Chapter 2 – fundamentals of image processing: point transformation

TEST

1 – Let us consider an **input grayscale image Ie**, its size is: **M** rows and **N** pixels per row. The associated signal (gray levels) is called **s_e(m, n)**.
We perform the three following image processes which create:

A) An output grayscale image I_1, which is (M × N). The associated signal is called $s_1(m, n)$ and given by: $s_1(m, n) = \sum_{k=m-2}^{m+2} \sum_{l=n-3}^{n+3} s_e(k, l)$.

B) An output grayscale image I_2, which is (M × N). The associated signal is called $s_2(m, n)$ and given by: $s_2(m, n) = 128 + [\, 255 - s_e(m, n)\,] / 2$.

C) An output array A_3, which is (M × N). The element a(m, n) is given by: $a(m, n) = \sum_{k=1}^{M} \sum_{l=1}^{N} K(k, l).s_e(k, l)$.

Give for each of these three image processes the kind of transformation: **global**, **local**, **point to point**. Explain your response in one sentence.

2 – Let us consider a digital grayscale image (8-bit pixel coding: gray levels from 0 to 255). Build the content of a LUT so that:

a) it makes a **video inversion** of the gray levels only into the range [a, b] (with a = 88 and b = 148).

b) all the pixels of the input image with values into the range [a, b] are **set to the black level** whereas there is an **inverse video** effect for all other pixels (a = 88 and b = 148).

c) it makes it possible to linearize the display on a TV screen. The function which gives the luminance “L” from the gray levels “gl” is:

$$L/L_{MAX} = (gl/255)^2, \text{ with } L_{MAX} = 70.$$

3 – Let us consider an achromatic image of a scene. There are only three objects in this scene:

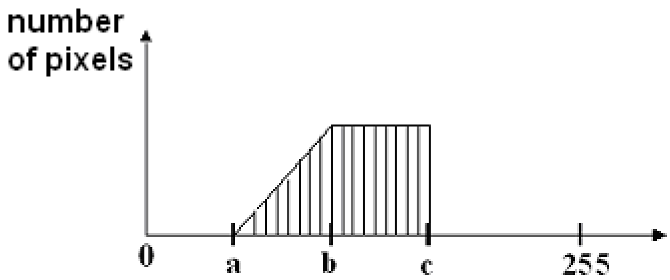
- the background: gray levels into the range [0, a] ;
- an object 1: gray levels into the range [a, b] ;
- an object 2: gray levels into the range [b, 255] ;

with: a = 64 and b = 192.
Build three LUTs which are respectively associated to the three primary colors: Red, Green, and Blue (LUT_R, LUT_G, LUT_B). We want:

- background pixels displayed in **yellow** ;
- object 1 pixels displayed in **Magenta** ;
- object 2 pixels displayed in **Cyan** ;

For each object the level of luminance does not change. Build the content for each of the three LUTs and plot it as a function graph (i.e. plot three functions: $LUT_X=f_X(gl)$)

4 – Here is the histogram of the grayscale digital image I_0:



with: a = 8 ; b = 16 ; c = 24.
We perform a maximal histogram stretching to enhance the contrast. What will be the **maximal stretching factor**?
Plot the new histogram obtained with this factor.