SF2702 Wavelets

Homework nr 4

Handed out November 16, 2009
To be handed in November 30, 2009

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 positive integers.
Hint. Avoid loops, but rather use the matlab functions: zeros, reshape, sum and squeeze // and that indexing array$(a : b, c : d) = \ldots$

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 columns, and h and g are column vector of the low-pass resp. high-pass one dimensional filters. The resulting low-pass matrices LL LH,HL HH should both be columns and rows half the length of the columns respective rows of the matrix a.
Hint Use the matlab functions:

$$[Y] = conv2(fc, fr, X)$$

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

3. Create a matlab function wavelet-tree2:

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

where SS, SD, $DS$and D are matlab cell structures, 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 from its wavelet coefficients.

5. **Application on an image**
   The image Birds is given of a file in the
   http://www.math.kth.se/~jostromb/SF2702/Birds.
   The image is of size 512×512. Each pixel is represented by one byte given the gray-scale 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.