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THE NATIONAL UNIVERSITY OF IRELAND, CORK

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SUMMER EXAMINATION 2007

BSc in Computer Science

CS4405: Multimedia Compression and Delivery

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Answer all questions.

90 minutes

1. Consider a low-end screen or printer with a maximum resolution of 640x400 that is only capable to output black or white pixels (it has 1-bit color depth). For example, monochrome LCD screens on certain portable gadgets or printers in cash registers may fall in this category. The questions below deal with algorithms that display *gray-scale images* on a device with above specification.
 - a) Which algorithm would you use to display a gray-scale image with resolution 160x100 on such a device? Justify your answer. (9 marks)
 - b) Which algorithm would you use to display a gray-scale image with resolution 640x400 on such a device? Justify your answer. (9 marks)

2. The questions below deal with common file formats for still color images.

a) Recall that 16bpp means *16 bit per pixel*.

Explain the reason why most 8bpp file formats utilize a *color look-up table* while 24bpp and 32bpp file formats do not contain such tables. (8 marks)

b) Recall that the JPEG standard describes a *lossy compression algorithm*. Explain that step where information is actually lost during the compression. (9 marks)

c) Classical cathode ray tubes have a gamma value of approximately 2.2. What would images on these displays look like, if no gamma correction at all was applied? Justify your answer. (9 marks)

3. The questions below deal with various mathematical transformations which are applied in file compression algorithms.

a) Recall the following form of a one-dimensional *signal transformation*:

$$y(t) \approx a_0 \cdot f_0(t) + a_1 \cdot f_1(t) + a_2 \cdot f_2(t) + \dots$$

where $y(t)$ is the input data (such as sound), $f_0, f_1, f_2 \dots$ are a fixed set of functions and a_0, a_1, a_2, \dots are coefficients which are to be found such to achieve a best fit.

Explain the concept of *orthogonal functions* and how it simplifies the calculation of the coefficients. (9 marks)

b) There are many variants of RGB-YUV color space transformation. Consider a transformation with the following specification:

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.3 & t_{12} & 0.3 \\ -0.3 & t_{22} & 0.8 \\ 0.7 & t_{32} & -0.2 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

The three coefficients t_{12} , t_{22} and t_{32} are not given. Calculate these three coefficients using the following reasonable assumptions:

- Y should represent the *actual luminance* (gray level) of the sample.
- U and V should represent *true chrominance* levels, i.e. they should assume zero for gray samples.

(9 marks)

4. These questions deal with digital representations of sound.

a) The frequency spectrum of Human speech reaches up to 4Khz (4000Hz), i.e. speech does not contain frequencies higher than 4Khz. Consider a large digital archive of human speech. Give at least one reason why storage on CDs (compact disks) is not a memory efficient technique to organize such an archive.

Justify your answer.

(9 marks)

b) Huffman coding is a well-known lossless compression algorithm for *any type* of digital data. When applied to *sound* it is usually combined with some other algorithm to improve efficiency.

Explain the reason for this statement.

(9 marks)