Homework 1 Solutions **EECS 651** **Jan. 24, 200**

In this homework you will run the JPEG image compression algorithm on the image "lena" with various "quality factors" and compute encoding rates and signal-to-noise ratios. Instructions for doing so are given below. The goal is to give you some feeling for typical values of encoding rate and the significance of variou signal-to-noise ratios.

Table of quality factors, rates and SNR's (dB) for JPEG encoding of "lena". Your answers should be consistent with these values.

Q %	R bits/pixel	SNR dB
95	2.8	29.3
90	1.8	26.3
85	1.4	24.9
80	1.2	24.0
75	1.0	23.3
70	0.9	22.8
65	0.81	22.3
60	0.74	21.9
55	0.68	21.6
50	0.64	21.3
45	0.60	21.0
40	0.55	20.6
35	0.51	20.2
30	0.47	19.8
25	0.42	19.2
20	0.37	18.4
15	0.31	17.4
10	0.25	15.9
5	0.18	12.8

Below is a table of the answers given by member of a previous class to questions 1a and 2.

	Questions	
	1a	2
	indistinguishable	satisfactory
	1.81	.41
	1.39	.466
	1.16	.466
	1.15	.42
	.90	.46
	.86	.365
	.8	.4
	.706	.297
	.64	.62
	.64	.37
	.64	.24
	.6	.465
	.475	.355
	.47	.25
	.41	.28

(1) (a) *By trial and error encoding and decoding of the image, find (to within a couple of tenths) the smallest encoding rate (in bits/pixel) at which the compressed image is indistinguishable from the original. The answer is somewhat subjective. What quality factor did you select?*

People will get different answers depending on how discriminating they are and also depending on th the quality of their monitor. With a good monitor one should be able to see more of the flaws in the JPEG encoded image. Typical answers are Q = 60 to 80 with rates ranging from .74 to 1.2 bits/pixe

(b) *Compute the resulting signal-to-noise ratio (SNR) in dB. The signal-to-noise ratio, is the ratio o the empirical variance of the image to the average of the squared differences between pixels of the original and encoded versions of the image. Taking* $10 \log_{10}$ *of the ratio gives the SNR in dB.*

The SNR's for the quality factors mentioned in (a) range from 21.9 to 24 dB.

(2) *Estimate the smallest encoding rate that gives "satisfactory quality". This is even more subjective tha the part (a). State the quality factor and compute the resulting SNR (in dB).*

Typical quality factors are in 20 to 40 range yielding rates from .37 to .55 bits/pixel.

(3) *Encode the image using half the rate found in (2), state the quality factor, compute the resulting SNR and comment on the appearance of the decoded image in comparison to the decoded image in (2).*

This results in much worse quality unless your original rate was very high.

(4) *Encode the image at SNR 3 dB less than found in (2). State the quality factor, find the resulting rate*

(5) *Find the encoding rate achieved by the UNIX "compress" command applied to lena. This applies a version of the Lempel-Ziv lossless compression algorithm. (As a sanity check, you may want to decode the compressed file using "uncompress" and check that the original and decompressed files ar identical using the "diff" command.) Compare the rate to that found in (1).*

"compress" achieves rate 7.05, though I could image slightly different results on different operating systems

(6) *Find the encoding rate achieved by "compress" on the encoded versions of the image produced in (1) and (3). Did "compress" achieve significant additional compression?*

Most implementations will find that "compress" achieves no further compression. Some versions wi actually notice that it cannot compress the data and simply leave the original file unchanged.