CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year: 2009/2010

Examination Period: Autumn

Examination Paper Number: CM0340

Examination Paper Title: Multimedia

Duration: 2 hours

Do not turn this page over until instructed to do so by the Senior Invigilator.

Structure of Examination Paper:

There are 3 pages.
There are 4 questions in total.
There are no appendices.
The maximum mark for the examination paper is 80 and the mark obtainable for a question or part of a question is shown in brackets alongside the question.

Students to be provided with:

The following items of stationery are to be provided:
ONE answer book.

Instructions to Students:

Answer 3 questions.
The use of translation dictionaries between English or Welsh and a foreign language bearing an appropriate departmental stamp is permitted in this examination.

Q1. (a) What is the *distinction* between lossy and lossless data compression? [2]
Give *one example* of a lossy and lossless compression algorithm. [2]

(b) List *three pattern substitution* based compression algorithms. [3]
For each algorithm, give one application where it is used with respect to multimedia data. [3]

(c) What is the basic concept used in defining an *Information Theoretic* approach to data compression? [2]

(d) Why is the *Huffman coding* algorithm *better* at data compression that the *Shannon-Fano* Algorithm? [2]

(e) What *advantages* does the *arithmetic coding* algorithm offer over *Huffman coding* algorithm with respect to data compression? [3]
Are there any disadvantages with the *arithmetic coding* algorithm? [2]

(f) Given the following Differential Pulse Code Modulated (DPCM) Sequence *reconstruct* the *original signal*.

$$+4 + 2 + 3 - 2 + 3 - 1 + 1 + 1$$

[4]

(g) Given the following Run Length Encoded (RLE) Sequence *reconstruct* the *original 2D 8x8 (binary) data array*.

$(0, 8)$,
$(0, 1), (1, 1), (0, 4), (1, 1), (0, 1)$,
$(0, 1), (1, 2), (0, 2), (1, 2), (0, 1)$,
$(0, 1), (1, 6), (0, 1)$,
$(0, 2), (1, 4), (0, 2)$,
$(0, 3), (1, 2), (0, 3)$,
$(0, 2), (1, 1), (0, 2), (1, 1), (0, 2)$,
$(0, 1), (1, 1), (0, 4), (1, 1), (0, 1)$

[4]

Q2. (a) What is *MIDI*? [1]

(b) What features of MIDI make it *suitable* for use in the *MPEG-4 audio compression standard*? [2]

(c) Briefly outline the MPEG-4 *structured audio* standard. [6]

(d) What *features* of MIDI make it suitable for *controlling* software or hardware devices? [6]

(e) With relation to *controlling devices*, what *limitations* does MIDI have in terms of the level of control, the number of devices and the number of independent control items within a device? [6]
Suggest a solution that can employed to remedy *each* of these problems using *standard* MIDI devices. [6]

Q3. (a) Briefly, with the aid of suitable diagrams, outline the *JPEG/MPEG I-Frame compression pipeline* and list *the constituent compression algorithms* employed at each stage in the pipeline. [9]

What are the *key differences* between the JPEG and MPEG I-Frame compression pipeline? [4]

(b) *Motion JPEG (or M-JPEG)* is a video format that uses JPEG picture compression for *each frame* of the video. Why is M-JPEG *not widely used* as a video compression standard? [2]

Briefly state what *additional approaches* are used by MPEG video compression algorithms to improve on M-JPEG. [2]

(c) What processes, outlined in (a), give rise to the *lossy* nature of JPEG/MPEG video compression? [4]

(d) Given the following portion from a *block* (assumed to be 4x4 pixels to simplify the problem) from an image after the Discrete Cosine Transform stage of the compression pipeline has been applied:

128	32	64	160
32	16	12	32
128	64	46	128
4	31	40	32

i. What is the result of the *quantisation step* of the MPEG video compression method assuming that a constant quantisation value of 32 is used? [3]

ii. What is the result of the following *zig-zag step* being applied to the quantised block? [3]

Q4. (a) In MPEG audio compression, what is *frequency masking*? [2]

(b) Briefly describe the *cause* of frequency masking in the human auditory system? [3]

(c) In MPEG audio compression, what is *temporal masking*? [2]

(d) Briefly describe the *cause* of temporal masking in the human auditory system? [3]

(e) Briefly describe, using a suitable diagram if necessary, the *MPEG-1 audio compression algorithm*, outlining how frequency masking and temporal masking are encoded. [10]

(f) Given two stereo channels of audio:

Left Channel:	14	11	10	16	17	20
Right Channel:	11	14	16	5	44	20

i. Apply *Middle/Side (MS) stereo redundancy coding* to the sequence. [3]

ii. How may this result be employed to achieve *compression* of the audio signal? Illustrate your answer with respect to the above data. [4]