsell value on three surfaces of the cubes. The surface value is larger, the luminance difference among top surface (the brightest), right surface (middle), left surface (the darkest) seems to be larger.

Figure 3 shows the relationship between the Munsell value and the gradation of luminance on three surfaces of varying value. The lines which connect the nine measured data are straight, and the gradients of them shift according to the surface value just as we see at figure 2. The color luminance alternation using brightness slider in brightness and contrast dialog couldn't express it.

To change surface color with keeping the difference of luminance which shifts depending on the lighting condition, we are able to use tone curve dialog in Photoshop. It's function is one kind of filter which transforms input gradation to output gradation as introduced at figure 4.
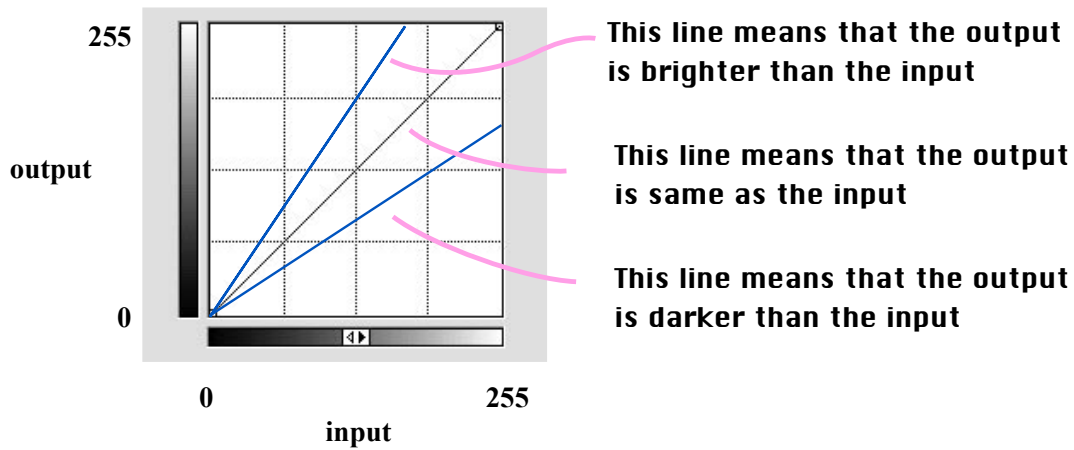
The setting of the line which shows the transmission of gradation was calculated using the data shown in figure 3. The gradient of the line
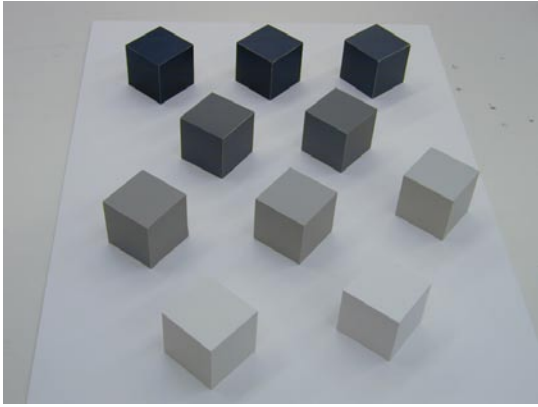
Figure 2. The image of cubes which surface has varying Munsell Values
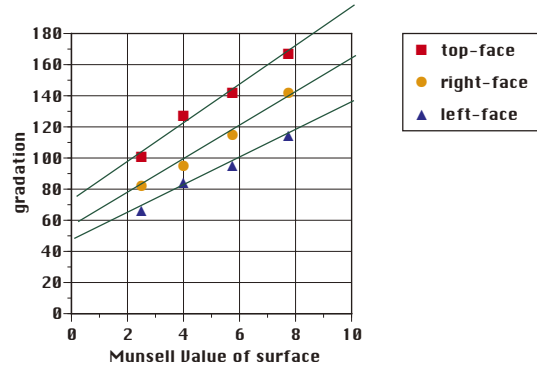
Figure 3. The relationship between Munsell Value and gradation of surfaces of cubes

Figure 4. The tone curve dialog

was calculated by following steps.

(1) The straight lines which fits best to three surfaces' gradation was drawn.

(2) The point where all lines cross together was determined.

(3) The line setting in tone curve dialog is determined by this crossing point and the another point determined by the luminance of the original surface color of bright part and the target surface color of it.

The line is straight, and the gradient shifts depending on the difference between original color value and target color value. The distance from 45 degree line is larger when the value difference is larger.

The color simulation using this tone curve was more similar on the gradation of three surfaces than the one using brightness and contrast dialog.

4. CONSIDERATION OF GROSS OF SURFACE

Color simulation considering the lighting condition to the surfaces succeeded in the sample case, however, the confirmation whether the gradient of tone curve is constant to every setting or not is necessary to apply the tone curve to the new scene for color simulation. Therefore, 8 pictures of interior or exterior with achromatic cube (value: 3, 6, 9) were taken.

Four of these samples are similar to the sample case shown at figure2, the lines of three surfaces on the value-gradation graph meet together, however, the rest four have the nearly parallel lines. Thus, it is clear that the line decided in sample case can't be applied to all color simulation scenes.

The another examination in which the relationship

papers between window
and camera

papers between wall
and camera
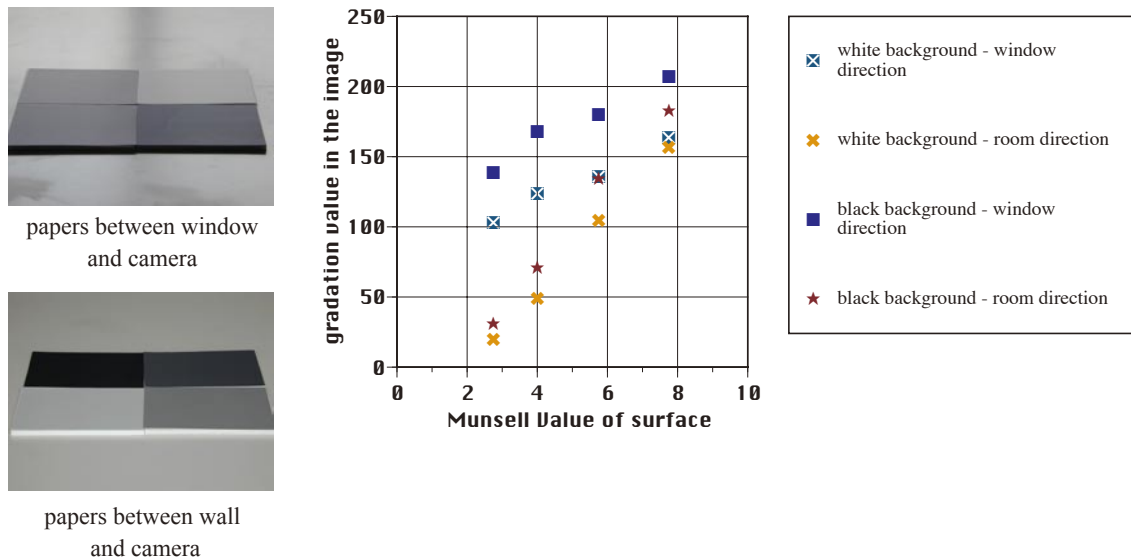
Figure 5. The relationship between Value and gradation of four achromatic papers in different four situations

between gradation of luminance and the Munsell Value of four achromatic paper was conducted to find the clue of this question (See figure 5). The gradation of papers on a table between window and camera vary less than the papers between camera and the wall in a room regardless of the background color. It is natural to explain this phenomenon by reflection; the high luminance in front of camera makes the change of the surface luminance less. Therefore, we should change the gradient of tone curve line in color simulation according to the surface condition and the luminance distribution of the setting, especially the one in the direction from observer or camera to color simulation area. On this point, further experiments are necessary.

ACKNOWLEDGMENTS

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