Midterm Examination, 2001: CMPUT 414/CMPUT 510
Closed book, (only pen/pencil allowed; no electronic equipment)
60 mins., (Max. 50 marks/414; 60 marks/510)

1. (a) [5] Derive the variable length Huffman codes for coding the following set of 6 symbols:

   A,A,A,A,A,A,A,A,A,A,A,A,A,A,A,A,B,B,B,B,B,B,B,B,B,B,C,C,C,C,C,D,D,D,D,D,D,
   E,F,E,F,E,F,E,F,F,F,F,F,F,F,F,F

   (b) [2] What is the average code length using Huffman codes for the above?
   (c) [2] What is the expression for the Entropy of a set of symbols?
   (d) [2] Write an expression for the Entropy of the set of symbols in part (a)?
   (e) [2] What is the probability distribution of a set of symbols that maximizes Entropy?

2. (a) [2] What is Delta Modulation in the context of coding a 1-D sequence of numbers, such as, digitized audio?
   (b) [4] Code the following sequence of numbers using Delta Modulation with a step size of 3:

   11, 16, 15, 12, 15, 16, 9

   (c) [2] What are the decoded sequence of numbers for part (b)?
   (d) [2] What is the mean square error of the decoded data in part (d)?

3. Consider a hierarchical implementation of JPEG that uses averaging of neighborhoods for sub-sampling and replicates pixel values for up-sampling images. Assume that data is transmitted without any loss & a hierarchy is created by reducing resolution by a factor of 2 at each step until a 1 x 1 resolution image is obtained. With reference to the 8 x 8 image below answer the following questions:

   (a) [2] What are the images in the buffer for image coding?
   (b) [2] What are the first & second images transmitted?
   (c) [3] What is the last image transmitted?

100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100

4. This question relates to motion encoding.

(a) [1] How many block are present in a Macroblock in MPEG coding?

(b) [1] How many of the blocks in (a) are chrominance blocks?

(c) [2] What is the difference between P and B frames?

(d) [4] Consider the following sequence of frames at the encoder input:

1	2	3	4	5	6	7
B	B	B	I	B	B	P

What is the resulting sequence of frames at the encoder output (and at the decoder input)?

(e) [2] What are the two types of quantization matrices used by MPEG? How do the values in these matrices differ?

(f) [2] What is the difference between slices in MPEG and Group of Blocks in H.263?

(g) [4] Consider estimating motion for a 512 x 512 image. What is the RELATIVE COST of FULL SEARCH compared to:

Modified full search.
Logarithmic search, starting with every fourth pixel.

(h) [4] What is the major problem with logarithmic search? Propose a solution to this problem which keeps search complexity low.

5. (For graduate students registered in 510)

Assuming that $2N^2 \text{Log}_2 N$ computations are needed for FFT on an N x N image.

(a) [2] What is the cost of direct point wise correlation of an N x N image with an M x M mask?

(b) [4] What is the cost of computing correlation using the FFT and convolution/correlation theorem?

(c) [4] For what M is (b) preferable to (a)?

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   E,F,E,F,E,F,E,F,F,F,F,F,F,F,F,F

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0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
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0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
0	100	0	100	0	100	0	100
100	0	100	0	100	0	100	0
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