

## Homework nr 4

Handed out October 20, 2011  
To be handed in November 17, 2011

**Create the 2-dimensional versions of the functions periodize, LHfilter, and waveletree with application on an image:**

1. Create a matlab function periodize2():

$$[X_{per}] = \text{periodize}(X, N, M)$$

which periodize a matrix  $a$  into a periodic matrix  $a_{per}$  of size  $N \times M$  where  $N$  and  $M$  are positiv integers.

Hint. Avoid loop, but rahter use the matlab functions: zeros, reshape, sum and squeeze // and that indexing array( $a : b, c : d$ ) = ...

2. Create a matlab function LH2filter();

$$[LL, LH, HL, HH] = \text{LHfilter}(a, h, g)$$

where  $a$  is a matrix of data of even number of rows and colomns, and  $h$  and  $g$  are colomn vector of the lowpass resp. highpass one dimensional filters. The resulting lowpass matrices  $LL$   $LH,HL$   $HH$  should both be colomns and rows half the length of the colomns respective rows of the matrix  $a$ .

*Hint* Use the matlab fountions:

$$[Y] = \text{conv2}(fc, fr, X)$$

where the matrix  $X$  is convolved along the colomns with the vector  $fc$  and is convolved along the rows with the vector  $fr$

3. Create a matlab function wavelettree2:

$$[SS, DS, SD, DD] = \text{wavelet2tree}(X, g, h)$$

where  $SS$ ,  $SD$ ,  $DS$  and  $D$  are matlab cellstructures, where  $DS(k)$  containing the high -low pass wavelet coefficients on level  $k$ , and so on. ( $SS$  the low-low pass coefficients should only have one cell). You may include an extra parameter  $N$  telling how many levels down in the wavelet tree you should go:

$$[SS, DS, SD, DD] = \text{wavelet2tree}(X, g, h, N)$$

4. Make a function that do a reconstructions of the original two dimensional signal form its wavelet coefficients.
5. **Application on an image**  
The image Birds is given av a file in the <http://www.math.kth.se/~jostromb/SF2702/Birds>.  
The image is of size  $512 \times 512$ . Each pixel is represented by one byte given the grayscale from 0 (black) to 255 white.  
Do a decomposition of the image into wavelet coefficients and use thresholding to get a compression of the image. Show the reconstructed image obtained from 20% , 10%, 5% and 2% of its wavelets coefficients.
6. **Noise reduction of an image**  
The image file BirdsN obtained from <http://www.math.kth.se/~jostromb/SF2702/BirdsN> contains the image Birds with noise added to it. Try to reduce some nose from it by thresholding of its wavelet coefficients.
7. Compute SNR (signal to noise rate in db ) for the compression above and also for the image with noise compared with the original image without noise.