Multimedia IGDS MSc Exam 1999 SOLUTIONS

Setter: ADM
Checker: OFR

Answer 3 Questions out of 4

1. (a) *What is meant by the terms Multimedia and Hypermedia? Distinguish between these two concepts.*

Multimedia ---- An Application which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video.

Hypermedia --- An application which uses associative relationships among information contained within multiple media data for the purpose of facilitating access to, and manipulation of, the information encapsulated by the data.

2 MARKS ---- BOOKWORK

(b) What is meant by the terms static media and dynamic media? Give examples of each type of media.

Static Media – does not change over time, e.g. text, graphics

Dynamic Media --- Time dependent (Temporal), e.g. Video, sound, animation.

4 MARKS --- BOOKWORK

(c) What issues of functionality need to be provided in order to effectively use a wide variety of media in Multimedia applications. Your answer should briefly address how such functionality can facilitated in general Multimedia applications.

The following functionality should be provided:

- Digital Representation of Media --- Many formats for many media
- Capture: Digitisation of Media --- special Hardware/Software
- Creation and editing --- assemble media and alter it
- Storage Requirements --- significant for multimedia
- Compression --- related to above and below, ie can save on storage but can hinder retrieval
- Structuring and retrieval methods of media --- simple to advanced DataBase Storage
- Display or Playback methods --- effect of retrieval must view data

- Media Synchronisation --- display multimedia as it is intended

8 MARKS --- BOOKWORK

(d) Different types of media will require different types of supporting operations to provide the adequate levels of functionality. For the examples of static and dynamic media given in part 1(b) briefly discuss what operations are need to support a wide range of multimedia applications.

A selection of the items below is reuired for good marks NOT ALL. Other Solns Possible?

Typical Range of operations required for common media

Text: Editing
Formatting
Sorting
Indexing
Searching
Encrypting
ABOVE REQUIRE: :
Character Manipulation
String Manipulation

Audio: Audio Editing
Synchronisation
Conversion/Translation
Filtering/ Sound Enhancing Operators
Compression
Searching
Indexing
ABOVE REQUIRE: :
Sample Manipulation
Waveform Manipulation

Graphics: Graphic primitive Editing
Shading
Mapping
Lighting
Viewing
Rendering
Searching
Indexing
ABOVE REQUIRE: :
Primitive Manipulation
Structural/Group Manipulation

Image: Pixel operations
Geometric Operations
Filtering
Conversion
Indexing
Compression
Searching

Animation: Primitive/Group Editing
Structural Editing
Rendering
Synchronistaion
Searching
Indexing

Video: Pixel Operations
Frame Operations
Editing
Synchronisation
Conversion
Mixing
Indexing
Searching
Video Effects/Filtering

10 MARKS --- UNSEEN

2. (a) Why is file or data compression necessary for Multimedia activities?

Multimedia files are very large therefore for storage, file transfer etc. file sizes need to be reduced. Text and other files may also be encoded/compressed for email and other applications.

2 MARKS --- BOOKWORK

(b) Briefly explain how the Discrete Cosine Transform Operates and why is it so important in data compression in Multimedia applications

The discrete cosine transform (DCT) helps separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain.

With an input image, A, the coefficients for the output "image," B, are:

$$B(k_1, k_2) = \sum_{i=0}^{N_1 - 1} \sum_{j=0}^{N_2 - 1} 4 \cdot A(i,j) \cdot \cos\left[\frac{\pi \cdot k_1}{2 \cdot N_1} \cdot (2 \cdot i + 1)\right] \cdot \cos\left[\frac{\pi \cdot k_2}{2 \cdot N_2} \cdot (2 \cdot j + 1)\right]$$

The basic operation of the DCT is as follows:

- The input image is N2 pixels wide by N1 pixels high;
- A(i,j) is the intensity of the pixel in row i and column j;
- B(k1,k2) is the DCT coefficient in row k1 and column k2 of the DCT matrix.
- The DCT input is an 8 by 8 array of integers. This array contains each pixel's gray scale level;
- 8 bit pixels have levels from 0 to 255.
- he output array of DCT coefficients contains integers; these can range from -1024 to 1023.
- For most images, much of the signal energy lies at low frequencies; these appear in the upper left corner of the DCT.
- The lower right values represent higher frequencies, and are often small - small enough to be neglected with little visible distortion.

10 MARKS --- BOOKWORK

(c) A Simple Transform Encoding procedure maybe described by the following steps for a 2x2 block of monochrome pixels:

1. *Take top left pixel as the base value for the block, pixel A.*
2. *Calculate three other transformed values by taking the difference between these (respective) pixels and pixel A, i.e. B-A, C-A, D-A.*
3. *Store the base pixel and the differences as the values of the transform.*

Given the above transform

- *What is the inverse transform?*

Let transform be:

X0 = A
X1 = B – A
X2 = C – A
X3 = D- A

Then the inverse transform is:

An = X0
Bn = X1 + X0
Cn = X2 + X0
Dn = X3 + X0

- *How may such a transform scheme be used to compress data?*

  Any Redundancy in the data has been transformed to values, *Xi.*
  So We can compress the data by using fewer bits to represent the differences.
  I.e if we use 8 bits per pixel then the 2x2 block uses 32 bits/
  If we keep 8 bits for the base pixel, *X0,* and assign 4 bits for each difference then we only use 20 bits. Which is better than an average 5 bits/pixel

- *Show how you would encode with compression the following image block*

10	*20*	*20*	*25*
15	*25*	*15*	*20*
20	*25*	*10*	*20*
15	*20*	*15*	*25*

Basically there are 4 2x2 blocks here so apply transform to each in turn

So we get For top left 2x2
X0 = 10
X1 = 10
X2 = 15
X3 = 15

NOTE: Easy to compress these values to 4 bits/pixel woth NO LOSS. Not general though

For Top Right 2x2:
X0 = 20
X1 = 5
X2 = -5
X3 = 0

Note: Here need 1 bit for negative value so 4 bits may not seem so BIG NOW.

Bottom left 2x2 identical to top right
Bottom Right 2x2 identical to top left

- *Why is this scheme not very suitable general image compression?*

TOO SIMPLE:

Needs to operate on larger blocks (typically 8x8 min)

Calculation is also too simple and from above we see that simple encoding of differences for large values will result in loss of information --- v poor losses possible here 4 bits per pixel = values 0-15 unsigned, -7 – 7 signed so either quantise in multiples of 255/max vale or massive overflow!!

12 MARKS --- UNSEEN

3 (a) What are the major factors that need to be considered when considering what storage requirements are necessary for Multimedia Systems?

Major factors:

Large volume of date
Real time delivery
Data format
Storage Medium
Retrieval mechanisms

8 MARKS --- Unseen/applied bookwork

(b) What is RAID technology and what advantages does it offer as a medium for the storage and delivery of large data?

RAID --- Redundant Array of Inexpensive Disks

Offers:

Affordable alternative to mass storage
High throughput and reliability

RAID System:

Set of disk drives viewed by user as one or more logical drives
Data may be distributed across drives
Redundancy added in order to allow for disk failure

4 MARKS --- BOOKWORK

(c) Briefly explain the eight levels of RAID functionality .

Level 0 – Disk Striping --- distributing data across multiple drives
Level 1 – Disk Mirroring --- Fault tolerancing
Level 2 – Bit Interleaving and HEC Parity

Level 3 - Bit Interleaving with XOR Parity
Level 4 – Block Interleaving with XOR Parity
Level 5 - Block Interleaving with Parity Distribution
Level 6 – Fault Tolerant System --- Error recovery
Level 7 – Heterogeneuos System --- Fast access across whole system

8 MARKS --- BOOKWORK

(d) A digital video file is 40 Mb in size. The disk subsystem has four drives and the controller is designed to support read and write onto each drive, concurrently. The digital video stored using the disk striping concept. A block size of 8 Kb is used for each I/O operation.

(i) What is the performance improvement in sequentially reading the complete file when compared to a single drive subsystem?

We have 5120 segments to write to RAID disks. Given 4 disks we have 1280 actual I/Os to perform

On 1 drive we clearly have 5120 operations to perform.

(ii) What is the percentage performance improvement expressed as the number of physical I/O operations to be executed in on the RAID and single drive systems?

The improvement is
(5120 – 1280)/1280*100 = 300%. Obvious given 4 concurrent drives and RAID!!

8 MARKS --- UNSEEN

4 (a) Give a definition of Virtual Reality.

Virtual Reality provides a human interface such that computers and its devices create a sensory environment which is dynamically controlled by the actions of the individual, so that the environment appears real to the user.

2 MARKS --- BOOKWORK

(b) What specialised input and output devices have been developed for Virtual Reality? Describe each device briefly.

Head Mounted Displays
Glove input devices
Body Suits

Three dimensional auditory displays
Stereoscopic computer display
Touch feedback gloves/suits

8 MARKS --- BOOKWORK

(c) Virtual Reality is not only for entertainment. How can Virtual Reality help in professional environments? Write a brief essay discussing this topic. Your answer may include current applications in this or address future avenues for this application of the technology.

Open ended anwer could embrace any of the following plus many more

Advertising
Architecture/Science – exploration of buildings or other objects
Simulations
Cooperative Work environments
Meeting Room Telepresence

14 MARKS --- Unseen, discussion of points made in lectures/bookwork etc.