Homework Set 1 **EECS 651** **Due: Wed., Jan. 17, 2007**

Homework submission policy: Homework is due in class on the listed date. However, as an extended deadline, homework may also be turned in to my office by 9 AM the following morning. If the door is closed, just push it under the door. Do not put it in my mailbox. No homework will be accepted after 9 AM. If you slide it under my door, write the date and time at the top of the paper.

Write your solutions neatly and submit them in the order of the problems.

Note: When computing the course grade at the end of the semester, your lowest homework grade will be dropped.

In this homework you will use Matlab to perform JPEG encoding on an image. The goal is to give you some feeling for typical values of encoding rate, for the significance of various signal-to-noise ratios, and for the relationship between encoding rate and SNR. Three Matlab tutorials are available on the class website from the Homework Auxiliary files webpage.

From the Homework Auxiliary Files webpage, download the template Matlab script `jpegtest.m` and the image `cameraman.tif`. (There are other images you may also experiment with.) This script runs JPEG with one parameter, called the 'quality factor', which can be set to control the rate/quality tradeoff. The quality factor is an integer between 1 and 100, with larger values causing higher coding rate and lower MSE. The script allows you to enter three values of the quality factor into an array `Q`. It runs JPEG and displays the original image, the image after coding and decoding with each quality factor, and the rates, MSEs, SNRs, and PSNRs for each encoding. (SNR = 10 $\log_{10}$ (image power/MSE), PSNR = 10 $\log_{10}$ (255^2/MSE). You may run the script with various choices of the quality factor. Or you may modify the script in any way you like.

(1) Make a plot showing PSNR vs rate for uniform scalar quantization, nonuniform scalar quantization, and JPEG, all on the same plot. Include points in your plots just for rates R = 1, 2, 3, 4, 5. The PSNR's for the two types of scalar quantization can be found in the quantization examples posted on the website. The PSNR's for JPEG can be found by experimenting with `jpegtest.m` .

(2) For each type of coding, find the gain in dB when increasing rate from R=4 to R=5. (When we study quantization later, we will discover that many quantization systems gain 6 dB when rate increases by 1 bit.)

The answers to the next four problems have subjective answers. When answering them, display images as large as possible, but not so large that you see pixellation. Once you decide on a size, record the size in inches in your answer, and view all images at this size in all four problems..

(3) For each type of coding, find the smallest rate at which you cannot see evidence of quantization. Find the corresponding PSNRs. For scalar quantization you are restricted to integer rates, but not for JPEG.

(4) For each type of coding, find the smallest rate that you think would be acceptable, i.e. not too annoying, for posting on the internet. Find the corresponding PSNR. For scalar quantization you are restricted to integer rates, but not for JPEG.

(5) For each type of coding, find the smallest rate at which someone can clearly recognize what is in the image? Find the corresponding PSNR? For scalar quantization you are restricted to integer rates, but not for JPEG.

(6) Encode with JPEG at rate 0.25. Find the PSNR. Now encode to attain 0.5 dB larger PSNR. Can you see an improvement? Repeat at 1.0 dB and 2.0 dB larger PSNR's than the original PSNR at rate 0.25. From this problem you can gain some idea of the visual significance of a 0.5, 1 or 2 dB gain in PSNR.