# Multiresolution analysis

# Exercise Session 5

### Exercise 1: Wavelet transform

Build an image that corresponding to a polynomial 2D function (N=M=256). For the resulting image and for the image `mandrill.tif`

1. Perform the Discrete Wavelet transform with the parameters listed in the Table and visually compare the results.

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

2. Choose one wavelet killing the maximum degree polynomial appearing in your image. 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.

3. In which case the image is most deteriorated?

4. 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.

**Exercise 2: Subband statistics**

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

1. Plot the histogram of the image (using 64 bins);
2. Perform the DWT and the SWT with $J = 3$ and filter 'sym2';
3. Plot the histogram of each subband using the same number of bins;
4. Comment the results. Hint: note that the `imhist` function requires a normalized input (values between zero and 1).