Assignment 2

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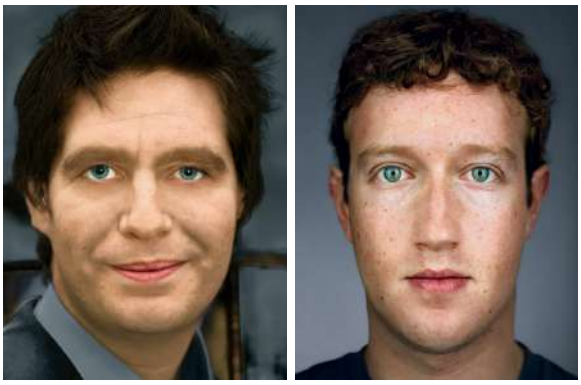
1 Introduction

In this assignment, it is aimed to transfer color using two different images given to us as source and target image. For this process, the Reinhard model, which is shown to us as a reference, will be used. In addition, for part 2, color transfer will be performed using one of the NCC or SSD algorithms that we also use in Assignment 1. At the end of these processes, it is aimed to apply a realistic color transfer by applying the colors from the Target Image to the Source Image.

2 Experiment

2.1 Part 1

Before going into the details of the assignment, I would first like to clarify the formulas I applied due to the situation I was experiencing. Some parts of the current ones have completely changed with the formulas when you published the first assignment. While the formula in the fourth stage of Part 1 was the opposite when it was first published, it has now been corrected, but the locations of the source and target are changing. Therefore, when I perform this desired operation, an irrelevant result appears. The desired and resulting output is as follows.



The first photo that appears above is the output that should be, and the second is the image that I created using the last updated formulas. As it seems, all results will be different, as the main photo is not the same. That's why I used the Reinhard Color Transfer Methods, which were shown to us as a reference in this assignment.

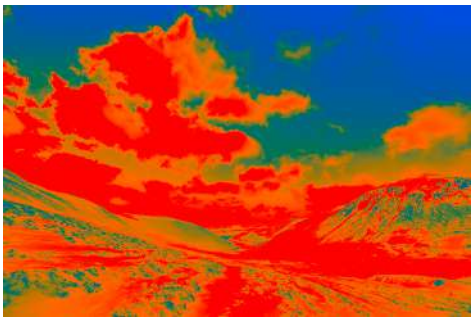
In the first part of the homework, what is required of us is to apply the desired formulas in the homework PDF by using the binary photos, target and source. To implement these, I first performed the process of reading the photos using CV2. I have defined the names of the sample inputs given to us in an array so that all elements can complete the reading process. Then I read each of them with the for loop. I used the BGR2LAB function to separate the elements I read into LAB, and then I finished the division. Then I calculated the mean and standard deviation of each LAB element, respectively, source and target. I put the results I have reached in the desired places in the formulas given to us.

2.1.1 Important Note

The following formula was included in the third stage of Part 1 of the attached homework pdf;

$$l^* = l - \mu_l$$
$$\alpha^* = l - \mu_\alpha$$
$$\beta^* = l - \mu_\beta$$

I used this formula for the first time while doing the homework, but I came to an irrelevant result because the formula was wrong. An example output that I created using the formula in the pdf is as follows:



After this process, I looked at the Reinhard Color Transfer formulas given to us as a reference and decided that this was the formula that should be applied. The formula I used is as follows:

$$l^* = l - \langle l \rangle$$
$$\alpha^* = \alpha - \langle \alpha \rangle$$
$$\beta^* = \beta - \langle \beta \rangle$$

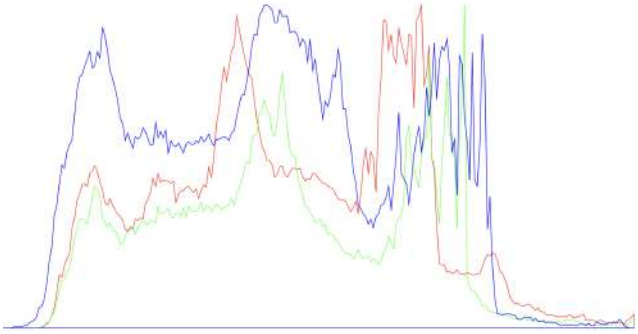
And I applied this formula and other desired parts. Finally, I collected the resulting outputs under the name of "Result-Part1" folder. In this folder I will show some of the outputs I created.

2.2 Part 1 Results

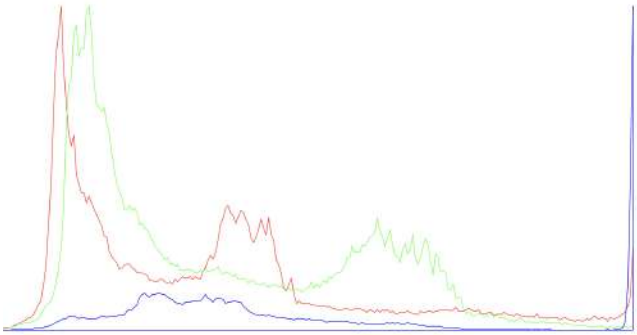
In Part 1, almost all the photos came out with the desired results. I've included three of these examples. While showing them, I added Source Target and Output respectively, and created histograms showing the distribution of colors next to each. For these examples I chose to show example 06, 02 and 29.

2.2.1 Output 1

Source Photo



Target Photo

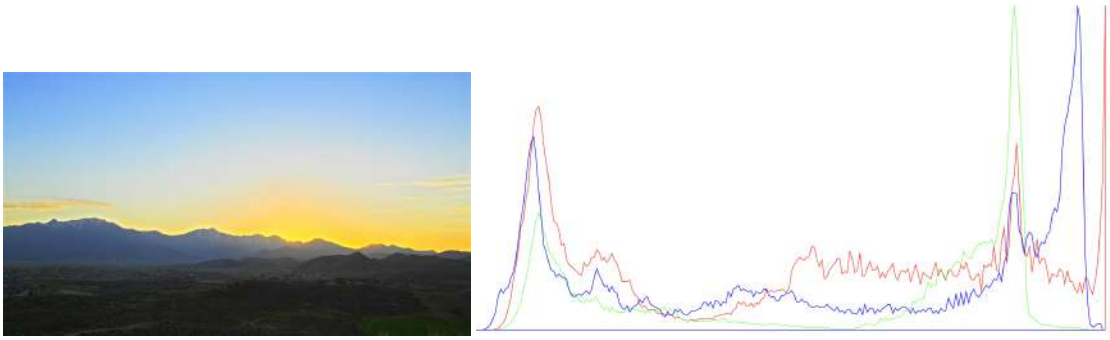


Result Photo

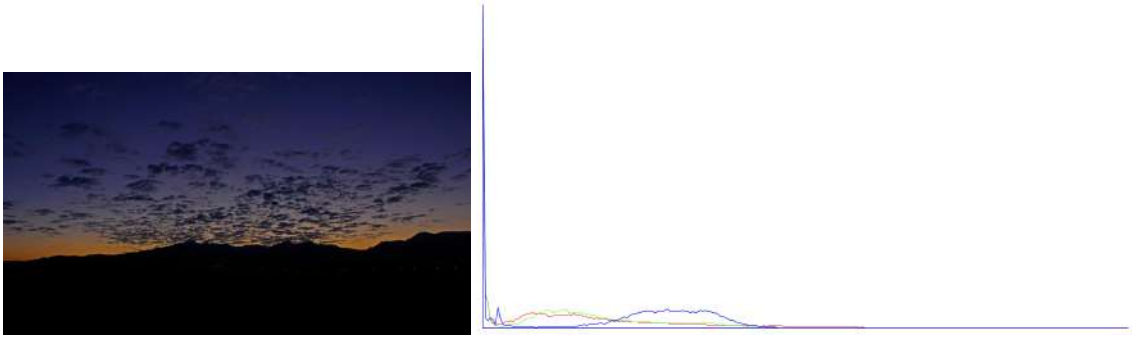
As can be seen in this picture, the color transfer has been carried out successfully. The vibrant colors of the photo in Target are properly transferred to the photo in Source. Looking at the histograms of the photos, especially the blue intensity in the second photo has been transferred to the output photo.

2.2.2 Output 2

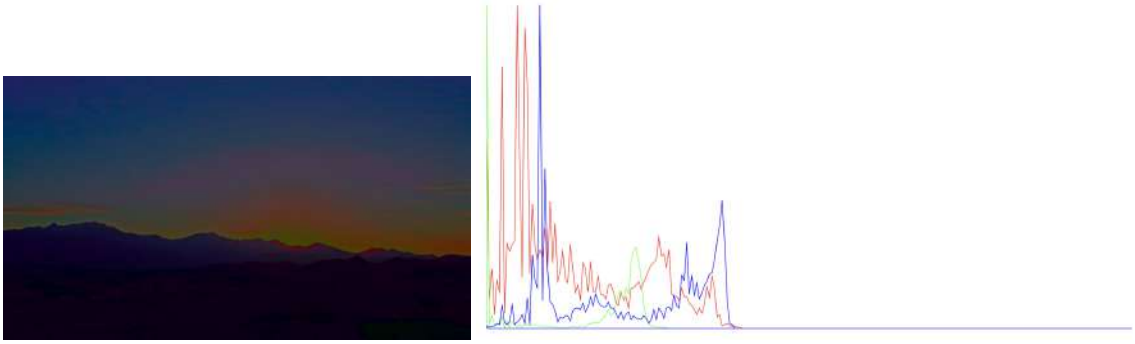
Source Photo



Target Photo



Result Photo



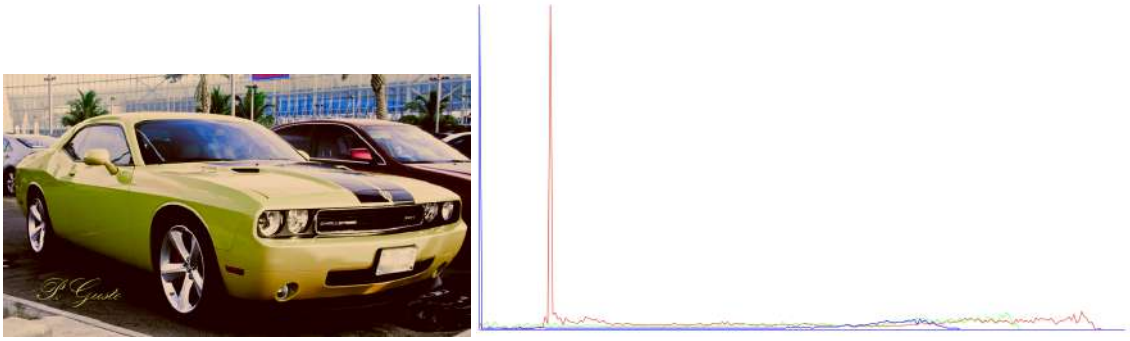
When we look at these examples, we can observe that the first photo, the source, is light-colored, and the second target photo is dark. After the color transfer of these two photos, the last photo switched from light to dark colors. We can see this very easily in the histograms. In the first photograph, the color intensity in the histogram spread to the right, while the color intensity shifted to the left enough in the output that occurred.

2.2.3 Output 3

Source Photo

Target Photo

Result Photo



In these examples, we see that two different photographs are very close in terms of both color and image. Therefore, it cannot be said that there has been a great change in the result. Especially the white parts of the car turned yellow. We can understand this from the histogram of the output photo. But in general, all three histograms are very similar. Since the blue intensity on the left is the same in the source and target photos, it has remained the same in the output.

2.3 Part 2

In this section, besides the method I explained above, I will explain how to make Color Transfer using NCC in a different way. First of all, I started my process by creating photos again. But unlike Part 1, I divided the source and target photos given in this section into the parts I wanted. The reason why I split them is to have each element of the photo I divided separately checked. I used the ncc algorithm for this. With the for loops I created, I found the source and target parts that are closest to each other. After this process, I sent two similar image pieces to my function called colorTransfer. I applied this process for all source parts that I divided respectively.
I have also added the functions I use in this process to the table below.

2.3.1 Methods

Table 1: Methods

Method Name	Input(s)	Output(s)	Info
colorTransfer	src, trgt	result	make color transfer between two image
ncc	var1, var2	nccResult	make normalize cross correlation

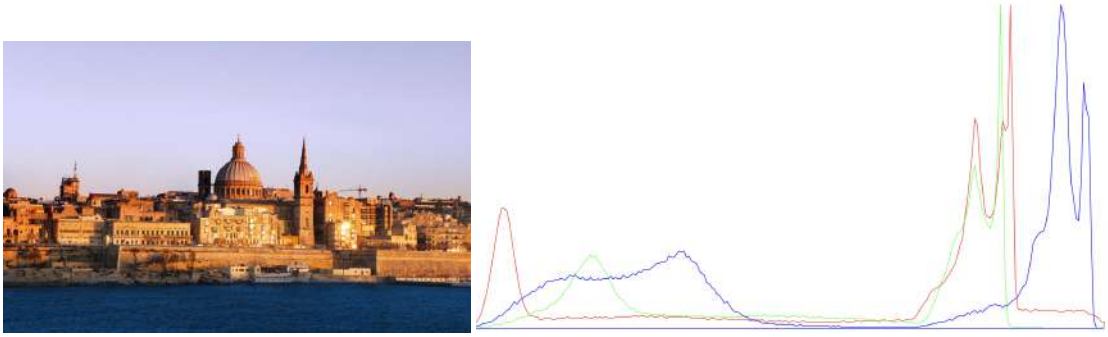
Finally, I collected the resulting outputs under the name of "Result-Part1" folder. I examined each example in three different parts, respectively source, target and result. While doing this review, I had the opportunity to examine the results of color transfer graphically by adding its own color histogram next to each photograph.
The three examples I created after all the processes I completed are as follows;

2.4 Part 2 Results

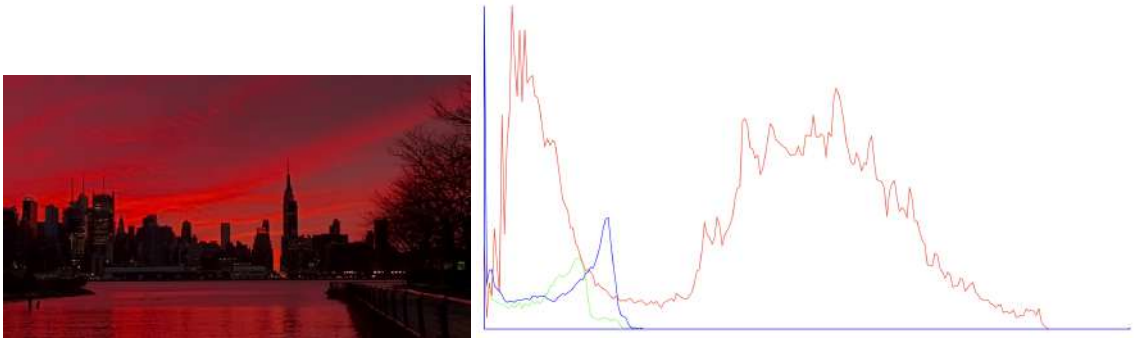
Unlike Part 1, there is a combination problem in the outputs in Part 2. I examined the outputs in the examples below. As you can see, the number of parts I have divided is clearly visible because it does the color transfer operations piece by piece. The reason it is like this is because the transfer process in each piece of photo is not the same location in the two photos. In this part, I used output examples 01 , 51 and 09.

2.4.1 Output 1

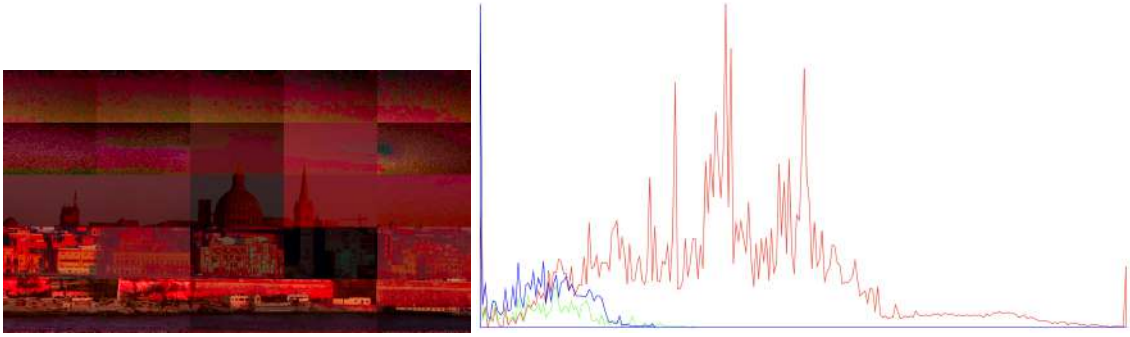
Source Photo



Target Photo



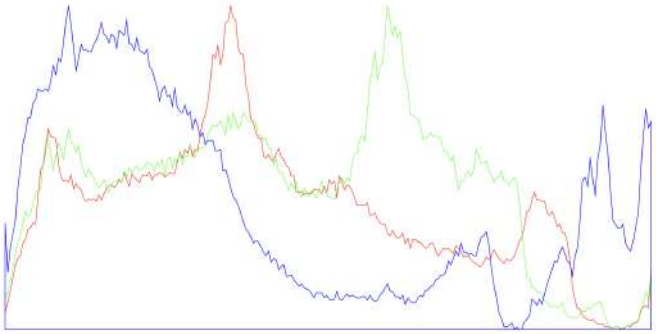
Result Photo



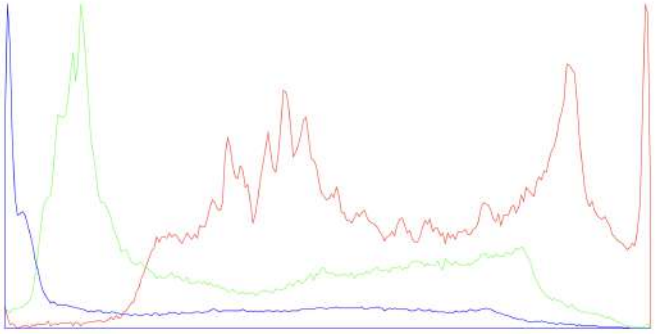
When we look at the first example, we can say that the colors spread almost proportionally in the first photograph. In the second photo, there is a graph of red intensity, as seen in its histogram. The result of combining these two photos using NCC. The third photo has been created. While doing the color transfer of the photograph, I divided it into 25 parts, 5 crosswise and 5 longitudinally. After calculating the similarity ratios with NCC, the value of each box was different. That's why the photo was created with unwanted boxes

2.4.2 Output 2

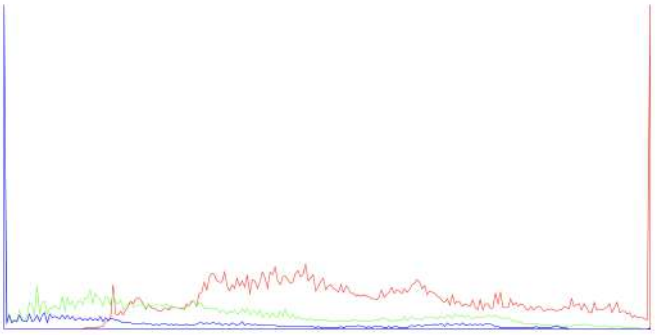
Source Photo



Target Photo



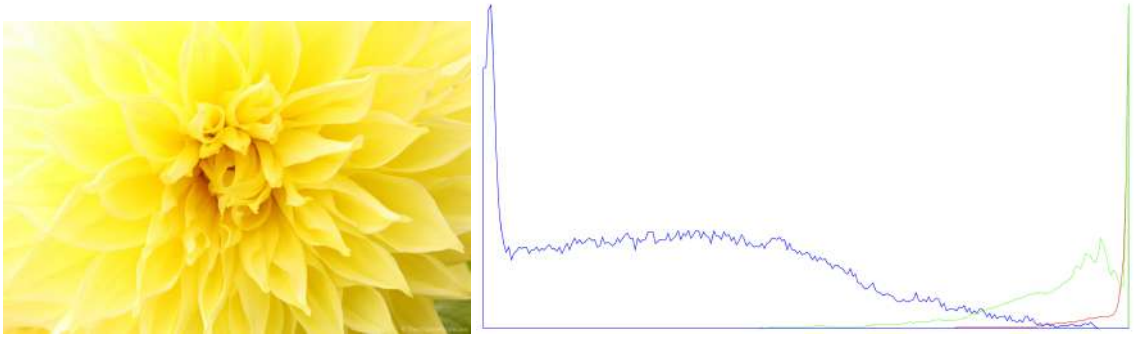
Result Photo



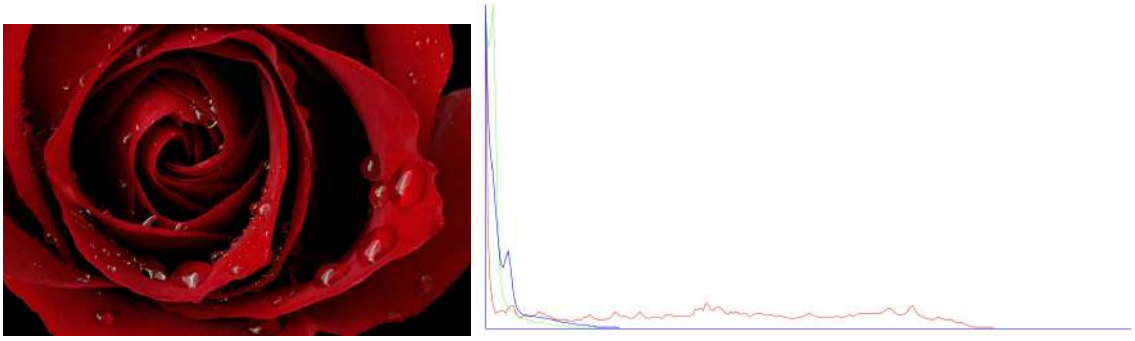
When we look at the colors formed in this example, the result is much worse than the example above. The reason for this is due to the NCC method we used to transfer color. The NCC method seeks to find the closest result by searching for 25 different parts between two images. However, since this photo contains much more detail, unlike the other photo, the NCC method could not find the desired similarity in some parts and therefore produced irrelevant results in the color transfer method used afterwards.

2.4.3 Output 3

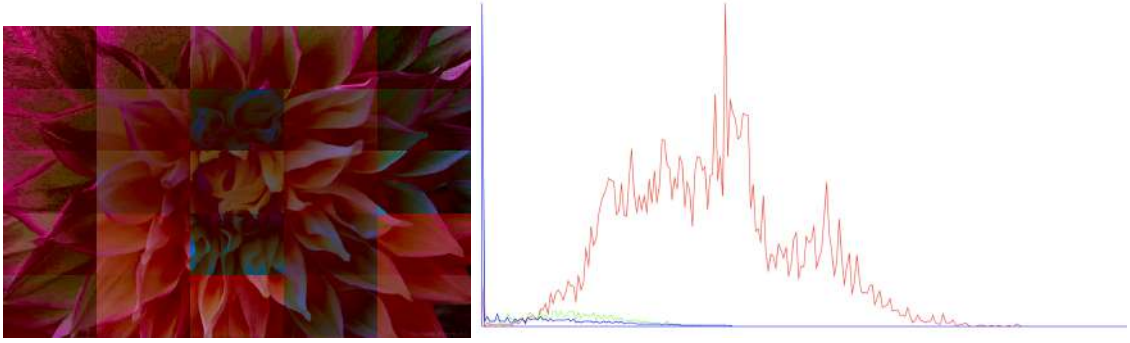
Source Photo



Target Photo



Result Photo



When we look at the third output, there are two different flower photos. Again, problems are experienced as a result of the color transfer of the two photographs. One of these problems is the formation of blue rectangles. This is because it is not compatible with NCC, for example, as in output 2 above. Although the picture seems to be in less detail in general, it actually contains details that NCC will have a hard time finding similarity to. So the output image can be displayed like this.

3 Conclusion

In this assignment, I learned how to color transfer using two different photos. I applied different formulas and understood their logic. In Part 1, I performed the transfer process using the overall photo. In addition, I learned to apply the NCC method in the color transfer process by remembering the NCC method that I wrote in the previous assignment in Part 2.
[1]

4 References

References

[1] *Color Transfer Between Images.*