Lab 2 - Image Processing EEE412

Report is due **two weeks** from the date of running this lab

Objectives:

1- To master how to use different histogram enhancement techniques.
2- To master how to use different spatial filtering techniques.

Matlab functions:

Check the following *Matlab* functions :

```
Imhist, histeq, blockproc

Imfilter, fspecial, medfilt2, blockproc, deconvwnr
```

Hint: read the help about each of the previous functions and any other function you might use. Some Matlab functions have a section describing the *Algorithm(s)* they use; it is worth reading this section.

Hint:

Divide big task into smaller sub-tasks, and write a function for each sub-task.

While designing your functions try to make them as general as possible, you may need to use them for other tasks in future.

Use **meaningful names** for your functions and their variables, don't use names such as a, aa, …

Save all your functions in a folder and include it in the Matlab path

Tasks:

To enhance the efficiency of your Matlab codes, when it is possible, try to avoid using `for/while` loops while writing your scripts.

1. Task 1 (**10'**):

   Write a function to measure the Peak Signal to Noise Ratio (*PSNR*) between two gray images in *dB*. For the peak value use 255.

$$PSNR(dB) = 10log_{10}(\frac{255\text{^}2}{mse})$$

   Where *mse* is the mean square error, and it is evaluated as:

$$mse = \frac{1}{N}\sum_{\forall ri}\sum_{\forall ci}\left(im(ri,ci) - im_2(ri,ci)\right)^2$$

2. Task 2 (**20'**):

   Download from ICE the file lab2-material.zip which includes:

   i. A monochrome image lenna512.bmp (load it into Matlab as `im`) which will be used as reference.
   ii. The images: lenna512_AWGN.bmp, lenna512_SandP.bmp, lenna512_low_dynamic_range.bmp, and load them into Matlab as `im_wn`, `im_SP`, `im_low_dynamic_range`, respectively.
   iii. Evaluate the PSNR of the previous images with respect to the reference image `im` and complete the following table:

Image	lenna512_AWGN	lenna512_SandP	im_low_dynamic_range
PSNR (dB)			

   Check the histogram of all the previous images, compare them with the histogram of the reference image, comments and **briefly** explain your finding.

3. Task 3 (**20'**):

   Write a function to generate a piece-wise linear mapping transform to enhance the contrast of im_low_dynamic_range, verify the effectiveness of several mapping transform in the following terms: (1) subjectively, and objectively by evaluating the (2) PSNR with respect to the reference image. Include also in your report the best intensity mapping function you obtained.

4. Task 4 (**10'**):

   Use the command `histeq` which enhances the contrast of the images by transforming the values in an intensity image. Compare the current result with the one obtained in Task 3. Comment and **briefly** explain your finding.

5. Task 5 (**20'**):

   One important question that needs to be considered when developing digital camera or digital photo software is how to remove commonly occurring noise from images. In the activities below you will explore different methods for removing noise.

   Design a linear spatial domain filter to attempt to improve the PSNR of the image lenna512_AWGN.bmp by as much as you can, it is suggested that you try 3X3 and 5X5 kernels.

   Display and compute the PSNR of the filtered image and comment on the effects of the filtering process. Describe in your report the designed filter(s) and justify your choices.

   Comment on how effectively the noise is reduced while sharp edges and features in the image are preserved.

   Comment on the trade-offs in image quality while changing the filter type and size?

6. Task 6 (**20'**):

   Apply the median filter with a 3X3 window and a 5X5 window on the image im_SP. Display and evaluate the PSNR of the obtained images. For each window size, comment on how effectively the noise is reduced while sharp edges and features in the image are preserved.

   Use the average filter 3X3 to filter the image im_SP. Compute the PSNR and display the filtered image. As you experimented with the mean and median algorithms what different "performance" did you notice? Was the average or median filter better, and why?

Lab Report

Write a **short** report which should contain a **concise description** of your results and observations and explanations. **Include** listings of the **Matlab scripts** that you have written. **Describe each of the images** that you were asked to display.

Submit the report electronically and a hardcopy version into the white collecting box beside the office EB310 (Hand written reports are not accepted).

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