

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4115 Audio-Visual Engineering

Session : Semester B 2007/08

Time allowed : Two hours

This paper has **FOUR** pages (including this cover page).

Instructions to candidates :

- (1) Answer ALL questions.
 - (2) Show clearly all essential steps and state any assumptions made.
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Materials, aids & instruments permitted to be used during examination:

City University Approved Electronic Calculator

Special materials

Nil

Answer ALL questions

Question 1 (34 marks)

- (a) A monochrome video signal has the following specification:

Lines per frame - 625

Fields per second - 50

Bandwidth - 6MHz

Calculate the maximum horizontal resolution of the video signal. (10 marks)

- (b) A Comb filter with a Sum output and a Difference output is employed to separate the U and V components of a PAL video signal. Given that the delay line in the Comb filter has a delay time of $T = 64\mu s$, sketch the structure of the filter and determine its magnitude transfer functions.

(14 marks)

- (c) Describe with a diagram how the frequency response of the Comb filter can be used to separate the chrominance components of a PAL video signal.

(10 marks)

Question 2 (33 marks)

- (a) The resolution and frame rate of a color video signal are 720 (horizontal) x 576 (vertical) pixels and 25 fps, respectively. The signal is decomposed into the YUV domain and the chrominance components are sub-sampled with one of the following methods.

(i) 4:2:2

(ii) 4:2:0

Assuming that the Y , U and V samples are each quantized with 8 bits, compute the bit-rate (per second) required to represent the video signal in each of the above cases.

(10 marks)

- (b) An 8x8 macroblock is shown in Figure Q2 with the intensities of black and white pixels being 0 and 255, respectively. Determine the frame and the field based variances, and whether this macroblock should be classified as a frame or a field macroblock.

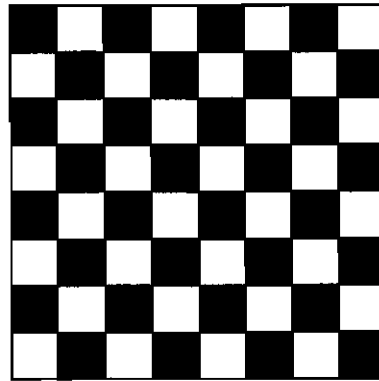


Figure Q2

(10 marks)

- (c) A video signal with resolution of 720 (horizontal) x 576 (vertical) is encoded with MPEG2 and reconstructed on three different types of receivers. Each of the latter can only decode MPEG2 encoded video bit-stream with maximum resolution as listed in Table Q2.

Table Q2

Receiver	Maximum horizontal resolution	Maximum vertical resolution
A	720	576
B	360	288
C	180	144

Describe with one or more diagrams how the MPEG2 encoder can be made compatible with the three types of decoders with the use of spatial scalability.

(13 marks)

Question 3 (33 marks)

- (a) A pair-wise pan pot system is designed based on the two loudspeaker configuration shown in Figure Q3. Given $\theta_1 = 330^\circ$ and $\theta_2 = 30^\circ$, and assuming that the gain of each channel decreases linearly with increasing angular displacement from the corresponding loudspeaker, determine the total gain and total power at $\theta = 10^\circ$.

(10 marks)

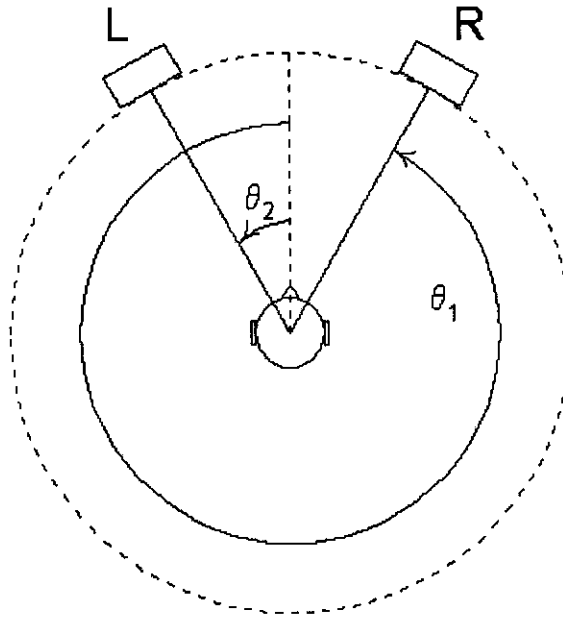


Figure Q3

- (b) In a quantization process a signal with a dynamic range $[0, X_{\max}]$ is uniformly quantized with 8 bits. Assuming that the quantization error is distributed uniformly over each step size q , determine the Signal to Noise ratio after quantization.

(10 Marks)

- (c) With the use of a block diagram, explain the concept of audio signal compression in the Adaptive Transform Coding (*ATRAC*) scheme.

(13 marks)

← END →