

## Exercise set 1: Image Processing

**Bonus submission deadline: 23.03.2021 23:59**

The exercises marked with **BONUS** should be returned in Moodle by the submission deadline. Successfully solving it will give you bonus points to boost your final grade. During the exercise session, the solution of the exercises will be discussed.

### Exercise 1: Median filter (BONUS)

Implement in Matlab the function `median_filter(l, K)` which applies median filtering to the image  $I$  using a window of size  $K \times K$ . You can assume  $K$  is odd. You are allowed to use the matlab `median` function, but you are not allowed to use any Matlab built-in image processing functions, such as `medfilt2`, `filter2` etc. The output image should have the same size of the input image. For the border pixels, where the median window is partially outside the image, you should take the median of the pixels inside the image only. Your function should work both for grayscale and color images. You can test your function works with the script `task1.m`. Return your function implementation to moodle.

### Exercise 2: Pyramids

- Given the following image  $I$ , compute the Gaussian and Laplace pyramids. Use a  $2 \times 2$  averaging block for the approximation step and pixel replication for the interpolation step.

$$I = \begin{bmatrix} 7 & 30 & 12 & 1 \\ 13 & 18 & 6 & 1 \\ 9 & 9 & 25 & 6 \\ 29 & 5 & 19 & 14 \end{bmatrix}$$

- Reconstruct the original image from the laplace pyramid you computed in the previous part.

### Exercise 3: Filtering

- Prove that if a  $m \times n$  matrix  $\mathbf{H}$  has rank one, then it can be written as  $\mathbf{H} = \mathbf{u}\mathbf{v}^T$ , where  $\mathbf{u}$  and  $\mathbf{v}$  are  $m \times 1$  and  $n \times 1$  vectors.

2. In this part we will create a hybrid image combining two pictures: a person and a wolf. An easy way to do so is to apply a low-pass filter to the first image , a high-pass filter to the second image and combine the filtered images. Open the `hybridimage.m` and complete the missing parts. Why does filtering the images produce a better result than just combining the raw images?
3. The last cell of the script plots the magnitude of the FFT of the original and filtered images. Explain what you see.