Chapter 3 – Linear filtering

TEST

Let us consider linear filters $\boldsymbol{H}$ which are defined by a 2D convolution kernel called $\boldsymbol{h}$. The kernel size will be 3×3 for this entire test. The h(0,0) element is located on the center of the kernel support. $\boldsymbol{I_0}$ stands for the input image and $\boldsymbol{I_S}$ stands for the output image. $\boldsymbol{I_0}$ is a grayscale image. Its luminance values belong to the range [0, 255].

1 – What is the 3×3 convolution kernel $\boldsymbol{h_1}$ of the ***Identity filter*** (such as $\boldsymbol{I_S} = \boldsymbol{I_0}$)?

2 – Let $\boldsymbol{H_2}$ be the filter whose convolution kernel $\boldsymbol{h_2}$ is:

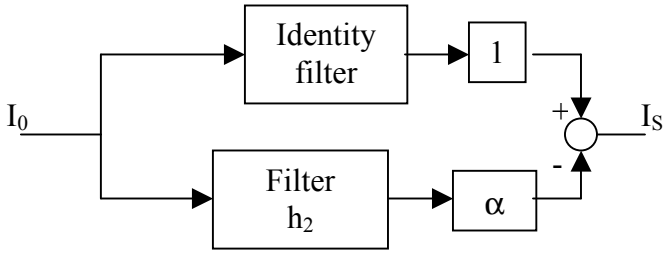
$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

2.1 – What is the DC gain of this filter (gain according to the spatial frequencies $\nu_X = 0$ and $\nu_Y = 0$)?

2.2 – If the image signal is constant and equal to A on an image area whose size is larger or equal to 3×3, what is the $\boldsymbol{I_S}$ computed value at the center of this area?

3 – By editing a Matlab program, perform the filtering of an (M × N) image $\boldsymbol{I_0}$ whose kernel is $\boldsymbol{h_2}$. The output image must be the same size as the input image $\boldsymbol{I_0}$. What do you notice on the object edges of the image "***Boats_lumi.bmp***"?

4 – We want to enhance the contrast of the image $\boldsymbol{I_0}$ objects. To do that, we want to create a third, functionally equivalent filter to find the difference between the Identity filter and a fraction (value: α) of the filter whose kernel is $\boldsymbol{h_2}$.



Write the Matlab program to create this third filter. Visualize the results with the following values of α: 0, 1/10, 1/4, 1/2. Describe the results obtained on the zones corresponding to the fishing boom and the fishing rope on the image "***Boats_lumi.bmp***".