

# Elaborazione di immagini

## Exercise Session 4

### Exercise 1: Wavelet transform

For each of the following images: `einstein.jpg`, `mandrill.tif`, `Flowers.003.tif`

1. Convert the images to grayscale and save them;
2. Perform the Discrete Wavelet transform with the parameters listed in the Table:

Number of levels	J=4
Filters	haar, biorthogonal 2.2, biorthogonal 2.4, Daubechies' 4 (db4)

3. Choose one wavelet and set  $J = 3$ . Perform the following operations on the subband coefficients:
  - (a) Successively set to zero the different subband coefficients (first subband by subband and then level by level);
  - (b) Keep the absolute value of the coefficients (change each negative sign to positive);
  - (c) Keep the signs of the coefficients while setting the absolute value of each coefficient equal to  $(\sqrt{2})^j$ , where  $j$  represents the level;
  - (d) Quantize the coefficients by rounding to the nearest integer;
  - (e) Quantize the coefficients of the different subbands according to the rule  $\Delta_k = 2^{-j}$ , where  $\Delta_k$  is the size of the quantization bin.

Then, for each case, perform the inverse transform to reconstruct the image. Save the corresponding image and comment the result.

4. In which case the image is most deteriorated?
5. Calculate the PSNR between the original the noisy image

$$PSNR = 20 \log_{10} \frac{255}{\sqrt{MSE}} \quad (1)$$

$$MSE = \frac{\sum_i \sum_j (im1[i, j] - im2[i, j])^2}{N_x N_y} \quad (2)$$

Comment the results.