Shiraz University

Digital Image Processing(March 2023)

Home work #1

Due Date: 17/12/1401

Point processing:

1. Basic gray-level operations:

Input image: barbara.png

For applying point operations, we should select a function that maps each pixel of the picture to another intensity value. This transformation can be formalized like this:

$$s = T(r)$$

Which r, s represent the real pixel value and mapped pixel values, respectively. In this problem, apply these operations as function T and plot the functions. Discuss the results and describe changes by changing constants.

a. Image negative

$s = L - 1 - r$

L : maximum number of gray levels

b. log transformation

$s = c\ \log_{10}(1 + r)$

c: 1,2,3

c. gamma correction:

$$s = cr^{\gamma}$$

c=1, $\gamma = 0.4, 1.0, 1.5$

d. Thresholding:

$$s = \begin{cases} 255 & if\ \ r \geq k \\ 0 & else \end{cases}$$

K = 45, 128, 225

2. Histograms:

In this section, read the images *org.png* , *noisy_1.jpg* , *noisy_2.jpg* , *noisy_3.jpg* and then follow the listed instructions:

1. Plot the histogram of the images.
2. Resize every image to [512, 512].
3. Match the histogram of *org.png* to *noisy_1.jpg* , *noisy_2.jpg.*
4. apply min-max stretching to both result images from previous step .
5. Perform Histogram Equalization on the entire image.
6. Perform Contrast limited Adaptive Histogram Equalization(CLAHE).(you can use library for this).
7. Repeat stages 4 to 6 for the image *noisy_3.jpg*.
8. What is the difference and similarity between Histogram Equalization and Contrast stretching?
9. Report PSNR and MSE criteria of these images and compare them.

3. Image resizing & Rotatation:

Input image: digital_images.jpg

a. Down-sampling: shrink the image size by a factor of 2. For serving this purpose, you should first inner product a filter with the size of 3×3 that all its elements are 1/9.Then, remove $2^{th}, 4^{th}, \ldots$ row and columns. Show the original and downsample image together.

Up-sampling: After subsampling the image, upsample the image to its original size which means upsampling with a factor of 2. For upsampling image, try these methods:

I. Suppose that we have an image with size of [M, N]. For every odd-valued $i \in [0, M-1]$ and odd-valued $j \in [0, N-1]$, set the value of new upsample image (i, j) equal to the value of the low-resolution image at $(\frac{i+1}{2}, \frac{j+1}{2})$.

II. inner product the result from previous step with a filter:

$$\begin{matrix} 0.25 & 0.5 & 0.25 \\ 0.5 & 1.0 & 0.5 \\ 0.25 & 0.5 & 0.25 \end{matrix}$$

Apply MSE and PSNR to upsampled and original image. Compare the results.

Note:

For $M \times N$ image:

$$MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} [(x(i,j) - y(i,j))^2]$$

$$PSNR = 10 \log_{10} \frac{maxI}{MSE}$$, maxI = maximum possible pixel value