

REU Site Program in CVMA

Lab 2 – Exercise on Image Enhancement in the Spatial Domain

Warm-up Demo:

Click on the “Demo” on the “Help” menu bar of Matlab. Follow the following links on the left panel bar: Toolboxes → Image Processing → Enhancement → Contrast Enhancement Techniques. It will display the details on how to use three built-in functions, i.e., `imadjust`, `histeq`, and `adapthisteq`, to enhance the contrast of an image. Please carefully read the code and understand how to correctly use these three functions.

Problem 1. Exercises on Bit-plane and Linear Transformation Operations

Read in the image (**Food.jpg**) and save it in an array **Food**.

- a) Implement a **Scaling** function to linearly rescale the input image into a new intensity range. The prototype of this function should be:

function [ScaledIm] = Scaling(InputIm, Range)

where `InputIm` is the original grayscale image, `Range` is a vector containing the new range of the scaled image, and `ScaledIm` is the rescaled (transformed) image. Make sure that your function shows the appropriate error messages if the range contains the invalid data. Note: Both input and output images of the **Scaling** function should be an array with data type `uint8`.

Call the **Scaling** function to scale the image **Food** into an appropriate range [`NewMin`, `NewMax`] so the original image is enhanced to a good quality. Save the scaled image into **ScaledFood**.

- b) Use the Matlab built-in function **imadjust** to scale the image **Food** into the same range [`NewMin`, `NewMax`] and save the scaled image into **MatScaledFood**.
- c) Display the original image, your scaled image, and matlab’s scaled image side-by-side on figure 2 with appropriate titles.
- d) Close all figures.

Problem 2. Exercises on Histogram Equalization and Plot

- a) Implement a **ComputeHistograms** function to calculate either histogram or normalized histogram or both of the grayscale input image. Note: Here I do not provide any function prototype for this function. So you can implement it based on your preference.

Call function **ComputeHistograms** to calculate both histogram and normalized histograms of the image **scaledFood**. Call function **ComputeHistograms** to calculate the normalized histogram of the image **matScaledFood**.

- b) Display the above calculated normalized histograms of the images **ScaledFood**, and **MatScaledFood** on figure 1 with appropriate titles. For each histogram, you must add label “intensity” to x -axis and label “intensity numbers” to y -axis. You are not allowed to simply use the “`imhist`” or “`hist`” function in Matlab, although you are encouraged to compare your results with those obtained using these functions when solving the subproblem e).
- c) Implement a **HistEqualization** function to perform histogram equalization on a grayscale input image by following the four steps explained in class. The prototype of this function should be:
function [EnhancedIm] = HistEqualization(InputIm, Level)

where `InputIm` is the original grayscale image, `Level` is the maximum gray-level of the desired enhanced image, and `EnhancedIm` is the histogram equalization result. [Note: Both input and output images of the **HistEqualization** function should be an array with data type `uint8`.] Call this function to generate the enhanced image **EqualizedFood** of the original image **Food**.

- d) Apply the appropriate Matlab function(s) to perform the histogram equalization on the original image **Food**. Save the enhanced image as **MatEqualizedFood**.
- e) Apply the appropriate Matlab function(s) to display the histograms of **Food**, **EqualizedFood**, and **MatEqualizedFood** on figure 2.
- f) Obtain the execution time of your histogram equalization method and Matlab's histogram equalization. Display how much faster or slower your solution compared to Matlab's solution in terms of seconds.
- g) What are the differences between two Matlab built-in functions **hist** and **histc**? Which function should be used to generate the histogram of an image? Please write a sample function call to compute the histogram of an image. Show your answers by using the `display` command.
- h) Close all figures.