HW4: Color Image Processing

DIP Teaching Stuff, Sun Yat-Sen University

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Congratulations! You have survived from the most difficult parts of this course. HW4 is a quite easy journey. Most programming tasks will reuse codes that you have finished before. Take it easy and submit a report (in PDF format) and all relevant codes as the homework solution. However, please pay attention again: Plagiarism == Fail, and there may be at least 30% penalty for late homework.

1 Exercise

Please answer the following questions in your report.

1.1 Color Spaces: RGB→HSI (25 Points)

Consider the following 64×64 RGB image in Figure1, which is divided into 4 non-overlapping blocks. Each block contains exactly 1 color, with the corresponding RGB value shown. Now we convert this RGB image into the HSI color space.

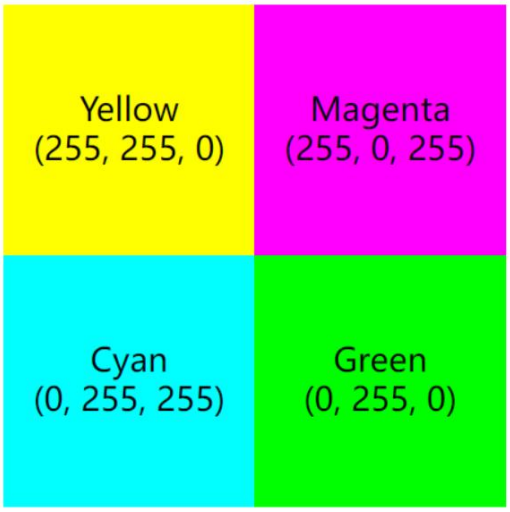


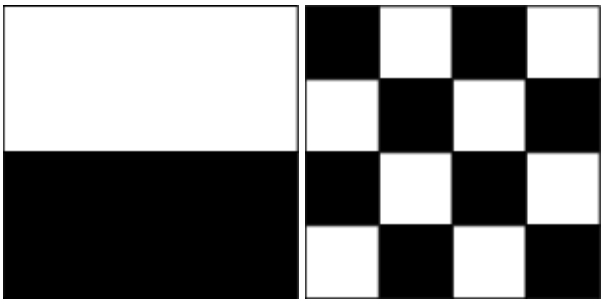
Figure 1: 64×64 *RGB image*

1. Describe the appearances of the hue channel, the saturation channel, and the intensity channel, respectively. (15 Points)

2. Suppose we blur the saturation channel by a 16×16 arithmetic mean filter, describe the appearance of the result. (you may ignore image border effects in the filtering operation) (10 Points)

1.2 Color Spaces: HSI→RGB (25 Points)

Suppose that Figure2 (a) and Figure2 (b) correspond to two channels of a color picture in HSI space, in which Figure (a) corresponds to channel H (hue), Figure (b) corresponds to channel S (saturation), and channel I (intensity) corresponds to an image with $\frac{1}{3}$ of all pixel values. Please describe the color of each part of the color picture in RGB space.



(a) (b)

Figure 2: *(a) channel H (hue) (b) channel S (saturation)*

1.3 Chromaticity Diagram(20 Points)

Consider any two valid colors c_1 and c_2 with coordinates (x_1, y_1) and (x_2, y_2) in the chromaticity diagram of Figure 3. Derive the necessary general expression(s) for computing the relative percentages of colors and composing a given color that is known to lie on the straight line joining these two colors.

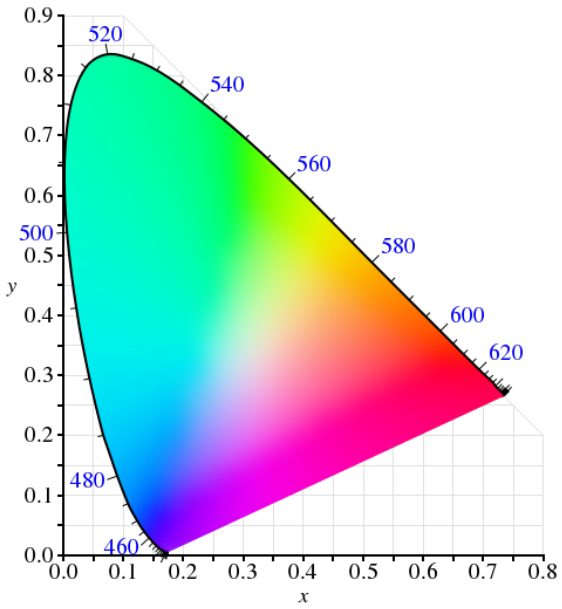


Figure 3: *Chromaticity diagram.*

2 Programming Tasks

Write programs to finish the following three tasks, and answer questions in your report. Don't forget to submit all relevant codes.

2.1 Pre-requirement

There remain some issues that you should pay attention to:

1. Any language is allowed.

2. You can use third-party packages for operating images. But you should manually implement your programming tasks. For example, though you can use "imread" of Matlab to load an image, you cannot invoke "medfilt2" of Matlab for median filtering.

3. Good UX (User Experience) is encouraged, but will only bring you negligible bonuses. Please don't spend too much time on it, since this is not an HCI course.

4. Keep your codes clean and well-documented. Bad coding styles will result in 20% penalty at most.

2.2 Histogram Equalization on Color Images (30 Points)

2.2.1 Input

Please download the archive "hw4.zip", unzip it and pick up the image in the directory "task 3" according to the last two digits of your student ID. You can convert the image format (to BMP, JPEG, ...) via Photoshop if necessary.

2.2.2 Target

Read the input image in RGB mode. Then:

1. Use the function "equalize hist" that you have written in HW2 to process the R, G, B channels separately. Rebuild an RGB image from these three processed channels and paste it in the report. (4 Points)

2. Calculate the histogram on each channel separately, and then compute an average histogram from these three histograms. Use the average histogram as the basis to obtain a single histogram equalization transformation. Apply this transformation to the R, G and B channels individually, and again rebuild an RGB image from the three processed channels. Paste the RGB image in the report. (8 Points)

3. Convert the input image to the HSI color space, and then perform histogram equalization on the intensity channel. Convert the result back to the RGB color space and paste it in the report. (8 Points)

4. Compare and explain the differences in the above three results within 1 page. (10 Points)