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:

- (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

	(a) [1] 1	IOW III	iny bloc	k are p	resent in	a Mac	roblock	in MPEG coding?						
	(b) [1] H	low ma	ny of th	ne blocl	cs in (a)	are chr	ominanc	ee blocks?						
	(c) [2] V	Vhat is	the diffe	erence	between	P and	B frames	s?						
	(d) [4] C	Conside	r the fol	lowing	sequenc	e of fr	ames at t	he encoder input:						
	1 B	2 B	3 B	4 I	5 B	6 B	7 P	•						
	What input	t is the	resulting	g seque	nce of fi	rames a	at the end	coder output (and at the decoder						
	(e) [2] W value	(e) [2] What are the two types of quantization matrices used by MPEG? How do the values in these matrices differ?												
	(f) [2] W H.263	(f) [2] What is the difference between slices in MPEG and Group of Blocks in H.263?												
	(g) [4] Cos	(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] W probl) [4] What is the major problem with logarithmic search? Propose a solution to this problem which keeps search complexity low.												
5.	(For grade	uate stu	idents re	gistere	d in 510)								
	Assuming	that 2	N ² Log ₂	N com	putation	s are n	eeded for	r FFT on an N x N image.						
	(a) [2] WI x M m	hat is th ask?	ne cost c	of direc	t point w	ise cor	relation	of an N x N image with an M						
	(b) [4] WI	nat is th	ie cost o	f comp	uting co	rrelatio	on using	the FFT and						

4. This question relates to motion encoding.

convolution/correlation theorem?

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

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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	motio	n encod	ing.								
	(a) [1	(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 B	2 B	3 B	4 I	5 B	6 B	7 P							
	W in	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] H.	What is 263?	the diffe	rence t	etween	slices i	n MPEG	and Grou	p of Bloc	ks in				
	(g) [4] C(Conside OST of F	r estimat JLL SE	ing mo	tion for	a 512 x	512 ima	ige. What	is the RE	LATIVE				

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)

Modified full search.

Assuming that 2N²Log 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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100	0	100	0	100	0	100	
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

	(b)	b) [1] How many of the blocks in (a) are chrominance blocks?													
	(c)	(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														
		1 B	2 B	3 B			5 B	6 B	7 P						
	What is the resulting sequence of frames at the encoder output (and at the decode input)?														der
	(e)	e) [2] What are the two types of quantization matrices used by MPEG? How do the values in these matrices differ?													
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5.	(Fo	r gradu	ate stud	lents ro	egist	tered i	n 510)								
	Ass	uming	that 2N	² Log	2 N (compu	ıtations	are nee	eded f	or FFT	on a	n N x	N ima	ge.	
	(a)	[2] Wh x M ma	at is the ask?	e cost o	of di	irect p	oint wi	se corre	elation	of an	NxN	V ima	ge witl	n an M	[
	(b)	[4] Wh convolu	at is the	cost o	of co	omput heore	ing cori m?	elation	using	g the FI	FT an	d			
	(c)	[4] For	what M	f is (b)	nre	ferabl	e to (a)	2							

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

4. This question relates to motion encoding.