بسم الله الرحمن الرحیم

University of Tehran
College of Engineering

Digital Image Processing

Instructor: Dr. Hamid Soltanian-Zadeh

Homework Assignment 5:

Color Image Processing

Due date: 1404/02/04

Corresponding TA:
Zahra Nakhaei

zahranakhaei1999@yahoo.com

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Contents

1 Instructions

Please answer the following questions based on Chapter 6 (*Color Image Processing*) of the textbook by Gonzalez and Woods. Submit your solutions by the due date. Read the following carefully and follow these instructions when submitting your answers:

Requirement	Description	Consideration
Standard Due Date	1404/02/04- 23:59	
Elearn HW Upload	**Only**	Only use ELearn to submit your homeworks.
Email Address	zahranakhaei1999@yahoo.com	Feel free to say hello!
Submit format	Read Note 4	Extremely important
Late Submit	Penalty	$5 - 10\%$ penalty per day

Note 1: *This request is not intended to impose any hardship on you, but to help with better management of the class. Your cooperation is greatly appreciated in making the process more efficient. Thank you!*

Note 2: *We will also have a Telegram group for Q&A. The link (clickable) is provided here:* [open the link]

Note 3: *Use camera scanners if you wish to submit your handwritten answers. While readability is always important, it is especially critical in the DIP course, which focuses on quality enhancement.*

Note 4: *You must send a zip or rar file named* `DIP-HWx-std.no` *where x is the number of the homework (e.g.* `DIP-HW5-810199034`*). Inside the zipped file will be a folder for each question containing its code and output images. There should also be a single pdf file in the root folder as your main report.*

Academic Integrity: *Plagiarism, cheating, or using unauthorized external resources (including AI tools, solution manuals, or copying from peers) is strictly prohibited. All assignments will be checked for originality, and any violations will result in academic penalties. Please submit only your own work.* It's easy to detect whether your answers are generated by AI or are truly your own work, so be sure to submit original solutions.

2 Histogram Equalization & Matching

Background

The goal of this assignment is to enhance color images using histogram equalization.

2.1

(a) Load the color image "flowers.png".Convert the image to RGB format if needed.

(b) Compute the histogram of each color channel (R, G, B).

(c) Apply histogram equalization separately to the R, G, and B channels using their individual histograms.

(d) Reconstruct the color image using the equalized R, G, and B channels.

(e) Display the original and the equalized images side by side in a single figure.

(f) Compute the average histogram by combining the R, G, and B histograms from part (c).

(g) Use the average histogram to create a single histogram equalization intensity transformation function.

(h) Apply transformation function of part (h) to each of the R, G, and B channels individually.

(i) Reconstruct and display the final enhanced image.

2.2

Background

Histogram matching is a technique that can be used to artificially add color to grayscale images.

(a) Explain the process of using histogram matching to colorize the image.

(b) Load "dessert.jpg" and "pencils.jpeg". Use the RGB image as reference and implement the matching procedure.

(c) Display the histograms of the original grayscale image, reference RGB image, and the resultant RGB image in a single figure using subplots. Briefly explain if this meets your initial expectation at part(a).

3 Denoising Techniques in RGB Images

Background

Usually, the noise content of a color image has the same characteristics in each color channel, but it is possible for color channels to be affected differently by noise. In this problem, we will be implementing denoising techniques on color images.

(a) Load the image "frog_noisy.png".

(b) Remove salt and pepper noise as well as the green and red wave artifacts.

(c) Plot the denoised image alongside the noisy image in a single figure.

(d) Now load "lenna_noisy1" and "lenna_noisy2".

(e) Try to recognize what kinds of noises are on each image. Try to suppress the noises as much as possible using appropriate filtering method. (Averaging, median, harmonic, etc.)

Note:

You may use some basic built-in functions such as conv2, filter2,... in order to implement your algorithm but you should explain each step thoroughly.

4 RGB & HSI

Background

In this section, we will become familiar with some of the properties of the HSI color system that make certain image processing procedures easier.

(a) Write your own function that changes an image from RGB color space to normalized HSI color space. The function should take an image as input and give three outputs: Hue, Saturation, and Intensity.

(b) Load the image called "cars.jpg", use your function on it, and show the results (H, S, I) together in one figure.

(c) In this part, use MATLAB's built-in functions to convert the image from RGB to HSI. Compare the results obtained from your custom function with the results from MATLAB's built-in functions. Discuss any differences you observe and explain why they might occur.

(d) Use "cars.jpg" and try to convert yellow cars into purple ones using the function you have implemented in part(a) by following these steps:

- Identify the yellow cars.
- Generate a mask in which the yellow cars are identified by `1` and the rest are `0`.
- Apply the mask to the original image.
- Display the original image, the mask, and the final result in a single figure using `subplot`.

Note:

You may not use MATLAB (or any library e.g., OpenCV) built-in functions..

5 Pseudo Coloring with Intensity Slicing

Background

The method of intensity slicing and color coding is one of the basic instances of pseudo-color image processing. In this scenario, we aim to apply this technique to colorize the image "phantom.tif".

(a) Load "phantom.tif".

(b) Plot its histogram to check the intensity range of the image.

(c) Divide this range into 5 intensity intervals and then assign arbitrary color to each of them.

(d) Plot the result together with the original image in a single figure for comparison.

6 Basic RGB Image Processing Procedures

Background

In this part, we want to change the intensity of a particular color in RGB image.

(a) Load the image "woman_baby.tif". Then, write a function with three different inputs:

- image
- color type (cyan, black, magenta, and yellow)
- weakness or heaviness in the selected color

Use this function and display the weakness and heaviness in cyan, yellow, magenta, and black in your report as it is depicted in the textbook and compare each one with the original image.Show the results in a figure with two rows and four columns, where each sub-image demonstrates the effect of applying weakness or heaviness to each color type.

(b) Write a script m-file that does the following. Load image "peppers.png". Convert it from RGB to grayscale using the function rgb2gray. Find the edges in the image

using the MATLAB function edge. Use the following methods: Sobel, Prewitt, Roberts, Laplacian of Gaussian, and Canny. Compare your results. Plot the results together with the original image in a single figure with 2 rows and 3 columns.

Textbook Questions

Please provide the solutions to the questions presented in the 6th chapter of the Image Processing book (Edition3):5,22,23,26