DIP HW3 Report

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Task 1 Chromatic Adaptation

Method1: Max RGB

This method assume that the brightest pixel in each channel is pure white, therefore it is only scaling the RGB channel based on its maximum value.

$$R' = R \times \frac{\max(L)}{\max(R)}, \quad G' = G \times \frac{\max(L)}{\max(G)}, \quad B' = B \times \frac{\max(L)}{\max(B)}$$

However, if the image contains too much high value pixel (too bright) or all of the image is dim (too dark), the proportion of the scaling factor will be unnatural, leading to poor white balancing result (input3 & input4).

Method2: Shades of Gray

This method is a mix of Max RGB method and Gray World method, which uses n-norm to calculate the scale of each channel. Where n-norm representation is shown below.

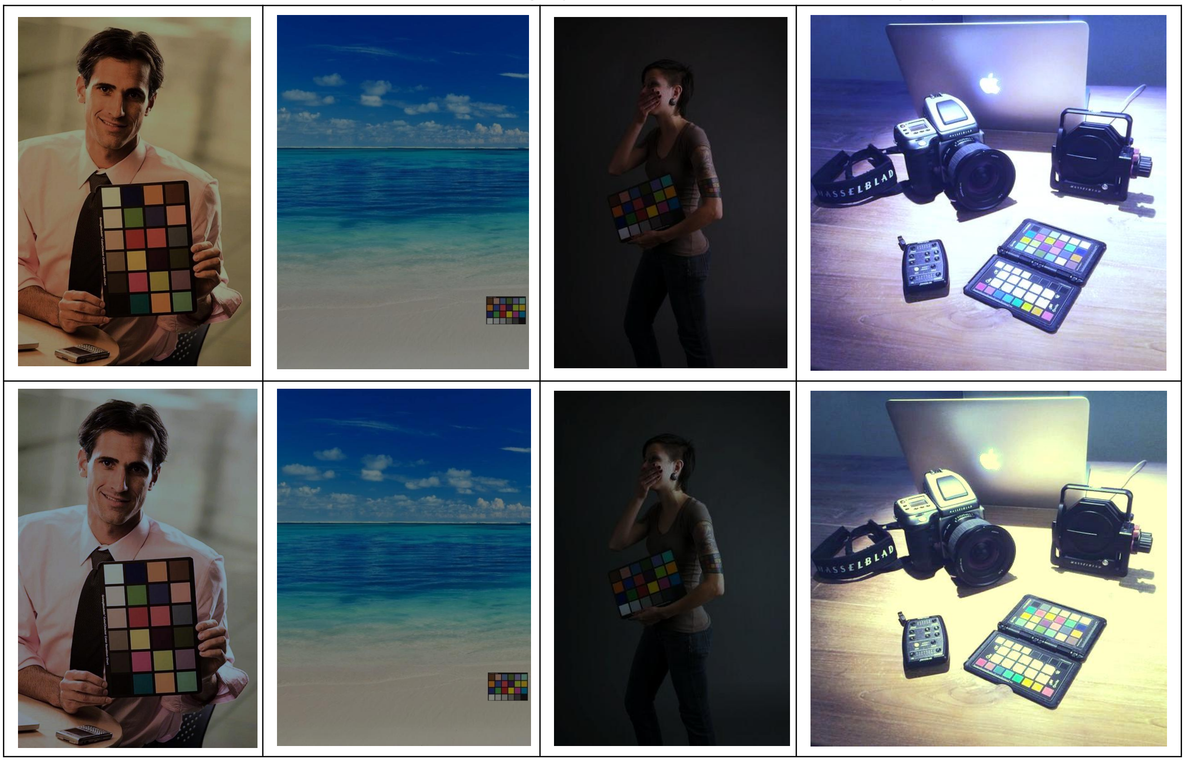
$$R' = R \times \frac{\|L\|_n}{\|R\|_n}, \quad G' = G \times \frac{\|L\|_n}{\|G\|_n}, \quad B' = B \times \frac{\|L\|_n}{\|B\|_n} \qquad \|C\|_n = \left(\frac{1}{N} \sum_{i=1}^{N} C_i^n \right)^{\frac{1}{n}}$$

This method greatly reduce the effectiveness of the distribution of the pixel value, adjusting the n value can accommodate more variety of pictures.

Result:

Top row Max RGB / Bottom row Shades of Gray

Since the overall result is better on shades of gray method, I use the shades of gray instead.



Task 2 Image Enhancement

Since all of the image appears a bit dim, and the colors are not saturate enough, I implement a saturate function to enhance the color and apply several filters implement in HW1 and HW2.

Saturation Enhancement:

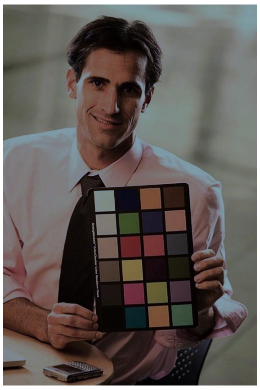
To avoid changing too much intensity value, I choose to enhance the Cb Cr channels instead of directly enhance the RGB channels. Since the transition between RGB and YCbCr channel include a 128 offset value, we need to consider it during the scaling process.

```
pixel[i][j].Cb = Clamp( (pixel[i][j].Cb - 128)*factor + 128, 0, 255 );
pixel[i][j].Cr = Clamp( (pixel[i][j].Cr - 128)*factor + 128, 0, 255 );
```

Other Image enhancement:

Apart from than saturation enhancement, I also improve luminality using gamma correction, and improve image details using sharpness enhancement.

Result:

From the result image, we can see that all images have significant improve on the quality. However, there are still a bit far from the ground truth image. The problem lies in how the color temperature works in the original images. We cannot guarantee the original image lies under white light condition. In example, the original image of input4 is under a warm tone of lighting. When we convert the image using white balance algorithm, it almost seems like the image is bluish compare to ground truth.

Task 3 Color Temperature adjustment

This task is very straight forward, we can simply tune the RGB channel value to achieve warmer or cooler tone of the image.

Warmer image:

With warmer image, we need to scale up the R channel, and lower the B channel. Typically the G channel will be a little bit higher to accommodate overall image color quality.

```
pixel[i][j].R = Clamp((pixel[i][j].R * 1.2 ), 0, 255);
pixel[i][j].G = Clamp((pixel[i][j].G * 1.05 ), 0, 255);
pixel[i][j].B = Clamp((pixel[i][j].B * 0.8 ), 0, 255);
```

To avoid value overflow, we clamp the RGB value between 0 ~ 255 range.

Cooler image:

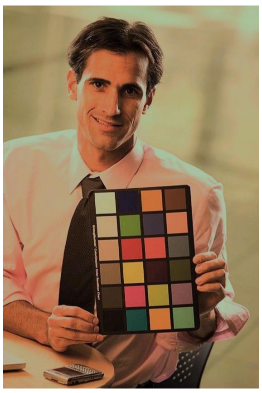
With cooler image similarly, we increase the B channel with a factor, and decrease the R channel value. Finally, we increase the G channel a little bit.

```
pixel[i][j].R = Clamp((pixel[i][j].R * 0.8 ), 0, 255);
pixel[i][j].G = Clamp((pixel[i][j].G * 1.05 ), 0, 255);
pixel[i][j].B = Clamp((pixel[i][j].B * 1.2 ), 0, 255);
```

The scale factor here are set fixed, I can set it to variable to input, but I found out this set of factor is the best to show a hint of temperature change without over-tuning the colors. Therefore the factors are fixed.

Result:

Top row Original / Middle row Warmer image / Bottom row Cooler image




More Discussion

I found out that this set of image all have something unique. The first image is quite normal other than a bit reddish, the second image contains ocean mainly consist of color blue, and the third, fourth image correspond to darker and brighter image. All of the above factor will influence the outcome of the white balance algorithm.

In example, if I only use Gray World method in task1, the second image will turn almost reddish because of the dominant blue color channel.
Apply the shades of gray with different level of n-norm factor improve the outcome a lot.

When doing task 2, different image has different value of gamma correction value. I listed the parameter below.

	N-norm	Gamma value (Luma)	Saturation scale factor	Sharpness factor
Image 1	10	0.7	1.1	0.5
Image 2	10	0.6	1.5	0.2
Image 3	5	0.65	2.0	0.5
Image 4	2	1.2	1.4	0.5

We can see that image4's gamma value is particularly high because of the bright image input. To get better contrast image, we enhance the darker part.