Gamma Correction-based Hue-preserving Image Enhancement Method for Elderly Person

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***Abstract*—In this study, an image enhancement method taking account of color vision characteristics of the elderly is proposed. The proposed method consists of lightness conversion, contrast enhancement, and hue preservation process. The performance of the proposed method is verified by comparing it with other conventional methods in experiments using several digital images.**

I. Introduction

The performance of human visual functions declines with age. Then visual field of the elderly person becomes darker than that of the younger person. Several image enhancement methods have been proposed for the elderly [1] [2]. However, there are some problems such as image contrast reduction, and image quality degradation due to changes in hue.

In this study, we propose a hue-preserving image enhancement method considering the color vision characteristics of the elderly. The effectiveness of the proposal method is verified by the experiments using several digital images.

II. Proposed method

According to the previous research [3] , the lightness of a pixel i of the elderly is $K_i''(< 1)$ times lighter than that of the young and is darker overall. In this study, a power function using K_i'' is used to enhance the lightness of images. Let $\boldsymbol{x}_i = (x_{Ri}, x_{Gi}, x_{Bi})^T$ be the RGB values. The lightness value x_i is defined as $\max\{x_{Ri}, x_{Gi}, x_{Bi}\}$.

The lightness conversion by a power function is performed as $x_i' = 255{w_i'}^{K_i''}$, $w_i' = (w_i/w_{max})/\kappa$, $w_i = x_i/K_i''$, where κ is a parameter to decide the maximum of w_i'. w_{max} is the muximum of w_i for all pixels. The power function ensures that x_i' is always within the color gamut [0, 255].

The lightness conversion described above effectively enhances the lightness of images, but tends to reduce the contrast. Therefore, we introduce the contrast enhancement process using an S-shape function. The lightness x_i'' after the contrast enhancement is given by

$$x_i'' = \begin{cases} 255(G/255)^{1-\eta}(x_i'/255)^{\eta} & (0 < x_i' \leqq G) \\ 1-(1-(G/255))^{1-\eta}(1-(x_i'/255))^{\eta} & (G < x_i' \leqq 255) \end{cases}, \quad (1)$$

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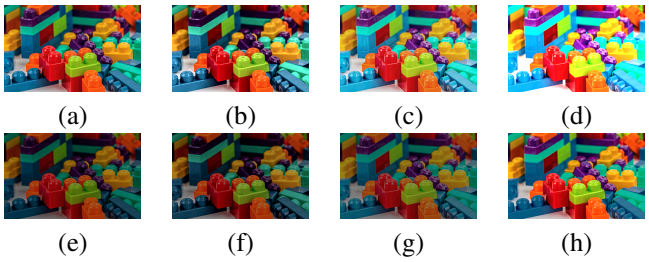

Fig. 1. Experimental results of image 1. Upper row: (a) original image, resulting images by (b) Ueda's method, (c) Moriyama's method, (d) proposed method. Lower row: converted images by color vision simulation of the elderly (age of 80) for (e) (a), (f) (b), (g) (c), and (h) (d).

where $G =< x' >$ is the average of x' for all pixels and η is a parameter satisfying $\eta \geqq 1$. The final resulting RGB values $x_{ci}'', c \in \{R, G, B\}$ are obtained by $x_{ci}'' = (x_i''/x_i')x_{ci}'$. The hue of the input image is preserved. The RGB values x_{ic}' after the lightness conversion are obtained by $x_{ci}' = (x_i'/x_i)x_{ci}$. Since the RGB ratio of the image after the lightness conversion is the same as that of the input image, the hue is preserved before and after the conversion.

III. Experiments

Figure 1 shows examples of the experimental results corresponding to an elderly person at age 80. From Fig. 1(h), we can see that the proposed method enhances the image while maintaining the impression of the original image.

MSE, mean color difference, mean hue difference, and SSIM, which are calculated between an original image and the simulated elderly vision image after the conversion, were used as quantitative evaluation criteria. In the proposed method, good results were obtained in all evaluations.

IV. Conclusions

In this study, we proposed a gamma correction-based hue-preserving image enhancement method based on lightness conversion considering the color vision characteristics of the elderly.

References

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