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## Multimedia Systems Assignment 1

Q.1

- Assuming the 30hz frame rate as field rate i.e. each frame consisting of odd/even lines.  
1080i resolution: 1920 x 540  
30hz: 1920 x 540 x 30  
5 min: 1920 x 540 x 30 x 5 x 60

The color subsampling scheme being used is 4:2:0 which means that effectively each pixel is 12 bits.

Therefore, total bits =  $1920 \times 540 \times 30 \times 5 \times 60 \times 12$

In MB,  $1920 \times 540 \times 30 \times 5 \times 60 \times 12 \times (1/8) \times (1/1024) \times (1/1024) = 13348.39 \text{ MB}$

- If we re-quantize each chrominance signal to 6 bits then effectively we will have 11 bits/pixel.

For example, if we consider 4 pixels in 2 x 2 grid, each pixel will have 8 bits for Y and one pixel will have 6 bits for U and 6 bits for V. Total bits =  $8 \times 4 + 6 + 6 = 44$  bits for 4 pixels i.e. 11 bits for 1 pixel

Total storage with re-quantization =  $1920 \times 540 \times 30 \times 5 \times 60 \times 11 \times (1/8) \times (1/1024) \times (1/1024) = 12236.02 \text{ MB}$

Compression ratio needed to store this video in a 256MB flash drive =  $12236.02/256 = 47.8$

Q.2

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4	33	34	33	32	33	32	8
31	5	33	32	32	31	7	34
31	35	5	31	30	9	33	33
30	34	32	28	8	27	32	33
31	33	32	7	3	29	30	31
32	33	7	31	32	3	32	32
32	9	31	31	29	31	5	32
6	34	32	32	31	33	33	6

- Down sampled values of the above region using specific sampling:

4	34	32	32
31	5	30	33
31	32	3	30
32	31	29	5

A better way would be to take an average of a specific size (2x2) grid for down sampling.

- Size of the quantized image:  
 $400 \times 400 \times 6 \times (1/8) \times (1/1024) = 117.2 \text{ KB}$

Q.3

- Speed of car = 36 km/h = 10 m/sec  
 Rotations per sec = distance travelled in 1 sec / circumference of tire  
 i.e.  $10 / (3.14 \times 0.4244) = 7.5 \text{ rotations/sec}$

The car is being recorded in 8 fps which is below the Nyquist rate and will cause temporal aliasing.

$$7.5 \text{ rotations/sec} = 7.5 \times 360 = 2700 \text{ degrees/sec}$$

Therefore, every frame will record a rotation of  $2700/8 = 337.5$  degrees

If we assume the white mark at 0 degree position then the 1<sup>st</sup> frame will record the wheel at 337.5 degree position. Hence, a difference of 337.5 degrees will exist between each frame.

The perceived rotation will therefore be  $360 - 337.5 = 22.5$  degrees per frame in opposite direction i.e.  $(22.5/360) \times 8 = 0.5 \text{ rotations/sec}$

- The highest speed of car should have 4 rotations of tires per sec to be perceived correctly when recording at 8 fps.

$$\text{That is, } 4 \times 3.14 \times 0.4244 = 5.33 \text{ m/s} = 19.19 \text{ km/h}$$