ECE468/CS519: HOMEWORK 4
Due by 1pm, December 4, 2017

Submit your HW4 report by email to our GTA: toufight@oregonstate.edu
Note that we will not be able to consider late submissions!

In this homework, we will use two input images and compute their wavelet transforms. For each image show the results in a separate figure.

Problem 1 — 40pts

For each input image, compute *two* levels of the wavelet transform using two different basis functions. Specifically, compute the vertical $W^V(j,m,n)$, horizontal $W_j^H(j,m,n)$, and diagonal $W^D(j,m,n)$ components, as in the block diagram illustrated in Fig. 1. Show the figures of the wavelet decompositions that you have computed, when the scaling and wavelet filters are specified as:

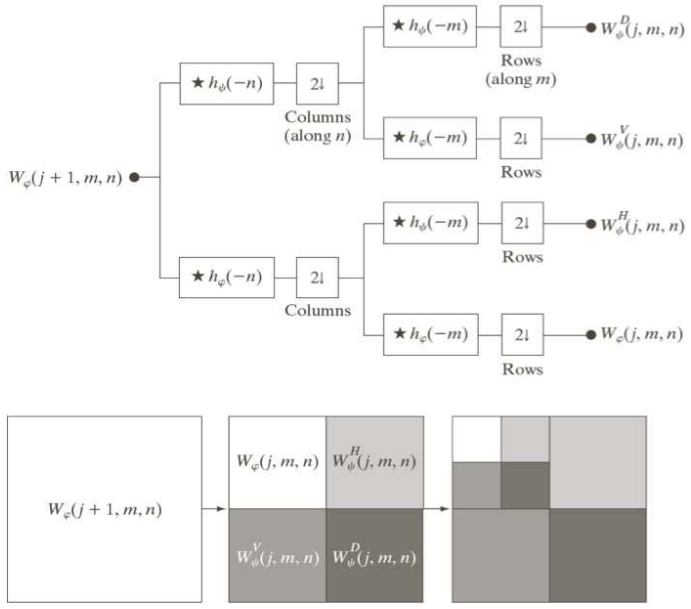

Fig. 1. One level of the wavelet decomposition of an image into vertical W^V, horizontal W^H, and diagonal W^D components.

1) Haar filters:

$$h_\varphi(n) = [\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}], \tag{1}$$

$$h_\psi(n) = [-\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}], \tag{2}$$

2) Daubechies filters:

$$h_\varphi(n) = [-0.0106, 0.0329, 0.0308, -0.1870, -0.0280, 0.6309, 0.7148, 0.2304], \tag{3}$$

$$h_\psi(n) = [-0.2304, 0.7148, -0.6309, -0.0280, 0.1870, 0.0308, -0.0329, -0.0106], \tag{4}$$

Hint:
While you may compute the wavelet decomposition using the standard convolution along rows and columns of the image, MATLAB makes this computation easier with the following commands:
'wfilters('haar')',
'wfilters('db4')',
'wavedec2(image,2,'haar')',
'wavedec2(image,2,'db4')',
For showing your results, you would need to transform the 1D output of 'wavedec2' to 2D image. This can be done using the command:
'reshape(array,m,n)'

Problem 2 — 40pts

For each input image, reconstruct the original image from its wavelet components of the lowest scale that you have computed for Problem 1, as in the block diagram illustrated in Fig. 2. Of course, you will get different results when using different wavelet basis functions. Show the two figures of the reconstructed image, when the scaling and wavelet filters are specified as in Problem 1 using:

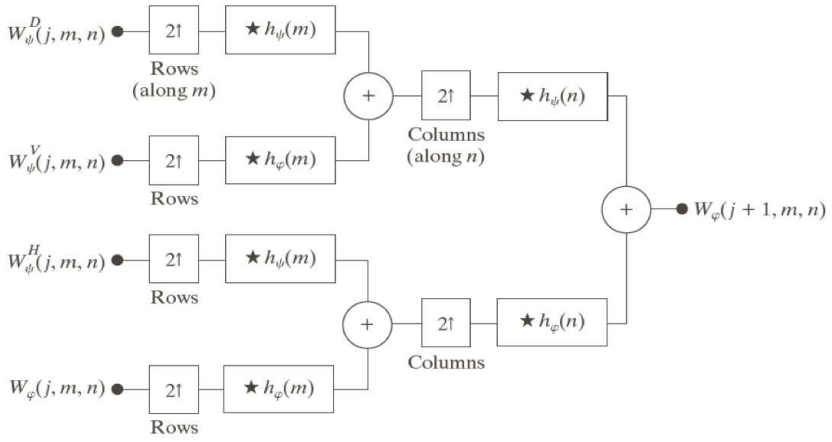

Fig. 2. Reconstruction of the image from its wavelet decompositions, using the vertical W^V, horizontal W^H, and diagonal W^D wavelet components.

1) Haar filters:

$$h_\varphi(n) = [\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}], \tag{5}$$

$$h_\psi(n) = [-\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}], \tag{6}$$

2) Daubechies filters:

$$h_{\varphi}(n) = [-0.0106, 0.0329, 0.0308, -0.1870, -0.0280, 0.6309, 0.7148, 0.2304], \quad (7)$$

$$h_{\psi}(n) = [-0.2304, 0.7148, -0.6309, -0.0280, 0.1870, 0.0308, -0.0329, -0.0106], \quad (8)$$

Problem 3 — 20pts

For each input image, subtract the original image from the two reconstructed versions in Problem 2, and show the corresponding residual errors in two figures. Which wavelet basis functions give smaller error?

IMPORTANT:
In your report, all figures must have captions. Each missing caption will be penalized with 5 points.