UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2002

BEng Honours Degree in Computing Part III
MSc in Computing Science
BEng Honours Degree in Information Systems Engineering Part III
MEng Honours Degree in Information Systems Engineering Part III
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the Associateship of the City and Guilds of London Institute

PAPER C346=I3.12

MULTIMEDIA SYSTEMS

Monday 22 April 2002, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

1 a i) Explain the meaning of the terms *lossless* and *lossy* compression.

ii) Define the terms *loudness*, *pitch* and *timbre* and briefly explain why sound is difficult to compress using lossless methods.

iii) Encode the following digital signal by using the basic DPCM method with 5 bit signal variations.

0, 2, 1, 5, 14, 0, 25, 30, 28, 26

iv) Briefly describe possible enhancements to DPCM that would reduce the variance of the encoded signal, and therefore increase the overall compression ratio.

b i) Distinguish between *voiced* and *fricative* sounds.

ii) You are asked to place a watermark in a digital audio stream for identification and security purposes. The stream is bandwidth limited so that only information between 20 *Hz* and 20 *kHz* is sent. The watermark must not affect the listener's perception of the audio in any way and must be sent every 8 *ms* so that it is present in any edited version of the stream. Propose a method of your own, detailing all the necessary steps involved in your algorithm for both encoding and decoding.

c What are the attributes that contribute to human brain's determination of the location of a sound? How would you encode a surround channel into 2-channel (left, right) audio?

The three parts carry, respectively, 40%, 40%, 20% of the marks

2 a i) Define the requirements of a Multiple Reduction Copying Machine (MRCM) in fractal image compression.

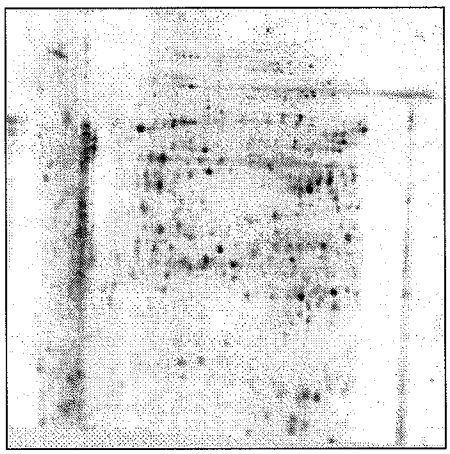
ii) A small ASCII file contains only the following characters with frequencies: P = 25, A = 3, B = 2, L = 8, O = 12. Construct a Huffman tree for the above text and list the corresponding Huffman codes. Calculate the average code word length and the compression ratio achieved.

b i) In block-matching for motion-compensation, state the principle of locality and explain in detail *one* example of sub-optimal search strategies.

ii) Given a video sequence with n by n blocks per image, calculate the complexity of an exhaustive search strategy and compare it with the order of your strategy from part b(i).

iii) Explain the key differences between block-matching and optical flow in deriving motion fields.

c A biochemical process called *2D Gel Electrophoresis* can separate tissue samples into their constituent proteins. The process outputs an image showing hundreds of smooth protein *spots* as illustrated by the following figure.



This is an analog process, *i.e.*, the gel image may be distorted such that spots from one image may not align exactly with spots from a repeated run of the same tissue sample. In addition, disease and drug treatments can inhibit or create specific proteins, so some spots may appear or disappear from the resultant images. You are asked to compile a large database for a particular tissue sample undergoing different combinations of drug treatments. Design a strategy that will use the minimal amount of storage space but will simplify the detection of spot changes. Explain all the necessary steps involved and provide detailed justification of your method.

The three parts carry, respectively, 25%, 35%, 40% of the marks

3a i) How do the requirements of real-time network applications, such as the delivery of audio and video, differ from those of traditional data communications?

ii) What factors affect network delivery of audio and video data? Explain why different categories of network audio/video applications are affected differently.

iii) Compare the resource requirements of both end nodes for streamed video over the Internet and BRI ISDN-based videotelephony. Include in your answer how the different nature of the two networks affects the potential quality of the transmissions in each case.

b Explain how Teletext is transmitted via

i) Analog television.

ii) Digital television.

Describe the functionality of each service.

c Your company provides design and programming services to allow customers to include interactive content on their websites.

i) What factors do you take into account when deciding on which technologies for providing interactive content to employ?

ii) A customer requires access to its content from the widest range of browser devices. Describe the approach you would adopt and what technologies you might use.

iii) Another customer requires a full multimedia experience for its visitors. Describe the approach you would adopt and what technologies you might use.

The three parts carry, respectively, 30%, 30%, 40% of the marks.

4a Briefly describe how a colour image is displayed using

i) A film projector

ii) A television or computer monitor

include in your answers whether each process is additive or subtractive.

b The local cable TV company is offering "video on demand" to its subscribers. A new company advertises in the area offering "video on demand" over a standard phone line, via a set top box. Explain any differences between the two services and why this is the case.

c i) Explain how the CIF format for video conferencing and video telephony via H.261 and H.263 is derived from ITU-R Recommendation 601 for digital video. Why does it use 4:2:0 rather than 4:1:1 chroma subsampling?

ii) Determine how many B channels of a Premium Rate Interface ISDN link would be required to send 15 CIF frames per second, assuming a compression rate of 20:1

iii) Would an extra B channel be needed to send synchronised audio (voice)? Justify your conclusions.

The three parts carry, respectively, 30%, 30%, 40% of the marks.