Dept. of Electrical and Computer Engineering, UCF

EEL5820 – Homework 6

Programming Assignment 4

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Image Compression: Fourier versus Haar Wavelets

Both Fourier and Haar wavelets can be used to represent images in a transform domain. The goal of this assignment is to determine which representation is better for image compression. For this assignment, we will assume that our coding method is able to perfectly discard a zero value in the transform domain and code the image with only non-zero values. So, we will use the ratio of zero values to the total number of pixels as the compression ratio.

You are given a set of matlab codes for performing forward and inverse Haar wavelet transforms and you can of course use the built-in matlab Fourier transform. The assignment also requires steps to sort and unsort data. So, for unsorting, I have provided a code. You are required to fill in the missing parts in two main codes for image compression (`compimHaar.m` and `compimFourier.m`) based on the above compression ratio assumption. Both codes take as inputs a gray-scale image loaded in the matlab environment as well as a user-defined compression ratio to return the compressed image and the signal-to-noise ratio (SNR) of the compressed image as outputs. The SNR for a compressed image I_c is defined in terms of the original uncompressed image I as:

$$SNR = 10\, log_{10}\left(\frac{\sum_i I^2}{\sum_i (I-I_c)^2}\right) \tag{1}$$

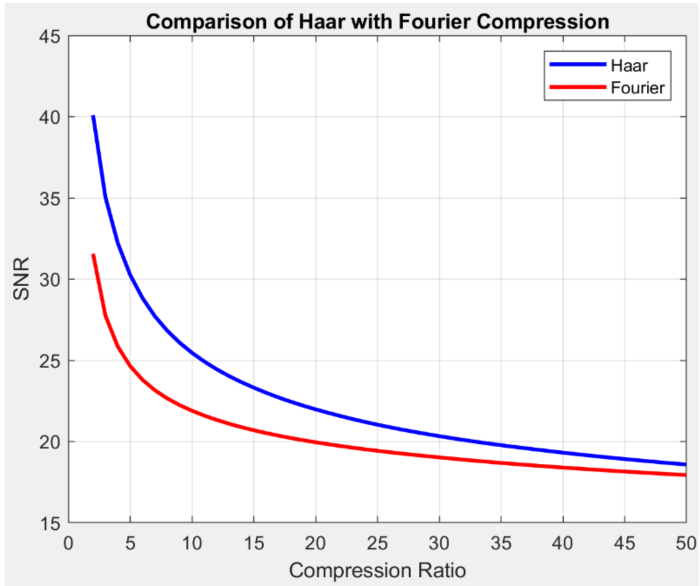
where the numerator is the sum of all squared pixel values of I, and the denominator is the sum of the squared differences of all pixel values in I and I_c. You can use a built-in matlab function for computing the SNR or write your own code.

The steps to complete the project are as follows:

1. Fill in the missing parts of the two functions `compimFourier.m` and `compimHaar.m`.

2. Write a matlab script to perform the following steps (see also the pseudo code provided below):
   a. Use matlab's `imread` function to load one of the images provided (lena.png, cameraman.png, and peppers.png).
   b. Cast the loaded image as double using matlab's `double` function.
   c. Use a `for` loop for the compression ratios in the range 2 to 50 and save the corresponding SNR values returned by `compimHaar.m` in one vector and the ones returned by `compimFourier.m` in another vector. These SNR vectors would obviously end up being of the same length as the vector `[2:50]`.
   d. Plot both SNR vectors on the same graph against the vector `[2:50]`. Label the axes and add a title (like the figure below). Note that to plot two graphs on the same figure you need to use matlab's `hold on` command.

Your plot should look something like this:



3. Repeat the above steps for the other two images provided and produce two other plots similar to above.
4. For each image, save the compressed image at compression ratio of 25 (25%), for both the Fourier and Haar method.
5. In a word document include the above images side-by-side along with the uncompressed (original) image for visually comparing the quality of the images compressed by the Fourier method versus the Haar wavelet method. Make sure you include a caption for each figure to indicate which image corresponds to which method.
6. Include the plots from Step 2.d. above in the same word document and answer the following question:
    a. Which method (Fourier or Haar) would you rather choose for compression? Why? (Be careful: SNR measures signal to noise ratio, NOT noise to signal ratio)
7. Submit your matlab codes and your word document in a single zipped file. Name the zip file as your lastname-hw5.zip

A pseudo-code of your matlab script for producing the plots may look something like this:

```
load the image in matlab as "im" using matlab's imread function.
cast "im" as double

for compression ratio "r" in the range [2:50] do
      Fourier SNR value = compimFourier(im,r);
      Save the SNR value as the next element in a vector for Fourier SNR's;
      Haar SNR value = compimHaar(im,r);
      Save the SNR value as the next element in a vector for Haar SNR's;
end for

plot Fourier SNR vector versus vector [2:50]
hold on;
plot Haar SNR vector versus vector [2:50]
label and title the plot
```