Digital Image Processing Homework 3

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1 Methodology

The main objective of this experiment is to restore images with color temperature deviations to their normal white-balanced state and enhance them to optimize the image quality.

1.1 Chromatic Adaptation

Firstly, concerning Chromatic Adaptation, the primary objective is to modify the color temperature of the input images to recover from the incorrect white balance of the given image. The approach employed in this experiment is **Shades of Gray (SoG)**, which is an algorithm that strikes a balance between MaxRGB and Gray World. Its mathematical formulation is as Equation 1. When the value of p is 1, the algorithm degenerates into the Gray World algorithm; and when p approaches infinity, it is equivalent to the MaxRGB algorithm. In this experiment, the value of p is set to 5 to achieve a more adaptive result that balances between MaxRGB and Gray World.

$$\left(\frac{\int (f(X))^p dX}{\int dX}\right)^{1/p} = \text{ke} \qquad \text{(Equation 1).}$$

1.2 Image Enhancement

Regarding Image Enhancement, this experiment references a method mentioned in *H. Ahn, B. Keum, D. Kim, and H. S. Lee's paper titled "Adaptive local tone mapping based on retinex for high dynamic range images," presented at the 2013 IEEE International Conference on Consumer Electronics (ICCE) in Las Vegas, NV, USA*. This method combines the Center/Surround Retinex mentioned in class and a locally adaptive HDR method to enhance the luminosity of images. The main process involves initially calculating the luminance for each pixel's R, G, B values (conversion formula as Equation 2). Then, the logarithmic average of the luminance (as Equation 3) is derived, followed by obtaining the corresponding Lg value for each pixel using Equation 4. Finally, each pixel's RGB values are multiplied by the ratio of Lg to luminance.

$$\text{Luminance} = 0.299 \times \text{R} + 0.587 \times \text{G} + 0.114 \times \text{B} \qquad \text{(Equation 2).}$$

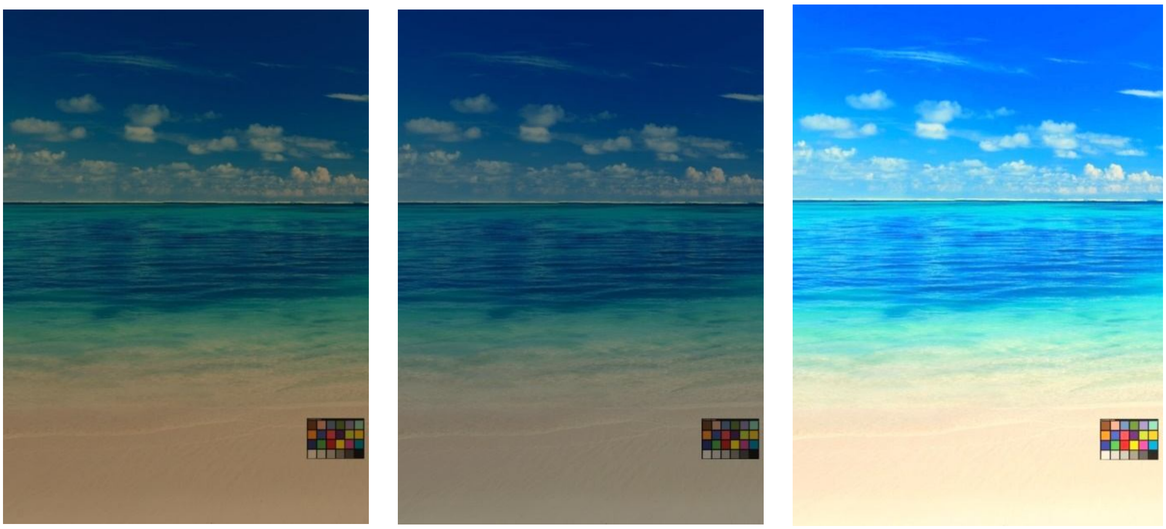
$$\bar{L} = \exp\left(\frac{1}{height \times width} \sum \log(0.001 + Luminace(x, y))\right) \qquad \text{(Equation 3).}$$

$$L_g(x, y) = \frac{\log(Luminace(x,y)/\bar{L} + 1)}{\log(Max(Luminace(x,y))/\bar{L} + 1)} \qquad \text{(Equation 4).}$$

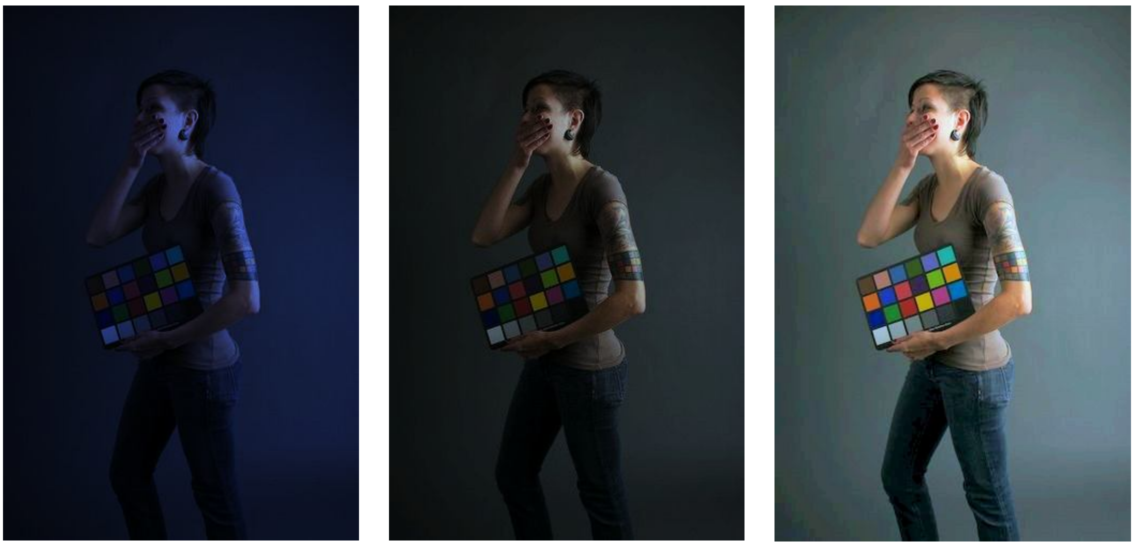
2 Result and Discussion

Fig 1 displays the results of applying Chromatic Adaptation and Image Enhancement to four input images. It's evident that using the Shades of Gray (SoG) method in this experiment successfully mitigates color temperature deviations in the images. Additionally, the Low-luminosity Enhancement applied in this experiment significantly intensifies the image's luminosity. However, upon closer inspection, it's noticeable that the images processed by Low-luminosity Enhancement exhibit some rough patches, especially in the background of Fig 1(c). This aspect should be refined in future iterations.

(a)



(b)



(c)

(d)

Fig 1. The results of this experiment. On the left-hand side is the original image, in the middle is the result after applying Chromatic Adaptation, and on the right-hand side is the outcome after performing Image Enhancement following Chromatic Adaptation. (a) input1.bmp, (b) input2.bmp, (c) input3.bmp and (d) input4.bmp.