**Laboratory 1:** Basic operations on images in Matlab

# **Exercise I**: Perform the convolution below by hand as preparation before the lab-exercise. Verify your result by comparing with the conv2 command.

|  |  |  |
| --- | --- | --- |
| 1 | 2 | 0 |
| 1 | [3] | 0 |
| 1 | 4 | 1 |

|  |  |  |
| --- | --- | --- |
| 1 | 2 | 0 |
| 0 | [2] | 0 |
| 0 | 1 | 3 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1** | **4** | **4** | **0** | **0** |
| **1** | **7** | **10** | **0** | **0** |
| **1** | **9** | **20** | **8** | **0** |
| **0** | **3** | **14** | **11** | **0** |
| **0** | **1** | **7** | **13** | **3** |

# 

# **\*** **=**

# **Exercise II**: Different perspectives of the Fourier transform F (u, v) of the image f (x, y) are shown in figure (2). The Fourier transform of a real valued image is Hermitian, i.e. F (u, v) = F ∗ (−u, −v), where ∗ denotes the complex conjugate. From this property, we can derive a set of symmetry relations. Examples of such symmetries are odd and even functions. Complete the answer below. Discuss with the teacher how the respective symmetries show up in figure (2).

# abs (IM): Even, since |F (u, v) | = |F (−u, −v) | angle (IM): Odd real (IM): Even, since according to the properties of the Fourier transform “A real signal has a Fourier transform with even real part […] (Hermitian)” imag (IM): Odd, since according to the properties of the Fourier transform “A real signal has a Fourier transform with […] odd imaginary part (Hermitian)”

# **EXERCISE III**: Formulate the translation theorem for 2D signals.

****According to the formula collection, the translation theorem for 2D signals is:

**EXERCISE IV:** What is the size of the filter kernel aver3?

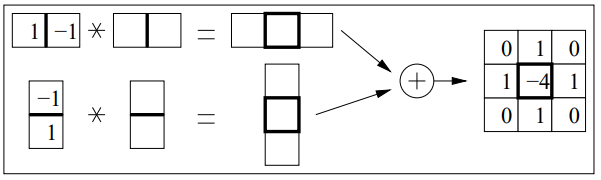
The size of the filter kernel aver3 is .

# **EXERCISE V**: What is the convolution theorem for 2D signals?

****According to the formula collection, the convolution theorem for 2D signals is:

# **EXERCISE VI**: Construct below.

# **EXERCISE VII**: Build a Laplace filter by filling in the fields below. The Laplace filter itself is given. Its origin is marked by a bold frame. For the derivative filters their origin is between the pixels.



1

-2

1

1

-2

1

-1

1

-1

1

**EXERCISE VIII**: Does the Laplace image (imlaplace) agree with the plot above? Motivate your response!  
The Laplace image (imlaplace) seems to agree with the plot above (written ) as it shows 4 spikes. The upper left should be corresponding to the black, the upper right to the white and the down ones to two different levels of gray. We can indeed see those colors is the Laplace picture.

**EXERCISE IX**: Look at the Laplace image (imlaplace) and compare it to the original image (im). What happens in smooth regions (e.g. cheek)?  
In the smooth regions, the sharpness is disappearing in the Laplace image like it was smoothened.

What happens at edges?  
However, we can see that the edges are in contrast emphasized compared to the original image.

What is the effect in highly dynamic regions (e.g. feathers)?  
The effect of this phenomenon in highly dynamic regions such as the feathers is to bring out every edge and emphasized them compare to the smoother regions. Hence, we have an accentuated contrast between sharp and smooth zones.

# **Question 1**: What is the min- and max-value of baboon?

1. The min value is 2 and the max value is 207.

# **Question 2**: Choose the symbol 'data cursor' (yellow with +-symbol) in the figure-window. Click in the middle between the monkey's eyes. Which coordinates (X, Y) and grayscale (index) do you get?

1. The coordinates and the grayscale index .

# Verify that you get the same value in the left and right image.

The values are approximately the same for both images.

**QUESTION 3**: Look at mycolormap0 (by removing the semicolon) and compare it with the normal gray scale color map presented in the first lecture. The principal is the same, but they do differ slightly, e.g. has mycolormap0 addresses between 1 and 256 instead of between 0 and 255. Mention one more difference!  
c) mycolormap0 has values between 0 and 1 instead of between 0 and 255.

**QUESTION 4**: Look at mycolormapR and give the command: colormap(mycolormapR)  
Explain how this colormap influences the image to the left.