HOMEWORK #1

General Instructions:

1. This document and all the mentioned files are posted on Sakai.

2. Homework submission and return will be handled electronically ONLY. Assignments are always due at midnight (11:59pm). **Late policy: 1pt deduction every hour. 48 hours at most.**

A. Submission

A complete submission should contain two files: one report file (*.doc (MS Word) or *.pdf) and one compressed file (*.zip, *.rar, *.tar, or *.gz) containing your source code. The naming of these two files should be hw#1_YourStudentID YourLastName.
* Links to the submission folders will be provided on Sakai along with the assignment. Please upload you report file and zipped source code file to the corresponding folders.

The report should include, but not limited to the following:

a. Description of your motivation
b. Description of your approach and procedures
c. Results from the provided testing images
d. Discussion of your approach and results
e. Your answer to the non-programming questions, if any
f. Your findings from your own created testing images. You should use AIGC (AI Generated Content) tools to create your own testing images for each exercise and document what you find after applying your code for processing. Please include your created image and the processed results in your report with detailed explanation and discussion for each question.

The compressed file should include the following ONLY

a. Your source code
b. Compiling and executing instructions

Please do NOT include any image data files or executables.

There are some restrictions if you are using Matlab, for example, Image Processing. Toolbox (except the imshow() and image()) are NOT allowed.

Please refer to homework submission guidelines for more details.

3. Please refer to the syllabus for DKU policy on academic integrity and the penalties for cheating and plagiarism. These rules will be strictly enforced.

Problem 1: Getting Started (35%)

(1) Making Gray-Scale Image from Color Image

In a gray-scale image, each pixel has the value of only one component to record its brightness (Y: 0 ~ 255). In an RGB color image, each pixel has the value of three color components (Red, Green, and Blue, respectively) to record the combined color. Suppose that the brightness Y of a pixel and its R, G, B components have the following relationship:

$$Y = 0.299\times R + 0.587\times G + 0.114\times B$$

The following samples images are color and gray-scale image of our campus Building.

(a) Color Image

(b) Gray-Scale Image

Figure 1. Color and Gray-Scale Image of "building_color.raw"

Please implement the program to change color image of "DKU Acadmic Building" to gray-scale image. Please also show the resultant image in your report.

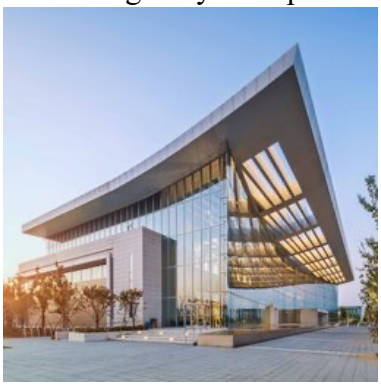

Figure 2. Color Image of DKU Acadmic Building
"building2_color.raw"

HINT

1. For your convenience, sample codes are provided to perform raw image file I/O in C/C++/ Matlab. You may use imshow() and image() function in MATLAB to display the image.
2. Color raw images are provided in 8-bit depth, interleaved format.

(2) Embedding Watermarks into Original Image

Digital watermarking is the process of embedding information into a digital signal. The signal may be audio, pictures or video, for example. In visible watermarking, the information is visible in the picture or video. Typically, the information is text or a logo which identifies the owner of the media.

Let's assume that we want to embed DKU logo in Figure 4 into "building2_color.raw" image.

(a) Color Image (b) Gray-Scale Image

Figure 3. DKU Logo

After embedding DKU logo watermark, Building image will have DKU logo watermark as shown in Figure 4.

(a) Color Image (b) Gray-Scale Image

Figure 4. Watermark Embedded "building2.raw"

Please implement the program to embed color DKU logo watermark image into the center position of color image "building2_color.raw" at in Figure 2. (DKU logo is embedded into upper left corner in our example.) Please also implement the program to embed gray-scale DKU logo watermark image into the center position of "building2_color.raw" gray-scale image obtained from the above Problem 1 (1).

Please describe procedures clearly and show the resultant images in your report.

(3) Generating Negative from Color Image

Your friend is a fan of airplanes and he has a picture of the F-16 jet. He wants to have the negative of the picture. He asked you if you could generate the negative from the scanned picture. Please carefully study the two images given in Fig.5 and find out their relationship.

Briefly describe your algorithm to generate the negative for a color image and apply the developed algorithm to the picture as shown in Fig.6. After generating the negative, compute and plot the color histogram (R, G, B) of the original image and the negative image and compare the results. (HINT: The source code to open a grayscale raw image file is provided. You need to modify it for reading color RGB raw image files, you may use image() function in MATLAB to display the image).

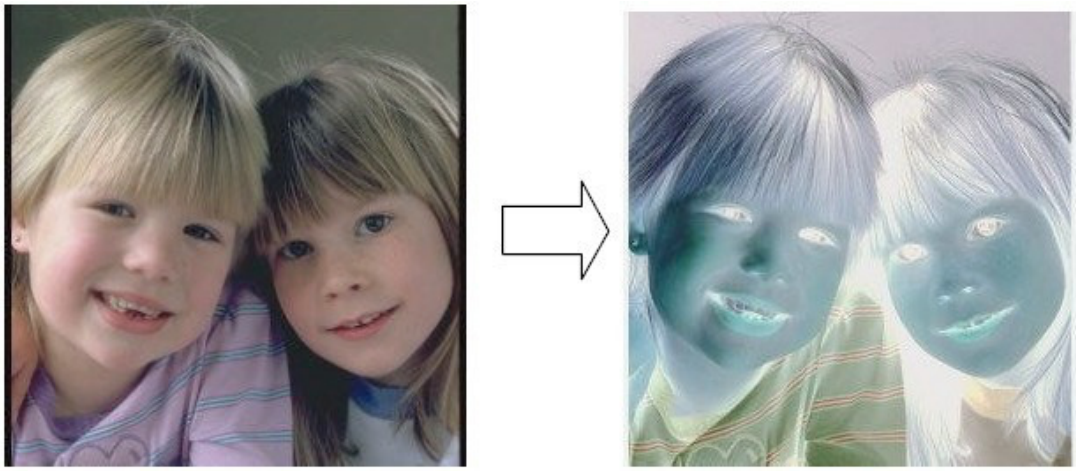

Figure 5. **(a) girls: the original image** **(b) girls: the negative image**

Figure 6. F-16: the original image

Problem 2: Image Enhancement (30%)

Please implement the following two contrast manipulation techniques to enhance the three different contrast rose images in Figure 7 (a), (b) and (c).
(i) full range linear scaling method
(ii) histogram equalization method

(a) Dark image (b) Middle image (c) Bright image

Figure 7: (a) rose_dark.raw (b) rose_mid.raw (c) rose_bright.raw

Describe the procedure and show the resultant images. Plot the histograms of all images (3 inputs and 6 outputs), and the transfer functions (6 functions). Compare and comment on the performance of the two methods.

If you implement your code in Matlab, the use of hist() and related functions are NOT allowed.

Problem 3: Noise removal (35%)

Please implement programs for noise removal under the following condition.

(1) Gray-level image

Figure 8(a) is an example of embedded uniform noise. Figure 8(b) is an example of embedded Gaussian noise. Please remove the noise from these two images and compare with the original image in Figure 8(c). What are the proper choices of filters and parameters? Justify your selections and discuss your results.

(a) Uniform noise (b) Gaussian noise (c) Original image

Figure 8. (a) rose_uni.raw (b) rose_gau.raw (c) rose.raw

(2) Color image

Figure 9(a) is a color image, where each channel is embedded with mixed noises. As a result, colors are disrupted. Please try your best to remove the noise, and compare with the original image as shown in Figure 9(b). Describe and justify your algorithm.

(a) (b)

Figure 9. (a) rose_color_noise.raw (b) rose_color.raw

Appendix: Image files and sample codes used in this project

Problem1: Getting Started

Figure 1 building_color.raw
Figure 2 building2_color.raw
The above two are 256x256 8-bit depth, interleaved RGB images.

Figure 3 (a) dku_logo_color.raw
The above is 128x128 8-bit depth, interleaved RGB images.

Figure 3 (b) dku_logo_gray.raw
The above is 128x128 8-bit depth, gray image.

Figure 5(a) girls.raw
Figure 5(b) girls_n.raw
The above two are 256x256 8-bit depth, interleaved RGB image.

Figure 6 F-16.raw
The above is 512x512 8-bit depth, interleaved RGB image.

Problem2: Image Enhancement Figure 7(a) rose_dark.raw Figure 7(b) rose_mid.raw Figure 7(c) rose_bright.raw

The above three are 256x256 8-bit depth, gray images.

Problem3: Noise Removal
Figure 8(a) rose_uni.raw
Figure 8(b) rose_gau.raw
Figure 8(c) rose.raw

The above three are 256x256 8-bit depth, gray images.

Figure 9(a) rose_color_noise.raw
Figure 9(b) rose_color.raw

The above two are 256x256 8-bit depth, interleaved RGB images.

Sample Code:
readraw.m MATLAB source code provided to read in grayscale raw image files
readraw_color MATLAB source code provided to read in color raw image files
writeraw.m MATLAB source code provided to output grayscale raw image files
writeraw_color MATLAB source code provided to output grayscale raw image files
readraw.c C code provided to read in and output grayscale and color raw image files