Lab 7: Wavelets

We are going to show some applications of wavelets. The most well-known is the image compression. Here we use that the Daubechies wavelets have compact support and several vanishing moments. Thus in the smooth regions, many coefficients are close to zero. We compare it with a Wilson basis (time frequency shifts of a square integrable function) that it is used in the standard jpeg compression (jpeg2000, used in digital cinema already uses wavelets).

```
pkg load ltfat
```

remove the small coefficients

```
% Use the cameraman image
f = cameraman;

% Ratio to keep
r=0.05;

%% Parameters for the Wilson systems
% Analysis window
ga='itersine';

% synthesis window
gs='itersine';

% No. of channels
M=8;


%% Parameters for the Wavelet system
% Analysis filters
wa='db6';

% Synthesis filters
ws='db6';

% No. of levels
J=5;

%% Show the original and
```

```
figure(1);
imagesc(f);
colormap(gray), axis('image');

%Compressed images

figure(2);

subplot(1,2,1);
c_fwt = fwt2(f,wa,J);
[cc_fwt,n]=largestr(c_fwt,r);
r_fwt =ifwt2(cc_fwt,ws,J);
imagesc(r_fwt);
colormap(gray), axis('image');

subplot(1,2,2);
c_wmdct = wmdct2(f,ga,M);
cc_wmdct = largestr(c_wmdct,r);
r_wmdct = iwmdct2(cc_wmdct,gs);
imagesc(r_wmdct);
colormap(gray), axis('image');
```

This produces the following images:

It is also possible use the same principle to eliminate noise from an image or sound. Typically the signal is concentrated In the next experiment, we will use the filter $H(z)$ to remove an undesirable white noise interference from a speech signal. To run the experiment, first read the file "easy.wav" that is provided with the instruction:

```
[x,FS] = audioread('easy.wav');
```

The vector x represents the audio signal and FS is an integer that denotes the frequency at which it has been sampled. You can play the sound with the instruction

```
player = audioplayer (0.8*x, FS);
play (player);
```

We add some white noise to the signal (we need to load the package statistics)

```
y = x + normrnd(0, 0.2, length(x),1);
```

We hear the noisy signal with

```
player = audioplayer (y, FS);
play (player);
```

FIGURE 1. Original

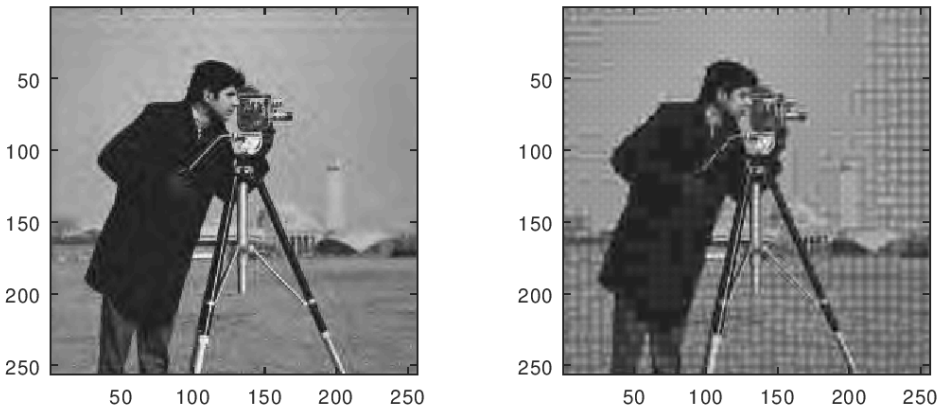

FIGURE 2. Compressed images: Wavelet and JPEG

EXERCISE 1. *Slightly attenuate the noise, computing the discrete wavelet transform and keeping only the most significant coefficients. You should experiment with different ratios close to one.*

Other possible uses are edge detection or discontinuity detection. This is possible due to the localization of the wavelets compared with the Fourier transform.n

Bibliography

[1] Stephane Mallat. A Wavelet Tour of Signal Processing: The Sparse Way. Third edition. Elsevier/Academic Press, Amsterdam, 2009