**CSE 166: Image Processing, Fall 2016 – Assignment 4**

Instructor: Ben Ochoa

Due: Wednesday, November 16, 2016, 11:59 PM

## Instructions

- Review the academic integrity and collaboration policies on the course website.
- This assignment must be completed in groups of two.
- This assignment contains both math and programming problems.
- Programming aspects of this assignment must be completed using MATLAB.
- You must prepare a report containing your solutions and results.
- Your report will be a pdf file named `CSE_166_hw4_lastname1_studentid1_lastname2_studentid2.pdf`, where `lastname{1,2}` and `studentid{1,2}` are the last names and student ID numbers, respectively, of the group members.
- All of your MATLAB source code must be included in an appendix of your report.
- One group member must submit your report on Gradescope and specify the other group member at the time of submission.
- Additionally, you must create a zip file named `CSE_166_hw4_lastname1_studentid1_lastname2_studentid2.zip`, where `lastname{1,2}` and `studentid{1,2}` are the last names and student ID numbers, respectively, of the group members. This zip file will contain the pdf file and a directory named `code` that contains all of your MATLAB source code.
- Submit your completed assignment by email to `vrg001@eng.ucsd.edu` **and** `dpradhan@eng.ucsd.edu`. The subject of the email message must be `CSE 166 Assignment 4`. Attach the zip file to the message.
- It is highly recommended that you begin working on this assignment early to ensure that you have sufficient time to correctly implement the algorithms and prepare a report.

## Problems

1. **Textbook problems (13 points)**
   (a) Problem 7.1 (1 point)
   (b) Problem 7.2 (4 point)
   (c) Problem 7.4 (2 points)
   (d) Problem 7.7 (1 point)
   (e) Problem 7.12 (2 points)

(f) Problem 7.22 (3 points)

2. **Programming: The wavelet transform and wavelet-based image processing (30 points)**

   (a) **The wavelet transform (10 points)**

   Develop a MATLAB script called `hw4_dwt.m` that reads the input image `cameraman.tif` (included with MATLAB), computes a 3-scale Haar discrete wavelet transform (DWT) of the input image, reconstructs the approximation coefficients for level 1 and writes the image to `cameraman_A1.png`, reconstructs the approximation coefficients for level 2 and writes the image to `cameraman_A2.png`, and creates a figure similar to Figure 7.25(d). Use the function `imread` to read the input image in MATLAB. Use `imwrite` to write the output image in MATLAB.

   Include in your report the input image, output images, and the figure similar to figure 7.25(d). Include a title with the figure.

   (b) **Wavelet-based edge detection (10 points)**

   Develop a MATLAB script called `hw4_edges.m` that reads the input image `cameraman.tif` (included with MATLAB) and computes a 1-, 2-, 3-, and 4-scale Haar DWT of the input image. For each resulting DWT, set the lowest scale approximation component to zero and compute the inverse Haar DWT.

   Include in your report the input image. Additionally, include figures of the inverse Haar DWT results (with colorbars to show the scale). Include a title with each figure. Comment on the resulting images, including any differences between them.

   (c) **Wavelet-based noise removal (10 points)**

   Develop a MATLAB script called `hw4_nr.m` that reads the input image `rice.tif` (included with MATLAB), computes a 2-scale-scale Haar DWT of the input image, sets the highest resolution detail coefficients to zero, computes the inverse Haar DWT, and writes the results to `rice_nr.png`.

   Include in your report the input image and output image. Comment on the results.