CSCI 516 Assignment

Theory Part

1) Let $l_0, l_1, l_2, \ldots l_{32}$ be the 32 levels of quantization.

Interval size $= I = l_1 - l_0 = -3.5 - (-3.75) = 0.25$

f_i is a real number in the sequence given between $[-4, 4]$ for i^{th} level

q_i is the quantized signal for i^{th} level

$$q_i = \text{Round}\left(\frac{f_i - f_{min}}{I}\right)$$

$$q_0 = \text{Round}\left(\frac{f_0 - f_{min}}{I}\right) = \text{Round}\left(\frac{1.8 + 3.75}{0.25}\right) = 22$$

$q_1 = 24$ $q_{12} = 20$ $q_{23} = 10$
$q_2 = 24$ $q_{13} = 20$ $q_{24} = 8$
$q_3 = 28$ $q_{14} = 22$ $q_{25} = 11$
$q_4 = 28$ $q_{15} = 24$ $q_{26} = 16$
$q_5 = 28$ $q_{16} = 24$ $q_{27} = 89$
$q_6 = 25$ $q_{17} = 24$ $q_{28} = 9$
$q_7 = 26$ $q_{18} = 23$ $q_{29} = 12$
$q_8 = 26$ $q_{19} = 24$ $q_{30} = 15$
$q_9 = 26$ $q_{20} = 19.8$ 20 $q_{31} = 19$
$q_{10} = 21$ $q_{21} = 16$
$q_{11} = 19$ $q_{22} = 10$

- The quantized sequence is 22, 24, 24, 28, 28, 28, 25, 26, 26, 26, 21, 19, 20, 20, 22, 24, 24, 24, 23, 24, 20, 16, 10, 10, 8, 11, 6, 9, 9, 12, 15, 19

- Since there are 32 levels and the highest level is 32,
  level 32 will be represented by 5 bits
  ($\because 2^5 = 32$)
  Bits required for 32 levels = $5 \times 32 = 160$ ⟸

Q2

No of lines per frame: 1080
No. of pixels per line = 1920
Frequency: 24 Hz

No. of pixels per second = 1080 x 1920 x 24
= 49766400

YUV ratio is 4:2:0
Bits Samples of Y = 4 X 12 = 48
Bits Samples of U = 1 X 12 = 12
Bits Samples of V = 1 X 12 = 12

∴ No. of bits per pixel = $\frac{72}{4}$ = 18

Incoming bit rate (Bi) = No. of pixels/sec X No. of bits/se
= 49766400 X 18
= 884994528 95795200

- Minimum compression ratio = $\frac{Bo}{Bi} = \frac{12\ MB}{884994528\ bits}$
$= \frac{12 \times 10^6 \times 8}{884994528\ 95795200}$
$= 0.107$

If we take Bo as 36 MB we get the minimum compression

Compression ratio: $\frac{B_o}{B_{in}}$

$= \frac{36\,MB}{89579520}$

$= \frac{36 \times 8 \times 10^6}{89579520}$

$= 0.321$

Thus minimum compression ratio is 0.107

When (If format is considered

$B_i = 352 \times 288 \times 24 \times 18$

$= 43794432$

→ $B_o = 12\,MB$

Compression ratio: $\frac{12 \times 10^6 \times 8}{43794432}$

$= 2.192$

Again B_o: 36MB will give minimum compression

Compression ratio $= \frac{36 \times 8 \times 10^6}{43794432}$

$= 6.576$

We get minimum compression ratio of 2.192 when $B_o = 12\,MB$

- Based on given formula of pixel aspect ratio

Original aspect ratio is 16:9

$N_p = 352$

$N_l = 288$

$$PAR = \frac{352 \times 288}{} \; (352/16)/(288 \times 9)$$

$$= \frac{352 \times 9}{16 \times 288}$$

$$= 0.6875 : 1$$

Since in the PAR numerator is less than the denominator, it means that the width became less and the width of the pixel shrinks

Q3 Speed of the car = 36 km/hr

$= \frac{36000\ m}{60 \times 60\ s}$

$= 10\ m/s$

- Car covers 10m in 1s and makes x rotations

One rotation = $2\pi d$ m

$\therefore$ x rotations/sec = $\frac{10}{2\pi \cdot d}$

$= \frac{10}{3.14 \times 0.424}$

$= \underline{7.5\ rps}$

- Camcorder rate = ~~24fps~~ 8 fps

Tire rate = 7.5 rps

~~Fire rate if recorded at 8 fps~~ =

Rotation of 1 frame in degrees = $\frac{7.5}{24} \times 360 = 112.5°$

Rotation of 8 frames in degrees = $112.5 \times 8 = 900 = 1080 - 180$

$1080° \equiv 3$ rotations

$\therefore 180° \equiv 0.5$ rotation in backward direction

Rotation/sec for 8 frames is 0.5 rotation/sec. in backward direction (Anticlockwise)

Speed = 180 km/hr

$= \frac{180 \times 1000}{60 \times 60} \frac{m}{s}$

= 50 m/s

Distance covered by tire: $2\pi r \times$ No. of rotation

Distand covered in 1s = 50

$\therefore \pi d \times 7.5 = 50$

$d = \frac{50}{3.14 \times 7.5}$

Sampling frequency $\geq 2 \times$ Nyquist frequency

$\therefore 24 \geq 2 \times NF$

$\therefore NF \leq 12$ fps

$\therefore$ rate of rotation ≤ 12

$\therefore \frac{\text{Distance}}{\pi d} \leq 12$

$\therefore \frac{50}{3.14 \times d} \leq 12$

$\therefore d \geq 1.326$ m to avoid temporal aliasing.