Data Provided: None

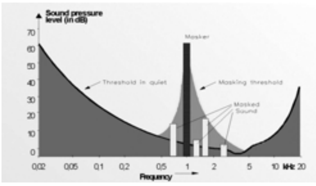
DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

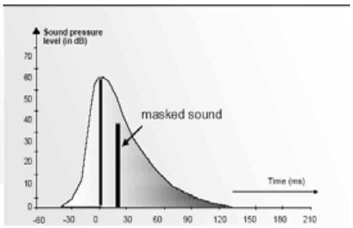
Autumn Semester 2007-2008

Multimedia Systems 1 (SOLUTIONS)

1. a. Temporal masking – For a strong signal, there is a short time afterwards while we cannot hear a quieter sound

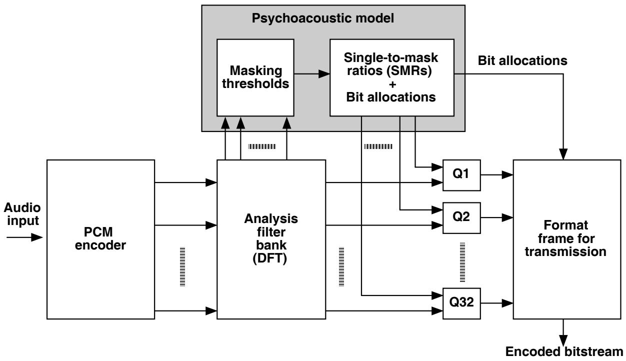
Frequency masking - When ear hears a signal at one frequency it may reduce the level of sensitivity of another signal at a similar frequency





(4)

b.



DFT – Decompose the data into frequency sub bands

Psychoacoustic model – Analyse the frequency sub-bands and frequency masking for bit allocation.

Q1- Q32 represent quantisation and Huffman coding for each of the frequency subbands

Finally format frame module represents creating a frame (inserting the frame header) to output the encoded bitstream. **(4)**

c. In R-G-B format, each colour plane contains the same amount of data and would have the same data rate and bits per sample. But in Y Cb Cr, we can exploit the human eye's tolerance to reduced resolution in chrominance layers. Therefore they can de down sampled and the data rates can be reduced.

Y Cb Cr format also useful in transition from back and white tv transmissions to colour tv transmissions. **(3)**

d. Artificial contours are visible in homogeneous regions when fewer bits are used. But not in high detailed regions, which are less affected. **(3)**

e. The bit rate required for the HDTV transmission.

W:H= 16:9   H=720;   Therefore, W= 720x16/9 = 1280

Y resolution: 1280 x 720

Cb and Cr resolution = 640 x 720

Frame rate = 50/2 =25

Bit rate= (Y resolution + 2xCb resolution) x colour depth x frame rate

= (1280x720 +2x640x720)x10 x 25

= 230400000 bits/second

to store a 1-hour HDTV programme:

File size = Bit rate x 60 x60 x 1

= 8.29×10^{11} bits

= 96.6 G Bytes. **(5)**

f. MPEG-2, MPEG-4, H.264 **(1)**

2.

a. The entropy:

	P_i	$-\log_2(P_i)$	$-P_i\log_2(P_i)$
	0.05	4.3219	0.2161
	0.25	2.0000	0.5000
	0.30	1.7370	0.5211
	0.25	2.0000	0.5000
	0.15	2.7370	0.4105
Sum	1		2.1477

Theoretical minimum data rate is 2.15 bits/symbol **(3)**

b. Huffman Code:

	P	Merge 1	Merge 2	Merge 3	Merge 4	Huffman Code
0	0.30			1 0.55	1 1.00	11
1	0.25			0		10
-1	0.25		1 0.45		0	01
2	0.15	1 0.2	0			001
-2	0.05	0				000

(6)

c. Average number of bits =

$$\sum_{i=1}^{5} n_i P_i = 2x(0.3+0.25+0.25)+3x(0.15+0.05)$$

= 2.2 bits/symbol

The efficiency of the derived Huffman code = 2.15/2.2 =97.7% **(3)**

d. By checking prefix condition. The short codes (11, 10 and 01) do not appear as the prefix of the longer codes (001 and 000) **(2)**

e. The Sampling rate is the Nyquist rate, which is 2x10kHz =20 kHz

The data rate is

data rate= bits/sample x sample/second

= 2.2 x 20 k

= 44 k bits /second.

Storage time = bits / data rate

= 64 x (1024 x 1024) x 8 / (44 x 1000)

= 12201.6 sec

= 203.4 minutes.

(4)

f. Advantage – low data rate, close to the theoretical minimum, high efficiency

Drawbacks – errors can propagate, need to know the probability of occurrence **(2)**

3. a. Bit-wise errors, lost packets, nodes and link failures, delayed messages, out-of-order delivery. **(3)**

b. 4 types of redundancies present in a digital image.

1. Spectral Redundancy: The correlation among different spectral bands. For example, the redundancy in RGB bands. Removed by colour transform
2. Inter-pixel Redundancy: This is due to spatial correlations with neighbouring pixels. - Removed by Transforms
3. Psychovisual Redundancy: The eye does not response with equal sensitivity to all visual information. Certain information has less relative importance than other information in normal visual processing. Such information is said to be psychovisually redundant. Removed by quantisation
4. Coding Redundancy: This is present in images when the probability of occurrence of symbols has not been taken into account when assigning binary codes. Removed by entropy coding. **(5)**

c. (i) coding efficiency - scenario 1 – low (due to no temporal redundancy removal), scenario 2 – higher than 1, scenario 3 – the highest (due to heavy compression of B frames)

(ii) computational complexity – Scenario 1 – low. Scenario 2 – high due to motion estimation, Scenario 3 – highest due to bi-directional predictions

(iii) propagation of errors - Scenario 1 – No propagation at all, Scenario 2 – High propagation of errors, Scenario 3 – only propagates within a GOP **(6)**

d. (i) 8 frames

(ii) 1 5 2 3 4 9 6 7 8

(iii) 2 **(3)**

e. Frame 7 is a B frame. That means bidirectional prediction. Therefore predicted using frames 5 and 9. The motion compensated prediction residuals are coded as in a still image coder. **(2)**

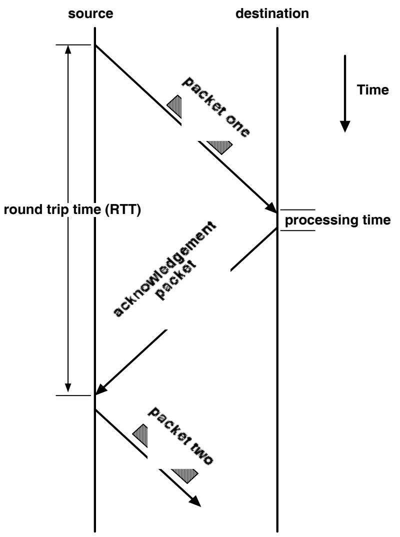
4. **a.** Circuit switching: carry data on dedicated channel (circuit)

e.g., original telephone network

Packet switching: take one hop at a time through switches (routers). Can use any available link. Needs to know the destination address

e.g., Internet **(4)**

b.



(4)

c. Any three of the following.

- Needs to make explicit connections - establishment and teardown phases
- Cope with very variable RTTs
- Packets can get reordered across internet –delivery in the order sent
- Cope with very old packets that are received
- Variable amount of data in the “pipe” - need to establish resources at destination
- Cope with network congestion - packets sent faster than can be received Supports arbitrarily large messages
- Allows synchronisation of sender and receiver
- Supports multiple application processes on same host
- Permits receiver to use flow control **(3)**

d.

- DestinationPort is a demultiplexing key to specify the destination application.
- SequenceNumber - refers to the outgoing data. It gives the sequence number of first byte of data in segment sequence and chosen randomly.
- AdvertisedWindow carry information about flow of data from receiving side (information on the remaining space at the receiver side) **(3)**

e. UDP-IP focuses only on best-effort delivery. UDP provides information of source and destination ports to determine the application programmes. On the other hand TCP-IP deals with reliable delivery.

UDP-IP is commonly used in live streaming of video and audio.. **(3)**

f. Calculate the delay due to **transmit time** for a 2 Kbyte packet sent across a 100 km microwave link with a channel capacity of 1 Mbps. Assume that the speed of light is 3×10^8 ms^{-1}. **(3)**

Transmit time = datasize/bandwidth

$$= \frac{2 \times 8}{1 \times 1024} = 15.6 \text{ milliseconds.}$$

GCKA / NMA