TEL411 – Digital Image Processing

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Assignment 3

Due date: Tuesday, December 5, 2021

Exercise 1

1. Construct a Gaussian filter using the fspecial() function of the size [15,15] with standard deviation $\sigma = 20$.

2. Read the "lena_gray_512.tif" grayscale image.

3. Do the zero padding around the image I.

4. Construct the 2D convolution function by yourselves. This function should take as an input a kernel K and an input image I. The output if this function should be the convolved image $\tilde{I}$

   function convImage = convolution(image,kernel)

5. Measure the distortion between $\tilde{I}$ and I using the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) metrics and explain the impact of the filter.

$$MSE(I,\tilde{I}) = \frac{1}{MN}\sum_{x}^{N}\sum_{y}^{M}(I(x,y) - \tilde{I}(x,y))^2$$

$$PSNR(I,\tilde{I}) = 10\log_{10}\left(\frac{(\max(I))^2}{MSE(I,\tilde{I})}\right)$$

Exercise 2

1. Use the default function “conv2()” to compute the convolution between the kernel K and the image I.
2. Set the correct input parameters to satisfy the same boundary conditions and produce a convolved image of the same size as the original one.
3. Compare the results using the MSE.

Exercise 3

1. Use the default function “imfilter()” to compute the convolution between the kernel K and the image I.
2. Set the correct input parameters to satisfy the same boundary conditions and produce a convolved image of the same size as the original one.
3. Compare the results using the MSE.

Exercise 4

Prove experimentally that the convolution theorem holds by applying the fft2() functions to the input image and the gaussian kernel. Once you do the multiplication in the Fourier domain use the Inverse Fourier Transform function ifft2() to get back to the time domain. Use the MSE to verify numerically that the convolution in time domain gives exactly the same results to the multiplication in Fourier domain.

What to turn in

You should turn in both your code and a report where you need to illustrate the results of 4 different convolutions. In addition, report the time each method requires to compute the convolution. Last but not least, you should compare the 4 different methods, given

the MSEs and leave a comment. **Name your file as “Lab_3_Omada_NumberOfYourTeam”**.