Multimedia Telecommunications

Exercise Session 6

Exercise 1: Wavelet based denoising

For the image `einstein.jpg`

1. Corrupt the images with zero-mean Gaussian white noise; choose the noise parameters such that the noise is visible ($\sigma = 0.001$).

2. Calculate the PSNR between the original the noisy image

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

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

3. Perform the DWT and the Stationary Wavelet Transform (SWT) on the noisy image with the following parameters:

Number of levels	J=3, 4
Filters	biorthogonal 2.2, d4, sym8

4. Threshold the coefficients of each resulting subband. Set the threshold value to (1) $T = \sigma\sqrt{2 \ln N}$; (2) $T^0_{j,k} = \sigma_{j,k}$ and (3) $T^1_{j,k} = \sigma_{j,k}\sqrt{2 \ln N_{j,k}}$, where $j = 1, \ldots, 3$ is the decomposition level, k selects the orientation, σ is the standard deviation of the image, N is the number of pixels in the image, $\sigma^2_{j,k}$ is the variance of subband j, k and $N_{j,k}$ is the number of samples in subband j, k. For all conditions, apply both soft and hard thresholding to the sub band coefficients.

5. Reconstruct the image and calculate the PSNR;

6. Plot the results.