

THE HONG KONG POLYTECHNIC UNIVERSITY
DEPARTMENT OF COMPUTING
EXAMINATION

Course : MSc Scheme - 61030

Subject : COMP5422 Multimedia Computing, Systems and Applications

Group : 201, 202, 203, 204, 2888

Session : 2008 / 2009 Semester II

Date : 04 May 2009

Time : 18:30-21:30

Time Allowed: 3 Hours

Subject Lecturer: Zhang Lei

This question paper has 10 pages.
(Pages 1-2 not to be provided)

Instructions to Candidates:

The question paper has 4 sections.

Section A: True/False (20 points);

Section B: Multiple choices (15 points);

Section C: Short Answers (25 points);

Section D: Long Answers (40 points);

There are totally 100 points.

Please write down your answers on the examination paper.

For Section B, each question has **at least 1** correct answer.

For Section C, you only need to give the final answer. No problem solving process is required.

Do not turn this page until you are told to do so!

Section C. Short Answers (25 points)

Question 16. Please explain why transform based coding works well in signal/image compression. (4 points)

Question 17. Discrete Cosine Transform (DCT) is used in JPEG compression standard. Please explain why DCT is effective in JPEG. (5 points)

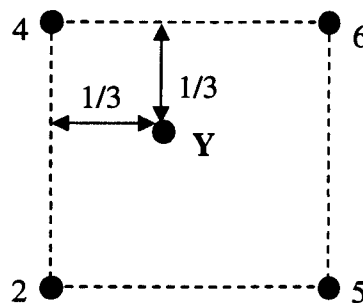
Question 18. The embedded zerotree wavelet (EZW) algorithm is widely used wavelet based coding. What are the two problems that EZW aims to address? (4 points)

Question 19. Please list three commonly used motion estimation techniques for video compression. (3 points)

Question 20. Interpolation. (4 points)

(a). By using bi-cubic interpolator, we can interpolate a signal $f(n) = [5, 8, 6, 3, 7]$ to $g(n) = [5, x_1, 8, x_2, 6, x_3, 3, x_4, 7]$ at the half-pixel positions. What are x_2 and x_3 ? (2 points)

(b) As shown in the figure below, the four pixels in an image are 4, 6, 2 and 5. By using bilinear interpolator, please interpolate the value of Y, which has $1/3$ pixel distance in both directions from pixel 4. (2 points)



Question 21. What is scalable coding in MPEG-2? Why scalable coding is especially useful for MPEG-2 video transmitted over networks? (5 points)

Section D. Long Answers (40 points)

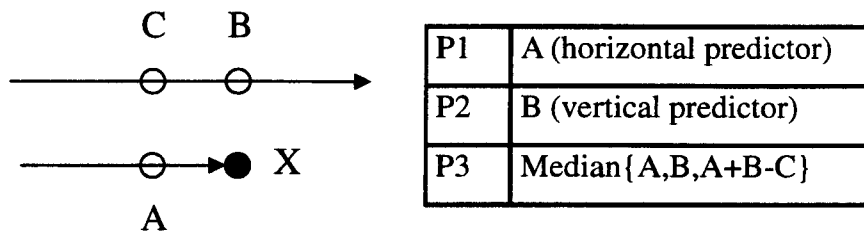
Question 22. JPEG-LS.

(10 points)

Suppose we have the following 4×4 image:

1	3	2	1
3	5	6	4
4	4	7	8
5	7	8	7

- (a) What is the entropy of this image? (2 points)
- (b) Three of the predictors used in JPEG-LS are listed in the following table.



We code the image as follows:

1. Code the first row using P1
2. Code the first column using P2
3. Code the other pixels using P3

Please calculate the prediction error image. (6 points)

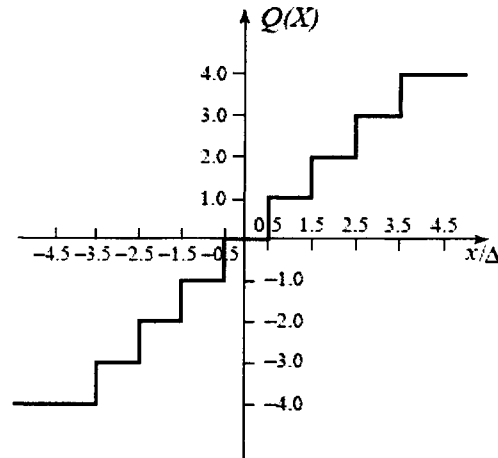
- (c) What is the entropy of prediction error image? (2 points)

Question 23. Quantization.**(10 points)**

Suppose the original signal is

$$x = [2.2, -3.8, 0.6, 3.3, -4.2, -1.7]$$

We quantize x based on the following quantizer:



- (a) What is the quantization output of x ? (5 points)
- (b) What is the mean square error of the quantized signal? (5 points)

Question 24. DCT.**(10 points)**

The signal $f = [100 \ 80 \ 10 \ -30 \ 40 \ -20 \ 90 \ 60]$. Please calculate its discrete cosine transform (DCT) coefficients $F(0)$ and $F(1)$.

Question 25. 1D Haar Wavelet Transform**(10 points)**

Suppose the original signal is

$$f = [f_1, f_2, f_3, f_4, f_5, f_6, f_7, f_8]$$

We decompose it into 2 levels by using the Haar wavelet and the wavelet decomposition coefficients are

$$d = [9.5, 16.5, 0.5, -3.5, -2, 1, -2, 1]$$

Please reconstruct the wavelet coefficients at the first level and the original signal f .

*** End ***