

# Image and Video Compression Assignment

URN - 6731873

## 1.1) Video formats and video coding basics (35 marks)

- (i) Calculate the uncompressed bit rates, in kbps, for one CIF and HD video sequence given. (4 marks).

Ans - CIF Video sequence –  $(322 \times 288) \times 1.5 \times 8 \times 30 = 3,33,84,960$  kbps bits/second

HD video sequence --  $(1920 \times 1080) \times 1.5 \times 8 \times 30 = 746496000$  kbps bits/ second

- (ii) Identify one key feature and state how it differs across H.264/AVC, HEVC and VVC. The feature needs to relate to the following coding concepts (10 marks)

	Feature	H.264/AVC	HEVC	VVC
Intra-prediction	Prediction modes	Vertical, Horizontal, DC, DIAGONAL DOWN LEFT, DIAGONAL DOWN RIGHT, HORIZONTAL DOWN, VERTICAL LEFT, HORIZONTAL UP	33 ANGULAR DIRECTIONS	65 Angular directions
Inter-prediction	Prediction blocks	7 prediction blocks	64 x 4	64 x 4
Coding Units	Coding units	macroblocks	CTU – can compute 64 x 64 pixels	128 x 128 pixels
Inter Prediction Units	blocks	7 prediction units	64 x 4	64 x 4

Transform	Transform	4 x 4 integer transform	4 x 4 , 8 x 8, 16x16, 32x32	Five transform units DCT-2, DST 7,8,9 .
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(iii) Encode/Decode 20 frames from the HD video sequence using H.264, HEVC and VVC at four Quantization Parameter (QP) Settings (i.e., 22, 27, 32, 37) – under following GOP structure: I-PPP-P-P-P... Tabulate bit rate, PSNR, Encoder time and Decoder time for each codec using the structure given below.

## H.264

QP	BIT RATE	Y- PSNR	Time - Encoder	Time - Decoder
22	<b>4592.80 kbits</b>	<b>44.097 db</b>	<b>103.262 s</b>	<b>0.5007</b>
27	<b>1983.48 kbits</b>	<b>42.424 db</b>	<b>93.960 s</b>	<b>0.390 s</b>
32	<b>1033.58 kbits</b>	<b>40.239 db</b>	<b>88.661 s</b>	<b>0.378s</b>
37	<b>608.40 kbits</b>	<b>37.872 db</b>	<b>86.045 s</b>	<b>0.347s</b>

	<b>Avg</b>	<b>2054.565 kbits</b>	<b>39.60175 db</b>	<b>92.982 s</b>	<b>0.403925 s</b>
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## VCC

QP	BIT RATE	Y- PSNR	Time - Encoder	Time - Decoder
22	<b>2141.3040 kbits</b>	<b>44.5361 db</b>	<b>2290.8970 s</b>	<b>1.5270 s</b>
27	<b>935.8200 kbits</b>	<b>42.8814 db</b>	<b>1401.680 s</b>	<b>1.2895 s</b>
32	<b>502.1520 kbits</b>	<b>40.8642 db</b>	<b>921.1408 s</b>	<b>1.1150 s</b>
37	<b>1290.7120 kbits</b>	<b>38.5815 db</b>	<b>606.070 s</b>	<b>1.110 s</b>
<b>AVG</b>	<b>1217.497</b>	<b>41.7158</b>	<b>1304.84695</b>	<b>1304.94695 S</b>

## HEVC

QP	BIT RATE	Y- PSNR	Time - Encoder	Time - Decoder
22	<b>2569.0080 kbits</b>	<b>44.0310</b>	<b>294.694 s</b>	<b>0.840 s</b>
27	<b>1139.7240 kbits</b>	<b>42.3339</b>	<b>247.020 s</b>	<b>0.715 s</b>

32	624.1200 kbits	40.2609	230.740 s	0.635 s
37	359.1720 kbits	37.8899	223.300 s	0.658 s
AVG	1173.006 kbits	41.128925 db	773.9385 s	0.712 s

- (iii) Based on the tables: a. Plot Y-PSNR Vs bit rate for each codec. Considering the plots and the average timings, compare the performance of the three codecs. (6 marks)

Answer –

HEVC provides better performance as compared to h.264. Also provides better compression like reduced file size and which reduces the required bandwidth and hence requires less memory storage. VVC performs better than the two h.264 and hevc some features like increase computational complexity, processing time, less bandwidth and less storage gives best results.

H.264 - The average time to encode is 92.982 seconds and to decode is 0.4039 seconds

Vvc – The average time to encode is 1304.946 seconds and to decode is 1304.946 seconds

HEVC- The average time to encode is 773.9385 and to decode is 0.712 seconds

- b. Compute the Bjontegaard Delta Bit Rate (BD-Rate) % for VVC and HEVC with respect to H.264. Use the provided “bjontegaard2.m” MATLAB function for the BD-Rate computation. (3 marks)

Answer – HEVC COMPARED WITH h.264 = 40.4721 and VVC compared with H.264 = 59.7535

- c. Compute the Encoder and decoder complexities (%) for VVC and HEVC with respect to H.264. (Eg:  $\text{EncTVVC} / \text{EncTH.264} * 100$  )(3 marks)

Answer – Encoder Complexities

QP	COMPARISION VVC AND H.264	COMPARISION HEVC AND H.264
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<b>22</b>	<b>2218.52859761</b>	<b>285.38475</b>
<b>27</b>	<b>1491.78373776</b>	<b>262.899106</b>
<b>32</b>	<b>1038.9470003722</b>	<b>260.2497153</b>
<b>37</b>	<b>704.363996</b>	<b>259.51537</b>

## Decoder Complexities

### DECODER

<b>QP</b>	<b>COMPARISION VVC AND H.264</b>	<b>COMPARISION HEVC AND H.264</b>
<b>22</b>	<b>304.973037 s</b>	<b>167.7651 s</b>
<b>27</b>	<b>330.6410 s</b>	<b>183.3334 s</b>
<b>32</b>	<b>294.9735 s</b>	<b>167.9894 s</b>
<b>37</b>	<b>319.88472 s</b>	<b>189.6253 s</b>

d. Discuss the implications of all three codecs in terms of the video quality and bit rates. (3 marks)

Answer – Hevc compresses information more efficiently than H.264.

H.264 – At QP -22 Bit rate and Ypsnr values are high, and the video quality is better at observation. At QP – 27, 32, 37 – Bit rate and Ypsnr values go on decreasing, hence the video quality goes poorer as compared to QP value 22.

ii) VVC – QP value 22 has a good quality video as compared to others. For QP 27 and 32 the bit rate and ypsnr value decrease and the video quality become poor as compared to QP 22. While for qp 37 a slight increase in bitrate has been seen but still the video quality is not that good.

iii) HEVC -QP value and y-psnr decrease and hence the video performance

e) For each codec, observe the visual quality of the decoded sequence at QP 32 and comment on your observations. (3 marks)

Answer – The shortest time to decode QP 32 IS H.264. The video quality was blurred with some lost pixels the video was still observable. The video quality of hevc is better than h.264 but still with some loss pixels loss with a blank black space. Vvc performed the best among the three with better video performance.

f) Discuss the implications of all three codecs in terms of the encoder, and decoder complexities.

Answer –

## 1.2 Video coding tools

(i) Encode 20 frames from the HD video sequence at four Quantization Parameter (QP) Settings (i.e., 22, 27, 32, 37) using VVC with the following changes following a. Set Multiple Transform (mts) flag off Calculate BD-Rate and Encoder complexities with respect to I-P-P-P-P-P configuration results of VVC obtained in 1.1 (iii) and compare the performances. (4 marks)

B-D rate complexity – 2.5371 .

Encoder complexity –

QP	Encoder complexity
22	95.8700
27	89.333
32	91.539
37	95.760